ENVIRONMENTAL ENGINEERING - I  CE 334

UNIT 1- INTRODUCTION

**Definition of Environment**

The term environment is used to mean the region, surroundings or circumstances in which anything exists and everything external to the organism is included in it.

**Environmentalist**

The environmentalist is a person working to resolve the environmental problems such as air and water pollution, the careless use of natural resources, noise pollution, uncontrolled population etc.

**Role of environmental engineer**

- He must be well conversant with the planning, designing, construction, maintenance and operation.
- He must be able to design the water works scheme in the best possible way with maximum economy and deficiency to remove impurities and bacteria’s.
- He must be capable to operate the water works without fail and should supply the safe palatable water to the public in the required pressure at various points.
- He should protect the source of water as well as treated water from the contamination or any type pollution.
- He should be able to do laboratory tests.
- He should be able to alter the purification methods depending upon the types of impurities and bacteria’s present in water.
- He must keep himself aware of the latest techniques and methods of purification of water and distribution methods of water.

**Environmental impact of development**

An impact can be defined as any change in the physical, chemical, biological and or socio economic environmental system which can be attributed to human activities relative to alternativeness under the study for meeting a project need.
Steps Involved For Prediction and Assessment of Impacts On The Air Environment

1. Identification of air pollutants from sources.
2. Base level ambient air quality of the area determination.
3. Estimation of air pollution dispersion pollution with the help of
   i. Monthly variation of mean mixing depths
   ii. Wind speed
   iii. Inversion heights
   iv. High air pollution potential
5. Air quality standards or emission standards along with the time required to meet them.
6. Identification of air pollution sources.
7. Estimation of impact caused by the project at one hand and also by various alternative methods.
8. Determination of ground level contamination of air pollutants from the alternative under varied metrological conditions.

ENVIRONMENTAL POLLUTION

Pollution
The term pollution is derived from the Latin word Pollittus

Pol means before

Lutus means wash.

The water before washing contains impurities and hence the term water pollution is used to indicate an act of contaminating or making foul natural water bodies such as rivers, streams, wells, etc.

In general, the term pollution is to mean the conditions disturbing the balance of natural environment in such a way that its beneficial use is adversely affected. Thus the pollution causes undesirable changes - and it threatens the land, water, air and outer space environment.
WATER POLLUTION

Definition
The water before washing contains impurities and hence the term water pollution is used to indicate an act of contaminating or making foul natural water bodies such as rivers, streams, wells, etc.

Sources of water pollution
Following are the two main sources of water pollution:
(1) Domestic sewage
(2) Industrial wastes.

(1) Domestic sewage:
  - The domestic sewage contains oil, human excreta, decomposed kitchen wastes, soaps, water, pathogenic bacteria and hospital sewage.
  - If domestic sewage is not properly handled after it is produced or if the effluent received at the end of sewage treatment plant is not of adequate standard, there are chances of water being polluted.
  - If sewage or partly treated sewage is directly discharged into surface waters such as rivers, the waters of such rivers get contaminated.

(2) Industrial wastes:
  - If industrial wastes are thrown into water bodies without proper treatment, they are likely to pollute the water courses.
  - The industrial wastes may carry a number of harmful substances such as grease, oil, explosives, highly odorous substances, etc.
  - The principal types of industries which contribute to the pollution of rivers in India are chemicals and pharmaceuticals, coal washeries, hydrogenated vegetable oil and soap, pulp-paper, sugar and distilleries, textile and tanneries, steel mills, fertilizers, oil refineries and various other miscellaneous industries.
MISCELLANEOUS SOURCES OF WATER POLLUTION

1) Catchments area:
Depending upon the characteristics of catchment area, the water passing through such area will be accordingly contaminated the advances made in agricultural activities and extensively causes pollution of surface waters. The haphazard dumping of the agricultural wastes and the seepage of agro-chem. from cultivated areas may pollute the water bodies.

(2) Distribution system: The water is delivered to the consumers through a distribution system of pipes which are laid underground. If there are cracks in pipes or if joints are leaky, the flowing water gets contaminated by the surrounding substances around the pipes.

(3) Oily wastes: The discharge of oily wastes from ships and tankers rushing oil as fuel may lead to the pollution of beaches. The oil is lighter than water and hence it remains on the surface. It is then shifted to some shore due to currents and winds. The beaches are thus spoiled and bathing becomes practically impossible.

(4) Radioactive wastes: The discharge of radioactive wastes into waters from industries dealing with radioactive substances may seriously pollute the waters. It may be noted that the radioactive substances may not have colour, odour, turbidity or taste. They can only be detected and measured by the use of special precise instruments.

(5) Source of water supply: From the surface run off, the waters of surface sources are likely to receive enormous load of organic and mineral matter and bacteria. Thus the water available from the source itself may be highly contaminated.

(6) Storage reservoir: The impurities such as particles of sand, etc. settle down at the bottom of storage reservoirs and hence a surface water of such reservoirs contains small amount of impurities.

(7) Travel of water: Depending upon the properties of ground through which water travels to reach the source of water supply, it charges with the impurities. For instance the streams passing through peaty land possess brown color.
SOURCES OF WATER POLLUTION

The water pollution may broadly be divided into the following three Categories:
(1) Physical pollution
(2) Chemical pollution
(3) Bacteriological pollution.

The physical pollution of water occurs due
- Color
- Taste and odour
- Temperature
- Turbidity
- Suspended matter
- Radioactivity
- Foam

Colour:
- The water bodies may be receiving colour from natural or artificial sources.
- Some of the important industries producing colored industrial wastes are paper industry discharging lignin, textile industry, tanneries discharging tannins, etc.
- It may be noted that pollution of water due to colour is mainly an aesthetic one and in many cases, it does not develop any threat to the public health.

Taste and odour:
- The industrial wastes contain many strong smelling chemical compounds and when such trade wastes are discharged into rivers or streams, the water of such rivers or streams gets unpleasant taste and odour.
- Some of the important chemicals producing taste and odour in water are salts, iron, manganese, tree chlorine, hydrogen sulphide, phenols, unsaturated hydrocarbons, etc. The taste and odour in water in general have no real public health significance. But the pollution of water by taste and odour has the following effects:
- Such waters may prove detrimental to fish life and may damage the value of fisheries.
Such waters are not liked by public and they are rejected even in preference to the
tasteless and odorless waters of poor quality.

If taste and odour in water are due to certain toxic chemical gases, the use of such
waters may seriously injure the public health.

**Temperature:**
- The temperature of trade wastes which are discharged into rivers or streams is
  high; there is rise of temperature of such water bodies.
- For instance, the cooling water from thermal and nuclear power stations is
  considerably warm and if such warm water is discharged into natural waters
  bodies, it will result in the rise of temperature of water of such natural bodies.

**Turbidity**
- The water becomes turbid due to the presence of the following:
  - Colloidal matter or very finely divided suspended matter which settles only with
    great difficulty,
  - Salts of iron and manganese which are oxidized to their Hydroxides, sewage, and
  - Industrial wastes of certain trades.
- The turbidity of water is usually not objectionable from the consideration of
  public health except when it occurs due to bacterial contamination of sewage.

**Suspended matter:**
The insoluble suspended matter present in water pollutes water. Such matter may be
organic or inorganic in nature. The presence of such matter in water bodies indicates

**Foam:**
The foam or froth indicates suspension of gas in water. The foam may develop in water
either by fall from height or by presence of some chemical matter. The foam formed by
fall in height lasts only for a few seconds. But it is persistent when it is formed by the
action of some chemical matter.
CHEMICAL POLLUTION
The chemical pollution of water occurs due to the presence of inorganic chemicals or organic chemicals. Pollution due to inorganic chemicals: Following are the five forms of inorganic or mineral pollution of water:

- Acids
- Alkalis
- Toxic inorganic compounds
- Dissolved inorganic substances
- Suspended inorganic substances.

(i) **Acids:**
- The acids are contained in industrial wastes of certain industries such as factories producing DDT, high explosive factories, battery factories etc.
- The water containing acids is harmful to the aquatic life and it leads to the corrosion of metal or concrete structures.
- The presence of acids destroys bacteria and other micro-organisms and it seriously affects the process of self-purification of rivers or streams.

(ii) **Alkalies**
- The alkalis are contained in industrial wastes of certain chemical manufacturing industries or chemical consuming industries.
- The presence of alkalies in water has the same effects as that of acids.

(iii) **Toxic inorganic compounds:**
The important toxic inorganic compounds include free chlorine, soluble sulphide, ammonia and salts of many metals such as chromium, lead, nickel, copper, uranium, mercury, silver, zinc, etc.

(iv) **DISSOLVED INORGANIC SUBSTANCES:**
The dissolved inorganic chemical substances include minerals and gases derived either naturally or from certain industrial wastes and when they are present in small concentrations, they are harmless to the fish and other aquatic life
(v) **Suspended inorganic substances:**

- The suspended inorganic substances include particles of clay, sand, silt, etc. The effect of these substances is to impart turbidity to the water.

- Pollution due to organic chemicals: The most common form of pollution of water due to organic chemicals is due to the presence of fats, proteins, carbohydrates and other organic substances. These organic chemicals get access to the water bodies either through sewage or through industrial wastes. The important industries which contribute such chemicals are those of drugs, dye-stuffs, insecticides, pesticides, chemicals, detergents, etc.

**BACTERIOLOGICAL POLLUTION:**

- The bacteriological pollution of water occurs due to the presence of pathogenic bacteria, certain fungi, pathogenic protozoa viruses, parasitic worms, etc.

- These organisms multiply excessively in water bodies and from the view point of public health, they are injurious and harmful and hence they are not desirable in water.

- The important sources of bacteriological pollution are domestic sewage and industrial wastes of certain trades.

- If sewage treatment plants and water treatment plants are not properly operated, there are chances of bacteriological pollution of water and it may result in the outbreak of water-borne diseases.

**PREVENTIVE MEASURES:**

In order to have an effective control for pollution of water, the following preventive measures are suggested:

1. **Administration:** The administration of water pollution control should remain in the hands of State or Central Government.

2. **Catchment areas:** The scientific techniques should be adopted (or the environmental control of catchments areas of rivers or streams).

3. **Closed-cycle operations** for industrial plants: The working of an industrial plant should be based on recycling operations. The plant starts off with a certain volume of
water required for one cycle and the amount of water lost during the production process is replaced regularly from the water supply source. Such a scheme affords the following advantages:

- ñ If possible, the by-products can be extracted from the wastes during treatment.
- ñ It is possible to modify the production process in such a way that unnecessary pollution of the water being used in the plant is avoided.
- ñ It stops the discharge of industrial wastes into natural water sources.
- ñ The management of the plant will be encouraged to save water and to use it most beneficially as cost will be incurred to purify the extra sewage formed.
- ñ The plant can manage to treat its own wastes cheaply and

(4) Conservation of forests:

- ñ According to the Botanical Survey of India, the plants control pollution and they also act as natural air-conditioners. A medium sized tree can absorb carbon dioxide exhaled by two families and can provide in return enough oxygen for them.
- ñ The provision of green areas in big cities and industrial areas results in the reduction of contents of sulphur dioxide and nitric oxide from the atmosphere.
- ñ Hence the conservation of forests should be a national goal and the campaign of plant more trees should be intensively carried out.
- ñ The global assault on forests either by axe, bulldozer, chain saw or fire should be discouraged or at least minimized because it is very clear that no one on earth will escape from the bad effects of a balding earth.

(5) Design:

The available facilities must be adequate for the economic and appropriate design of various undesirable trade wastes.

(6) Discharge into water sources: It is advisable not to discharge any type of wastes, treated or otherwise, into streams, lakes and reservoirs. The industrial plants should
develop closed-loop water supply schemes. The domestic sewage may be used for irrigation.

(7) **Economic use of water:** It should be emphasized that the water is not an inexhaustible gift of nature. As a matter of fact, the water is such a raw material that there is no substitute for it. The industries consuming water to a great extent should carry out research for finding out dry methods of production. The water resources should be used in the best possible economic way.

(8) **Legal provisions:** There should be a proper administrative machinery for enforcing the legal provisions regarding water pollution. It should however be seen that such legal enforcements are made without injuriously affecting the growth of industries in general.

(9) **Personnel:** The services of highly qualified and experienced personnel should be taken to achieve the effective water pollution control.

(10) **Planning of towns:** Depending upon the availability of water resources in a particular area, the new towns, agricultural farms and industrial plants should be planned and located at suitable spots.

(11) **Regulations:** The appropriate by-laws, standards and practices should be framed to regulate the entry of undesirable flow in water bodies and such regulations should be modified from time to time to accommodate the changing needs and technological advancements.

(12) **Re-use:** The possible wise re-use of the treated sewage effluents and industrial wastes should be emphasized and encouraged.

**World environment day (WED):**
The General Assembly of the United Nations at its 27th session in 1972 created The United Nations Environment Programme (UNEP). Every year June 5 is celebrated as world environment day, abbreviated as WED, throughout the world. The Indian Posts and Telegraphs department issued a special postage stamp of Ps. 2 denomination on the 5th June 1977 for the celebration of WED of year 1977. The stamp embodies some of the polluting factors and shows symbolically the efforts of man in protecting human, plant and animal life from environmental pollution.
AIR POLLUTION

Air pollution may broadly be defined as the presence or atmosphere of one or more contaminants like dust, odour, etc. in quantities, of characteristics and of duration be injurious to human beings, plants, animals or which unreasonably obstruct the comfortable enjoyment

Sources of Air Pollution:

For the purpose of convenience, the main sources of air pollution can grouped in the following two categories:

I. Natural sources

II. Unnatural sources.

Each of the above sources of air pollution will now be briefly discussed

I. Natural sources: Following are the natural sources contributing the air pollution

Atmospheric reaction:

In the tower atmosphere, the natural chemical reactions lead to the conversion of gases or vapors into solids and liquid products by oxidation, combination, condensation or by polymerization.

Micro-organisms:

These consist of viable particles in the form algae, fungi, bacteria, yeasts, rusts, moulds, spores, etc. All these cr0-organisms except algae can be transported by wind and they can infect plants, animals and human beings.

Following are some of the Unnatural Sources of the air pollution:

Combustion of fuels: The burning of fuels like oil, coal, etc. ‘the formation of undesirable gases which accumulate in the ire 7 Some of the industrial activities like non-ferrous liting and refining, iron and steel, manufacturing oil refining, producing factories, pulp and paper industries. Etc
VEHICULAR POLLUTION:

The exhaust from the automobiles contains gas namely carbon monoxide (CU) and due to the increased use of automobiles in the urban areas, it has become a great source of pollution in congested cities and towns of our country. The main air pollutants are

- Carbon monoxide
- Chlorine
- Halogenated solvents
- Hydrocarbons
- Hydrogen sulphide
- Nitrogen oxide
- Sulphur dioxide.

Carbon monoxide:

- The carbon monoxide (CO) is a dangerous gaseous pollutant because of its well-known health hazards.
- It is produced from incomplete combustion of carbonaceous fuels and organic matters. The vehicular exhausts largely contribute to the presence of CO in the urban air.
- The CO causes asphyxia i.e. loss of consciousness as a result of too little oxygen and too much carbon dioxide in the human blood. It may also lead to death by kinds of hemoglobin as carboxyhemoglobin. The other health effects of CO intoxication are headache, dizziness, weariness, loss of concentration and retardation of mental activity.

Chlorine:

There are certain chemical processes which release chlorine into the atmosphere. The photochemical oxidants result from complex series of atmospheric reactions initiated by the sunlight. They lead to the asthmatic attacks. They may also cause irritation of eye, nose and throat.
Halogenated solvents:

The halogenated solvents attack lived and sometimes lead to death. The halogen indicates any of the fl$ very active non-metallic chemical elements, namely, fluorine, chlorine bromine, astatine and iodine.

Hydrogen sulphide:

The hydrogen sulphide is a highly toxic gas and is generally found in the places where active microbial activities continues in short supply of oxygen like underground sewers, municipal drainage systems, etc. or where specific industrial operations occur.,

Nitrogen oxide: The nitrogen oxides result from air oxidation process of electrical discharges and solar radiations. The high temperature pressure operations like welding operations, steam generating equipments, 5 a other metallurgical operations, etc. yield oxides of nitrogen.it causes abnormal distention or expansion of the alveoli of the lungs accompanied by loss of elasticity in the tissues rnient in breathing. In the lungs, it is known to be transformed ounds some of which are known to be carcinogens. In areas

- Mobile sources
- Stationary sources.

Mobile sources:

The automobiles moving on the urban roads the mobile sources of emissions of the undesirable gases into atmosphere.

They initiate various kinds of health problems even when present in trace concentrations; promote corrosion of the metal works. a pollution:

Stationary sources:

The industrial installations form the. Stationary sources of the urban air pollution. The industrial emissions depend upon the nature of product, quantum of materials handled packing, nature of process, mode of handling, transportation, etc.

The rapidly expanding industrial activity in the urban areas has accelerate4j the problem of air pollution.
LAND POLLUTION

The land pollution is caused by the solid wastes and chemicals. One of the major pollution problem on large cities are disposal of waste materials, crop residuals, chemical garbage, paper, plastics, rubber, cloth, leather, brick, metals, etc…

Sources of soil pollution

Chemical pollutants

Industries like textiles, pesticides, pharma, fertilizers, tanneries, batteries, petroleum industries pour hazardous effluents in soil and water that has dangerous effects on living organisms.

Industrial pollutants

Industries are the major cause for soil pollution. Industries like textile, steel, paper, oil and dying industries are responsible for soil pollution.

Radioactive pollutants;

Atomic reactors, nuclear radioactive devices release radio active wastes.

Domestic effluents:

Use of municipal waste water for irrigation purpose leads to substantial increase in accumulation of available Zn, Cu, and Pb & Cd

Biological agents

Fungi, protozoa, bacteria are important agents for soil pollution. human and animal wastes garbage’s, waste water generate heavy soil pollution

Control of land pollution

- Solid wastes should be treated by Prolysis method
- Modern scientific techniques to reduce salts flow to soils
- Incineration or burning of wastes
- Preserve and protect top fertile soil, control of soil erosion by tree plantation
- Fertilizers may be applied only after estimation soil and crop measures
SUSTAINABLE Development

Definition:

The Brundtland commission, “Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”

The caring for the earth document define “sustainability as a characteristic or state that can be maintained indefinitely whereas development is defined as the increasing capacity to meet human needs and improve the quality of human life. This means that support of ecosystems the quality of human life would be improved.

SUSTAINABLE DEVELOPMENT IMPLIES THE FOLLOWING FACTORS

1. The necessary conditions for achieving sustainable development are ecological security, economic efficiency and social equality.
2. Economic sustainability can be defined as the way that humans must manage an economy to preserve its productiveness.
3. For achieving sustainable development we require less than a global movement and significantly.
4. Sustainable developmen conserve plant, land, water and natural resources technically, appropriate economically viable and social acceptable.
5. Sustainable development should ensure the preservation of ecological diversity and stability.
6. The primary needs of sustainable development are:

   (i) Modified eco friendly technology.
   (ii) Environmental awareness.
   (iii) Cooperation and coordination.

GLOBAL WARMING: A THREAT TO SUSTAINABLE DEVELOPMENT

The green house gases (CO₂ and Water vapour) are responsible for keeping our plant warm and thus sustaining life in the earth. With the increased level of CO₂, the
temperature on the earth surface rises and causes more evaporation of surface water which further leads to high temperature.

It is expected that this combined effect will bring 1 to \(5^0\)C rise on surface temperature. This result in melting of ice caps in polar region found over Greenland and in Antarctic.

It is essential for developing countries to take necessary action against those prospects. The government along with external experts or social service organization should take necessary actions.

**SOME STEPS TO MINIMISE THE GREEN HOUSE EFFECT**

1. Reduction in the use of fossil fuels.
2. Encouraging the use of alternative sources of energy.
3. Conservation of forests.
4. Reduction in the use of automobiles.
5. Ban of CFC and nuclear explosions.

**BIOTECHNOLOGY: A WAY TO SUSTAINABLE DEVELOPMENT**

Deforestation, Industrialisation, uncontrolled mechanization, use of chemical, pesticides and fertilizers in agriculture leads environment pollution.

Biotechnology offers a new technique, encourages stability and productivity. This technique reduces the adverse effect of synthetic pesticides and fertilizers. Biotechnology is new technology used to detoxifying the environment and also protect natural resources of the environment.

The new technical development of biofertilizers as alternatives to the chemical fertilizers is an important area of environmental protection and a way for sustainable development.

**MEASURES FOR SUSTAINABLE DEVELOPMENT**
1. Population Control

Population growth should be limited. This is one of the major components of sustainable development.

2. Water Resource Management

River flooding, poor treatment of effluents, over exploitation of ground water, poor drainage, pollution of water bodies are some of the factors of poor water resource management. Sustained development provides effective water resources management.

3. Reduced Consumption

Consumption of water, energy, air and other natural resources should be limited. Lesser consumption and simpler life styles is also one of the factors of sustainable development.

4. Renewable resources

Any resources like materials, energy that can be renewed or recycled that cannot be depleted in the near future. Solar energy is an ideal energy. It will not be reduced in future.

5. Biosphere conservation:

Man’s activities lead for pollution, thousands of plant and animal species threats due to pollution and destruction of habitat. In order to safeguard the environment he must protect it from pollution, destruction of natural resources and poaching of animals.

6. Pollution control

Pollution of water, air and soil are major threats for future mankind. New scientific technology is one of the major components of sustainable development.
Indicators of sustainable development

The question of achievement of sustainability could be answered by identifying the answers to the appropriate indicators of sustainability.

- Total production of growth rate
- Population control
- Water supply and issues
- The availability of clean and pure air
- Human resource development
- Air pollution in urban area
- Energy resources
- Recycling and reuses

Impact of development on environment

A development project is designed to change the environmental state of an existing area. Predictions and evaluation of these environmental changes enable the planner to plan better and take a long term view of the planning process.

Environmental impact assessment (EIA) is an objective and systematic analysis of the probable changes in the physical, bio physical and socio-economic characteristics of the environment from the proposed project.

Prediction of impacts

Prediction of impacts is an important step in an EIA study. It helps in carrying out the evaluation of impacts and in preparing the environmental management plan. There are many mathematical models, an analytical models and methodologies available to predict the impacts.
**Evaluation of impacts**

For the evaluation of impacts the environmental quality scale (EQ) and function graphs related parameters pertaining to the environmental impact have been developed by adopting **Battelle Environmental Evaluation System (BEES)**

In this system the environmental quality scale (EQ) is obtained for each of the identified factors, through the use of corresponding functional relationship called value functional curve. A value functional curve is a plot of factor measurements on x-axis and environmental scale on y-axis based on the scale of 1.0 for good EQ and 0.0 for poor EQ.

For each of the alternatives the **EIU** (environmental impact are obtained using the following relationship

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EIU = (EQ)_{IJ} (PIU)_I
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- **EIU** = Environmental Impact Units for \(J^{th}\) Alternative
- **EQ\(_{IJ}\)** = Environmental Quality Scale for \(I^{th}\) Factor of \(J^{th}\) Alternative
- **PIU** = Parameter Importance Units for \(I^{th}\) Factor