

Ability Enhancement Compulsory Course
(AECC)

Environmental Science

For All UG Courses
Semester III

Study Material : 2 (Lesson 10 - 16)



SCHOOL OF OPEN LEARNING
University of Delhi

Editors

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Environmental Science

(For All Undergraduate Courses)

Semester I/II

Study Material-2 (Unit: 5-7; Lesson: 10-16)

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LESSON-10

ENVIRONMENTAL POLLUTION

(Air, Noise and Nuclear Pollution)

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INTRODUCTION

E.P. Odum (1971) defined pollution as an alteration in the physico-chemical and biological nature of air, water and soil that ultimately affects the whole environment. It also specifies its hazardous impacts on living organisms (both flora and fauna), other environmental systems and non-living material.

Pollution is caused by anthropogenic (man-made) or natural activities. Examples of natural pollutions are volcanic eruptions, forest fires, floods caused etc. Incomplete technology lacking close integrated systems is the main cause of man-made pollution.

Today, the problem of pollution has become a major challenge to scientists, environmentalists and humanists as the pollution of various components has gone to such an extent that we are unable to breath fresh air, drink fresh water and eat pure food. If man has to survive, he has to fight and overcome this gigantic problem before it swallows him and his very existence.

LEARNING OBJECTIVES

After going through the Unit, you will be able to understand

- The sources, causes and impacts of Air, water, noise and soil and Nuclear pollution.
- How various kind of pollutants impact the ecosystem and human health.
- Various measures and steps that can be employed for reducing pollution.
- Government initiatives and programs as mitigating measures for Pollution across India.
- Definition, types, sources of solid waste, the impact of landfills and importance of an integrated Solid waste management plan.
- Critically assess the various issues discussed above with respect to relevant case studies.

1. Sources of Pollution

Pollution may be caused by several sources depending upon the nature of pollutants:

1. **Solid Wastes as a Source of Pollution:** Solid Wastes may be domestic or industrial in nature. Various solid wastes can be categorised as follows:
 - (i) Industrial wastes, e.g. particulate wastes from various industries such as glass fragments, leather pieces, rubber pieces etc.

- (ii) Domestic Wastes, e.g. garbage of kitchen, slaughter houses etc. These may be combustible (such as leaves, twigs, papers etc.) or non-combustible (such as crockery, plastics, glass etc.) in nature.
- (iii) Sewage, e.g. human and animal excreta, domestic effluents, detergents etc. (solid faecal is called sludge)
- (iv) Agricultural Wastes, e.g. plant and animal residues, broken twigs, wood fractions, fruits, pesticides, fertilizers etc.

2. Liquid Wastes as a Source of Pollution: Industrial effluents and domestic wastes in the form of liquid are the major sources of water and soil pollution. Industrial pollution may reach the lethal magnitude. Liquid discharges from chemical factories, refineries, breweries, tanneries etc. contain acids, alkalies, oil and dissolved heavy metals which enter the river water and adversely affect the aquatic life and impair its self-purification system.

Liquid wastes from domestic sources may be of inorganic or organic nature. Inorganic liquid wastes include soap water and detergent water from bathing and washing clothes whereas organic wastes include kitchen garbage, faecal water, urine etc.

Run off from agricultural fields carry residual fertilizers, pesticides, biocides etc. which enter the water streams and harm the aquatic life.

3. Gaseous Wastes as a Source of Pollution: The common gaseous pollutants like carbon monoxide, sulphur oxides, nitrogen oxides, hydrogen sulphide etc. are frequently released from various industries and automobile exhausts. Pollution resulting from gaseous wastes is the one of the most dangerous and lethal type. Life on earth is dependent upon the air we breathe and if this source of life is contaminated and polluted by lethal gaseous discharges, the very existence of all living organisms is threatened.

4. Energy Wastes as a Source of Pollution: A significant addition to the sources of pollution are the invisible pollutants i.e. pollutants without mass or weight and invisible to the eyes. Examples of such pollutants are heat and radioactive emissions. Radioactive emissions are most hazardous, and their cumulative effects are far reaching and damaging to the genetic makeup of living organisms.

5. Noise as a Source of Pollution: Unwanted sound or noise above the particular level in the atmosphere is an important pollutant. Indiscriminate and continuous use of radios, traffic horns, public broadcasting systems etc. are common sources of noise pollution. Aeroplanes and supersonic jets also produce noise of high intensity which may sometimes rupture the ear drum and cause irreparable damage to the brain.

2. Kinds of Pollution

Pollution has been classified in various ways based on different factors such as on the basis of:

1. Nature of Pollutants

Two categories are recognised on the basis of degradability of pollutants:

- (i) **Biodegradable:** These are those substances which can be decomposed naturally in the presence of microorganisms. For example, any organic waste, leaf litter etc.
- (ii) **Non-biodegradable:** These are those substances which cannot be decomposed or break down into simpler substances by any natural process. For example, plastic waste, metallurgical waste etc.

2. Components of Environment

Pollution has been classified on the basis of particular component of the environment being polluted, such as:

- Air Pollution
- Water Pollution
- Soil Pollution
- Radioactive Pollution
- Noise Pollution
- Thermal Pollution

3. Management of Environmental Pollution

At present what is required is not so much the ability of human beings to conquer the nature, rather there is a need of a balanced and harmonious collaboration with its forces. The ultimate goal of environmentalists should be to manage the environment in such a way that it can contribute to man's happiness, health and enjoyment and to improve the quality of human life.

The various activities of civilisation invariably interact with the environment predicting various forms of environmental problems. These problems may be local, national or international in nature and must be managed accordingly. Following are few suggestions to combat pollution:

1. Environmental education must be made compulsory in all education systems, from primary to university levels.
2. Awareness about general environmental issues should be circulated at large scale through media services.
3. Formulation of quality standards should be implemented and breaking of these standards should be a punishable offence.
4. Sustainable approach towards environment should be made through community participation.

5. Relocation of industrial units, airports etc at the countryside to reduce the risk of air pollution.
6. Private and public enterprises should adopt pollution mitigation plans through laws and policies.
7. Nuclear testing should be restricted to the minimum by international agreements.

The entire world is now involved in combating environmental problems in various ways. National and International efforts, Important Environment Dates, Indian Centres for Environmental Studies, Centres for Excellence, Important National Awards etc. are also the important pillars of environmental studies.

I. Air Pollution

It is defined as the pollution caused by anthropogenic and natural agents that degrades the quality of air and having impact on living and non-living systems. The essential component of our life, "air", resides in one of the spheres of the environment, called as "Atmosphere". The envelope of air surrounds the earth's surface is called as "atmosphere". It consists of both major and minor components which includes gases, particles, water vapour and biological particles. It makes up nearly 80% of man's daily intake by weight. Humans breathe almost 22,000 times per day, taking in almost 16kg of air. So, quality of air that we breathe is very important for our sustenance of life, otherwise it leads to loss of lives and produce disturbance in ecological systems. The atmosphere has two natural deterrents that have the capacity to remove the pollutants from an air parcel: high mixing height plus high wind speed which favours high dispersion and high precipitation in the form of rainfall. Rainfall acts as the best scavenging agent for removal of air pollutants.

1. Categorization of Air Pollutants

Agents or carriers which cause air pollution are known as air pollutants. Air Pollutants are divided on the basis of their origin, composition and kind of matter.

A. Origin:

- i. Primary air pollutants are those which have their own origin and have direct emission into the atmosphere. For example, oxides of nitrogen, oxides of sulphur, oxides of carbon, volatile organic compounds and particulate matter (dust particles).
- ii. Secondary air pollutants are those which are derived from primary air pollutants. For example, O₃, PAN etc.

B. Chemical Composition:

- i. Organic compounds: These are those which contain carbon and hydrogen units. For example, aldehyde (formaldehyde) and ketone (acetone).
- ii. Inorganic compounds: These are those which are having mixed formation of compounds and doesn't contain carbon and hydrogen units. For example, carbonates, nitrogen oxide etc.

C. Kind of Matter:

- i. Size-segregated particles in micrometre size ranging from 10 μ m to less than 1 μ m. For example, dust, aerosol, total suspended particulate.
- ii. Gaseous air pollutants. For example, oxides of nitrogen, oxides of sulphur, oxides of carbon and volatile organic compounds.

2. Types of Air Pollution

Indoor air pollution: This type of air pollution has mainly the anthropogenic source. Domestic activities like cooking fuel burning, coal burning, crop residue burning etc. Mostly household women are severely affected due to emissions of indoor air pollutants. Approximately 2.5 Billion people, mostly in developing nations are exposed to high levels of indoor air pollution and consequently suffer.

Outdoor air pollution: Vehicular and industrial emissions are major sources of outdoor air pollution. Overpopulation growth and industrialization are also the major indirect contributors. Outdoor air pollution affects over 1,100 million people, predominantly in cities.

3. Sources of Air Pollution

A. Natural Sources:

The natural sources can be thunderstorms, emissions of gases and particulates from forest fires, methane emissions from marshy lands, bioaerosols from pollen grains, volatile organic compounds emissions from trees and plant species, volcanic eruptions generates sulphur dioxides emissions and decomposition of organic matter emits carbon dioxide and methane.

B. Anthropogenic Sources:

Along with natural pollutants, there are pollutants of anthropogenic origin too. The main anthropogenic sources are gasoline exhaust emissions, industrial emissions, mining activities, cooking fuels, construction works, fireworks etc. The details of each emission source categories are as follows:

- i. Household works: Coal combustion generates enormous amount of smoke, soot, dust, CO, SO₂, NO_x. However, burning of LPG releases fewer amounts of pollutants comparatively.
- ii. Gasoline Exhaust: Different categories of vehicles like 2 wheelers, 4 wheelers, heavy duty vehicles, etc. release a number of gaseous air pollutants and particulate matter. They mainly includes NO_x, SO_x, VOCs, CO, O₃, PM₁₀, PM_{2.5} and sometimes lead. Vehicles contribute approximately 70% of air pollution as they are major source of primary and secondary air pollutants.
- iii. Industries:
 - a. Chemical Industries: They generate SO_x, NO_x, VOCs and PM.
 - b. Coal Powered Plants: SO₂, CO, NO_x and PM.
 - c. Electroplating and metallurgical Industries: CO, CO₂, NO_x, PM, cooper, lead etc.

- d. Gasoline-fuel industries: They include petroleum, diesel which emits VOCs, NO_x, SO_x, CO, PM, O₃ etc.
- e. Paper manufacturing industries: PM₁₀, PM_{2.5}, SO₂ etc.
- iv. Agricultural Practices: agriculturally based chemical fertilizers which includes pesticides and herbicides like chlorinated hydrocarbons, etc.

4. Classes of Main Air Pollutants

The air pollutants are divided into following categories:

- a. Aerosols and VOCs
- b. Other Hydrocarbons
- c. Particulate matter (inorganic and organic)
- d. Oxides of carbon
- e. Oxides of Sulphur
- f. Oxides of Nitrogen

Aerosols: Aerosols are very small particles suspended in the atmosphere and have crucial role in the formation of cloud condensation nuclei, radiative forcing etc. For example, pollen grains, haze, smog etc. The main source of aerosols in the atmosphere is from anthropogenic sources. Most of the percentage of aerosols Most of the aerosols are concentrated in Northern Hemisphere due to wind patterns and other favourable meteorological factors. Crop residue burning and construction activities are major sources of aerosols.

Natural aerosols also contribute in altering the composition of air quality. The natural sources include, sea salt spray, pollen grains, forest fires, dust storms etc. Aerosols have the tendency to block the solar radiation and this will result in radiative heating. High concentration of aerosols also affects the crop species and mainly biochemical and physiological processes and mechanisms. They are also responsible for the photochemical smog formation.

Volatile Organic Compounds (VOCs): VOCs refer to those organic compounds which are having vapour pressure 0.1mm Hg and vaporise at or less than 25°C. There are different classes of VOCs as non-methane hydrocarbons, aldehydes, ketones, aromatic compounds, amides, carbonyls etc. They are the only air pollutants whose maximum source contribution is from natural sources (80%) and rest is from anthropogenic (20%). Natural sources are trees, plant species and animal breath. Trees have major contribution of VOCs emissions from leaves, stems, flowers etc. as compared to any other source. Anthropogenic sources include vehicular emissions from gasoline exhaust, industrial emissions like paints, mosquito repellents, adhesives, varnishes, cleansers and disinfectants and mining activities.

POPs: POPs are organic compounds that adversely affect the lives of human beings all over the world. POPs including some pesticides, heavy metals evaporate from the soil in the equatorial and tropical countries; travel in the air towards comparatively cooler

regions, where they condense with the falling of temperature. The processes repeat in 'hops' and are thus carried across thousands of kilometres away within few days. The more the volatility, the far they are carried and retained in the air. Such a mechanism of long range atmospheric transport and subsequent deposition of POPs is called 'grasshopper or global distillation process'. The process goes on and on with highest concentrations in the circumpolar nations. In view of this, the Arctic Council was constituted by Denmark, Sweden, Iceland, Norway, Russia, Alaska, Greenland, Finland etc. to monitor and assess the source and pathway of POPs.

The POPs remains in the environment for a long period and can easily transfer from one stage to another in an ecological chain. In 1992, under United Nations (UN)/ECE (European Commission of Europe) the Convention of Long-Range Transboundary Air Pollution (LRTAP) was constituted to identify the chemicals of potential concern.

Particulate Matters: Particulate matter (PM) or dust particles are those which remain suspended in the atmosphere and have deleterious impact on human health. Particulate matter is divided on the basis of their particle size. The finer the particle, the more dangerous it is for human health. Particles with aerodynamic diameter less than 10 μm are known as PM_{10} . Particles with aerodynamic diameter less than equal to 2.5 μm are known as $\text{PM}_{2.5}$. PM_{10} particles are also called as coarse particles, as they are bigger in size so they trap inside the nose and doesn't penetrate inside. Whereas $\text{PM}_{2.5}$ are also called as fine particles and our nose doesn't have efficient filters to trap them, therefore, they penetrate inside the lungs and accumulate in the trachea. The particles having size less than 2.5 μm are also called as nanoparticles and deep penetrate inside the lungs and settle inside the alveoli. They are the most dangerous particles for human health. Vehicular emissions, industrial emissions, construction activities, domestic activities, mining and religious activities are the main sources of particulate matter in the atmosphere.

The symptoms of particulate matter emissions on human health are nausea, dizziness, respiratory illness, asthma, inflammation of lung tissue, chest pain and in most severe case, lung cancer.

CFCs: Chlorofluorocarbons (CFCs) are those organic compounds which contain groups of halogen family and produced as an important product of methane and ethane called as freons. The main sources of CFCs are refrigerators, propellants etc. The examples of CFCs are hydrochlorofluorocarbons (HCFCs), dichlorodifluoromethane (R-12 or Freon-12) etc. CFCs.

Table 1: Summary of air pollutants, sources and impacts

S.No.	Pollutant	Source/Cause	Effect
1.	Carbon monoxide (CO)	Vehicular emissions, wood burning, coal burning, incomplete combustion etc.	Nausea, dizziness, severe headache, cardiac arrests, brain stroke, low blood pressure and CO poisoning. After inhalation due to incomplete combustion, CO inhales deep into the lungs and combine with haemoglobin as it has high affinity than oxygen. The resultant is carboxyhaemoglobin. When a large number of carboxyhaemoglobin molecules increases in the human body then it decreases the oxygen level. Due to high decrease in O ₂ levels, the condition becomes fatal and leads to death.
2.	Carbon dioxide (CO ₂), declared as pollutants only at elevated levels.	Biomass burning	Global warming, greenhouse effect and climate change.
3.	Sulphur dioxide (SO ₂)	Industrial processes, fossil fuel combustion, wild fire, thermal power plants, smelters and volcanic eruptions	Respiratory ailments, dizziness, bronchitis, reduced plant production, yellowing, necrosis and corrosion to marble, spoiling of leather, corrosion.
4.	Polynuclear Aromatic Hydrocarbons (PAHs)	Gasoline exhaust emissions, emissions from garbage sites, coal tar lining.	Nausea, dizziness, lung cancer, respiratory disorders, eye irritation etc.

5.	Chlorofluorocarbons (CFCs)	Refrigerators, ACs, cleaning solvents, disinfectants.	Ozone layer depletion, formation of ozone hole.
6.	Nitrogen Oxides	Biomass burning, forest fires, gasoline exhaust emissions, mining etc.	Nausea, dizziness, cardiovascular disorders, photochemical smog, acid rain etc.
8.	Peroxy Acetyl Nitrate (PAN)	Vehicular emissions, Chemical industrial emissions, domestic activities etc.	Irritation of eye, throat and trachea, damages clothing, paints and rubber etc.
9.	Particulate matter	Vehicular emissions, construction based activities, industrial emissions, wood burning etc.	Respiratory disorders, bronchitis, emphysema, asthma; some are carcinogenic.

5. Air Pollution Control

A. Source Emissions - Industries

- Low-sulphur fuels should be encouraged to use to reduce the emission of sulphur dioxide and reduction in benzene in gasoline fuels (petrol) from 10% to 1% is implemented as per central pollution control board norms.
- Exhaust hoods are the latest modifications in industrial ovens which have good efficiency to recover the solvents that have the possibility to become air pollutants.
- Cost effective instruments are implemented to reduce the air pollutant concentrations.
- Removal of pollutants at source reduction like wet scrubber, cyclone separator, electrostatic precipitator etc.

B. Source Emissions - Vehicles

- Eradication of Old Vintage Vehicles. The vehicles, particularly cars, which are older than 15 years, should be discarded due to their low efficiency and malfunctioning of engines. These vehicles are also one of the main reasons for emissions of air pollutants in the atmosphere.
- Catalytic converters are efficient devices fitted in engines of different set of vehicles and plays an important role in converting noxious gases in to less harmful gases through chemical reaction.
- Improvement in quality of vehicular fuel which will reduce the tail-pipe emissions and further betters the air quality. For e.g. sulphur content was reduced from 0.5 to 0.2 percent in diesel to reduce the emission of SO₂ from tail-pipe. Methyl tert-

butyl ether (MTBE) should be added as a gasoline additive for increasing the octane number and reducing knocking of engine

- Unleaded petrol is recommended to use especially in Delhi to reduce the lead emissions from gasoline fuels.
- Alternative fuels should be used in place of gasoline fuels like CNG, LPG, biodiesel, vegetable oils, ethanol etc to curb the emission of air pollutants..
- To promote the use of electric vehicles

C. Legal and Policy Measures

For the control of air pollution, two main acts are implemented, The Air Pollution prevention and Control Act, 1981 and Environmental Protection Act, 1986.

Implementation of Air Quality Standards (NAAQS)

- The National Ambient Air Quality Standards (NAAQS) were first suggested under Air Pollution Prevention and Control Act, 1981 for prescribing the standards of different hazardous air pollutants. In 1984, a statutory body called Central Pollution Control Board (CPCB), India adopted 12 parameters which are need to prescribed for air quality standards. The 12 parameters are, particulate matter (PM10 and PM2.5), sulphur dioxide (SO₂), nitrogen dioxide (NO₂), carbon monoxide (CO), ammonia (NH₃), ozone (O₃), lead (Pb), benzene (C₆H₆), benzopyrene, arsenic and nickel. CPCB had initiated this programme and later called as National Air Monitoring Programme (NAMP).

National Air Quality Monitoring Programme

There are about 610 monitoring stations in 227 cities in India as on 1 January 2019. The air quality monitoring was undertaken under the supervision of CPCB, SPCB, DPCC, National Environmental Engineering Research Institute (NEERI), Nagpur and pollution control committees. Meteorological (weather related) parameters is also carried out along with air quality data.

D. Greenbelt Development/Landscape Green Planning

- To plant tolerant species which are good absorbers of different air pollutants. These types of plant species are called as sinks and help in purifying the air.
- These tolerant plant species will be screened by a biological method called as Air Pollution Tolerance Index (APTI) and planted around the periphery of the affected area.

E. Emission Norms and Emission Standards

Emission norms are the threshold or permissible limit set by nodal agency for a particular category of vehicle. These limits are for those air pollutants which are emitted usually from tail-pipe of vehicles like CO, NO_x, VOCs, PM etc. If any vehicle has emission of these air pollutants above the set permissible limit, it is considered as unfit vehicle. The Automobile Research Institute, Pune is the certifying authority for the vehicles fulfilling the standards.

Euro norms are applied in Europe and also for setting up of permissible limits for different categories of vehicles. In India, Euro I norms are referred to as INDIA 2000 because they have been effective since 4 January 2000. The regulations corresponding to Euro II, known as 2005 norms, have not yet been indicated by the Government of India.

F. Air Pollution Control Equipments

i. Control for Particulate Matter

1. Wet Scrubbers are used to take away the pollutants from furnace flue gas. They consequently pass through scrubbing liquid and hence, particulate matter is removed.
2. Electrostatic Precipitator (ESP) is also a fine device for removal of PM which is based on the principle of opposite charges attract each other. The dust particles which are having positive charge, they get deposited on negative charge electrode (cathode) and similarly, negative charge dust particle deposits on positive charge electrode (anode).
3. Cyclone Separators: Particulate matter is removed by centrifugal force taking place in a rotator machine. It will remove particles 10 microns or larger.

ii. Control for NO_x

1. Exhaust gas recirculation (EGR).
2. Catalytic converter.

iii. Systems to Decrease VOC

1. Gas Flare
2. Biofilters are devices that use living matter to trap biologically degradable pollutants.

II. Noise Pollution

Noise is an unwanted and unpleasant sound. Noise pollution may be defined as unwanted sound released into the atmosphere and may create some adverse effects or the unwanted noise. The high intensity sound may have great physical/physiological damaging effects which can be extremely damaging.

The sound intensity has been measured in terms of decibel (dB). The various levels of the sounds with the loudness sensation are given in the Table1.

S. No.	Noise levels (dB)	Sensation	Source
1	0-20	Whisper	Rustle of leaves, Soundproof room
2	20-40	Faint	Quiet home, Private office, Empty auditorium
3	40-60	Moderate	Noisy home, conversation quit radio

4	60-80	Loud	Average radio, average street noise, average factory
5	80-100	Very Loud	Loud street noise, noisy factory, Police whistle
6	100-120	Deafening	Elevated train, Thunder, Nearby riveter
7	120-140	Physical Pain	Jet aircraft, auto horn and Train horn

1. Source of sound pollution

There are number of sources available indoor and outdoor for the sound generation. The most common source in our houses are gadgets like mixture/grinder, vacuum cleaner, washing machines, cooler, air conditioner, radio, TV system, whereas the outdoor sources are factories, vehicles, aeroplane, train, loud speakers and crackers used in the various festivals.

2. Effects of Noise pollution

Noise exposure cause variety of adverse health effects and it depends on its intensity, frequency and periodicity.

- 1. Effects of high intensity sound:** The sound (80-100dB) of such intensity is emitted by machineries, motor cycles, high speed music system etc. It may cause the emotional and behavioural changes by producing nervous tension and cardiovascular problems like heart disease and blood pressure. Such regular exposure to machineries can cause complete hearing loss, rise in the blood cholesterol level and body plasma concentration.
- 2. Effects of Explosive sound:** The sound above 110dB referred as the explosive sound which may be generated by crackers, train, motor cycles etc. Such sound may easily cause vomiting, sever concussions of internal ear and profound deafness.
- 3. Effects of loud and sudden noise:** A sonic boom produces startle effects and damage brain. It may also damage the property such as window breaks.
- 4. Effects of intermittent noise:** Such sound is very disturbing and may cause of psychiatric illness as found in the area having regular sound of aeroplanes.
- 5. Effects of low noise:** This is the common noise produced by crowed, roads, radios and TVs etc. Interfere with the conversation and causes emotional and behavioural stress. Such noise increases the consumption of the alcohol, drug tranquilizers and sleeping pills.
- 6. Effects of absolute silence:** Absolute silence is also undesirable for man. An perfect anechoic room (sound levels 0-5dB), one stay for a few minutes, he will be overcome by an uncomfortable sensation as pounding of heart will be felt and ringing noises start in the ears. Mild sound (about 10 dB) found very necessary for the human existence and feel pleasant in such sound produced by nature like bird songs.

3. Control of Noise Pollution

Control of noise pollution is basically, reduction of the sound intensity of any available sources. There can be three ways to reduce such type of the noise pollution:

- i. Eliminate the noise at the sources,
- ii. Modify the path of the sound transmission
- iii. Provide receiver with some forms of protection

Some of the important ways for noise reduction are as follows:

1. **Noise pollution reduction in industries:** Noise of the industries can be reduced by replacing old machineries by newer and efficient ones. The noisy generator must be located far from the work area. Factory workers must wear ear-muffs (for sound above 90dB) or ear plug (for sound below 90dB). Apart from this some plants such as Ashok, Banayan, Neem, Kadamb etc should be grown around factory to minimise noise pollution.
2. **Reduction of community noise:** The use of loudspeaker in the marriages or other occasions should be banned else permitted for a certain period of time. Measures should be taken to prohibit the manufacture, sale and use of crackers of high sound intensity.
3. **Reduction of traffic noise:** Old and sound producing motor vehicles should be banned on roads and denied operating. Hooting and blowing of horns needless should be restricted legally. All along the highways 50 feet wide plantation strips should be developed.
4. **Reduction of aeroplane and jet noise:** Aerodrome should be located very far from the residential area. The heavy and thick green belts should be developing to reduce the noise pollution levels around aerodrome.
5. **Planning of cities and housing system:** Well planned cities should be developing to reduce the noise pollution created by the industries and highways. There should be sufficient number of green belts in between residential areas.
6. **Legal control of noise pollution:** Recently, Central Pollution Control Board (CPCB) and State Pollution Control Boards (SPCBs) have been given power to the frame certain rule and regulations to control noise pollution. Certain rule and regulations are:
 - i. Silence zone should be created near hospitals and educational institute.
 - ii. Use of sound amplifiers should be strictly restricted.
 - iii. All the vehicle should have effective silencers and uncontrolled blowing of horn should be declared illegal.
 - iv. Mid-night aircraft flight should be restricted/minimised.
 - v. Restriction on the factory noises should be handled legally and soundless machineries should be promoted.
 - vi. Developmental authorities should have a legal procedure and protocol to establish significant number of green belts in and around cities.

III. Nuclear Pollution

1. What is nuclear hazard: Introduction

Nuclear hazard can be stated as potential risk arising due to exposure to radiation emanating from the atomic nuclei. The important process leading to emission of radiation by different nuclei is known as radioactivity.

The source of radioactivity is emission of energy from radioactive isotopes such as Carbon-14, Uranium-235, Uranium-238, Uranium-239, Radium-226, etc. The energy from these sources is released in the form of alpha, beta or gamma radiation. All these radiations have different impact on tissues. The alpha rays are highly ionizing but have low tissue penetration. If alpha emitting source is ingested it causes severe problem. Beta rays have more penetration ability and can cause cell damage and mutagenesis. It is also used in radiation therapy for cancer patients. Gamma radiations have high penetration value and can cause severe problems. These sources are also used for sterilization of medical and scientific equipment and treatment of food. The nuclear power plants using radioactive elements for energy generation (see **Fig 1.1**) have been among the cause of disasters affecting millions with radiation fallout.

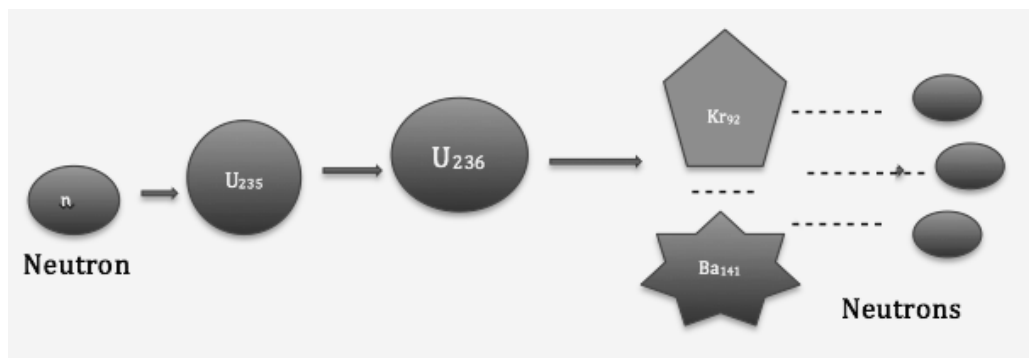


Figure 1.1: Nuclear chain reaction occurring in nuclear reactors also known as nuclear fission reaction.

2. Causes of Radioactive Pollution

- 1. Nuclear accidents:** Nuclear energy is one of the important energy sources discovered in recent time. The high energy in nuclear substances is due to their high latent power, also responsible for high level of radiation. Due to the safety issues, the use of nuclear materials are not promoted much but research is still underway to determine its environmental safety. Nuclear power plant accidents such as the Fukushima Daiichi nuclear disaster, Chernobyl disaster, and Three Mile Island accident are very well-known nuclear disaster that left many dead and many more affected person and contaminated environment by the radiation released.
- 2. Weapons of Mass Destruction (WMD):** The Second World War was end up with the use of nuclear missiles and atomic bombs; a form of nuclear energy may easily explain the damaging nature of radioactive pollution. These two strikes in Hiroshima and Nagasaki in 1945 after which the children were reported with complications such

mental retardation, autism and other disorders. In the present situations, the number of cancer cases present in the two towns is more than those of the rest of Japan.

3. **Use of radio isotopes:** These are radioactive isotopes, since they have an unstable atomic nucleus and emit energy and particles when it changes to a more stable form. Each radioisotope has a definite half-life period and characteristic disintegration. Such type of energy liberated mostly in the form of alpha, beta, or gamma rays. Radio isotopes are used to make detectors and in other industrial activities. Isotopes such as uranium have high concentrations of radiation. While the common Isotopes such as carbon containing radioactive material are easily found in water ways through sewage lines. Since most of the raw sewage is untreated before release, once released, the isotope combines with other compounds and elements in water. Consumption of this water through any means is a potential intake of radiation.
4. **Mining:** Mining basically related to the excavation of the mineral ores. Radium and Uranium, for instance, are naturally occurring in the environment and are equally radioactive. Other minerals with a hint of radiation are thorium, plutonium, radon, potassium, carbon and phosphorus.
5. **Tests on radiation:** Due to the lots of interesting properties radiation grabs attention of scientist to carry out research. It plays one of the important roles in the treatment of cancer. Chemotherapy is now widely used in the treatment of cancer in which radiation used to prevent further growth of the cancer cells as well as keep the immune system strong.
6. **Cosmic rays:** The radioactive pollution also caused by cosmic rays coming from the outer space to our Earth. Gamma rays, for example, are said to have the highest level of radiation and yet, depending on their intensity, some are not visible to the human eye.

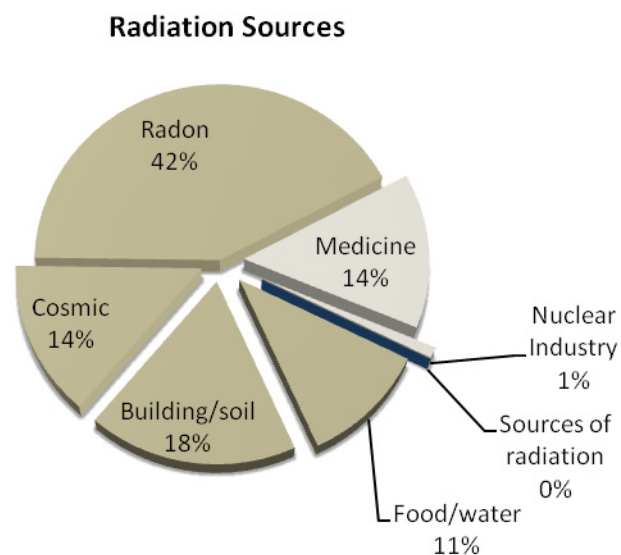


Figure 1.2: Contribution of harmful radiation from natural and human activities. Nuclear industry and medicine are the main man- made sources of radiation.

3. Impact of nuclear hazards

The nuclear hazard can pose a great threat to the environment according to spread of radioactive radiations. These are:

- The radioactive substances are known to be hazardous and when released in environment can disperse or accumulate in living organisms by passing from one trophic level to another in a food chain.
- One of the radioactive substances known as Strontium-90 has properties similar to calcium and can be easily deposited in bones replacing calcium. Contaminated milk is regarded as a source entering human body through ingestion.
- The nuclear power plants use tritium, which has a half-life of 12.3 years, and emit radioactive Beta particles. These power plants are known to be routinely or accidentally releasing tritium into air and water. If tritium enters a body by inhaling or swallowing, the beta particle released by it can bombard cells causing mutation.
- There are certain areas where exposure to nuclear radiation is high and poses threat, which are uranium mineworkers, radium watch dial painters, technical staff at nuclear power plants etc. The people working in these areas are exposed to radiations for longer duration, which can cause cancer, mutations and teratogenesis (prenatal toxicity characterized by structural or functional defects in the developing embryo or foetus) in them.

4. Effects of Radioactive Pollution

The effect of radioactive pollutants depends upon:

- i. half-life time
- ii. energy releasing capacity
- iii. rate of diffusion and
- iv. rate of deposition of contaminants

Various atmospheric and climatic conditions also determine the pollution effects. Biological effects of ionising radiations may be:

a. Short range effects

The short-range effects are acute and expressed within few days or weeks after the exposure to radiation. The effects may be:

- i. physical crippling or
- ii. immediate death

b. Long range effects

The long-range effects take longer time to express. Such delayed effects of the radiations are now centres of the World's interest. These include:

- (i) Genetic changes
- (ii) point mutation and chromosomal aberration

- (iii) increase incidence of tumour and cancer
- (iv) Shortening of the life span
- (v) Loss of vitality
- (vi) Anaemia
- (vii) Haemorrhages etc.

5. Mitigation of nuclear hazards

Taking precaution for safe disposal of nuclear waste should be the first priority. The radioactive nuclear waste can be damaging to the environment and so the best way is considered to be burial of wastes in deep trenches.

- **Delay and decay:** The radioactive waste generated from nuclear reactors, industries should be stored in airtight containers and allowed to decay deep beneath the ground in pits.
- **Concentrate and contain:** The small amount of high radioactive waste should be mixed with other components such as concrete and solidified and dumped deep in ocean or beneath the earth.
- **Dilute and disperse:** The moderately or weak radioactive waste should be released in the environment after diluting it with some inert materials.

Protective Measures

Some of the protective measures are listed as follows:

1. While handling UV lamps, dark glass spectacles or goggles must be worn. UV rays can't penetrate dark glasses.
2. Visible light neutralises UV damage considerably. Thus exposure to the sun light to any individual exposed to UV could be a good remedial measure to treat the exposed individual.
3. Nuclear fallout Hazards must be minimised by adapting certain precautions, e.g.
 - (i) **High level wastes** are long-lived and have high radioactivity per unit volume. These must be contained somewhere as follows:
 - (a) In underground tanks without treatments
 - (b) Liquid should be converted into the solid like ceramic and then buried deep underground
 - (c) Stored in deep salt mines

LEARNING OUTCOME

- Basic concepts of pollution, components of pollution, related impacts on environment and its management.
- Introduction of air pollution, causes, impacts and control.
- Brief introduction to air quality standards and policy measures.

- Understanding noise pollution, causes, impacts and control.
- Basic concepts of solid waste and its management and introduction of nuclear pollution or hazards and its control.

STUDY QUESTIONS

- Q.1 What is pollution? Describe the different types of pollutants and pollution.
- Q.2 What do you understand by air pollution? Describe its various causes.
- Q.3 What are various air pollutants? Discuss their effects on vegetation and human beings.
- Q.4 Explain the following terms:
- i. Air pollution Tolerant trees.
 - ii. Electrostatic precipitators.
- Q.5 Give a brief account of noise pollution.
- Q.6 Describe in detail about impacts of noise pollution on human health.
- Q.7 What are the causes of nuclear hazards? What is its impact upon the human population?

Multiple-choice questions:

- 1) Which element among these can cause radioactivity?
- (a) Lead
 - (b) Uranium
 - (c) Iron
 - (d) Sulphur

Answer: **Uranium**

- 2) Which of the following is the major cause of pollution?
- (a) Silk
 - (b) Clouds
 - (c) Fungi
 - (d) Hydrocarbon Gas

Answer: **Hydrocarbon Gas**

- 3) What is the unit for measurement of noise?
- (a) Hertz
 - (b) Parts per billion
 - (c) Centimetre
 - (d) Kilometre

Answer: **Hertz**

- 4) The radioactive decay of elements release which types of radiations?
- (a) Alpha

- (b) Beta
- (c) Gamma
- (d) All of these

Answer: **All of these**

5) The nuclear radiations can cause disease like

- (a) Pneumonia
- (b) Malaria
- (c) Cancer
- (d) Hypertension

Answer: **Cancer**

6) All are primary pollutants except?

- (a) Ammonia
- (b) PAN
- (c) Sulphur dioxide
- (d) Hydrogen sulphide

Answer: **Sulphur dioxide**

7) Which among the following is known as a nuclear disaster?

- (a) Three Mile Island, 1979
- (b) Chernobyl, 1986
- (c) Fukushima, 2011
- (d) All of these

Answer: **All of these**

LESSON-11

ENVIRONMENTAL POLLUTION

(WATER, THERMAL, SOIL AND CASE STUDIES)

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INTRODUCTION

Nowadays, the problem of pollution has become a major task in everyday's human lives. Due to high concentration of pollutants in any of the environmental system like water, air, soil etc. poses a higher risk to environmental health.

Apart from air, noise and nuclear pollution, there are other types of pollution too like water, soil and thermal pollution which also becomes a challenging task in day to day life. These pollutants are discharged or emitted from various natural as well as anthropogenic sources which ultimately harm the plant as well as human health.

LEARNING OBJECTIVES

After going through the Unit, you will be able to understand

- the sources, causes and impacts of Water, soil and thermal pollution.
- How various kind of pollutants impact the ecosystem and human health.
- Definition, types, sources of solid waste and Solid waste management plan.
- various measures and steps that can be employed for reducing pollution.
- government initiatives and programs as mitigating measures for Pollution across India.
- Critically assess the various issues discussed above with respect to relevant case studies.

I. Water Pollution

Nearly 50% of all marine pollution is caused by sewage and wastewater discharge. Annually, about 400 billion tons of industrial waste are produced globally, bulk of which is discharged untreated into the streams, rivers, seas, oceans and other water bodies. Water pollution means one or more substances building up in aquatic bodies to a limit that they cause trouble life forms. Water pollution also deals with the amount of polluting substance released and also the amount of water it is discharged into.

1. Types of Water Pollution

There are different perspectives of considering pollution.

A. Based on water bodies.

- Surface water pollution – The most evident type of water pollution affects surface waters like huge oceans, lakes, rivers and streams. For example, an oil slick from oil tanker can affect a huge area of the marine region.
- Groundwater pollution – All of Earth’s water is not surface water. An immense amount of water is present in the underground of rock structures or aquifers that are not visible to one and people hardly ever think of. Water that is stored in aquifers is groundwater. The rivers and streams are not only nourished by aquifers but they also supply drinking water. Fertilizers applied in the fields often seep into the soil and contaminate the waters. Groundwater pollution though less evident than surface water pollution is also a mounting problem.

B. Based on source.

- Point Source – If pollutants are discharged from one place or spot for e.g. an effluent pipe of a plant, oil spillage from a tanker, smoke stack discharge etc. The pollution from such a source is known as point source pollution.
- Non point source – A prodigious amount of water pollution also happens from variety of speckled sources. This is called non-point source pollution.

C. Based on Chemical Composition:

- Soft Water – water with little or no dissolved salts of magnesium and calcium.
- Hard water– In contrast to soft water, hardwater has high mineral content. It primarily consists of calcium and magnesium metal cations, and sometimes other dissolved compounds such as bicarbonates and sulphates. Such water is unsuitable for use.
- Sometimes the pollution may enter the environment from one place and extend an outcome hundred or even thousands of miles away from that place. Such pollution is known as transboundary pollution. Examples include the persistent organic pollutants and the radioactive wastes that may travel across the oceans and national boundaries.

2. Sources of Water Pollution

Approximately 33 percent of water pollution is by domestic sources, followed by agriculture-livestock with 29 percent, 27 percent by industry and 11 percent from other sources.

A. Domestic: Domestic sewage is wastewater generated from the household activities. It is 99.9 percent pure water; remaining 0.1 percent are pollutants which are both organic and inorganic materials. Organic materials are food and vegetable waste, excreta, faecal matter whereas inorganic materials such as phosphates and nitrates come from soaps and detergents.

Sewage is an entirely natural matter that should degrade blandly in the environment. Sewage also contains a host of chemical substances, from drugs, papers, plastics, their drainage system. Soaps and detergents used in washing machines and dishwashers are finally drained into the sewage.

B. Agriculture: It is undoubted that extensive use of fertilizers and pesticides, collectively called as agro-chemicals, increases the agricultural output. These, mostly artificial chemicals, move into the waterbodies along with rainfall and groundwater by leaching. Such chemicals are persistent and may get entry into the food chain causing numerous problems in the animals.

i. Pesticides: Any chemical utilized in controlling pests is a pesticide. The pest can be insects, microbes, fungus, snails and slugs, worms, weeds etc. Consequently, pesticide can be in the form of insecticides, fungicides, herbicides etc. Pesticides can cause a number of diseases like lungs malignancy, chronic liver damage, cirrhosis and chronic hepatitis, hormonal and gonadal disorders, immune-suppression, cytogenic effects, breast cancer, non-Hodgkin's lymphoma, polyneuritis etc.

Class of pesticides on the basis of their chemical nature are:

a. Organochlorine compounds: This is the most hazardous of all pesticides.

There are three classes of organochlorines:

- Dichlorophenylethanes – DDT, methoxychlor. They are highly penetrable and soluble in fats.
- Cyclodienes – Aldrin, endosulphan, endrin, heptachlor, toxaphene, chlordane. The metabolites of these products are more toxic.
- Hexachlorocyclohexanes – Lindane or benzene hexachloride (BHC)

The best known representative of this class is DDT, made by Swiss Scientist Paul Miller. He received noble prize for Physiology and Medicine in 1948 for his discovery. DDT was announced on the market in 1944. Upon exposure to high doses of DDT can produce parathesia, ataxia, dizziness, headache, nausea, restlessness. Chronic exposure results in anorexia, anaemia, tremor, weakness and anxiety. They are potent carcinogens and damage the liver and endocrine organs.

b. Organophosphates: They are frequently used in chemical warfare. Examples are Sarin, Tabun, Soman etc. Their toxic effects are additive; hence the toxicity amplifies with multiple exposures. The common organophosphates are malathion., parathion, diazinon and tetra ethyl pyrophosphate (TEPP).

c. Organo carbamates: The mode of actions of this class is quite similar to that of organophosphates. Their actions last for smaller duration and are thus the least toxic amongst the three. Examples are Sevin, Baygon etc. Exposure to such compounds may cause salivation, lacrimation and convulsions.

d. Biological insecticides: The most common is *Bacillus thuringiensis*. It is used to kill the larva against a diverse form of caterpillars. BT toxin from *Bacillus thuringiensis* could be successfully inoculated into the plants through genetic engineering.

C. Industries: Most of the industries are situated along the banks of the river for convenience and disposal of effluents. Often these effluents comprise acids, bases,

dyes, paints, and a range of other chemicals. Detergents form white foam. The industrial waste can be mercury, lead, cadmium, chlorides, fluorides, ammonia etc. Such addition alters the pH of water and turns it into a condition that is fatal to aquatic forms. The industries regularly discharge heavy amount of superheated water used in the thermal power plants, oil refineries, nuclear power plants, etc. such high temperature injuries and kills the aquatic flora and fauna. High temperature also reduces the amount of oxygen dissolved in water that may harm or even kill the aquatic life, the condition is called as thermal pollution.

- i. **Mining Industries:** The process of extraction of minerals exposes heavy metals and sulphur that were earlier inaccessible. Rainwater further leaches these chemicals out of the uncovered portions, causing AMD along with heavy metal pollution that lasts for a long period of time even after the closure of mining operations. The act of rainwater on the tailings contaminates the freshwater bodies. Cyanide is deliberately dispensed on mined piles in the gold mines for the extraction of gold. Some of cyanides used inevitably contaminate the close by water. Often, enormous amount of mining waste or ‘slurry’ are stored behind contaminant dams. In case of any accident or dam leakage or bursting, water pollution is assured.
- ii. **Oil Refineries:** Oil spill is a leading issue in the aquatic system. Oil seeps from the oil tankers and offshore oil refineries into the waters. Oil leakage from tanker accidents accounts to about 12 percent; more than 70 percent of oil pollution is from the usual shipping as well as from the oil that people drain out into the drainage system. Oil is lighter than water and thus floats on the surface of the water. Such a film blocks the aerial oxygen from dissolving in water. Oil can coat and smother the body of aquatic animals fatally. Oil can also find entry into the body while drinking. The oily beaches disturb the ecosystem balance and rigorously affect tourism.
- iii. **Radioactive Waste:** High concentrations can be lethal, whereas low concentrations of radioactive substances can cause malignancy and various forms of sickness. Two most important contributors in Europe are Sellafield and Ca La Hague.

Table 2: Major Types of Water Pollutants

S.No.	Substances	Sources or applications	Impact or effect
1.	Antimony – Sb	In electrical appliances, semiconductors, in expectorants, in manufacturing ammunitions	In large doses it can cause poisoning, stomach ulcers, heart diseases.
2.	Mercury – Hg	In industrial wastes, dental fillings, fungicides, soldering, and various scientific instruments such as	When ingested, mercury damages the Central Nervous System (CNS) leading to a disease called neuropathy.

		thermometers and barometers.	One of the famous cases is the Minnimata incident in Japan in 1953.
3.	Arsenic – As As ₂ O ₃ and trivalent arsenic	As component of animal feed, in treated wood, ceramics, medicines, pesticides, paints and fireworks.	70 mg of arsenic compounds is considered lethal if ingested. Lower doses of arsenic can result in disturbance in peripheral circulation, black foot disease, damage to liver, kidney, various types of cancer, such as skin cancer, bladder cancer and lung cancer.
4.	Cadimium – Cd	In Ni-Cd batteries and part of various metallic alloys, electroplating, pigments, nuclear reactors, and the anticorrosion coatings of other metals, tyres.	Often deposited in the hepatic, renal, pancreatic and intestinal lining. Poisoning with cadmium causes headache, regurgitation, anaemia, pneumonia, diarrhoea, osseous deformation and renal necrosis. It results in bioaccumulation to interfere with the body's metabolism. It also leads to cancer, teratogenesis and itai itai disease.
5.	Chromium – Cr	Used in tanning leather, treating wood, storing data in magnetic tapes, making pigments, photography and in manufacturing iron-based alloys. The human body needs trace amounts of trivalent chromium metabolize fats and carbohydrates.	Hexavalent chromium is dangerous, it causes dermatitis, gastrointestinal ulcers, lung cancer, weak immune system, liver damage. It is also a tertogen.
6.	Lead – Pb	It is found in plastics, ceramics, glassware, paints, pigments and batteries. Lead is also a crucial component in antiknock	Lead is easily absorbed in the blood. It affects liver, kidneys, osseous system, central and peripheral nervous system; red blood cells leading to

		agents.	anaemia. This toxic heavy metal can cause brain damage, coma and even death.
7.	Nickel – Ni	Used in the steel industry, in making batteries, welding rods, wires, adding pigments to paints, desalination plants, and producing dental and surgical prostheses.	Overexposure may cause allergic reactions, asthma-like symptoms, lung embolism and various organ problems.
8.	Beryllium – Be	Used mainly in defense and aerospace industries, used in field of x-ray detection diagnostic and in the manufacture of a variety of computer equipments.	Breathing beryllium particulates is hazardous as it damages the pulmonary tissue causing pneumonia. The most common effect being berylliosis. Beryllium is an allergen to hypersensitive people, in severe conditions it causes a person to be seriously sick, a condition known as Chronic Beryllium Disease (CBD). The symptoms are weakness, fatigue and breathing problems; people suffering from CBD sometimes develop a loss of appetite and blueness of hands and feet. In extreme condition CBD can cause death. Beryllium enhances the probability of malignancy and DNA damage.
9.	Aluminium – Al	Used in aerospace industry and very important in transport and construction where light weight, durability and strength are desirable. It forms alloys with many elements such as copper, zinc, magnesium, manganese and silicon. All present day mirrors and telescopic mirrors are prepared by using a thin reflective coating of	Health effects, such as damage to CNS, dementia or loss of memory, lethargy, rigors, trembling and lung problems. Inhalation of aluminium is reported to cause pulmonary damage in the form of pulmonary fibrosis. This effect, identified as Shaver's disease, is complicated by the existence of inhaled silica and oxides of

		aluminium on the back surface of a sheet of float glass. Other applications are electrical transmission lines, and packaging. Production of aluminium foam used in traffic tunnels and in space shuttles.	iron. Possibly it also contributes to Alzheimer's disease.
10.	Manganese – Mn	Iron and steel production. Manganese dioxide is also used as a catalyst. Used in decolourization of glass and craft violet coloured glass. Potassium permanganate is a strong oxidising agent and used to disinfect water. Used in making fertilisers and ceramics.	Effects occur mainly in the respiratory passages and in the brains. Symptoms of manganese poisoning are hallucinations, lack of memory and neuronal damage. Excess manganese causes Parkinson's disease, lung embolism and bronchial infection. A syndrome that is caused by manganese toxicity exhibits symptoms such as schizophrenia, dullness, weak muscles, headaches and sleeplessness.

3. Global Impacts of Water Pollution

1. **Eutrophication:** It refers to the enrichment of freshwater bodies by accumulation of nitrates and phosphates mostly due to the result of anthropogenic activities. It is predominantly found in sluggish rivers and shallow lakes.

The number of coastal areas affected by eutrophication globally is over 500. High amounts of nitrates and phosphates are present in sewage, fertilizers and other organic matters. The waters at depth are usually deficient in oxygen, ranging from hypoxic to anoxic condition. A number of algal blooms are identified by discolouration of water bodies often due to the high density of pigmented cells. The water usually becomes greenish. This is known as '**algal bloom**'. Rapid algal expansion leads to increased decomposers. All forms of aquatic life such as decomposers, other aquatic vegetation including the algae, aquatic animals including the fishes, consume the oxygen that is dissolved in the water for respiration. This in turn seeks a great requirement for oxygen and leads to oxygen depletion. Some algal blooms are harmful for instance the dinoflagellates belong to the genus *Alexandrium* and *Karenia*. Such bloom often assumes a red or brown colour and is conventionally known as red tides.

2. **Bioaccumulation and biomagnification:** **Bioaccumulation** is the accretion of substances like pesticides, metals and various organic compounds into the body of living organism over a period of time. This can occur either because the chemical gains entry faster than it can be utilized, or because the chemical cannot be metabolized by the organism.

Bioconcentration is a more precise term that refers to uptake and accumulation of a chemical substance from water alone.

Compounds like DDT and tetra-ethyl lead, being lipids soluble, are stored in the body's adipose tissues, which are used for energy production, the compounds on being released cause acute poisoning.

Biomagnification also known as bioamplification or biological magnification, on the other hand is the amplification in the concentration of a substance up the trophic level.

Biological magnification is the process by which particular substances such as pesticides or heavy metals go up the trophic level. Pollutants like DDT may also enter the body of humans through dietary milk provided the bovine animals get the exposure of DDT contaminated grass and water. The consequences are severe blood and nervous system disorders.

3. **Biological Pollution of water or Water-Borne Diseases:** Water-borne diseases are caused by pathogens. Microbes can also be the source of food-borne diseases through consumption of contaminated food. The most common water-borne diseases are summarized in the following tables.

Table 3: Few Important Protozoan Infections

Disease	Pathogen	Common Symptoms
Amoebiasis	<i>Entamoeba histolytica</i>	Discomfort in the abdomen, tiredness, loss of weight, diarrhoea, distension.
Cryptosporidiosis	<i>Cryptosporidium parvum</i>	Flu-like manifestations, diarrhoea, loss of weight, distension.

Table 4: Few Important Parasitic Infections

Disease	Pathogen	Common Symptoms
Taeniasis	<i>Taenia solium</i>	Intestinal disturbance, neurologic manifestations, loss of weight, cysticercosis.
Ascariasis	<i>Ascaris lumbricoides</i>	Inflammation, fever and diarrhoea. Loeffler's syndrome in lungs alongwith nausea, vomiting, malnutrition and underdevelopment.

Table 5: Few Important Bacterial Infections

Botulism	<i>Clostridium botulinum</i>	Blurred vision, thirsty and dehydrated mouth, difficulty in swallowing, slurred speech, vomiting diarrhoea, difficulty in breathing, death may be caused by respiratory failure.
Dysentery	<i>Shigella dysenteries</i>	Passing of faeces with blood and or mucus, in many a case vomiting blood.
E.coli infections	<i>Escherichia coli</i>	Diarrhoea and dehydration
Cholera	<i>Vibrio cholera</i>	Watery stool, nausea, cramps, nasal bleeding, rapid pulse, vomiting, haemorrhagic shock.
Typhoid	<i>Salmonella typhi</i>	Sustained fever up to 104°F, profuse sweating, diarrhoea, rarely rashes, if untreated leads to splenomegaly and hepatomegaly, progressive delirium and sometimes death.

Table 6: Few Important Viral Infections

Disease	Pathogen	Common Symptoms
Hepatitis A	Hepatitis A virus (HAV)	Fatigue, fever, abdominal pain, nausea, diarrhoea, loss of weight, itching, depression, jaundice
Gastroenteritis	Astro virus, Calici virus, Enteric adeno virus, Parvovirus	Diarrhoea, nausea, vomiting, fever, malaise, abdominal pain.
SARS (Severe Acute Respiratory Syndrome)	Corona virus	Pyrexia, myalgia, lethargy, cough, sore throat, gastrointestinal disturbance
Poliomyelitis	Poliovirus	Headache, fever, delirium, sporadic seizures, spastic paralysis, seldom aseptic meningitis and death.

4. Occupational Health Hazards

- a. **Itai-Itai Disease:** This was the famous case in Toyama Prefecture, Japan that as characterized by severe pain in joints and vertebral column. It was called as itai-itai disease by the local inhabitants and found to be produced by cadmium poisoning.

Several mining companies discharged cadmium into the rivers. The consequences are softening of the bones and kidney failure. It became one of the most prominent pollution-related diseases of Japan.

- b. Chisso-Minamata Disease:** Also known as Minamata Disease, the root cause of such disease is mercury poisoning. Primary symptoms are ataxia (loss of muscular coordination affecting speech, eyeball movements, swallowing, walking etc.), lack of sensation in the palms and feet, weakness in the muscles, hearing impairment, reduced visual field, etc. Such a neurological syndrome, in extreme cases, can lead to insanity, paralysis, coma and death that might follow within few weeks of inception of the symptoms. Mercury may cross the placenta and affect the in-utero foetus.
- c. Blackfoot Disease (BFD):** BFD is an endemic disease confined to the southwestern coast of Taiwan and is caused due to arsenic toxicity. The disease is initiated with people complaining about the coldness or numbness in the appendicular extremities, especially in the feet along with the irregular claudication (cramps and pain in lower leg while exercising or walking) making progress with course of time. This peripheral disease with severe systematic arteriosclerosis and gangrene like symptoms, affects the feet and occasionally the fingers.
- d. Methemoglobinemia:** Excess release of nitrates from fertilizers enters the human body through water. Then nitrates are ingested or in taken, they are transformed into nitrites in the alimentary system. The nitrites reacting with blood haemoglobin forms methaemoglobin. The haemoglobin molecule being preoccupied by nitrites cannot bind to the oxygen. The body is thus deprived of oxygen supply. This is fatal especially in the infants as they have very little amount of methaemoglobin reductase which could revert such effect. The syndrome is called blue baby syndrome or methaemoglobinemia. The symptoms are shortness of breath, vomiting and diarrhea. After confirming the test for the syndrome, an injection of required dose of methylene blue can help the baby's blood to return to the normals (www.uniassignment.com).

4. Measurement of water pollution

- 1. Biological Oxygen Demand:** Pollution in ater can usually be measured by estimating the biological/biochemical oxygen demand (BOD) of water. Lower value of BOD indicates lesser pollution whereas higher BOD value indicates higher pollution. It is one of the most useful parameters to indicate the organic strength of wastewater and can be defined as the amount of oxygen required by the aerobic bacteria to decompose the biodegradable matter in a given amount of water at 20°C over a period of five days. In reality it is an indirect measure to calculate the concentration of degradable matters present in waste. The BOD value of ra sewage may run to several hundred. Till 1971, the recommended BOD limit by World Health Organization (WHO) for potable water was 6 mg/l, there is no prescribed limit at present.
- 2. Chemical Oxygen Demand:** This is the most common method of measuring the strength of industrial water i.e. the amount of oxygen used for the chemical oxidation

of the pollutants. It is expressed in mg/l and is the total measurement of all the chemicals in water that can be oxidized. Higher COD values indicate higher values of pollution in the wastewater sample. COD can be employed for waters too toxic for BOD test and usually takes few hours for completion, an added advantage over BOD test. The decomposition is brought out by adding and boiling with a powerful oxidant, usually potassium dichromate. COD value is usually higher than the BOD value.

5. Steps to prevent or control water pollution

1. **Awareness:** Creating mass awareness is the foremost step towards preventing and controlling water pollution. Many NGOs have campaigned against over harvesting of fish and pleaded for tough penalties against the industries and factories discharging effluents in the water bodies.
2. **Legislation:** The major problem with water pollution is mainly because of the flowing nature of water that results in trans-boundary pollution. Most of the rivers cross national boundaries whereas ocean and seas may span continents. The pollutants released by the factories in one nation with pitiable emission standards cause glitches in the neighbouring countries. In many a case, the countries that suffer have stringent environmental legislation and elevated environmental standards. The environmental laws make a situation difficult for the people to foul, but it is more difficult to make such laws practically operative as they need to be implemented across national and international borders. To handle such trans-boundary issues several international negotiations and laws were negotiated and agreed upon:
 - The International Convention for the Prevention of Pollution of the Sea from oil tankers, London, 1954.
 - The International Convention for the Prevention of pollution from Ships, 1973, (MARPOL 73/78),
 - UN Convention on the Law of the Sea, 1982 enforced in 1994.
 - London Dumping Convention, 1972.
 - Convention on the control of trans-boundary movement of hazardous wastes and their disposal, 1989, Basel.
 - 1998 OSPAR Convention for the Protection of the Marine Environment of the North East Atlantic.
 - Nairobi International Convention on the Removal of Wrecks, 2007

The GOI has enacted the following legislations:

- The Water (Prevention and Control of pollution) Act, 1974 further amended in 1988.
- The Water (Prevention and Control of Pollution) Cess Act, 1977, last amended in 2003.

Table 7: Bureau of Indian Standards (BIS) drinking water – specifications for some of the important parameters IS 10500 – 2012 as per Ministry of Drinking Water and Sanitation (MDWS), GOI

S.N.	Characteristic	Unit	Requirement (Acceptable Limit)	Permissible limit in the absence of alternate source
1.	Total Dissolved Solids (TDS)	Milligram/litre	500	2000
2.	Colour	Hazen Unit	5	15
3.	Turbidity	Nephelometric Turbidity Unit (NTU)	1	5
4.	Total Hardness	Milligram/litre	200	600
5.	Ammonia	Milligram/litre	0.5	0.5
6.	Free residual Chlorine	Milligram/litre	0.2	1.0
7.	pH	-	6.5-8.5	6.5-8.5
8.	Chloride	Milligram/litre	250	1000
9.	Fluoride	Milligram/litre	1.0	1.5
10.	Arsenic	Milligram/litre	0.01	0.05
11.	Iron	Milligram/litre	0.3	0.3
12.	Nitrate	Milligram/litre	45	45
13.	Sulphate	Milligram/litre	200	400
14.	Selenium	Milligram/litre	0.01	0.01
15.	Zinc	Milligram/litre	5.0	15.0
16.	Mercury	Milligram/litre	0.001	0.001
17.	Lead	Milligram/litre	0.01	0.01
18.	Cyanide	Milligram/litre	0.05	0.05
19.	Copper	Milligram/litre	0.05	1.5
20.	Chromium	Milligram/litre	0.05	0.05
21.	Nickel	Milligram/litre	0.02	0.02
22.	Cadmium	Milligram/litre	0.003	0.003
23.	E.coli or Thermotolerant coliforms	Number/100 ml	NIL	NIL

II. Thermal Pollution

The water pollution due to the heat is popularly known as thermal pollution. Hot water from different sources when enters into the water bodies affects the water bodies adversely. Both plant and animals get affected by such type of the pollution.

1. **Sources of thermal pollution:** Several industries, thermal power plants, and nuclear power stations use large quantity of water as a cooling agent, resulting heating of water after the absorption of excess of heat from these processes. In the thermal power plants about 70% of the heat is lost as waste which is absorbed by the cooling water. The water becomes hot and then released into the reservoirs. Such types of water often raise the temperature upto 10-15 degree centigrade and became dangerous for the aquatic ecosystem. Sewage and industrial waste also rise of temperature of water bodies by 4-6 degree centigrade.
2. **Effect of warm water on aquatic life:** Some of the major adverse effects on aquatic life are as follows:
 - i. Small animals, phytoplankton, zooplankton, small fishes get affected and killed by the hot water.
 - ii. Cell walls of such type of animals and plants severely damage due to the hot water.
 - iii. Hot water may adversely affect the enzyme and metabolic activities of the plants and animals.
 - iv. The quantity of the dissolve oxygen also get effected by the presence of the hot water as the oxygen present into the water body bobbles out from the water body. It is also called as the gas bobble diseases of water. This results increase in the BOD levels of the water and causes suffocation of aquatic animals.
 - v. The hot water makes the aquatic organism susceptible towards toxic chemical and bacterial/viral/fungal infections.
 - vi. Thermal pollution adversely affects the overall ecological balance of the aquatic ecosystem, e.g. it affects the hatching of the eggs of some fishes, while other insects begin hatching with slight rise in the water temperature.
3. **Control of Thermal Pollution:** It is very hard to control thermal pollution because it is the results of actions of many people. But in case of already known source location, the water should be allow to cool down before discharged. The cooling towers and fountains can be used for the rapid cooling. Large tank and reservoir should be constructed to retain the water for a little longer time. It is also suggested to discharge such type of the hot water system into the running water bodies instead of stagnant water bodies.

III. Soil Pollution

Soil is a natural medium of inorganic and organic nutrients and has an inbuilt system of spontaneous recycling of matter. It is affected by changes in the atmospheric conditions as well as water contents and microbial population.

Soil pollution is defined as an undesirable change in the natural, physical, chemical or biological components of the soil.

1. Sources of Soil Pollution: The various sources of soil pollution may be categorized into two groups:

1. **Natural Sources:** They are as follows:

- i. **Plant Residues:** Normally plants, on death and decay, contribute organic matter to the soil and thereby increase soil fertility. Sometimes residues from crops, fields and orchards carry plant pathogens and pests. Burning of crops yields residues with CO (8.3%), NO (1.5%), hydrocarbons (5.3%) and particulate matter (8.5%).
- ii. **Animal Residues:** Animal wastes, such as faecal matter, urine, blood, slaughter house waste in the form of liquid or particulate matter, bodies of dead animals etc. are all indiscriminately dumped into the soil. Excessive organic contents are harmful for healthy growth of roots as they create hypertonic conditions in the soil causing wilting or stunted growth of the plants.

2. **Anthropogenic Sources**

- i. **Domestic:** Domestic sewage is wastewater generated from the household activities. It is 99.9 percent pure water; remaining 0.1 percent are pollutants which are both organic and inorganic materials. Organic materials are food and vegetable waste, excreta, faecal matter whereas inorganic materials such as phosphates and nitrates come from soaps and detergents.
- ii. **Agriculture:** It is undoubted that extensive use of fertilizers and pesticides, collectively called as agro-chemicals, increases the agricultural output. These, mostly artificial chemicals, move into the waterbodies along with rainfall and groundwater by leaching. Such chemicals are persistent and may after gain entry into the food chain causing numerous problems in the animals.
- iii. **Industries:** Most of the industries are situated along the banks of the river for convenience and disposal of effluents. Often these effluents comprise acids, bases, dyes, paints, and a range of other chemicals. Detergents form white foam. The industrial waste can be mercury, lead, cadmium, chlorides, fluorides, ammonia etc. Such addition alters the pH of water and turns it into a condition that is fatal to aquatic forms. The industries regularly discharge heavy amount of superheated water used in the thermal power plants, oil refineries, nuclear power plants, etc. such high temperature injuries and kills the aquatic flora and fauna. High temperature also reduces the amount of oxygen dissolved in water that may harm or even kill the aquatic life, the condition is called as thermal pollution.
- iv. **Radioactive Waste:** High concentrations can be lethal, whereas low concentrations of radioactive substances can cause malignancy and various forms of sickness. Two most important contributors in Europe are Sellafield and Ca La Hague.

2. Impacts of Soil pollution

- i. Soil pollution decreases soil fertility. Loss of soil fertility makes the soil inhabitable for plants and other organisms.
- ii. Soil pollution has adverse effects on soil microbial population that plays important role in soil formation and keeping it fertile.
- iii. Indiscriminate use of agro-chemicals destroys the soil flora and fauna and soil properties.
- iv. SO_2 , SO_3 and oxides of nitrogen of the atmosphere are washed down by rain in the form of H_2SO_4 , HNO_2 and HNO_3 which reach the soil and increase the acidity. Increased acidity develops unhealthy conditions for plant growth.
- v. Dumping of radioactive wastes onto the soil is lethal to plants and microbial life. Such pollution has far reaching effects and even human beings are not spared.

3. Control measures for Soil pollution

1. Control of pesticide pollution can be carried out by:
 - i. Lowering its use in agriculture.
 - ii. Use of degradable insecticides like organic phosphates.
 - iii. Use of short-lived chemical pesticides.
 - iv. Adopting biological control
 - v. Releasing sterile males into the natural population of insects.
 - vi. Rotation and diversification of crops etc.
2. Control of fertilizer pollution
3. Control of pollution due to garbage
4. Control of acid rains
5. Control of radioactive based soil pollution
6. Discharge of hot liquids and oil leakage in the soil should be avoided.
7. Sewage should be biologically treated and converted into manure instead of its uncontrolled release into the soil.

POLLUTION CASE STUDIES

The London Smog, 1952: In the winters of UK in the late nineteenth and twentieth centuries, on considerable occasions, in early December of 1952, the wind speed had fallen and temperature inversions were formed as stationary high pressure systems developed over western Europe. With increase in the concentration of pollutants, fogs became widespread. The condition was commonly referred to as smog. Initially the term smog was coined by Harold Des Voeux, the treasurer of Coal Smoke Abatement Society in 1905 to refer an odd combination of smoke plus fog.

Smog was formed from particulate emissions from the combustion of coal in the industrial furnaces, kilns and boilers, domestic grates and steam locomotives, canal ships. The visibility dropped, transport could not move, railways and air flights had to be closed and shops, stores and institutions were shut down completely paralyzing the city. PM went up by 56 times the normal level and SO₂ level went up by seven times.

Some 8,000 young and old people were hit by bronchitis and heart disease. The number of deaths rose so high from this Sulphur laden sooty condition that it was popularly known as Great Smog. These profound events led to the enactment of Clean Air Act of 1956.

The Los Angeles Smog Episode: This event was occurred in Los Angeles city in 1943. The Sulphur-laden sooty smog in time, however, eventually gave rise to the photochemical smog with the development of internal combustion engine as a prime source of transportation. Such smog are initiated by nitrogen dioxides, In the Presence of sunlight the free oxygen atoms react to form ozone. This was first evidenced in Los Angeles region of USA. It irritated the eyes, damaged the plants, for example tobacco. The major sources of nitrogen dioxides were vehicular emission, emissions from aircrafts, ships, trains, industries and houses. The symptoms are aching lungs, wheezing, coughing and headache. 'Smog complex' involves irritation of eyes and respiratory passages, chest pains, shortness of breath, nausea and headache. Lung's are ozone's primary target causing damages to cells in the airways, inflammation and swelling. It also reduces immunity. It poses a health risk to those people who already suffer from emphysema and chronic bronchitis.

The Bhopal Gas Disaster Episode: Commonly known as Bhopal Gas Tragedy, it is till date the ghastliest industrial disaster of the world. The incident took place on 2-3 December night, 1984 at the Union Carbide Industrial Plant in Bhopal, Madhya Pradesh, meant for the production of Sevin - a pesticide.

Over 40 tons of methyl isocyanate (MIC) gas escaped out from the Union Carbide Pesticide Plant, which instantaneously killed nearly 3,800 inhabitants and accused considerable despondency and early death for several thousands. Estimates from various sources vary on death toll. Another agency claimed over 15,000 deaths. As per government sources in 2006, the leak caused 5.58.125 injuries with disabling injuries. The vent gas crubber, a safety device had been turned off three weeks prior. It becomes apparent that a defective valve permitted a load of water that was meant for clean-up of the internal pipelines, got mixed with 40 tons of MIC. When MIC is exposed to 200°C heat, it formed more deadly hydrogen cyanide (HCN) gas. The evidence gathered does reveal the temperature of the storage tank to reach that disastrous level.

The effects from this tragedy were: Ophthalmic (chemosis, redness, watering, ulcers, photophobia); respiratory (distress, pulmonary edema, pneumonitis, pneumothorax), psychological (neuroses, anxiety states, adjustment reactions); neurobehavioral (impaired audio-visual memory, impaired alertness and reaction time, impaired analysis, interpretation and spatial ability, dysfunctional psychomotor coordination), Visual (constant watering,

corneal opacities, chronic conjunctivitis), respiratory (obstructive and restrictive airway disease, decreased lung function) etc.

Taj Mahal Issue: Taj Mahal, being one of the seven wonders and one of the most beautiful monuments of the world, attracts international tourists throughout the year. It was built along the bank of river Yamuna by Mughal Emperor Shahajahan in memory of his beloved wife Mumtaz more than 350 years back in Agra. It is now included in the list of World Heritage due to its archaeological importance. In 1972, Government of India established Mathura Oil Refinery in Mathura. This step was most resented by various environmentalists of the country and protested that its air pollutants were harmful to Taj Mahal. During the oil refining process, Sulphur dioxide (SO_2) is released in a large quantity along with the smoke. Air containing SO_2 blow all round and reacts with water during rains. SO_2 combines with water to form Sulphur us acid (H_2SO_3) and sulphuric acid (H_2SO_4) and produces acid rains. Environmentalists protested that acid rain causes damage to the marbles of Taj Mahal. The white marble has yellowed and blackened in places. Government constituted a committee in 1974 to find out the fact and authorized Italian Company Technico to evaluate the changes occurring in the air due to Mathura Oil Refinery of Indian Oil Corporation. According to the report of the committee and determinations carried out by Italian company, it was concluded that in Agra the quantity of SO_2 would increase up to 1-3 microgram which is negligible and harmless to the Taj Mahal. However, WHO (1982) has recognized 'Taj Trapezium Zone' (TTZ) (50 km radius area) to protect the monument from pollution hazards. Burning of coal and wood fuel has been banned in TTZ. Supreme Court has ordered to set up a solar power plant for energy requirement of TTZ.

The Ganga Pollution: River Ganga is so important and closely associated with Indian culture and civilization that it is often designated as 'Maa-the mother' and is worshipped in India and now the National River of India (2008).

The Ganga is the ninth largest river in the world and second largest in India with a length of 2,525 km. from Gangotri to Ganga Sagar. It constitutes about 25.2% water source of India. Several Himalayan rivers including Madakini, Alaknanda, Yamuna, Ghagra, Gandak, Koshi etc join it during its course. About 692 cities/towns are located along its bank of which 27 cities have population more than 1 lakh. More than 600 km part of the river, particularly between Kanpur and Patna is highly polluted. Every day it receives about 1300 million liters sewage and 250 million liters chemical effluents. The main causes of pollution of Ganges water are the mixing of the industrial effluents (20%) and domestic and municipal effluents (80%) into it.

Following are main causes of Ganga Pollution:

1. Sediments load of the Ganga River and other associated rivers.
2. Sewage disposal of villages, towns and cities.
3. Discharge of industrial effluents.
4. Release of dead bodies of animal and human beings.

5. Cremation along the bank of river and disposal of cremation material and burnt and half burnt dead bodies of human beings.
6. Surface run off of toxic chemicals, agro-chemicals, pesticides etc.

GAP helped in estimating the magnitude of Ganga Pollution. In an estimate, it was calculated that about 10,90,000 kg toxic effluents and 13,00,000 kg domestic and municipal effluents are discharged every year from the cities of UP only. The first step of GAP started in 1985 and second in 1995 to complete the plan by the end of 1999. Despite, 20,000 crore has been spent to clean the water, the results achieved remain insignificant. Various other projects have also been subsidized by the Government of Netherlands and Japan to clean the water of the Holy Ganges. Now Project of GAP includes cleaning of Yamuna and Gomti rivers. NGPRA has granted rupees 100 million to clean them.

Technical experts (2014) have recommended 5 programmes for cleaning National River of India, the Ganga, as follows:

- Formation of microdams
- Planning for floating population
- Reduction in number of riverside industries
- Limited storage of waters in barrages and
- Development of organic farming

The present Prime Minister, Shri Narendra Modi has launched a new scheme called Namami Gange to clean holy river Ganga (2015). Government has sanctioned rupees 20,000 crore for this project.

The Yamuna Pollution: River Yamuna after being originated for Yamunotri covers a passage of 1376 km before joining the river Ganga at Allahabad. The river has been divided into five segments from the point of view of pollution level.

1. Himalayan Segment from Yamunotri to Tajewala, 172 km, nonpolluted zone.
2. Upper segment from Tajewala to Wazirabad, 224 km polluted by agrochemicals used in Haryana.
3. Delhi segment from Wazirabad barrage to Okhla barrage, 22 km, highly polluted zone due to Delhi effluent discharges.
4. Eutrophicated segment from Okhla barrage to join place with river Chambal, 490 km, highly polluted with microbes and with highest BOD, Mathura and Agra covered in the segment.
5. Mixed segment from Chambal Sangam to Allahabad 468 km, pollution level decreases.

The pollution problem in Delhi segment is acute and highly dangerous. About 1900 million liter sewage is discharged every day in this segment of 22 km. The total treatment capacity of Delhi plants is about 1270 ml/day i.e. about 630 ml//day of it is still discharged directly to river Yamuna without any treatment. Moreover, the treated water is also not pure. It remains partially untreated. Further 2800 ml effluents day are discharged into the river by eleven main

nullahs which result in an increase of 200 BOD and 160 tones suspended solids. Najafgarh and Shahdara nullahs are most problematic.

In 1993, in the second step of Ganga Action Plan (GAP) of Government of India, Yamuna Action Plan (YAP) was also taken up. It included 127 working projects of which 48 are in UP, 76 in Haryana and 3 in Delhi. After 13 years of works on these projects, the pollution problem still remains serious. Pollution is further nurtured due to barrages built in Delhi, Mathura and Agra for civic water supply and number of canals made for irrigation. All this has made river Yamuna as *sewage vahine*.

Minamata Tragedy: Already discussed above.

LEARNING OUTCOME

- Basic concepts of water pollution, causes, impacts and control.
- Brief introduction about water quality standards.
- Understanding the problem of soil pollution, causes, impacts and control.
- Significance of solid waste disposal problem.
- Understanding the problem of thermal pollution and pollution case studies.

STUDY QUESTIONS

- Q.1 What is water pollution? Describe various causes and methods of control.
- Q.2 Outline the different sources of water pollution.
- Q.3 Discuss the nature of pollutants and suggest the remedial measures.
- Q.4 Define the following terms:
- Water pollution
 - Biomagnification
 - Algal blooms
 - Black foot disease
- Q.5 Write short notes on:
- Bhopal Gas Tragedy
 - London Smog Disaster
 - Minmata Episode
 - Ganga Pollution
- Q.6 Write a brief account of soil pollution.
- Q.7 What is soil pollution? Describe their causes, effects and remedies.

Multiple-choice questions:

- 1) BOD stands for?
- a) Biotic oxygenation demand
 - b) Biological Oxygen Demand
 - c) Biological Oxidation demand
 - d) Biochemical Oxygen Demand

Answer: **Biological Oxygen Demand**

- 2) The occurrence of pesticides in DDT in higher trophic levels is termed as?
- a) Bioremediation
 - b) Biomagnification
 - c) Biological Enhancement
 - d) Biopollution

Answer: **Biomagnification**

- 3) Soil Pollution is caused by
- a) Natural and manmade source
 - b) Natural source
 - c) Manmade source
 - d) None of the above

Answer: **Natural and manmade source**

- 4) What is the main impact of thermal pollution?
- a) Soil Pollution
 - b) Spawning of eggs
 - c) Air pollution
 - d) Corrosion

Answer: **Spawning of eggs**

- 5) Bhopal Gas Tragedy is caused by
- a) MIC
 - b) Sulphur dioxide
 - c) CFCs
 - d) Methane

Answer: **MIC**

LESSON-12

NUCLEAR HAZARDS AND HUMAN HEALTH RISKS

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INTRODUCTION

Waste is known as a material or substance or its by-product that is not found useful after completion of its process or use. The waste generated can be from residential, industrial, commercial or agricultural activity. The solid waste can be paper, metal, glass, organic matter or something else. Based on their hazard potential they are classified as toxic, non-toxic, flammable, radioactive or infectious.

LEARNING OBJECTIVES

After going through the Unit, you will be able to understand

- the sources, causes and impacts of Nuclear pollution.
- How various kind of pollutants impact the ecosystem and human health.
- various measures and steps that can be employed for reducing pollution.
- Definition, types, sources of solid waste, the impact of landfills and importance of an integrated Solid waste management plan.
- Critically assess the various issues discussed above with respect to relevant case studies.

SOLID WASTE MANAGEMENT

In 2018 the per capita waste generation was highest in USA and Canada approx. 2.58 and 2.33 kg per day and in India it was about 0.34kg per day. It is predicted with current rate, the global waste generation will rise to 2.2 billion tons per year by 2025. The municipal solid waste (MSW) contains organic waste (51%), recyclables (17%), hazardous (11%) and inert waste (21%). Waste segregation has been a very basic problem in solid waste management as about 40% of waste is not collected and litters the town, entering drains and water bodies-choking and polluting the environment. The unsegregated waste causes nuisance and various types of pollution and is spread to nearby areas and pollutes our environment. Burning of these wastes creates air pollution and releases gases that cause global warming.

2. Types of Waste

1. E-waste

E-waste is defined as electronic waste, which has been rendered useless after fulfilling their use. These wastes consist of televisions, computers, copiers, mobile phones, fax machines,

stereos and other equipment. Presently, the e waste generation is increasing at a very rapid rate throughout the world also supporting recycling, recovery and refurbishment and resale of this equipment. According to the Global E-Waste Monitor 2017, India generates about 2 million tons (MT) of e-waste annually and ranks fifth among e-waste producing countries (Global E-Waste Monitor -2017), led by USA and China. In India 95% of the e-waste is treated in informal sector.

The e waste connected health risks are very high and mainly related to handling and direct contact with harmful materials such as mercury, chromium, lead, cadmium, flame retardants and polychlorinated biphenyls present in these wastes. The recovery and extraction of various elements in these wastes can lead to inhalations of toxic fumes and accumulation of harmful chemicals in water, soil and food that can directly affect human health.

2. Biomedical Waste

Biomedical waste is classified as waste generated during the diagnosis, treatment, of human beings or animals, or research activities or as testing subjects.

According to latest Biomedical waste (BMW) Rules, 2016, several changes and additions have been made in earlier rules to further improve the collection, segregation, processing, treatment and disposal of the biomedical wastes in an environmentally sound manner. The waste consists of anatomical waste, soiled waste like plasters and bandages, medicines, chemical waste, discarded linen, syringes and needles, glassware etc. and they are incinerated or autoclaved to avoid infection in environment. According to new rules wastes have been color coded into four colours (yellow, red, white, blue) to address the issue of their handling and disposal.

3. Plastic Waste and Management

Plastic waste is considered as one the most persistent major waste in environment. According to the report from central pollution control board (CPCB) in 2017-18, India generated 9.4 million tons plastic waste annually. Only 60% of plastic is being recycled through organized and unorganized sector. The 50% of plastic waste generated consists of single use plastic like straws, plates, food packaging etc. The recycle rate is only 10% for single use plastic and majority ends up in ocean affecting aquatic life and creating pollution. The plastics have been graded according to their thickness used in different industries (**Fig. 1**). Management of plastic waste has become huge task for government resulting in banning of single use plastics in many states of India. Plastics cannot be decomposed and slowly breaks down into micro-plastics and remain in environment for thousands of years. A single plastic bottle cans stay in environment for thousands of year. The plastic waste management rules, 2016 specifies minimum thickness of 50 micron for plastic use in order to easily reuse and recycle the product. It also promotes use of plastic for road construction, energy generation and oil formation. Accordingly, CPCB has been entrusted to set the guidelines for thermoset plastics. The plastic waste management rules, 2018 by MoEFCC amended rules for phasing out multi

layered plastic (MLP), which cannot be recycled, non-energy recoverable, and has no alternate use.



Figure 1: Different types of plastic used in day today use. (Source: MoHUA-2019).

1 – Polyethylene Terephthalate (PET or PETE), 2 – High-Density Polyethylene (HDPE), 3 – Polyvinyl Chloride (PVC), 4 – Low-Density Polyethylene (LDPE), 5 – Polypropylene (PP), 6 – Polystyrene (PS), 7 – Other.

WASTE MANAGEMENT 5-R PRINCIPLE

One of the widely used waste reduction strategy can be used by people in towns and cities and is known as 5-R principle (**Fig 2**). This strategy can reduce the waste and can also use it for energy generation.

Reduce: The reduction of waste generation can be started from households by reducing the packages of commodities, increasing durability, avoiding disposable or single use plastic items, usage of jute bags or cloth bags for marketing etc. Reducing paperwork in homes and offices and promoting e- mails or e-bills should be promoted.

Reuse: The habit of re-using the commodities should be promoted. One can donate the books, old clothes, and electronics by getting in touch with the organizations that can direct you to the needful people who may find need of these resources.

Recycle: Segregation of waste is paramount for recycling of waste. Segregation of paper, metals, glasses, and plastics from the organic waste is very important. These wastes than can be used for recycling and creating a new product that can be used widely. Recycling saves

other resources and is good for our environment. A ton of recycled paper can save 25-30 trees, 25000 liters of water and 4000 kWh of energy.

Recover: Recovery is one of the methods where more resources are required i.e mechanical, technical to convert and reprocess the waste into energy. This means that energy can be generated in form of heat and can be converted into other forms as per requirement and resources.

Refuse: It is considered as a last resort to get rid of the waste generated and is dumped accordingly in landfills and dumpsites. The waste collected from the city or town in these areas remain for a longer period of time. These landfill sites are major concern for human population as they are home to feral animals and also making the adjoining areas unfit for habitation due to foul smell, leachate affecting water table and burning of waste causing air pollution.



Figure 2: Integrated method of solid waste management. Reduction is the primary concern and refuse being last.

4. Incineration

Incineration is a waste treatment process where combustion happens at very high temperature converting them into ashes releasing gases and heat. It is also considered as a waste to energy processes like pyrolysis, gasification and anaerobic digestion. The biomedical waste and hazardous waste are treated through incineration process as they cannot be treated with conventional methods. The disadvantage of incineration process is release of harmful gases like dioxins and furans that can cause severe health problems in humans.

5. Composting

Composting is a natural process that involves using micro-organisms for decomposition of biodegradable waste. The organic waste consisting of agricultural or kitchen waste can be used for composting. This process requires aeration for proper and faster decomposition.

In one of the methods of composting the earthworms are used to increase the rate of decomposition also known as vermicomposting. Earthworms such as *Eisenia fetida* are used which consume biomass and creates vermicasts. The vermicasts are rich in nutrients (N, P, K) and growth promoting substances required by plants. Vermi-compost is good for soil and

does not contain pathogens and weeds. The vermicomposting needs to be promoted as it is beneficial for the soil and growth of plants and also reduces waste generation.

6. Sanitary Landfill

Sanitary landfill is controlled reduction and disposal of waste away from human habitation in a designated area, which reduces the contact between waste and environment. In a sanitary landfill the garbage is compressed to reduce its volume and covered by a thick layer of soil in order to minimize odors, deter pests, limit rainwater runoff, prevent fire and discourage scavenging by feral animals. This process is repeated till the landfill is saturated with waste and covered with soil and plantation is done. At various stages provisions for tapping landfill gas (methane) is established for using in furnace or generation of electricity. In many parts of the world the landfill sites have been successfully converted into community parks.

CASE STUDIES

The London Smog, 1952: In the winters of UK in the late nineteenth and twentieth centuries, on considerable occasions, in early December of 1952, the wind speed had fallen and temperature inversions were formed as stationary high pressure systems developed over western Europe. With increase in the concentration of pollutants, fogs became widespread. The condition was commonly referred to as smog. Initially the term smog was coined by Harold Des Voeux, the treasurer of Coal Smoke Abatement Society in 1905 to refer an odd combination of smoke plus fog.

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The **early effects** (0-6 months) from this tragedy were:

Ophthalmic (chemosis, redness, watering, ulcers, photophobia); respiratory (distress, pulmonary edema, pneumonitis, pneumothorax), gastrointestinal (persistent diarrhoea, anorexia, persistent abdominal pain); genetic (increased chromosomal abnormalities), psychological (neuroses, anxiety states, adjustment reactions); neurobehavioural (impaired audio-visual memory, impaired alertness and reaction time, impaired analysis, interpretation and spatial ability, dysfunctional psychomotor coordination).

The **delayed effects** (6 months onwards) from this tragedy were:

Visual (constant watering, corneal opacities, chronic conjunctivitis); respiratory (obstructive and restrictive airway disease, decreased lung function); reproductive (increased abortion, increased child mortality, reduced placental/foetal weight); genetic (increased chromosomal abnormalities) and neurobehavioural (impaired associative learning, motor speed, precision).

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combines with water to form sulphurous acid (H_2SO_3) and sulphuric acid (H_2SO_4) and produces acid rains. Environmentalists protested that acid rain causes damage to the marbles of Taj Mahal. The white marble has yellowed and blackened in places.

Government constituted a committee in 1974 to find out the fact and authorised Italian Company Technico to evaluate the changes occurring in the air due to Mathura Oil Refinery of Indian Oil Corporation. According to the report of the committee and determinations carried out by Italian company, it was concluded that in Agra the quantity of SO_2 would increase upto 1-3 microgram which is negligible and harmless to the Taj Mahal. However, WHO (1982) has recognized 'Taj Trapezium Zone' (TTZ) (50 km radius area) to protect the monument from pollution hazards. Burning of coal and wood fuel has been banned in TTZ. Supreme Court has ordered to set up a solar power plant for energy requirement of TTZ.

The Ganga Pollution: River Ganga is so important and closely associated with Indian culture and civilisation that it is often designated as 'Maa-the mother' and is worshipped in India and now the National River of India (2008).

The Ganga is the ninth largest river in the world and second largest in India with a length of 2,525 km. from Gangotri to Ganga Sagar. It constitutes about 25.2% water source of India. A number of Himalayan rivers including Madakini, Alaknanda, Yamuna, Ghagra, Gandak, Koshi etc join it during its course. About 692 cities/towns are located along its bank of which 27 cities have population more than 1 lakh. More than 600 km part of the river, particularly between Kanour and Patna is highly polluted. Every day it receives about 1300 million litres sewage and 250 million litres chemical effluents. The main causes of pollution of Ganges water are the mixing of the industrial effluents (20%) and domestic and municipal effluents (80%) into it.

Following are main causes of Ganga Pollution:

7. Sediments load of the Ganga River and other associated rivers.
8. Sewage disposal of villages, towns and cities.
9. Discharge of industrial effluents.
10. Release of dead bodies of animal and human beings.
11. Cremation along the bank of river and disposal of cremation material and burnt and half burnt dead bodies of human beings.
12. Surface run off of toxic chemicals, agro-chemicals, pesticides etc.

In 1985, the Ministry of Environment and forests started the Ganga Action Plan (GAP) for preventing irreversible damage and restoring the water quality of Ganga. GAP has following objectives:

1. All round environmental improvements.
2. Installation of sewage treatment units and their proper operation and maintenance.
3. The basic facilities of sewage treatment to be coupled with production of energy and manure and provision of pisciculture, aquaculture and irrigation-treated water.
4. Economic benefits to the local population.

GAP helped in estimating the magnitude of Ganga Pollution. In an estimate, it was calculated that about 10,90,000 kg toxic effluents and 13,00,000 kg domestic and municipal effluents are discharged every year from the cities of UP only. The first step of GAP started in 1985 and second in 1995 to complete the plan by the end of 1999. Despite, 20,000 crore has been spent to clean the water, the results achieved remain insignificant. Various other projects have also been subsidised by the Government of Netherlands and Japan to clean the water of the Holy Ganges. Now Project of GAP includes cleaning of Yamuna and Gomti rivers. NGPRA has granted rupees 100 million to clean them.

Technical experts (2014) have recommended 5 programmes for cleaning National River of India, the Ganga, as follows:

- Formation of microdams
- Planning for floating population
- Reduction in number of riverside industries
- Limited storage of waters in barrages and
- Development of organic farming

The present Prime Minister, Shri Narendra Modi has launched a new scheme called NamamiGange to clean holy river Ganga (2015). Government has sanctioned rupees 20,000 crore for this project.

The Yamuna Pollution: River Yamuna after being originated for Yamunotri covers a passage of 1376 km before joining the river Ganga at Allahabad. The river has been divided into five segments from the point of view of pollution level.

6. Himalayan Segment from Yamunotri to Tajewala, 172 km, nonpolluted zone.
7. Upper segment from Tajeala to Wazirabad, 224 km polluted by agrochemicals used in Haryana.
8. Delhi segment from Wazirabad barrage to Okhla barrage, 22 km, highly polluted zone due to Delhi effluent discharges.
9. Eutrophicated segment from Okhla barrage to joining place with river Chambal, 490 km, highly polluted with microbes and with highest BOD, Mathura and Agra covered in the segment.
10. Mixed segment from Chambal sangam to Allahabad 468 km, pollution level decreases.

The pollution problem in Delhi segment is acute and highly dangerous. About 1900 million litre sewage is discharged every day in this segment of 22 km. The total treatment capacity of Delhi plants is about 1270 ml/day i.e. about 630 ml/day of it is still discharged directly to river Yamuna without any treatment. Moreover, the treated water is also not pure. It remains partially untreated. Further 2800 ml effluents day are discharged into the river by eleven main nullahs which result in an increase of 200 BOD and 160 tonnes suspended solids. Najafgarh and Shahdara nullahs are most problematic.

The pollution indicator coliform test revealed the presence of 24,000,000 *Escherichia coli* per 100 ml in the downstream of Okhla region which is indicative of the magnitude of wastewater pollution. Conditions become more severe during summer.

In 1993, in the second step of Ganga Action Plan (GAP) of Government of India, Yamuna Action Plan (YAP) was also taken up. It included 127 working projects of which 48 are in UP, 76 in Haryana and 3 in Delhi. After 13 years of works on these projects, the pollution problem still remains serious. Pollution is further nurtured due to barrages built in Delhi, Mathura and Agra for civic water supply and number of canals made for irrigation. All this has made river Yamuna as *sewage vahini*.

Minamata Tragedy: Already discussed above.

Chernobyl Disaster: The Chernobyl Disaster took place in April 1986 in Ukraine formerly known to part of USSR. Chernobyl disaster is known to be the biggest disaster to have occurred in nuclear power plant. In a routine maintenance of one of the four nuclear reactors of the plant a sudden power surge caused uncontrolled chain reaction in one of the reactors leading to explosions in the reactor. The explosion exposed the nuclear reactors causing spread of radioactive material in atmosphere. The initial response from the administration was to contain the fallout of disaster but later it realized that too much irreparable damage has already happened. The explosion had released around 30 percent of 190 metric tons of Uranium being used in reactors. The USSR government later informed the world of the explosion and started evacuating people when they realized fall out couldn't be controlled. It is estimated that 335,000 people were evacuated and more than hundreds died due to explosion. The periphery of the nuclear reactor approximately 19 miles wide was cordoned off as "exclusion zone" with no human activity. The incident site has been covered with thick sheets of steel in order to limit radiation leakage.

More than 34 years on, the scientists opine that the area won't be habitable for next 20000 years. The researchers predicted contamination of surrounding areas with high radiation which led to low and high-level radiation exposure to as many 10,000 people causing radiation related cancer which led to their death in later years. The disaster led to global anti nuclear movement discouraging the use of nuclear energy.

Fukushima Disaster: The Fukushima disaster is considered as second biggest disaster in history after Chernobyl Disaster. The Fukushima disaster occurred in March 2011 in one of the islands in Japan. The accident was rated 7 by INES scale due to high radioactive release for 5-6 days. Four nuclear reactors were damaged in the incident leading to radiation fallout in the region.

The accident mainly happened due to a major earthquake followed by 15 m high Tsunami causing damage to the reactors. There were no reports of death due to radiation sickness but more than hundred thousand people were evacuated from the area as precaution. The radiation mainly consisted of Iodine-131, Caesium-134, Caesium-137, strontium-90, and Plutonium-238.

Indore: Global model for Waste Management: Indore city is one of the big cities in India and has been named the cleanest city in India for record third time in *Swachh Survekshan* 2019. The city has managed to segregate 100% waste at source and successfully managed the organic waste through composting and other methods. The better implementation of cleanliness programs by Indore Municipal Corporation (IMC) had led to cooperation and participation from citizens. The IMC is a global model for the world especially big cities where waste management is a huge task due to quantity of waste and number of people needed for its handling. The success of the IMC can be attributed to following steps:

- Information, education and communication (IEC): This is key to behavioral change in the primary stakeholders-the citizens.
- Waste generation and segregation at source and at bulk in collection centers: Door to door collection of waste in segregated form of dry waste and wet waste. Special attention is given to hazardous or biomedical waste.
- Waste collection and transportation: the waste is collected from all the sources and reaches a central facility where data is gathered from different localities and assessed.
- Waste processing: The wet waste is sent to a central facility for composting and dry waste such as hazardous or biomedical waste is sent to incinerators. The waste is also used to create bio-compressed natural gas (bioCNG) that is being used to run vehicles in the city.

Swachh Bharat Abhiyan (Clean India Mission)

This is a campaign launched by prime minister of India on 2nd October 2014 to create awareness regarding cleanliness in our homes, streets, and infrastructure of the country. It is India's largest cleanliness drive where students, government employees and people from private sector participate. This movement has been successful in creating awareness for cleanliness and discouraging open defecation by building toilets in rural and urban areas. The movement has also created awareness for health and sanitation among the communities.

Ghazipur Landfill

Ghazipur landfill is one of the oldest and biggest landfill area in Delhi NCR region. The landfill area is more than 30 years old and highly saturated to its capacity. The 65 m high landfill is one of the towering structures in Delhi filled with municipal waste generated from various parts of the city. The landfill is releasing green house gases together with leachate in soil. More than 3 million people survive within 10 sq km radius of the landfill. In spite of using various management practices the early solution to this problem is not seen. Recently prime minister's office have shown interest in handling this problem and various institutions have been included to find a permanent solution in order to meet global sustainable development goals regarding health and environment.

LEARNING OUTCOME (Summary)

- The substances that are not considered useful are categorized as waste. The origin of these can be domestic, industrial, construction or agriculture.
- The waste management is important for categorization of different types of waste and their proper handling.
- The increasing waste generation in the world has supported the 5R principle for waste management that consists of –reduce, reuse, recycle, recover and refuse.
- The hazardous wastes are generally treated by a method known as incineration and organic waste is treated by method of composting.
- Special treatment is required for e-waste and biomedical waste as these can lead to serious health problems among people.
- The awareness and knowledge is the most important step in reduction and management of waste.

Questions:

Short Answer type questions

- Q.1 What are 5-R principle and its importance in solid waste management?
- Q.2 What is incineration process? Why is it only used for biomedical waste or hazardous waste?

Multiple-Choice Questions

1. Which among these is non degradable
- a) Paper bag
 - b) Woollen clothes
 - c) Plastic plates
 - d) Banana peel

Answer: **Plastic plates**

2. Which is the best methods to treat garbage consisting of newspapers, magazines and old books
- a) Incineration
 - b) Composting
 - c) Recycling
 - d) Landfill

Answer: **Recycling**

3. Vermicomposting to treat organic waste to compost uses which organism
- a) Fungi
 - b) Earthworms
 - c) Termites
 - d) Beetles

Answer: **Earthworms**

4. Harmful gases like dioxins and furans are released by
- Composting
 - Bio-gas
 - Landfills
 - Incineration

Answer: **Incineration**

5. In order to recycle the plastic, the minimum permissible thickness is
- 20 micron
 - 40 micron
 - 50 micron
 - 100 micron

Answer: **50 microns**

Study Questions

- Q.1 Describe briefly any three study cases, one each related with air pollution and river pollution.
- Q.2 Write short notes on:
- Bhopal Gas Tragedy
 - London Smog Disaster
 - Minamata Episode
 - Ganga Pollution

GLOSSARY

Landfills: Sites created for storage or dumping of municipal solid waste.

Incinerator: The furnace designed to burn hazardous or infectious waste at high temperature in controlled conditions.

Compost: Organic matter rich in nutrients created by decomposition of biodegradable waste.

Vermicomposting: The organic matter with high nutrient availability, good for soil and plants created with the help of earthworms by decomposition of biodegradable waste like kitchen waste.

Leachate: The liquid consisting of dissolved harmful substance enters the environment by seeping to soil from landfills.

Polychlorinated biphenyls: A group of toxic chemicals used for manufacturing various appliances and commodities including electrical appliances, adhesives, and fluids that are considered carcinogenic in nature.

LESSON-13

HUMAN COMMUNITIES AND THE ENVIRONMENT

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INTRODUCTION

Today the human communities are facing an unprecedented environmental crisis with respect to climate change and global warming. Never before has the world faced such an existential crisis with respect to livelihoods and survival. The recent Amazonian and Australian wildfires and once in a century flood in our own state of Kerala are testimony to this fact. The Himalaya, the highest and youngest mountain chain of the world and on whose rivers almost 1.5 billion human population survives are warming at an unprecedented rate – almost 3 times that of the global average. The melting Himalayan glaciers as a result are likely to have cascading effects in terms of floods, landslides, erosion and increasing desertification. The sea-level rise as a result of warming of the Arctic and the Antarctic glaciers are also likely to disrupt the hydrological cycle and result in increasing cyclones, hurricanes and typhoons along with the submergence of low-lying islands such as Maldives, Mauritius and Madagascar. The race for rapid economic development the world over is likely to contribute to more warming during the 21st and 22nd century and if left unstopped, it may lead to major impacts on agriculture, economies, health and well-being of human communities. It is high time that we take urgent pragmatic and scientific solutions to solve this grave problem of climate change and global warming. In this context, it is necessary to understand the science, causal factors and possible solutions of climate change and global warming.

LEARNING OBJECTIVES

After going through this section, you will be able to

1. Gain knowledge about global environmental issues like global warming, climate change, Ozone layer depletion, Acid rain, their causes, impacts on human communities and ecosystem and measures to mitigate and adapt.
2. Develop understanding about some international treaties that have been instituted for tackling important environmental issues through international co-operation
3. Develop understanding about Sustainable Development Goals set up by United Nations and India's National Action Plan for tackling climate change.

1. Climate Change

Climate change is one of the most predominant challenges of today's world. It is threatening the very existence of human communities and human civilizations throughout the world and

is affecting all spheres of life ranging from agriculture, economy, livelihoods, food and water security, ecosystem degradation, natural disasters, environmental hazards, etc. Climate change is defined as average change in weather conditions (temperature, precipitation, humidity, etc.) of a region over a minimum period of 30 years. Climate change can have both natural and anthropogenic causes. These can be briefly summarized as:

- i. **Natural causes:** There can be many factors that can cause climate change naturally. For example, increased volcanic activity can emit large amount of carbon dioxide (CO₂) and ash particles into the atmosphere that can increase the temperature of the region as they absorb more solar radiation. Other natural factors include changes in eccentricity, axial tilt and precession of Earth's orbit (commonly referred to as the Milankovitch cycles). All of these three factors (eccentricity, axial tilt and precession) are related to the amount of solar radiation reaching the Earth's atmosphere and in turn the average temperature of Earth's surface. For example, the orbit in which the Earth revolves around the Sun changes from nearly circular to mildly elliptical over a cycle of about 1,00,000 years. The more elliptical the orbit becomes the less solar radiation Earth receives. Thus, if the orbit becomes more elliptical, the average temperature of Earth decreases. Similarly, the tilt of Earth's axis (currently at 23.5°) varies between 21.5° and 24.5°, over a cycle of about 41,000 years. Increased tilt leads to greater amount of solar radiation reaching the Earth's surface and greater temperature on Earth's surface. Precession is wobbling of the Earth as it spins on its axis with a periodicity of 23,000 years. More wobbling leads to even distribution of solar radiation on the Earth's surface and less wobbling leads to increase in temperature in either Northern or Southern Hemisphere. Naturally, climate change can also occur due to changes in temperature of the Sun itself. Sun possesses an 11-year periodic 'Solar Cycle' in which the magnetic activity on the surface of the Sun changes. More magnetic activity leads to formation of 'sunspots' or regions of reduced surface temperature. In the 11-year solar cycle, some years are characterized by increased number of sunspots and some with lean number of sunspots. The years having records of less number of sunspots are the ones that have recorded more temperature than the others. The last natural cause of climate change is the slowing down or speeding up of 'Atlantic Conveyor Belt'. The Atlantic Conveyor Belt is a name given to the system of ocean currents in the Atlantic Ocean that mixes the warm waters of Atlantic with the cold waters of the Arctic and Antarctica. Through this mixing, the average temperature of Earth's surface is maintained at 15° C. Scientific evidence indicates that slowing down of this Atlantic Conveyor Belt leads to decades of rapid global warming.
- ii. **Anthropogenic causes:** The anthropogenic or man-made causes of climate change are the increase in concentrations of Greenhouse Gases or GHGs such as carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), ozone (O₃), water vapor (H₂O), chlorofluorocarbons (CFCs) and hydrofluorocarbons (HFCs). These Greenhouse Gases are capable of absorbing incoming solar radiation in the atmosphere. Therefore,

increase in the concentration of GHGs in the atmosphere, leads to increase in temperature of the Earth's surface. Normally, GHGs are present in concentrations of less than 1% in the Earth's atmosphere. However, their concentrations have progressively increased in the atmosphere after the Industrial Revolution (~ 1850 A.D.) due to the burning of fossil fuels in industries and automobiles, agriculture, land-use change, landfills, tourism, etc. It should however be borne in mind that GHGs are very essential for existence of life on the Earth. In absence of GHGs, the average temperature of Earth's surface would have been $-18\text{ }^{\circ}\text{C}$ as compared to the present average temperature of $15\text{ }^{\circ}\text{C}$ because other than the GHGs, no other gases have the property of absorbing solar radiation. In absence of GHGs, all of the incoming solar radiations would have either been reflected back or lost into the atmosphere and the Earth would have transformed into a 'Cold Planet'. However, the excess concentrations of GHGs could also threaten the existence of life on this Earth as it would lead to 'Global Warming' and Earth transforming into a 'Hot Planet'. Already, the concentrations of carbon dioxide and methane have increased by 40% and 150%, respectively since the pre-industrial period (before 1850). Therefore, every effort should be made to combat the increase of GHG emissions as soon as possible.

2. Global Warming

Global warming is defined as increase in average temperature of Earth (from the current $15\text{ }^{\circ}\text{C}$) due to the increase in concentration of Greenhouse Gases (GHGs). These main GHGs are: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), ozone (O_3), water vapor (H_2O), chlorofluorocarbons (CFCs) and hydrofluorocarbons (HFCs). The main sources of these GHGs are:

- a. Carbon dioxide (CO_2) – Mainly emitted from the burning of fossil fuels (coal, petrol and diesel) in the industries and automobiles.
- b. Methane (CH_4) – Mainly emitted from the decomposition of organic waste in the landfills and agricultural fields (mainly rice fields) as a result of anaerobic digestion.
- c. Nitrous oxide (N_2O) – Mainly emitted from combustion of coal and petrol, sewage, wastewater and fertilizers.
- d. Ozone (O_3) – Mainly produced due to chemical reaction of volatile organic compounds (VOCs) such as benzene, ethanol, etc. (used mainly in paints, sprays, etc.) in the troposphere.
- e. Water vapor (H_2O) – Produced mainly as a result of evaporation of water during the water cycle.
- f. Chlorofluorocarbons (CFCs) – Emitted mainly due to the use as a coolant in the refrigerators and air-conditioners (ACs).
- g. Hydrofluorocarbons (HFCs) – Emitted as a by product of use in air-conditioners and aerosols.

Of all the GHGs, CO₂ is the biggest contributor in global warming (76%), followed by methane (16%), nitrous oxide (6%) and CFCs along with HFCs (2%). Of greater concern is the average residence time of these GHGs in the atmosphere (time for which the gases are present in the atmosphere). Nitrous oxide has the highest average residence time of 114 years, followed by CO₂ (30-95 years), CFCs (45 years) and methane (12 years). Thus, if one molecule of CO₂ is emitted into the atmosphere in 2020, it can continue to cause global warming till 2050-2115. Therefore, it is very important to control the emission of these GHGs as soon as possible.

China, the European Union and United States of America are the top GHG emitters, together contributing more than one-half (50%) of the GHG emission worldwide. Sector-wise, the electricity and energy generation account for the highest GHG emission (31%), followed by transportation (15%), manufacturing (12%), agriculture (11%) and forestry (6%). The United Nations Intergovernmental Panel on Climate Change (IPCC) have predicted that if the emission of GHGs continues at its current pace, the average temperature of Earth's surface are likely to rise by 1.5 °C between 2030 and 2052. A rise of 1.5 °C in global temperature is likely to carry many climate-related risks for nature and mankind such as sea-level rise due to melting of ice caps and glaciers in Arctic and Antarctica, submergence of low-lying islands, acidification of oceans, increase in the numbers and frequency of natural hazards (floods, cyclones, typhoons, wildfires, etc.) and vector-borne diseases (malaria, dengue, etc.), decrease in agricultural productivity, negative impacts on economy, etc. However, going by the current emission trends, it is unlikely that there would be any significant drop in the GHG emissions, and the Earth would continue to warm significantly at a much higher rate than expected.

IMPACTS OF CLIMATE CHANGE AND GLOBAL WARMING

Climate change and global warming are likely to have many manifested effects on the human communities, biodiversity, agriculture and economy. Some of such major impacts are:

- i. **Melting of Polar Icecaps and Sea Level Rise:** The increasing temperature levels as a result of global warming and climate change are likely to result in accelerated melting of glaciers and ice in Arctic and Antarctica and consequently increase in average sea level of Indian, Atlantic and Pacific oceans. A sea level rise of just 1 m would be sufficient enough to completely submerge the low-lying islands such as Maldives, Mauritius, Fiji, etc. The increased sea levels would also lead to the intensification of water cycle and increased frequency of floods, cloudburst, cyclones, typhoons and hurricanes all around the world. Besides the Arctic and Antarctica, global warming is also likely to lead to loss of ice and glacier covers in the major mountain system such as Andes and the Himalaya. The loss of glacier cover in the headwaters of these major mountain systems would result in reduced water flow in the rivers flowing from these mountains such as Ganga, Brahmaputra and Indus.

- ii. **Loss of Biodiversity:** Global warming and climate change are one of the most predominant drivers of biodiversity loss all around the world, leading to extinction and extermination of species. Species that are likely to suffer the highest risk are the ‘endemic species’ (species found only small restricted localities), ‘migratory species’ (species that migrate long-distances from one place to the other), ‘alpine species’ (species that are found on the top of the mountains) and ‘specialist species’ (species that are found only in one kind of climate). Some of such species are penguins, polar bears, pandas, snow leopards, purple frog, monarch butterflies, Himalayan yaks, etc. These species are unlikely to adapt to the changing climate conditions and are likely to go extinct such as the Dinosaurs. Even coral reefs – underwater ecosystems that harbor greatest biodiversity of ocean fishes and marine organisms and provide one of the largest ecosystem services on Earth, are facing collapse due to ‘coral bleaching’ – a phenomenon in which the coral dies and turns white in color due to increasing temperature and acidification of oceans. Half of the Great Barrier Reef of Australia is already dead due to the phenomenon of coral bleaching.
- iii. **Impact on Agriculture:** Climate change is likely to have significant impacts on agriculture of a given region leading to decrease in productivity and shifts in cropping patterns in tropical biomes while increasing agricultural productivity in temperate biomes. However, it is likely to lead in disproportionate shifts in cropping patterns all over the world. For example, in India the patterns of *Rabi* and *Kharif* seasons are likely to change by at least one month. Climate change would also lead to widespread proliferation and dispersal of non-native pests and exotic invasive species such as *Parthenium*, *Lantana*, *Prosopis* and *Conyza* that would lead to invasion of agricultural lands and decrease soil fertility and agricultural productivity of a region.
- iv. **Impact on Human Health:** Climate warming and increased temperature and humidity levels are likely to help in the widespread proliferation of vector-borne diseases such as malaria, dengue, schistosomiasis, yellow fever, etc. besides food and waterborne diseases. The 2003 heat wave in France resulted in approximately 15,000 human deaths.
- v. **Impact on Economy:** Documentation of the impacts of climate change on economy is difficult due to multiple interrelated direct and indirect effects. However, some reports such as that of International Labour Organization (ILO) indicated that climate change would lead to loss of approximately 2.2% of working hours every year, 80 million full time jobs and 2,400 billion US dollars. Economics costs due to climate change would also rise in terms of health cost, infrastructure, insurance and energy costs. Fisheries, that constitute important source of livelihoods for millions of people all around the world are also likely to be significantly impacted leading to monetary and employment losses.

3. Ozone Layer Depletion

Ozone (O₃) layer depletion refers to the process of thinning of ozone layer in the stratosphere due to the presence of Ozone Depleting Substances (ODS) emitted due to anthropogenic activities. The major ODS are chlorofluorocarbons (CFCs), halons, carbon tetrachloride, methyl bromide, and methyl chloroform. CFCs are mainly used as coolants in air conditioners and refrigerators, propellants in aerosol cans and as in manufacture of insulation and packaging materials. Halons are used in fire retardants, methyl bromide in pesticides and methyl chloroform and carbon tetrachloride in industrial solvents. All these substances release either chlorine or bromine and cause catalytic destruction of ozone in the stratosphere. The scientists (Sherwood Rowland, Mario Molina and Paul Crutzen) who explained the process of ozone layer depletion due to ODS were awarded Nobel Prize in Chemistry in 1995.

The chlorine that are released from the ODS cause the destruction of ozone molecule in the presence of sunlight in a couple of chain reactions:

- i. Cl (Chlorine) + O₃ (Ozone) = ClO (Chlorine monoxide) + O₂ (Oxygen)
- ii. ClO (Chlorine monoxide) + O (Oxygen) = Cl (Chlorine) + O₂ (Oxygen)

The chlorine released in the above process (2nd step) goes on to break another molecule of ozone. Like this, one molecule of chlorine can destroy over 1,00,000 molecules of ozone over a period of 50 years.

Maximum ozone layer depletion (thinning of ozone layer) occurs in Antarctica between September and November every year. Two important conditions favor the ozone depletion during these seasons: (i) Presence of sunlight in the Polar Regions, and (ii) Development of circumpolar vortex (mass of cold air around the southern polar region). The presence of sunlight promotes the catalytic destruction of ozone while the development of circumpolar vortex causes the water vapor in the atmosphere to cool rapidly and form ice crystals. The ice crystals thus formed adhere to each other to form 'Polar Stratospheric Clouds' that in turn provide a platform for the chlorine and bromine to destroy ozone molecules. When the circumpolar vortex breaks down after November, the ozone-depleted air spread to the neighbouring regions of Australia, New Zealand and South America and starts thinning the ozone layer out there.

Recognizing the disastrous consequences of using ODS, a worldwide agreement was signed in 1987 in Montreal, popularly known as 'Montreal Protocol' to ban the use of ODS globally, and CFCs. It was initially decided in the agreement that 50% reduction in CFC production would be achieved by 1998 and would be replaced by hydrofluorocarbons (HFCs) and hydrochlorofluorocarbons (HCFCs). Unlike CFCs, HFCs and HCFCs do not destroy ozone molecules. The satellite measurements revealed in 1997 that ODS had started declining in the atmosphere and ozone layer has started recovering. In the absence of further use of ODS, the ozone layer is slated to fully recover by 2050.

3.1 Effects of Ozone Layer Depletion

The depletion of ozone layer in the stratosphere is likely to have very serious effects. Ozone layer protects us from the harmful Ultraviolet (UV) radiations. Depletion of ozone layer can expose us to UV radiations that in turn lead to skin cancer, cataracts and weakened immune system in humans. UV radiations have the ability to cause loss of pigmentation in skin cells and harmful changes in the deoxyribonucleic acid or DNA of skin cells. These ultimately lead to skin cancers and related cancer diseases such as malignant melanoma. UV rays can also damage the proteins of cornea and retina cells in the eye and cause blindness and cataracts. UV radiations also inhibit the photosynthetic activity and cause damage to natural vegetation and agricultural productivity. Besides these, increased exposure to UV radiations can also harm ecosystem structure and function of both terrestrial and aquatic ecosystems by disturbing food chain, altering biochemical pathways and disrupting nutrient and energy flow between the different components of ecosystem.

4. Acid Rain

Acid rain is defined as the rainfall with pH (a unit of measuring acidity or basicity) values of 5.6 or less due to the chemical reaction of sulfur dioxide and nitrogen oxides with water vapor in the atmosphere. The term “acid rain” was first coined by a British chemist, Robert Angus Smith in 1872 after observing the impact of acid rain on buildings with heavy industrial activities. Acid rain can either occur in the form of wet deposition (as rainfall) or dry deposition (dry particles of sulfuric and nitric acid).

Acid rain is mainly formed when sulfur dioxide and nitrogen oxides combine with moisture in the atmosphere to form acids that are then deposited on land surface either through rain, snow or dew. The process occurs mainly in those areas that have large presence of fossil-fuel burning industries and automobile density. Sulfur dioxide is mainly produced from coal-burning industries, smelters, petroleum refineries and thermal power plants while nitrogen oxides are mainly produced from motor vehicles and automobiles that run on petrol and diesel. In India, cases of Acid rain have been reported from Agra, Mumbai and Delhi.

4.1 Effects of Acid Rain

Acid rain can cause a number of harmful effects such as:

- i. **Damage to Buildings and Infrastructure:** Acid rain has the most damaging effect on buildings and historical monuments. One of the most noteworthy examples is the yellowing of Taj Mahal due to acid rain in Agra. The sulfuric and nitric acid of acid rain reacted with the marble (calcium carbonate) of the Taj Mahal to form crystals of calcium sulphate and caused yellowing of the historical monument (a phenomenon now referred to as the ‘Marble Cancer’). To protect the Taj Mahal from further degradation due to acid rain, the Government of India in 1995 decided to ban industries located in the neighbouring areas of Agra, Mathura, Bharatpur and Firozabad ('Taj Trapezium') that burnt fossil fuels and polluted the air of Agra and caused acid rain.

- ii. **Damage to Aquatic Ecosystems:** Acid rain can cause damage to aquatic life especially fishes and phytoplanktons as a result of water acidification. Acid rain can also lead to the leaching of harmful heavy metals such as zinc, mercury, manganese and lead from the surrounding rocks into the water bodies and cause heavy metal toxicity in the aquatic organisms. Formation of deformed embryos and young ones and destruction of food base of fishes (insect larvae, etc.) can also occur as a result of acid rain.
- iii. **Damage to Terrestrial Ecosystems:** Acid rain can cause dieback diseases (reduced growth and mortality) in trees by damaging the cuticle, damaging the chlorophyll and leaching of nutrients from the leaves. Besides causing damage to the trees and foliage, acid rain can also cause soil acidification that leads to the leaching of essential elements such as calcium and magnesium from the soil. Loss of these essential elements leads to reduced growth of plants and decrease in photosynthetic activity. In addition, death of microbes also happens due to soil acidification that in turn effect plant-microbe interactions in the ecosystem. Evidence also indicates that acid rain causes decrease in the rate of nitrogen fixation in the soil, leads to death of roots of the plants in some cases and increased sensitivity to diseases and pathogens.

LEARNING OUTCOMES (Summary)

- Climate change is defined as average change in weather conditions of a particular region over a minimum period of 30 years.
- Climate change can have both natural and anthropogenic causes.
- Global warming is defined as the increase in average temperature of the Earth's surface due to the emission of Greenhouse Gases.
- Greenhouse gases are the gases in the atmosphere that have the ability of absorbing solar radiation.
- The main Greenhouse Gases responsible for global warming on Earth are carbon dioxide, methane, nitrous oxide, ozone, water vapor, chlorofluorocarbons and hydrofluorocarbons.
- Ozone (O₃) layer in the stratosphere protects us from harmful Ultraviolet (UV) radiations.
- Ozone (O₃) layer depletion is the thinning of ozone layer in the stratosphere due to emission of Ozone Depleting Substances (ODS) in the atmosphere. The major ODS are chlorofluorocarbons (CFCs), halons, carbon tetrachloride, methyl bromide, and methyl chloroform.
- Ozone hole generally forms over Antarctica during September and November every year.

- Montreal Protocol was signed in 1987 to ban the use of Ozone Depleting Substances (ODS) especially CFCs in the atmosphere.
- Acid rain is defined as the rainfall with pH values of 5.6 or less.
- Acid rain is mainly caused due to the chemical reaction of sulfur dioxide and nitrogen oxides with water vapor in the atmosphere.
- Acid Rain mainly causes damage to buildings and historical monuments such as the yellowing of Taj Mahal in India.

Objective Questions

1. Global warming is caused due to:
 - (a) Industrial emissions
 - (b) Automobile emissions
 - (c) Agricultural emissions
 - (d) All of the above

Answer: (d) All of the above

2. The biggest contributor of Greenhouse Gases in the world is:
 - (a) China
 - (b) India
 - (c) Germany
 - (d) USA

Answer: (a) China

3. Which one of the following is not the result of global warming:
 - (a) Melting of polar ice caps
 - (b) Sea level rise
 - (c) Coral bleaching
 - (d) Acid rain

Answer: (d) Acid rain

4. Which of the following represents natural causes of climate change:
 - (a) Volcanic eruptions
 - (b) Greenhouse Gases
 - (c) Industries
 - (d) Automobiles

Answer: (a) Volcanic eruptions

5. Which one of the following represents a Greenhouse Gas:

- (a) Bromine
- (b) Carbon monoxide
- (c) Methane
- (d) Benzene

Answer: (c) Methane

6. Climate change is measured on a scale.

Answer: Decadal

Objective Questions

1. Ozone layer depletion is commonly observed over:

- (a) Russia
- (b) India
- (c) China
- (d) Antarctica

Answer: (d) Antarctica

2. Which one of the following is not an Ozone Depleting Substance (ODS):

- (a) Chlorofluorocarbons (CFCs)
- (b) Carbon tetrachloride
- (c) Methyl chloroform
- (d) Sulfuric acid

Answer: Sulfuric acid

3. Ozone depletion can cause:

- (a) Skin cancer
- (b) Blood cancer
- (c) Asthma
- (d) Bronchitis

Answer: (a) Skin cancer

4. Ozone depletion occurs in:

- (a) Troposphere
- (b) Stratosphere

(c) Mesosphere

(d) Ionosphere

Answer: Stratosphere

Objective Questions

1. Acid rain is caused due to:

(a) Sulfur dioxide

(b) Nitrogen oxide

(c) Both of the above

(d) None of the above

Answer: (c) Both of the above

2. Acid rain has a pH of:

(a) 5.6

(b) 7

(c) 7.8

(d) 6.5

Answer: (a) 5.6

3. Acid rain causes:

(a) Marble cancer

(b) Lung cancer

(c) Eutrophication

(d) Skin cancer

Answer: (a) Marble cancer

GLOSSARY

Acid Rain: Rainfall with pH values of 5.6 or less and caused due to chemical reaction of sulfur dioxide and nitrogen oxides with water vapor in the atmosphere.

Climate Change: Average change in weather conditions of a particular region over a minimum period of 30 years.

Climate: Long-term average of a weather of a given region on a decadal (10 year) scale.

Global Warming: Increase in average temperature of the Earth's surface due to the emission of Greenhouse Gases.

Greenhouse Gas: Gases that can absorb incoming solar radiation.

Ozone Depleting Substances: Substances (chemicals) that cause ozone layer depletion

Ozone Layer Depletion: Thinning of ozone layer in the stratosphere

Weather: Short-term phenomenon of daily changes in meteorological conditions (temperature, precipitation, humidity, etc.)

EXERCISE

1. Differentiate between global warming and climate change.
2. Discuss the natural and anthropogenic factors that cause climate change.
3. What are Greenhouse Gases?
4. Discuss the major impacts of climate change on human communities and environment.
5. Give examples of the effects of climate change on humans.
6. What is Ozone Layer Depletion and how is it caused?
7. How does the ozone layer protect life on Earth?
8. Discuss the major impacts of Ozone Layer Depletion.
9. What is Acid Rain?
10. Discuss the factors that cause Acid Rain.
11. What are the major impacts of Acid Rain?
12. What is Marble Cancer?

LESSON-14

ENVIRONMENTAL LEGISLATIONS IN INDIA

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INTRODUCTION

In India, environmental protection and improvement has been in practice since ancient times to the present age. In ancient India, simple but quite effective laws were in place to protect and conserve environment. The long history of environmentalism in India is signified with the passage and codification of several acts e.g. The Indian Motor Vehicle Act, The Factories Act, The Indian Forest Act, The Mines and Minerals (Regulation and Development) Act, The Industries (Development and Regulation) Act, The Forest (Conservation) Act, The Merchant Shipping Act. The present-day Constitution of India allows the State to protect and improve the environment in order to safeguard public health, forests and wildlife.

LEARNING OBJECTIVE

Gain knowledge about important environmental legislations enacted in India

1. The Indian Wildlife (Protection) Act, 1972

The Wildlife Act provides the State Wildlife Advisory Boards provisions to regulate hunting and trade of wild animals, birds and their products. The State Wildlife Advisory Boards can also establish sanctuaries and national parks and judicially impose penalties for violating the Act. This Act was amended in 1982, to introduce provisions for the capture and transportation of wild animals to scientific institutions and bodies for management of animal populations. In 1991, the parent Act was comprehensively amended to insert special chapters dealing with the protection of specified plants and the regulation of zoos. The major activities and provisions in the Act can be summed up as follows:

- It defines the wildlife related terminology.
- Appointment of Wildlife Advisory Board, wildlife warden, definition of their powers and duties etc.
- Listing of endangered wildlife species and provisions to prohibit their hunting
- Protection to some endangered plants like Bed dome cycad, Blue Vanda, Ladies slipper orchid, pitcher plant etc.
- Constitution of Central Zoo Authority.
- Trade and commerce in some wildlife species with license for sale, possession, transfer etc.
- Ban on the trade or commerce in scheduled animals.

- It provides for legal powers to officers and punishment to offenders.

Several conservation projects for individual endangered species like lion (1972), tiger (1973), crocodile (1974) and brown antlered deer (1981) were started under this act. This Act is adopted by all Indian states.

2. The Water (Prevention and Control of Pollution) Act, 1974

The Water (Prevention and Control of Pollution) Act, 1974, defines water pollution, as the direct or indirect discharge of sewage, industrial effluents or any liquid, gaseous or solid substance into water which alters the physical, chemical or biological properties of water to make it harmful or injurious to public health and health of animals or of aquatic organisms’.

This Act lead to the creation of Central Pollution Control Board (CPCB) and State Pollution Control Boards (SPCBs). CPCB primarily promotes cleanliness of streams and wells in the different states of India.

The other functions of the board are;

- To lay down the standards for a stream or well, and in consultation with the State Government concerned modify or annul those standards.
- plan and cause to be executed a nationwide programme for the prevention, control and abatement of water pollution;
- Preparation of manuals, codes or guides related to treatment and disposal of sewage and trade effluents. Also, collection, compilation and publication of technical and statistical data related to water pollution and the measures devised for its effective prevention and control.
- advise the Central Government on any matter concerning the prevention and control of water pollution;
- Providing technical assistance and guidance to the SPCBs and coordinating their activities
- Control and abatement of water pollution through investigation and research related to problems related to water pollution.
- The functions of State Pollution Control Boards are similar to those of Central Pollution Control Board but they are to be executed at state level, and these are governed by the directions of CPCB.
- The board advises the state govt. the location of any industry that might pollute a stream or a well.
- The board is authorized to take samples from industrial streams, well or trade effluent or sewage and it lays down standards for effluents.
- The board is licensed to take legal samples of trade effluents in accordance with the prescriptions in the act. In the presence of the occupier or his agent, the collected sample is divided into two parts, sealed, signed by both parties, then it is sent for analysis to some recognized lab. If the samples cross maximum permissible limits, then consent is refused to the unit.

- Industries has to apply for consent from the board in a prescribed format, providing all technical details, along with a prescribed fee. After application analysis of the effluent is carried out and consent is provided for a fixed duration.
- The board suggests efficient methods for utilization, treatment and disposal of trade effluents.

3. Forest (Conservation) Act, 1980

This Act was passed to prevent deforestation, which results in ecological imbalance and environmental deterioration. It prevents even the State Governments and any other authority dereserve a forest which is already reserved. It prohibits forestland to be used for non-forest purposes, except with the prior approval of the Central Government. The Salient features of Forest Act:

- The state government can use the forests only for forestry purposes. For non-forest purposes like mining or for monoculture of the economically important trees the state government has to take prior approval of central government.
- Provisions for conservation of all types of forests and for this purpose there is an advisory committee which recommends funding for it to the central government.
- Immediate halt to any illegal forest activity within a forest area.

1992 Amendment in the Forest Act

- In 1992, a few amendments were made in the Act which made arrangements for permitting some non-forest exercises in forests, without cutting trees or restricted cutting with advance endorsement of central government. These activities involve setting of transmission lines, seismic reviews, investigation, drilling and hydroelectric tasks. The last action includes large-scale destruction of forests, for which earlier endorsement by the central Govt. is necessary.
- Under this Act, investigation or review in Wildlife sanctuaries, national parks etc. is absolutely prohibited without prior endorsement by central government, even if no tree-felling is included.
- Cultivation of cash-crops e.g. tea, coffee, spices, rubber and plants, are included as non-forestry activity and not permitted in reserve forests.
- The central govt. has to endorse even the cultivation of fruit-bearing trees, oil-yielding plants or plants of medicinal value in forest area. This is on the grounds that recently presented species in the forest area may cause an imbalance in the forest ecology. In case the species to be planted is a local species, then no prior clearance is required.
- Tusser cultivation (a kind of silk-yielding insect) in forest areas by tribals is a method for their livelihood is treated as a forestry activity as long as the host trees are not some specific trees like Asan or Arjun. This is done so as to dishearten monoculture rehearses in the woodland which are otherwise wealthy in biodiversity.
- Plantation of mulberry for rearing silkworm is viewed as a non-forest exercise. The explanation is same as described previously.

- Mining is a non-forestry activity and prior endorsement of central govt. is required. The Supreme Court for a case involving T.N. Godavarman Thirumulkpad Vs. Association of India (1997) guided all on-going mining exercises to be stopped quickly in any forest area of India if it had not been endorsed in advance by the central government.
- Removal of stones, bajri, rock and so on from river-beds situated inside the forest zone fall under non-forest activity.
- Any proposition sent to central govt. for non-forest action must have a cost-benefit analysis and Environmental Impact Statement (EIS) of the proposed exercise regarding its ecological and socio-economic effects.
- Consequently, the Forests (Conservation) Act has made abundant arrangements for preservation and security of forests and prevention of deforestation.

4. The Air (Prevention and Control of Pollution) Act, 1981

The Central Government used Article 253 to enact this law and made it applicable throughout India. This Act defines air pollutant as ‘any solid, liquid or gaseous substance (including noise) present in the atmosphere in such concentration as may be or tend to be injurious to human beings or other living creatures or plants or property or environment’. The CPCB and the SPCBs created under the Water Act 1974 are entrusted with the implementation of the provisions of the Act. The CPCB may

- Counsel the central government on any matter related to the improvement of air quality and prevention, control or abatement of air pollution.
- Plan and cause to be executed a nation-wide programme for the prevention, control or abatement of air pollution;
- Provide technical assistance and guidance to the SPCBs and coordinate their activities.
- Prepare manuals, codes or guides relating to prevention, control or abatement of air pollution; and collect, compile and publish technical and statistical data relating to air pollution and the measures devised for its effective prevention, control or abatement.
- The CPCB also lay down standards for the quality of air.
- The functions of the SPCBs also include inspection of any control equipment, industrial plant or manufacturing process and to take steps for the prevention, control or abatement of air pollution. The units identified as polluting industries should obtain approval before their establishment or/and continuing their operations. The SPCBs, in consultation with the State Governments, wherever necessary, can exercise the following powers:
 - Declare certain areas within the State as air pollution control area; prohibit the use of certain fuels or appliances in this control area.
 - Set standards for emission from automobiles and disallow discharge of the emission of any air pollutant beyond the permissible limit.
 - Approach court for restraining persons from causing air pollution and restrict certain industrial plants

- Authority to enter and inspect the premises of the polluters to take samples of air

5. The Environment (Protection) Act 1986

This act defines environment as ‘water, air and land and the interrelationship which exists among and between water, air and land, and human beings, other living creatures, plants, micro- organism and property’. It defines hazardous substance as ‘any substance or preparation which, by reasons of its chemical or physiochemical properties or handling, is liable to cause harm to human beings, other living creatures, plants, micro-organism, property or the environment’.

This Act empowers the Central Government to:

- Coordinate actions of the State Governments, officers and other authorities under the Act or any other law which is relatable to the objects of the Act;
- Planning and execution of a nation-wide programme for the prevention, control and abatement of environmental pollution;
- Laying down standards for emission or discharge of environmental pollutants from various sources and setting maximum permissible limits
- Identification of areas in which any industry, operations or processes or class of industries, operations or processes shall not be carried out.
- Prevention of accident mediated environmental pollution by laying down safeguards and setting procedures for remedial measures after such accidents;
- Identification of materials, substances and manufacturing processes, which can cause environmental pollution;
- Carrying out and sponsoring investigations and research relating to problems of environmental pollution;
- inspection of any premises, plant, equipment, machinery, manufacturing or other processes, materials or substances as a source of pollution, and giving order to authorities to take steps for the prevention, control and abatement of environmental pollution.
- establishment or recognition of environmental laboratories and institutions;
- preparation of manuals, codes or guides relating to the prevention, control and abatement of environmental pollution and publication of information related to environmental pollution

The Central Government may organize an authority or authorities to make rules covering the following matters:

- The permissible standards of air, water or soil quality for various areas and purposes;
- The permissible limits of various environmental pollutants (including noise) for different areas;
- The procedures, safety methods, prohibitions and restrictions for the handling of hazardous substances in different areas;

- The limitations on the location of polluting industries and the prohibition and restrictions on the polluting processes and operations.

6. Scheduled Tribes and other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006

- The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, has been enacted to apprehend the rights of residing Scheduled Tribes and other traditional forest dwellers, who have been residing in such forests for generations.
- This Act recognizes the rights of forest dwellers to keep the forest land for habitation or for self-cultivation for livelihood, it also guarantees their hold over forest area resources which includes collection, use and disposal of community forest produce, it also provides the right to protect, regenerate or preserve or manage any community forest area for sustainable use.
- The Act also provides for utilization of forest land for public utility facilities managed with the aid of the Government, along with schools, dispensaries, fair price shops, electricity and telecommunication lines, water tanks, etc. With the advice of Gram Sabha's. Special Central Assistance provides monetary support to Tribal Sub Plan for infrastructure paintings viz. Roads, healthcare, primary education, sanitation, community halls, etc. for development of forest villages.
- Under Section 3(1)(h) of the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, the rights of agreement and conversion of all forest villages, vintage habitations, un-surveyed villages and different villages in forests, whether recorded, notified, or not, into revenue villages have been identified as one of the forest rights of forest residing Scheduled Tribes and different traditional forest dwellers on all forest lands.

LEARNING OUTCOMES

- The Constitution of India clearly states that it is the obligation of the state to 'protect and improve the environment and to safeguard the forests and wildlife of the country'. It's an obligation of every citizen 'to ensure and improve the natural environment including forests, lakes, streams, and wildlife'. Directive Principles of State Policy as well as the Fundamental Rights has also referred to the environment.
- The established arrangements are upheld by various laws – acts, rules, and notices. The EPA (Environment Protection Act), 1986 came into power soon after the Bhopal Gas Tragedy and is viewed as an umbrella enactment as it fills numerous holes in the current laws. Hereon, an enormous number of laws appeared as the issues started emerging, for instance, Handling and Management of Hazardous Waste Rules in 1989.
- The following environmental legislations have come into effect:
- 1972 - The Wildlife Protection Act, protects the birds and animals for all issues that are associated with them whether it be their habitat or the forests that provide for them.

- 1974 - The Water (Prevention and Control of Pollution) Act builds up an institutional structure for prevention and decrease in water contamination. It sets up standards for water quality and effluents. Industries must look for permission to release waste into water bodies.
- 1980 - The Forest (Conservation) Act and Rules, 1981, accommodates the conservation and the protection of the forests.
- 1981 - The Air (Prevention and Control of Pollution) Act accommodates the control and reduction of air contamination. It provides CPCB the authority for successful implementation of this act.
- 1986 - The Environment (Protection) Act enables the central government to secure and improve ecological quality, control and diminish contamination from all sources, and forbid or limit the setting and/or activity of industries on environmental grounds. The CPCB (Central Pollution Control Board) was comprised under this demonstration.
- 2006 - The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, was implemented to protect the forest rights and occupation of forest land in forest dwelling Tribes, in order to balance their socio-economic class and their right to environment.

Terminal Exercise

1. The Forest (Conservation) Act was enacted in the year:
 - (a) 1986
 - (b) 1974
 - (c) 1980
 - (d) 1972
2. The Wildlife (Protection) Act was enacted in the year:
 - (a) 1986
 - (b) 1974
 - (c) 1994
 - (d) 1972
3. This act leads to the creation of Central Pollution Control Board and State Pollution Control Board:
 - (a) Environment Protection Act, 1986
 - (b) Air (Prevention and control of Pollution) Act, 1981
 - (c) Forest Conservation act 1980
 - (d) Water (Prevention and control of Pollution) Act, 1974
4. Enlist the functions of Central and State pollution control boards.

5. The Central Govt. used Article 253 to enact this law and made it applicable throughout India.
 - (a) Environment Protection Act, 1986
 - (b) Air (Prevention and control of Pollution) Act, 1981
 - (c) Forest Conservation act 1980
 - (d) Water (Prevention and control of Pollution) Act, 1974
6. This act provides protection to certain endangered plants like Beddome Cycad, Blue Vanda, Pitcher plant etc.
 - (a) Environment Protection Act, 1986
 - (b) The Indian Wildlife (Protection) Act, 1972
 - (c) Forest Conservation act 1980
 - (d) Water (Prevention and control of Pollution) Act, 1974

LESSON-15

HUMAN COMMUNITIES AND THE ENVIRONMENT

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INTRODUCTION

Human population growth is the genesis of most of the environmental issues we face today and can be linked with negative environmental, economic and social impacts. The environmental impacts may include deforestation, land degradation, land-use change, water crisis and climate change. Several steps have been taken to ensure sustainability in growth and development, but the ever-growing human population keeps on challenging these initiatives.

LEARNING OBJECTIVE

After going through this unit, you will be able to

- Gain understanding about the various factors responsible for the human population explosion, the negative impacts of the ever-growing human population on the environment and human health.
- Develop knowledge about certain measures and policy decisions that can be adopted to keep a check on the growing population
- Examine the challenges associated with Resettlement and rehabilitation of project affected families and communities, outline the legal framework available to formulate an effective plan for the resettlement of displaced people.
- Understand the importance of communication for protection of environment and the means to disseminate information
- Gain understanding about the various environmental movements that have taken place in India and that have helped in progress of environmentalism in the country.
- Be aware about some initiatives by Ministry of Environment, Forests and Climate Change

1. Human Population Growth

1.1 Introduction

The current human population on earth is over 7.6 billion and is ever increasing with projections of over 9 billion by 2040 and 11 billion by 2100. The rapidly growing population is far outpacing the carrying capacity of the planet, which is the ability of the planet to support the overly sized population of humans as per the available resources. Overpopulation

is the genesis of most of the environmental issues we face today and can be linked with negative environmental, economic and social impacts.

1.2 Factors Responsible for Human Population Growth

Growth in the human population can be largely attributed to some advancement in the recent past in the field of agriculture, science, technology and health facilities. The surplus of food and other supplementary resources has provided ample space for the growing human population. Overpopulation at specific locations mainly cities can also result from migration in search of better living conditions. Several factors which led to such unprecedented growth in the human population are:

- Increase in agricultural productivity: Inclusion of modern techniques in agriculture like use of agrochemicals (like fertilizers, pesticides and insecticides) and modern machinery has led to multi-fold increase in agricultural yield. The surplus of food resources has been able to support the growing human population.
- Decrease in death rate and infant mortality rate: With the advancement in medical facilities including improved medicines and vaccines there has been a considerable worldwide decline in the death rate and infant mortality rate, which has led to larger population size.
- Advancement in Science and Technology: Advance scientific technology which fueled the industrial revolution provided a surplus of resources that could support a larger human population.
- Lack of awareness: Illiteracy, poverty and lack of awareness about the harmful impacts of a large population have also led to the problem of overpopulation. Awareness and use of various family planning methods are also lacking in most highly populated countries.

1.3 Impacts of Human Population Growth on Environment, Human Health and Welfare

Following are some of the major environmental and health impacts of growing human population:

- **Deforestation: The growing human population will lead to an increased demand for food, space and energy which will ultimately lead to destruction and clearing of pristine forest areas.** In order to increase the agricultural yield to support a large population, new areas have to be brought under agriculture which will lead to large scale deforestation. Forest will also be cleared due to urbanization, infrastructure development and industrialization. Deforestation will lead to reduced carbon dioxide absorption which will ultimately lead to global climate change phenomenon.
- Biodiversity loss: Decline in forest cover and other available habitats will also lead to a decline in floral and faunal biodiversity. This will lead to ecological imbalance and a decline in the biological resource of the planet.

- **Urbanization:** Rapidly growing human population has led to rapid urbanization which has adversely affected the environment and natural resources. Due to the growing population natural resources in the urban areas are depleting at a faster rate. A large part of the urban population is devoid of proper sanitation facilities and pure drinking water which has resulted in adverse health impacts.
- *Industrialization: The establishment of industries such as fertilizers, cement, steel, chemicals and oil refineries to support the needs of the growing population, leads to environmental degradation, land-use change and pollution. Growing levels of toxic pollutants in the atmosphere have a detrimental effect on the respiratory health of the affected people.*
- *Land Degradation: Intensive farming, excessive use of agrochemicals, and overexploitation of land and water resources leads to soil degradation, including soil erosion, salination and desertification.*
- *Generation of Waste: The large human population generates humungous solid and liquid waste which has detrimental environmental and health impacts.*
- **Loss of Fresh Water: Overexploitation of both surface and groundwater leads to a decline in available freshwater resources.** This leads to water scarcity issues and unavailability of safe drinking water. It is projected that 2/3 of the world's population will be living with water shortages by 2025.
- *Climate Change: Overpopulation and excessive use of fossil fuels have increased the level of various gaseous pollutants in the atmosphere including greenhouse gases.*
- *Transport Infrastructure: Development of transport infrastructure for the large human population has led to the release of large quantities of poisonous gases such as carbon monoxide, nitrogen oxides and hydrocarbons. The development of ports and harbours in the sea has led to oil spills from ships which adversely affect the marine biodiversity and ecosystems.*
- **Productivity:** Environmental degradation not only harms the environment but also reduces economic productivity. Polluted air and water causes several diseases in different parts of the world and thus reduces the productivity of the country. Water pollution has led to a decline in fisheries and water availability for agriculture. Soil degradation leads to the siltation of reservoirs and canals and transport channels.

1.4 Steps for Population Control

India has the second-largest population (1.3 billion) in the world and it is still growing. Hence, effective population control measures have become the need of the hour. Following measures can be taken to control the population growth in India:

- **Minimum age of Marriage:** In India, the minimum age for marriage is 21 years for men and 18 years for women. This law should be effectively implemented and people should be made aware regarding the same through publicity.

- Better Education: Education to different strata of society changes the outlook of people. Educated families prefer to delay marriage and adopt small family norms.
- More employment opportunities: Developing employment opportunities in both urban and rural areas will improve people's income and standard of living and thus their chances of adopting small family norms.
- Family Planning: Increasing awareness about various family planning methods and their easy availability can ensure their use and thus help in reducing family size.
- Incentives: The government can provide various types of incentives to the people to adopt birth control measures. This can include monetary incentives, tax benefits and other facilities like leave and promotion which can be extended to the working class which adopts small family norms.

1.5. Carbon Footprint

Carbon Footprint is the amount of greenhouse gases mainly carbon dioxide released into the atmosphere by any anthropogenic activity. It can be a broad measurement of the environmental impact of the actions of an individual, family, organization, industry or even an entire nation. e.g, To calculate an individual's carbon footprint we need to include a rough estimate of our overall carbon dioxide production from several daily activities including the use of electrical appliances, the distance we drive, our food consumption and how much we recycle.

Our carbon footprint can be reduced by using environment-friendly vehicles (battery operated), using public transportation, using energy-efficient appliances, insulating our homes to reduce electricity consumption on room heaters and air conditioning and consuming local and organic food. Individuals and companies can also offset some of their carbon dioxide emissions by purchasing carbon credits, the money from which can go into environment-friendly initiatives such as planting trees or investing in renewable and clean energy.

7.2 Resettlement and Rehabilitation of Developmental Project Affected Persons and Communities

Displacement of human populations in India is mostly initiated by factors such as large scale developmental projects like mining, dam building and industrial establishments apart from political conflicts, natural disasters, and declaration of an area as a National Park, Wildlife Sanctuary or a Biosphere Reserve. In India, a national policy on Resettlement and Rehabilitation of project affected families came into force in 2004. However, all displacement and resettlement programs have faced several challenges due to regional issues and administrative delays.

Resettlement and Rehabilitation (R&R) of families and communities displaced during the establishment of any large-scale developmental project is an integral part of the Environmental Impact Assessment and Environmental Management Plan Reports (EIA and EMP). The R&R Plan for project affected families for any proposed or ongoing is prepared

based on the National Policy for Rehabilitation and Resettlement, 2003 and as per National Rehabilitation and Resettlement Policy, 2007 (NRRP-2007). The plan for resettlement is implemented in association with the concerned State Government, representatives from the project affected families and other stakeholders in the area. A detailed socio-economic survey has to be conducted before the formulation of the R&R Plan.

Large scale infrastructure projects involuntarily displace many people which give rise to severe economic, social, and environmental problems. People are relocated to new places where their productive skills may be less applicable, production systems are degraded, employment opportunities and income sources are lost. The social fabric within the community is broken if the families from one area are displaced to separate locations. The resettlement of affected people (oustees) must aim to minimize involuntary resettlement, provide a time-bound resettlement plan and compensation for land and other assets affected by the project.

The resettlement package offered to project oustees mostly includes:

- Compensation: Monetary compensation includes the cost of house and land or it may include land in lieu of land.
- Physical Rehabilitation: A family that is resettling to an alternative site also receives well constructed residential houses, sanitary facilities, cattle shed, agricultural/horticulture land, Transportation/displacement grant, etc.
- Development of village infrastructure: Infrastructure at the resettlement colony is developed at the cost of the project. This includes the development of grazing land, roads, providing power and water supply, construction of schools, panchayat bhawan, sanitation and sewage facilities.
- Economic rehabilitation: Resettled families are supported in agricultural activities, poultry and non-farm economic activities.

Case Study: Tehri Dam Rehabilitation & Resettlement

Tehri Dam Project included the construction of a reservoir spread of 42 sq. km. which submerged the Old Tehri Town and 24 villages, while another 88 villages were partially affected. In addition to these 13 more villages were fully affected due to land acquisition the project infrastructure and establishing new colonies. The plan of rehabilitation and resettlement was broadly divided into Urban Rehabilitation and Rural Rehabilitation. Those families whose 50% or more land was being acquired were treated as *fully affected*, while those families whose less than 50% of land was being acquired were categorized as *Partially Affected* and were not relocated.

R&R Policy & Package

The resettlement policy for Tehri Dam was evolved by the state government and was implemented through Tehri Hydro Development Corporation (THDC). The basic principle of the rehabilitation policy was to compensate the rural oustees through allotment of agricultural

land or cash in lieu. The displaced families were settled in large colonies so that the fabric of their social life remains intact. Representatives of the displaced families were involved in selecting the site for the resettlement colonies. Basic community facilities like schools, hospitals, water supply and sanitation facilities were provided at the resettlement colony at the cost of the project, even if these did not exist in the original settlement. Apart from the compensation for property, every rural family was also given 2 acres of developed irrigated land in a rural area. The total cost towards R&R (including land acquisition, compensations, development of facilities, etc.) was Rs. 1,484 cr. which was nearly 18% of the total cost of the Tehri Dam Project.

LEARNING OUTCOME (Summary)

- Challenges associated with Resettlement and rehabilitation of project affected families and communities
- Legal framework available to formulate effective resettlement plan
- Case Study: Tehri Dam Project and displacement of families due to the construction of Tehri Dam.
- Negative impacts of the ever-growing human population on the environment and human health
- Factors responsible for the human population explosion
- Population control measures

Terminal Questions

State True or False.

1. World's human population is less than 7 billion. (*False*)
2. Population explosion can lead to a decline in biodiversity and species extinction. (*True*)
3. Using solar panels to assist the household electricity supply will reduce the carbon footprint of an individual/ Family. (*True*)

Long Questions

1. Write a short paragraph on 'Human Population growth and Natural Resources'.
2. The human population explosion is causing severe resource depletion and environmental degradation. Discuss with suitable examples.
3. Define Carbon Footprint.
4. Why is resettlement and rehabilitation of project-affected people a major challenge in India? Illustrate your answer with a case study.

LESSON-16

ENVIRONMENTAL COMMUNICATION AND PUBLIC AWARENESS

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INTRODUCTION

Effective communication is key pillar of an environmental campaign communicating an environmental or scientific message at any level - local, regional, national or global. Environmental communication became recognized from work having relevance to all academic subjects.

The environmental movement was ignited by a spark from Rachel Carson pen in the book named “Silent Spring” in 1962, highlighting about chemical pesticides. Alexander Flor considers environmental communication to be a significant element in the environmental sciences as depicted in his 2004 textbook named as “Environmental Communication: Principles, Approaches and Strategies”. According to Alexander Flor, environmental communication has some fundamentals such as information of ecological laws; sympathy to the cultural dimension; ability to network effectively; efficiency in using media for social agenda setting; gratitude and practice of environmental ethics; and conflict resolution, mediation and arbitration.

Professionals in environmental communication can communicate the importance of conservation to the public, governmental agencies, and private corporations; communicate your agency’s commitment to good environmental stewardship; persuade others of the need for compliance with environmental regulations; communicate with the media about environmental issues; write speeches; help sell environmentally-safe products etc. Non-profit conservation and advocacy organizations, private corporations, governmental agencies, politicians can hire professionals for the same.

Communications strategy: The objective of the communications strategy is to convince individuals and institutions whose actions –or lack of actions– prevent the conservation targets of the strategy should include both agents of change (policy- and decision-makers and key institutions) and end-users. An effective communications strategy should be based on two major assumptions:

- Public awareness can be used to change behavior by influencing changes in attitudes; and
- Influencing profound changes in attitudes will require sustained, long-term efforts.

The contemporary India experiences an almost unrestricted exploitation of resources because of the lure of new consumerist lifestyles. The balance of nature is disrupted. This has led to many conflicts in the society.

In this lesson plan, our focus will be on history of environmental communication and ecological movements like Bishnois of Rajasthan, Chipko movement, Appiko movement, Silent Valley Movement, The Narmada Bachao Andolan, Tehri Dam Movement Etc. The focus of these movements was not only on basic survival subjects but also on higher environmental worries and public awareness. Tarun Bharat Sangh a nongovernmental organization is working restoring rivers and johads in Rajasthan. Urban and Rural-based Environmental Movements like CNG Vehicles imitative in Delhi and Swachh Bharat Abhiyan indicate their importance in countering prevailing environmental pollution. Moreover many initiatives are taken under MoEF, Government of India like National Environment Awareness Campaign (NEAC) and National Green Corps (NGC) strengthening the same.

LEARNING OBJECTIVES

- Environmental communication and public awareness: case studies (e.g., CNG vehicles in Delhi, Swachh Bharat Abhiyan, National Environment Awareness Campaign (NEAC), National Green Corps (NGC) “Eco-club” programme, etc)
- Environmental movements: Chipko movement, Appiko movement, Silent valley movement, Bishnois of Rajasthan, Narmada Bachao Andolan, etc

HISTORY OF ENVIRONMENTAL MOVEMENTS

The escalation of environmentalism is rooted in the misuse of Mother earth like deforestation, slaughtering of animals for food, fun and sport, destroying rivers and turning lakes and ponds into garbage etc. which is endangering the earth’s life support system. Earth represents motherhood and peace and these are potent forces of the movements.

The rapid pace of industrialization and commercialization has made the government and all of us ignore realities of the grassroots leading to scarcity of resources. The natural ecosystems are affected adversely. The victims of development chose to various means to get their voice heard like, protests, demonstrations and suicidal fasts. Sunderlal Bahuguna, famous environmentalist referred to these movements as, ‘the only ray of hope in the middle of darkness’. These movements are aimed at overcoming hunger, non-sustainability, injustice etc. and establishing human and environmental balances leading to least impact on natural resources of mother Earth.

India has witnessed vital movements on environmental issues focused upon the species loss in aquatic life, depletion of forests, loss of heritage sites, rehabilitation of ecological refugees, air and water quality, biodiversity etc. They protest against deadly consequences of dams, national parks, irrigation and forestry and have philosophical leanings on Gandhism and Vinobha Bhave and Jai Prakash Narayanan. These movements have been in The Himalayan

Region, Tehri, Narmada Sagar, Jharkhand, etc. Famous environmentalists are Sunderlal Bahuguna, Medha Patkar, Swami Agnivesh, Ram Chandra Guha, Vandana Shiva, Maneka Gandhi, C.P. Bhatt, Anna Hazare, Arundhuti Roy etc.

These environmental movements increase awareness on conservation and are worried with development and depletion of resources. The common characteristics in these movements are:

these emerge from the question of social justice; focus on sustainable growth; generally non-violent; despite civil disobedience, they have to face torture, coercion and atrocities and moreover these movements have attracted a lot of media attention through their methods like, street plays, *padyatras*, effigy burning, *Jal Samadhi* etc.

The environmental movements can be divided into three broad groups although these overlap many a times. These are:

- i) *The land associated protest* of the peasants, landless, foresters, nomads, shifting agriculturalists and native tribes. The disputes under this category would relate to waste land management practices, mechanized farming, use of minor forest produce, plantation of trees etc.
- ii) *The water associated protests* of the fisherman over rivers and seas and the conflict over dams.
- iii) *The animal associated activism* of mainly urban middle class who want to free animals from circuses, entertainment industries, slaughterhouses, laboratory vivisection exercises etc. This is related to the issues of endangered species, fear of losing animal based occupation etc.

ENVIRONMENTAL MOVEMENT: CASES STUDIES

1. The Bishnois of Rajasthan: Initial Preservationist of the Environment

The Bishnois is a small tribal community belonging to Khejri village in Rajasthan. The religion of Bishnois, is an offshoot of Hinduism, was instituted by Guru Maharaj Jambaji, who was born in 1451 AD in the Marwar region of Rajasthan. Guru Maharaj Jambaji, in his youth, witnessed a severe draught in the region. The people cut down trees to feed the animals. The draught continued for a long time and there was nothing to feed the animals that died. He realized that if trees had been protected then the impact of draught on animals and community would not have been so severe. As a protective moral scheme, he formulated 29 injunctions (This is how BISHNOI name came in place as 'BIS' is twenty and 'NOI' stands for nine), like ban on felling of trees, killing of any bird or animal etc. The community consistently implemented these and their land was converted into lush green and dense forest. They practice environmental conservation as a part of their daily religious duty. Their ardent belief is that cutting a tree or killing an animal or a bird is sacrilege. They preserve Khejri trees, Blackbucks, Neelgai, Peafowl and Chinkara.

Bishnois can truly be considered first eco-warriors. Their history is of confrontation with local monarchs who attempted to interfere in their sacred zone. About three centuries back that is around 1700AD, the king of Jodhpur desired to build a palace and soldiers were sent for acquiring timber to the forests where Bishnois dwelt. This met tough resistance of the locals led by women who encircled the trees to protect them with their bodies. The soldiers who were ordered to fetch timber started killing the protesters. Amrita Devi, a female villager could not bear to witness the destruction of both her faith and the village's sacred trees. She hugged the trees and encouraged others to do the same. 363 Bishnoi villagers were killed in this movement. The Bishnois sacrificed their lives to honour the injunctions formulated by their Guru. When the king was informed about the carnage, he called back the soldiers and provided state protection for the strong belief of the Bishnoi community, forbidding harm to trees and animals. This legislation still exists today in the region.

Later, they organized resistance against the British officials who wanted to start commercial forestry. In 1930s, a number of Satyagraha Movements were organized by the farmers and people living in forests in many parts of the country to protect forests from destruction from the British Rulers. The rebels were varied and comprised of peasants, pastoral nomads, artisans and native hunters. The anti-colonial movement spread in the villages and forests during the 19th century supported environmental causes. They raised their voice for preservation of native heritage, local agriculture and opposed the use of biomass resources.

Even today, the Bishnois follow respect, love and protection of nature with the same zeal. Their sacrifice is an example of Satyagraha for environmental protection and Chipko Movement was greatly inspired by their belief.

The Bishnoi villagers register a complaint against Salman Khan on 2nd October 1998 and his 'Hum Saath Saath Hain' co-actors Saif Ali Khan, Tabu, and Sonali Bendre who allegedly hunted down two blackbucks in the Kankani village of Rajasthan. Latter he was arrested in the connection with the poaching of endangered animals, and subsequently, granted bail.

2. The Chipko Movement

Chipko means to 'to hug' or 'to embrace'. The villagers formed a human chain and encircled earmarked trees to save them for being felled. This movement draws its inspiration from the Gandhian philosophy of non-violence and has become a full eco feminist-development movement. The movement started at Alkananda catchment area of mid-western Himalayas where the people were unable to sustain their livelihood due to deforestation. The women had to walk for miles in search of firewood, fodder and patches of land for grazing their animals. A few logging firms were given contracts to bring down forest rims around the hills of Central Himalayas. Due to deforestation for construction of roads by Border Security Force (BSF), there was soil erosion. In July 1970, there was a massive flood. The *Dasholi Gram Swarajya Mondal* (DGSM) carried out relief work and sensitized the local people that the reason of flood was destruction of forests.

The Forest Department turned down the Sangh's yearly request for ten ash trees for its farm tools workshop was the first instance, and instead bestowed a contract for 300 trees to Simon Company. Simon company was a sporting goods manufacturer in distant Allahabad, to make tennis racquets. In 1973, the village Mandal confronted the lumbermen who arrived at Gopeshwar, where about many villagers along with Dasholi Gram Swarajya Mondal were beating drums and shouting slogans, thus forcing the contractors to retreat. It is a movement that practiced methods of Satyagraha where both male and female activists from Uttarakhand played vital roles, including Gaura Devi, Suraksha Devi, Sudesha Devi, Bachni Devi and Chandi Prasad Bhatt, Virushka Devi and others.

Today, beyond the eco-socialism hue, it is being seen increasingly as an ecofeminism movement. Although many of its leaders were men, women were not only its backbone, but also its mainstay, because they were the ones most affected by the rampant deforestation which led to a lack of firewood and fodder as well as water for drinking and irrigation. Over the years they also became primary stakeholders in a majority of the afforestation work that happened under the Chipko movement. In 1987, the Chipko movement was awarded the "Right Livelihood Award" for its dedication to the conservation, restoration and ecologically-sound use of India's natural resources.

Sunderlal Bahuguna an eminent leader of chipkoandolan also spread the message bare footed in the Doon Valley in the Himalayan foothills. In the valley, due to mining of limestone, trees like Banj, Tun, Sinsyaru and Chir were cut. The natural water storage got disturbed which hit the rural women hard who had to fetch water from long distances. They emulated the ethos of the Chipko Movement of the Garhwal and laid blockage in the mining operations near the stream SinsyaruKhala, whose source had been mined for twenty years. Chamundevi and Iswairi Devi led local Chipko movement for more than two decades. They employed varied forms like, hugging trees and embracing living materials.

Later, many movements were observed in the shade of the Chipko force in the Western and Eastern Ghats. The main target for both was the Eucalyptus sapling being planted by the paper and pulp industries. A number of countries from the developed world namely, Switzerland, Germany, Sweden, France etc. also acknowledged the Chipko Movement. The United Nation's Conference on Human Environment held at Stockholm in 1972 asserted its importance on the global level.

3. The Appiko Movement

The undulation effect of Chipko Movement was evident in the Uttar Kannada region of Karnataka (Uttara Kannada and Shimoga districts of Karnataka State) situated in the Western Ghats by starting Appiko Movement in 1983. The Appiko Movement was locally known as "Appiko Chaluvali". It can be said that Appiko movement is the southern edition of the Chipko movement. The Appikos (Chipko of the Western Ghats) were protesting against the polyfibre industry in their region. The contractors targeted to grow timber for commercial purposes cleared the natural forests impacting water resources, silting and soil erosion. The

forest department was converting the tropical forests into monoculture of teak and eucalyptus plantations. Sunderlal Bahuguna eminent activist who was invited to provide direction to the movement. This led the youth and women to replicate Chipko Movement and they walked five miles to nearby forests and hugged trees to stop the axe-men from felling of trees. It was a 38 days long protest and Government had to withdraw orders to cut trees. The Appiko movement used various techniques to raise awareness such as walking on foot in the interior forests, photograph demonstrations, folk dances, street dramas etc.

In November, 1983, this movement reached Nilgod (Siddapur Taluka) where 300 people demanded ban on falling of trees. The Appikos exposed the role of politicians and forest department in permitting the contractors to pursue commercialization. The *Parisar Samrakshana Kendra* (Environmental Conservation Centre) fulfilled objectives like: to protect existing forest and prevent deforestation, regeneration of trees, plantation of new trees, conservation of natural resources, and create awareness. The Appiko movement was successful in protecting medicinal trees, bamboo trees and the natural forest cover. The movement became a success. The current status of the project is – stopped.

4. Silent Valley Movement

Silent Valley is moist evergreen tropical forest spread over 90 kilometers and situated in Palakkad district of Kerala. This densely forested valley is highly deep and peaceful. Environmentalists argue that the valley was one of the world's richest biological and genetic heritages, one of the few remaining rainforests in India and home for over 900 species of flowering plants and many endangered species of animals and birds. In 1973, the Planning Commission of India approved a hydropower project at a cost of about Rs 25 crores on the river 'Kunthipunza' flowing across the valley with an objective to generate 240 MW electricity. Romulus Whitaker, founder of the Madras Snake Park and the Madras Crocodile Bank, was probably the first person to draw public attention to the small and remote area. And then the people opposed raising its threat on ecology, forest cover and animals, many of which belonged to endangered categories. The *Kerala Sastriya Sahitya Parishad* (KSSP) launched a mass movement. The Kerala Sastra Sahitya Parishad (KSSP) an NGO, and the poet-activist Sughatha Kumari played an important role in the Silent Valley protests.

Many feared that the project would submerge 8.3 sq km of untouched moist evergreen forest. Several NGOs strongly opposed the project and urged the government to abandon it. In January 1981, bowing to unrelenting public pressure, Indira Gandhi declared that Silent Valley will be protected. In June 1983 the center re-examined the issue through a commission chaired by Prof. M.G.K. Menon. In November 1983 the Silent Valley Hydroelectric Project was called off. In 1985, Prime Minister Rajiv Gandhi formally inaugurated the Silent Valley National Park. Moreover, the National Committee on Environmental Planning (NCEP) also gave negative reports. These developments compelled the Kerala Government to call off the project in December 1980. The Silent Valley was converted into a National Park so that its ecological surroundings are preserved.

5. The Narmada Bachao Andolan

The Sardar Sarovar Project aimed at construction of a massive dam on Narmada river in Maharashtra and Gujarat began in collaboration with World Bank in 1978. The Sardar Sarovar dam is one of the largest dams ever constructed. It consisted of more than 3000 major and minor dams with an outlay of approximately 25,000 crore. The project was estimated to displace nearly one million people and submerge nearly 350,000 hectares of forestland and 200,000 hectares of cultivated land.

By 1985, people from all sections of society started mass movement to save Narmada. The movement first started as a protest for not providing proper rehabilitation and resettlement for the people who have been displaced by the construction of Sardar Sarovar Dam. Later on, the movement turned its focus on the preservation of the environment and the eco-systems of the valley, growth oriented developmental policies and traditional rights of indigenous people over land and protection of forests. The *Narmada Bachao Andolan* founded in 1989 (Save Narmada Movement) and started under the leadership of Baba Amte, later lead by Medha Patkar and eminent Novelist Arundhati Roy intensified the movement. The Activists questioned design, implementation, resettlement and rehabilitation policies of Sardar Sarovar Project. They organized *Jan Vikas Sangharsha Yatra* in December, 1990 and around 6000 protesters marched from Rajgha, Madhya Pradesh to Gujarat. The environmental groups pressurized World Bank against the project. Later, activists also demanded the height of the dam to be reduced to 88 m from the proposed height of 130m. The outcome of the pressure was that World Bank withdrew from the project.

The environmental issue was taken into court and in October 2000, the Supreme Court gave a judgment approving the construction of the Sardar Sarovar Dam with a condition that height of the dam could be raised to 90 m. This height is higher than the 88 m which anti-dam activists and environmentalists demanded, but it is definitely lower than the proposed height of 130 m. The project is now largely financed by the state governments and market borrowings. The project is expected to be fully completed by 2025.

Although not successful, as the dam could not be prevented, but this movement of Narmada Bachao Andolan has successfully constructed an anti-big dam belief in India and outside. It questioned the prototype of development.

6. Tehri Dam Movement

Another major controversy erupted around the Soviet aided Tehri Dam in 1972 situated in Garhwal Himalayas. The Tehri and Narmada movements evoked the conscience of people all over the world. The project was targeted on two Himalayan Rivers, Bhagirathi and Bhilangana. The larger plan aimed three storage reservoirs at Bhagirathi at Tehri, Kotli Bhel, a little downstream and Utyasu at another tributary of the Ganges, Alaknanda. The Tehri Dam was expected to be 260.5 m high and be the fifth highest dam in the world and submerged around 6200 ha. of land and more than 9 villages in the vicinity. The reservoir

would extend up to 45 kilometers in the Bhagirathi valley and 25 kilometers in the Bhilangana valley with a water spread area of 42.5 sq. kilometers. The Soviet financed project would cost about Rs. 3000 crores. The Planning Commission gave its approval in 1972.

The main controversy emerged because Tehri is a geologically vulnerable area and prone to seismic activities and tectonically risky area. The seismic activity may entirely destroy Deoprayag, Munikireti, Hardwar and Rishikesh. Thereafter, 35 Gaon Sabhas in the Tehri district jointly passed a resolution to oppose the project. Despite all opposition, the Uttar Pradesh decided to go ahead with it. The environment movement took the shape of public protest to oppose dam in the form of *Tehri Bandh Virodhi Sangharsha Samiti (TBVSS)*. Its first resolution opposing the construction of dam was passed unanimously in January 1978. Mass protest followed the construction of diversion tunnels by UP Government.

In August, 1980, V.D. Saklani, freedom fighter and lawyer requested the Planning Commission to review the project. Later, Sunderlal Bahuguna initiated a fierce movement. Sunderlal Bahuguna fasted for 56 days that resulted in stopping the blasting operations. The opposition led to suspension of construction of dams in 1990. Leaders like Sunderlal Bahuguna supported the cause but the movement failed to gather adequate support at national as well as international levels.

7. NGO Role in Water Conservation: Tarun Bharat Sangh of Rajasthan

Tarun Bharat Sangh is a non-profitable environmental, non-governmental organization, with headquarter in Bheekampura, Alwar, Rajasthan. It was founded in 1975 in Jaipur by a group of students and professors from the University of Rajasthan. In 1985 the course of the organization changed when four young members from this organization went to live in the rural area of Alwar to teach rural children and do rural development. Of those four, Rajendra Singh stayed when the other three left. He asked the local people about their basic necessity and he found that they needed easier access to water. So, with the help of villagers he organized the building of a johad, which is a traditional rainwater storage tank. Dr Rajendra Singh is also now known as Water man of India, is serving as chairman of this reputed organization since 1985.

This organisation has built on existing cultural traditions of the village communities and successes to create an understanding and ethos of integrated ecosystem development. At present the contribution of the organisation is spread around in 1000 villages of 15 districts in the state of Rajasthan. The organisation has also been part of rejuvenating and enlivening 11 rivers in the state of Rajasthan namely, Ruparel, Sarsa, Arvari, Bhagani, Jahajwali, Shabi, and establishment of about 11,800 johads. As a consequence of these contributions the organisation was awarded with "Stockholm water Prize" in 2015. Presently, it's focus rests upon access to water by rejuvenation of water resources, tackling issues like human and wildlife conflicts, and combating the mining mafias for the benefit of the indigenous communities.

Major Objectives of Tarun Bharat Sangh

Community participation is the main strength through which this organization carries out development programmes. Major objectives can be listed as below:

1. Finding a balance between human and natural resource development.
2. Ensuring women participation in the process of decision making.
3. Improvement of the level of education in the community.
4. Incorporation of better health facilities to create healthy
5. Energizing human power, especially youth power, to harness energy to value-based work.

Strategic Themes of Tarun Bharat Sangh

As this organization gets strength by local its strategy gradually categorized into five themes, which are as follows:

1. The effort has to be collective one from the community in which all would benefit proportionately from the improvement that would be planned.
2. The collective wisdom could be conceived in an atmosphere where informal communication took place, and every one had an equal opportunity to be heard.
3. All decisions would be strictly enforced, and the community would be its own self-disciplinarian.
4. Each person in the collective community would be individually responsible to carry out the tasks.
5. The community would only use outside help as a catalyst for their guidance and for the facilitation of the work processes.

8. Urban and Rural-Based Environmental Movements

After 1950s environmental pollution caused due the rapid industrialization has become the focus of collective action by the civil society organisations, NGOs, concerned individuals, especially lawyers, scientists, environmentalists and social activists in the form of urban and rural based environmental movements. They sought the intervention of the judiciary along with large scale public participation and drew the attention of the serious state of environment. However, the main focus of the collective action against pollution has been in the urban areas. Certain tragedies like gas leakage in Bhopal based Union Carbide multinational company; Chernobyl in former Soviet Union where thousands of people were killed created worries among the people on the negative effect of the industrialization.

All the major cities of India are facing acute air, water and other kinds of environmental pollution. Continuous immigration of the people from rural areas into the cities, their habitat in the congested areas which exist along with the polluting small-scale industries; increasing

number of vehicles; and unplanned expansion of cities, open drainage, etc. have already crossed permissible levels of environmental hazards. This pollution made people susceptible to multiple diseases.

But today the protection of environment forms significant part of the policies of the state. The judiciary has made the people's rights to protect their environment by using a powerful weapon named Public Interest Litigation (PIL). The intervention of the judiciary forced the state to introduce some measures for prevention of environmental pollution. Justice Krishna Iyer, Justice Kuldeep Singh and advocate MC Mehta have made remarkable contribution in protection of the environment. This judicial pattern has strengthened the urban and rural based environmental movements such as emergence of CNG vehicles in Delhi and grand success of Swachh Bharat Abhiyan.

9. CNG (Compressed Natural Gas) Vehicles Initiative in Delhi

Rising levels of pollution have been a major cause of concern in the National Capital Delhi, which has been put in the list of 20 most polluted cities of the world by World Health Organization. Main issues related to the environmental pollution are air pollution caused due to the vehicular and industrial pollution and water pollution in Yamuna River. The number of private and public vehicles has increased many folds in the recent past. This has polluted the environment and made people, especially children and old vulnerable to multiple diseases in the city.

Reacting to the court order which was result of a PIL, the government made it compulsory to introduce the CNG vehicles and make the pollution check mandatory for all private vehicles. The introduction of the CNG vehicles has resulted in the reduction of the environmental pollution in the city. Similarly, the Delhi government has been force to shift the polluting industries out of the city and launch the Yamuna River cleaning operation. Moreover, taking action as per recent orders of the Supreme Court of India to check it, Delhi Government is planning to push Hydrogen-enriched CNG buses on its roads. From just five lakh vehicles in 1981, the increase in the number of vehicles has tremendously proliferated. According to Delhi traffic police, around eighty thousand vehicles travel through Delhi every day between 8 pm and 6 am indicating that its fleet On 28th July 1998, the Supreme court ordered all commercial vehicles to be mandatorily converted to CNG vehicles especially taxi, buses and three wheelers.

Advantages of usage of CNG: CNG may be generated and used for bulk storage and pipeline transport of renewable energy and also be mixed with biomethane, itself derived from biogas from landfills or anaerobic digestion. This would allow the use of CNG for mobility without increasing the concentration of carbon in the atmosphere. It would also allow continued use of CNG vehicles currently powered by non-renewable fossil fuels that do not become obsolete when stricter CO₂ emissions regulations are mandated to combat global warming.

Limitations of usage of CNG: The use of CNG vehicles faces several limitations such as fuel storage and infrastructure available for delivery and distribution at fuelling stations.

CNG must be stored in high pressure cylinder only and. this cylinder takes up more space than gasoline or diesel tanks. Other limitation include: relatively price and environmentally insensitivity.

Due to burning issues like climate change and estimations that non-renewable fuels like crude oil will get exhausted in near future, exploring new fuels like CNG is a boon. Thus the Government shall now take more initiatives so that alternative fuels can be commercialized.

10. Swachh Bharat Abhiyan

Swachh Bharat Abhiyan is one of the most widespread and noteworthy missions in the history of India which was introduced by the Prime Minister, Narendra Modi and was launched on 2nd October 2014 to honor Mahatma Gandhi's vision of a clean Bharat. This campaign was run on a national level in all the towns, rural and urban areas.

The major objective of the Swachh Bharat Abhiyan is to spread the consciousness of cleanliness and the importance of it. The perception of Swachh Bharat Abhiyan is to afford the basic sanitation facilities like toilets, solid and liquid waste disposal systems, village cleanliness and safe and adequate drinking water supply to each and every person. The action plan is to be laid by the Ministry of Drinking Water and Sanitation. The apparition is to triple the facility of sanitation by 2019. The major change to be implemented of an Open Defecation Free (ODF) India.

Action Plan of Swachh Bharat Abhiyan targeted towards improving the percentage of toilets from 3% to 10% by 2019 through intensification in the construction of toilets from 14000 to 48000 daily; Launch of a National Level/State Level Media campaign through audio graphic, mobile and regional actions to communicate the message of mindfulness and moreover, participation by school children in these activities.

Swachh Bharat Mission in Urban ecosystems came under the Ministry of Urban Development and is commissioned to give sanitation and household toilet facilities in all statutory towns. It also drives to establish solid waste management facilities in every town. At the core of this mission lie six gears namely, Separate household toilets; Municipal toilets; Public toilets; Municipal Solid Waste Management; Information and Educating Communication (IEC) and Public Awareness along with Capacity Building.

Swachh Bharat Mission in Rural ecosystems known as Swachh Bharat Gramin, goals to make Village Panchayats open defecation free by October 2, 2019. Eradicating hindrances and addressing critical issues that affect results is the new push of this rural sanitation mission. It aims to provide all rural households with individual defecation slots; and build cluster and community toilets on public-private partnership approach. Schools in the villages are given special emphasis for basic sanitation amenities. Moreover, construction of Anganwadi toilets and management of solid and liquid waste in all Village Panchayats is also focused under this important mission.

Initiatives by MoEFCC of the Government of India

The Ministry of Environment, Forest and Climate Change (MoEFCC) of the Government of India has undertaken several initiatives towards the goal of Education for Sustainable Development (ESD). ESD recognizes the fact that over the lifetime the education needs of the people change. The Environment Education (EE) division of the ministry has, therefore, designed several modules as part of its Environment Education Awareness and Training Scheme programmes. These initiatives were taken as part of two programmes- National Green Corps (NGC) and National Nature Camping Programme (NNCP) also known as National Environment Awareness Campaign (NEAC).

National Environment Awareness Campaign (NEAC)

National Nature Camping Programme (NNCP) also known as National Environment Awareness Campaign (NEAC) is an important campaign of the Ministry of Environment and Forests (MoEF), Government of India. This campaign was initially organised in 1986, with the objective of creating environmental awareness at the national level and, since then, it has become an annual activity.

This is one of the major programmes of the MoEF that targeted public participation in conservation and management of the environment. Every year, the MoEF selects NEAC activities with a fresh agenda and a new theme. It is a widespread outreach programme reaching out to grass-root levels of several sections of the society. The campaign follows a decentralised approach where the Regional Resource Agencies (RRAs) work with many of the non-government organisations (NGOs) on environmental protection. The flexibility of the interaction between the RRAs and the participating organisations makes the programme creative and workable, in spite of the vast numbers involved. The NEAC has managed some very creative programmes and useful resource materials, with the help of both RRAs and NGOs. The NEAC has been able to reach out to people through effective means, such as performing arts, debates, nukkad nataks etc. It has been realized that practical means of educating the masses are more effective than lectures and seminars. What are common among the preferred processes are the low cost, entertainment value, easy accessibility and comprehensibility.

National Green Corps (NGC)

National Green Core (NGC) popularly known as “a programme of Eco-clubs” is also a nationwide initiative of the Ministry of Environment & Forests and Climate Change. This programme was started in the year 2001-02, and today has a network of more than 1,20,000 schools that aims at building core groups of young students working towards environmental conservation for more secure and sustainable world. In Madhya Pradesh this programme is implemented by Environmental Planning and Coordination Organisation (EPCO), as State Nodal Agency having 12500 schools at 50 districts. 250 schools in each district in the state which includes all the Kendriya Vidyalayas, Navodaya Vidyalayas and all other schools under CBSE and ICSE and State Boards have formed eco-club of 50-60 students.

Main Objectives of NGC

1. To impart knowledge to school children, through hands-on experience, about their immediate environment, interactions within it and the problems therein.
2. To develop requisite skills of observation, experimentation, survey, recording, analysis and reasoning for conserving the environment through various activities.
3. To inculcate the proper attitude towards the environment and its conservation through community interactions.
4. To sensitize children to issues related to environment and development through field visits and demonstrations.
5. To promote logical and independent thinking among children so that they are able to make the right choices in a spirit of scientific inquiry.
6. To motivate and stimulate young minds by involving them in action projects related to environmental conservation.

Methodology Adopted by Eco-Clubs:

The scheme is being operated through Eco-clubs of 50-60 students having interest in environment related issues, formed in member schools. Eco clubs are supervised by a Teacher In-charge, who is selected from among the teachers of the member school on the basis of his/her interest in environment related issues. There is District Implementation and Monitoring Committee to supervise, organise training for In-charge teachers, and monitor periodically the implementation of scheme at the District level. There is a State Steering Committee for guidance, direction and to oversee the implementation of the scheme. The State Nodal Agency coordinates the implementation of the scheme in the State and organize related activities like training to Master Trainers. The National Steering Committee will give overall direction to the programme and ensure linkages at all levels.

Activities for NGC (Eco-Clubs)

1. Organize seminars, debates, lectures and popular talks on environmental issues in the school.
2. Field visits to environmentally important sites including polluted and degraded sites, wildlife parks etc.
3. Organize rallies, marches, human chains, and street theatre at public places with a view to spread environmental awareness.
4. Action based activities like tree plantation, cleanliness drives both within and outside the school campus.
5. Grow kitchen gardens, maintain vermi-composting pits, construct water-harvesting structures in school, practice paper re-cycling etc.
6. Prepare inventories of polluting sources and forward it to enforcement agencies.

7. Organize awareness programmes against defecation in public places, pasting posters in public places and to propagate personal hygiene habits like washing hands before meals etc.
8. Maintenance of public places like parks, gardens both within and outside the school campus.
9. Mobilize action against environmentally unsound practices like garbage disposal in unauthorized places, unsafe disposal of hospital waste etc.

LEARNING OUTCOME (Summary)

- The environmental communication have emerged as result of peoples' struggle for life and dignity. The developmental projects have serious implications on social structure and economy. The overutilization of natural resources has posed a severe threat to the livelihood of millions of people who are dependent on the natural resources. The developmental projects should be harmonized with the environmental effects and be ecologically sensitive.
- An environmental movement can be defined as a social or political movement, for the conservation of environment or for the improvement of the state of the environment. The terms 'green movement' or 'conservation movement' are alternatively used to denote the same.
- The environmental movements favour the sustainable management of natural resources. The movements often stress the protection of the environment via changes in public policy. Many movements are centred on ecology, health and human rights.
- The Bishnois of Rajasthan were influenced by the teachings of Guru Maharaj Jambheshwarji, who founded the Bishnoi faith in 1485 and set forth principles forbidding harm to trees and animals.
- The Chipko movement or Chipko Andolan, was a forest conservation movement in India. It began in 1970s in Uttarakhand, then a part of Uttar Pradesh (at the foothills of Himalayas) and went on to become a rallying point for many future environmental movements all over the world.
- It can be said that Appiko movement is the southern version of the Chipko movement. The locals embraced the trees which were to be cut by contractors of the forest department. Moreover, the movement targeted towards promote afforestation on denuded lands. The movement later focused on the balanced use of ecosphere through familiarizing alternative energy resource to reduces pressure on the forest.
- Silent Valley movement, Narmada Bachao Andolan and Tehri dam movement are other environmental movements targeted towards protest against construction of dams raising the issues of design, implementation, resettlement and rehabilitation policies.

- Tarun Bharat Sangh seeks to bring dignity and prosperity to the life of a destitute section of the nation through sustainable development measures. It aims for the holistic development of men, women, and children, regardless of economic situation, caste or religion. It also promotes the community-driven-decentralized-management of the natural resources.
- Urban and rural based environmental movements escalated after 1950s due to rapid industrialization causing environmental pollution and the focus of collective action by the civil society organisations, NGOs, concerned individuals, especially lawyers, scientists, environmentalists and social activists tried to minimized the impacts.
- The Ministry of Environment, Forest and Climate Change is implementing Environment Education, Awareness and Training Scheme with the objective to promote environmental awareness among all sections of the society and to mobilize people's participation for conservation of environment. Under the National Green Corps (NGC) programme of the Ministry, about one lakh schools have been identified as Eco-clubs, wherein, nearly thirty lakh students are actively participating in various environment protection and conservation activities, including the issues related to the air pollution.

Terminal Exercises

- 1) Discuss the role of environmental communication and public awareness in environment protection.
- 2) Highlight the main issues and concerns of the environmental movements in India.
- 3) Discuss the main feature of the Chipko movement.
- 4) Write a note on Narmada Bachao Andolan.
- 5) In your view, how are the environmental and ecological rights related to democracy and development in India? Explain.
- 6) What is the objective of Swachh Bharat Abhiyan? What are the challenges and how can we make this movement more effective and successful?
- 7) With appropriate examples, discuss the contribution of women in protecting the environment and raising environmental awareness in India.