MODULE I

INTRODUCTION: Classification of Pollution and Pollutants, Evolution of EIA (Global and Indian Scenario), Elements of EIA — Screening – Scoping - Public Consultation, Environmental Clearance process in India, Key Elements in 2006 EIA(Govt. of India) Notification

Pollution and Pollutants

Pollution

Pollution is defined as "the presence of impurities or pollutant substances in sufficient concentration levels, causing harmful effects on human beings, animals, plant life or material resources when exposed for a sufficient duration of time, thus reducing quality of life in the environment."

Environmental Pollution

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

Types of pollutions

1. Air Pollution
2. Water Pollution
3. Soil/Land Pollution
4. Noise Pollution
5. Radioactive Pollution
6. Thermal Pollution
7. Industrial Pollution

1. Air Pollution

Air pollution may be defined as the presence of one or more contaminants in the air in large quantities and for long durations which may be or tend to be injurious to human, animal, plant life, or property, or which unreasonably interferes with the comfortable usage of air.

2. Water pollution

Water pollution is the contamination of water bodies (e.g. lakes, rivers, oceans and groundwater), very often by human activities. It occurs when pollutants (particles, chemicals or substances that make water contaminated) are discharged directly or indirectly into water bodies without enough treatment to get rid of harmful compounds.

3. Soil/Land Pollution

Soil contamination occurs when chemicals are released by spill or underground leakage. It can also occur by directly dumping and disposal of wastes. Among the most significant soil contaminants are hydrocarbons, heavy metals, herbicides, pesticides and chlorinated hydrocarbons.

4. Noise Pollution

Noise pollution is the disturbing or excessive noise that may harm the activity or balance of human or animal life. The source of most outdoor noise worldwide is mainly caused by machines and transportation systems, motor vehicles, aircraft, and trains. Outdoor noise is summarized by the word environmental noise.

6. Radioactive pollution

Radioactive pollution can be defined as the release of radioactive substances or high-energy particles into the air, water, or earth as a result of human activity, either by accident or by design.

7. Thermal pollution

Thermal pollution is defined as sudden increase or decrease in temperature of a natural body of water which may be ocean, lake, river or pond by human influence. This normally occurs when a plant or facility takes in water from a natural resource and puts it back with an altered temperature.

8. Industrial pollution

Industrial pollution is generally referred to the undesirable outcome when factories (or other industrial plants) emits harmful by-products and waste into the environment such as emissions

to air or water bodies (water pollution), deposition on landfills etc. (land pollution) or emission of toxic chemicals into the atmosphere (air pollution).

Pollutant

A Pollutant is a substance or energy introduced into the environment that has undesired effects, or adversely affects the usefulness of a resource. Pollutants include solid, liquid or gaseous substances present in greater than natural abundance, produce due to human activity, which have a determined effect on our environment.

Types of Pollutants

1. Depending upon their existence in nature

Quantitative Pollutants

They normally occur in environment but acquire the status of a pollutant when their concentration increases due to unmindful human activities.

Eg: CO_2

Qualitative Pollutants

Do not naturally occur in the environment but are added by man.

Eg: Insecticides

2. Depending upon the form in which they persist after being released into atmosphere

Primary Pollutants

Those which are emitted directly from the source and persists in the form in which they were added to the environment.

Eg: Ash, dust, hydrocarbon etc.

Secondary Pollutants

Those which are formed from primary pollutants.

Eg: Ozone, PAN (Peroxyl Acetyl Nitrate), Ketones, Aldehydes etc.

3. Depending upon the way in which they are removed/accumulated in the environment

Biodegradable

Those which can be degraded/decomposed by living organism.

Eg: Wood, sewage, paper, card board, garbage etc

Non-biodegradable

Those which cannot be degraded/decomposed by living organism

Eg: DDT, plastic etc

4. Depending upon their source

Natural

Those which are released from natural resources.

Eg: Volcanic eruptions, wind borne and dust release of H_2S etc

Man-made

Those which are released due to human activities (commercial, industrial, residential etc)

Eg: Insecticides, Pesticides, Radioactive substances etc.

Evolution and History of EIA

Pre-1970	• Project review based on the technical/engineering and economic analysis. • Limited consideration given to environmental consequences.
Early/mid – 1970s	• EIA introduced by NEPA in 1970 in US. • Basic principle: Guidelines, procedures including public participation requirement instituted. • Standard methodologies for impact analysis developed (e.g. matrix, checklist and network). • Canada, Australia and New Zealand became the first countries to follow NEPA in 1973-1974. Unlike Australia, which legislated EIA, Canada and New Zealand established administrative procedures. • Major public inquires help shape the process's development.
Late 1970 and early 1980s	• More formalised guidance. • Other industrial and developing countries introduced formal EIA requirements (France, 1976; Philippines, 1977), began to use the process informally or experimentally (Netherlands, 1978) or adopted elements, such as impact statements or reports, as part of development applications for planning permission. • Use of EA by developing countries (Brazil, Philippines, China, Indonesia) • Strategic Environment Assessment (SEA) [1], risk analysis included in EA processes [2]. • Greater emphasis on ecological modelling, prediction and evaluation methods. • Provision for public involvement. • Coordination of EA with land use planning processes.
Mid 1980s to end of decade	• In Europe, EC Directive on EIA establishes basic principle and procedural requirements for all member states. • Increasing efforts to address cumulative effects. • World Bank and other leading international aid agencies establish EA requirements. • Spread of EIA process in Asia.

1990s	• Requirement to consider trans-boundary effects. • Increased use of GIS and other information technologies. • Sustainability principal and global issues receive increased attention. • India also adopted the EIA formally. • Formulation of EA legislation by many developing countries. • Rapid growth in EA training.

[1] Definition of SEA: Policy tool to assess the environmental consequences of development policies, plans and programmes

[2] Definition of risk assessment: An instrument for estimating the probability of harm occurring from the presence of dangerous conditions or materials at a project site. Risk represents the likelihood and significance of a potential hazard being realized.

EIA in Global Scenario

- EIA systems vary by each country and agency, and each system holds their own unique characteristics.

EIA Implementation in Canada

- Introduced in 1973 with the passing of a federal cabinet directive.
- Canadian Environmental Assessment Act (CEAA) was passed in 1992 and came into force in January 1995.

EIA Implementation in Europe

- In 1997 the European Commission began drafting a directive on EIA.
- Directive 85/337/EEC on the *Assessment of the Effects of Certain Public and Private Projects on the Environment*, "EIA Directive" was adopted in July 1985.
- The EIA Directive defines a project as:
  - The execution of construction works or of other installations or schemes
  - Other interventions in the natural surroundings and landscape including those involving the extraction of mineral resources
- Member States had until 3 July 1988 to implement its requirements:

- France 1976 Belgium 1985
- Spain 1986 Netherlands 1986
- Italy 1988 Denmark 1989
- Germany 1990 Portugal 1990
- Greece 1990 UK 1990

EIA Implementation in Asia

- Thailand -1975
- Philippines -1978
- Indonesia -1987
- Japan -1984

EIA Implementation in China

- In 1979, the *Environmental Protection Law* (pilot-phase) stipulated that all construction related projects must implement EIA.
- In 1981, the *Basic Construction Items Environmental Preservation Management Law* clearly defined EIA procedures.
- China's new *Environmental Impact Assessment Law* was passed in 2002 and became effective on September 1, 2003.

EIA in International Treaties and Protocols

- 1982 - United Nations Law of the Sea Treaty
- 1991 - Convention on Environmental Impact Assessment in a Transboundary Context (the Espoo Convention)
- 1991 - Protocol on Environmental Protection to the Antractic Treaty
- 1992 - Biodiversity Treaty
- 1992 - United Nations Framework Convention on Climate Change

History of EIA in India

- The Indian experience with Environmental Impact Assessment began over 20 years back. It started in 1976-77 when the Planning Commission asked the Department of Science and Technology to examine the river-valley projects from an environmental angle.
- Till 1994, environmental clearance from the Central Government was an administrative decision and lacked legislative support.
- On 27 January 1994, the then Union Ministry of Environment and Forests, under the Environmental (Protection) Act 1986, promulgated an EIA notification making Environmental Clearance (EC) mandatory for expansion or modernisation of any activity or for setting up new projects listed in Schedule 1 of the notification.
- The Ministry of Environment, Forests and Climate Change (MoEFCC) notified new EIA legislation in September 2006.
    - The notification makes it mandatory for various projects such as mining, thermal power plants, river valley, infrastructure (road, highway, ports, harbours and airports) and industries including very small electroplating or foundry units to get environment clearance.
    - However, unlike the EIA Notification of 1994, the new legislation has put the onus of clearing projects on the state government depending on the size/capacity of the project.

Environmental Impact Assessment (EIA)

- Environmental Impact Assessment (EIA) can be defined as the systematic identification and evaluation of the potential impacts (effects) of proposed projects, plans, program or legislative action on the physical and socio chemical, biological, cultural, the total economic components of environment.
- EIA is a process which ensures that all environmental matters are taken into account quite early in the project at planning process itself.
- It takes into consideration not only technical and economic considerations but also, traditional aspects like impact on local people, biodiversity etc.

- EIA provides information about adverse environment effects, predicts, the overall risks arising from any activity, helps in identifying areas where risks can possibly be reduced.
- EIA is intended to prevent or minimize potentially adverse environmental impacts and enhance the overall quality of a project. The main benefits and advantages of EIA are:

Need of EIA

- Environment is composed of Biotic & Abiotic components.
- There is a dynamic equilibrium between these components.
- When a project is undertaken it tends to disturb these components.
- To maintain the quality of environment the perspective impacts of the project on natural environment are studied on time and remedial measures must be taken so as to promote sustainable and holistic development of the project. This is done through EIA.
- For Example, a forest ecosystem is a complete ecosystem which provides food, shelter to a wide variety of species. It provides firewood, resins, timber, medicinal herbs, etc. to us. Therefore forests are our lifeline. Whenever a project is undertaken which demands clearing of the forest like construction of road or a dam, then EIA helps us to access the impact of that activity on this life line. It also suggests alternate project sites and alternate process technologies.

Elements of EIA

- Screening
- Scoping
- Public Participation
- Prediction and Mitigation
- Management and Monitoring
- Audit

Screening

- Screening often results in a categorization of the project and from this a decision is made on whether or not a full EIA is to be carried out.

Scoping

- Scoping is the process of determining which are the most critical issues to study and will involve community participation to some degree.
- It is at this early stage that EIA can most strongly influence the outline proposal.

Public Participation:

- Law requires that the public must be informed and consulted on a proposed development after the completion of EIA report.
- Any one likely to be affected by the proposed project is entitled to have access to the Executive Summary of the EIA.
- The affected persons may include:

  (i) Bonafide local residents

  (ii) Local associations,

  (iii) Environmental groups: active in the area

  (iv) Any other person located at the project site/ sites of displacement

- They are to be given an opportunity to make oral/written suggestions to the State Pollution Control Board as per Schedule IV of Annex I.

Prediction and Mitigation

- Detailed prediction and mitigation studies follow scoping and are carried out in parallel with feasibility studies.

Management and Monitoring

- The main output report is called an *Environmental Impact Statement*, and contains a detailed plan for managing and monitoring environmental impacts both during and after implementation**.**

Audit

- Finally, an audit of the EIA process is carried out some time after implementation. The audit serves a useful feedback and learning function.

Environment Clearance Process in India

The EIA process in India is made up of the following phases: (EIA procedure)

1. Project description
2. Screening
3. Scoping and consideration of alternatives
4. Baseline data collection
5. Impact prediction
6. Assessment of alternatives, delineation of mitigation measures and environmental impact statement (EIS)
7. Public hearing
8. Environment Management Plan (EMP)
9. Decision making
10. Monitoring the clearance conditions
11. Post Monitoring (EIA audit)

1. Project description

- It is the condensed description of all aspects of the project showing boundary, site layout, location map etc. it is based on the project feasibility study.
- The project proposal shall also include all relevant information available including a land use map in order for it to move to next stage which is screening.
- The submission of project proposal signifies the commencement of the EIA process.

2. Screening

- First stage of EIA, screening is the scrutiny of application, which determines whether the proposed project requires an EIA and if it does, then the level of assessment required.
- Screening is done to see whether a project requires environmental clearance as per the statutory notifications.
- Screening Criteria are based upon:
    a. Scales of investment;
    b. Type of development; and,
    c. Location of development.

- A Project requires statutory environmental clearance only if the provisions of EIA notification and/or one or more statutory notification is mentioned.

3. Scoping

- Scoping is a process of detailing the terms of reference of EIA.
- It has to be done by the consultant in consultation with the project proponent and guidance, if need be, from Impact Assessment Agency.
- The Ministry of Environment and Forests has published guidelines for different sectors, which outline the significant issues to be addressed in the EIA studies Quantifiable impacts are to be assessed on the basis of magnitude, prevalence, frequency and duration and non-quantifiable impacts (such as aesthetic or recreational value), significance is commonly determined through the socio-economic criteria.
- After the areas, where the project could have significant impact, are identified, the baseline status of these should be monitored and then the likely changes in these on account of the construction and operation of the proposed project should be predicted.
- Recent years, scoping was determined by "Term of reference" clearance by MoEF.

4. Baseline Data

- Baseline data describes the existing environmental status of the identified study area.
- The site-specific primary data should be monitored for the identified parameters and supplemented by secondary data if available.

5. Impact Prediction

- Impact prediction is a way of 'mapping' the environmental consequences of the significant aspects of the project and its alternatives.
- Environmental impact can never be predicted with absolute certainty and this is all the more reason to consider all possible factors and take all possible precautions for reducing the degree of uncertainty.
- The Following Impacts of the Project should be assessed:

a) Air:

- Changes in ambient levels and ground level concentrations due to total emissions from point, line and area sources effects on soils, materials, vegetation, and human health.

b) Noise:

- Changes in ambient levels due to noise generated from equipment and movement of vehicles effect fauna and human health.

c) Water:

   a. Availability to competing users
   b. Changes in quality
   c. Sediment transport
   d. Ingress of saline water

d) Land:

   a. Changes in land use and drainage pattern
   b. Changes in land quality including
   c. Effects of waste disposal
   d. Changes in shoreline/river-bank and their stability

e) Biological:

   a. Deforestation/tree-cutting and shrinkage of animal habitat
   b. Impact on fauna and flora (including aquatic species if any) due to contaminants/pollutants
   c. Impact on rare and endangered species, endemic species, and migratory path/route of animals
   d. Impact on breeding and nesting grounds

f) Socio-Economic:

   a. Impact on the local community including demographic changes
   b. Impact on economic status
   c. Impact on human health
   d. Impact of increased traffic

6. Assessment of Alternatives, Delineation of Mitigation Measure and Environmental Impact Assessment Report (EIS):

- For every project, possible alternatives should be identified and environmental attributes compared.
- Alternatives should cover both project location and process technologies. Alternatives mould considers ‘no project’ option also.
- Alternatives should then be ranked for selection of the best environmental option for optimum economic benefits to the community at large.

- Once alternatives have been reviewed, a mitigation plan should be drawn up for the selected option and is supplemented with an Environmental Management Plan (EMP) to guide the proponent towards environmental improvements.
- The EMP is a crucial input to monitoring the clearance conditions and therefore details of monitoring should be included in the EMP.
- An EIA report should provide clear information to the decision-maker on the different environmental scenarios without the project, with the project and with project alternatives.
- Uncertainties should be clearly reflected in the EIA report.

7. Public Hearing

- Law requires that the public must be informed and consulted on a proposed development after the completion of EIA report.
- Any one likely to be affected by the proposed project is entitled to have access to the Executive Summary of the EIA.
- The affected persons may include:
    a. Bonafide local residents
    b. Local associations,
    c. Environmental groups: active in the area
    d. Any other person located at the project site/ sites of displacement
- They are to be given an opportunity to make oral/written suggestions to the State Pollution Control Board as per Schedule IV of Annex I.

8. Environment Management Plan

- It is a plan or program that seeks to achieve a required end state and describes how activities, which have or could, have an adverse impact on the environment, will be mitigated, controlled, and monitored during the commissioning, mobilization, construction, operation, maintenance and decommissioning of a project; and that the positive benefits of the projects are enhanced.

9. Decision Making

- Decision making process involve consultation between the project proponent (assisted by a consultant) and the impact assessment authority (assisted by an expert group if necessary).

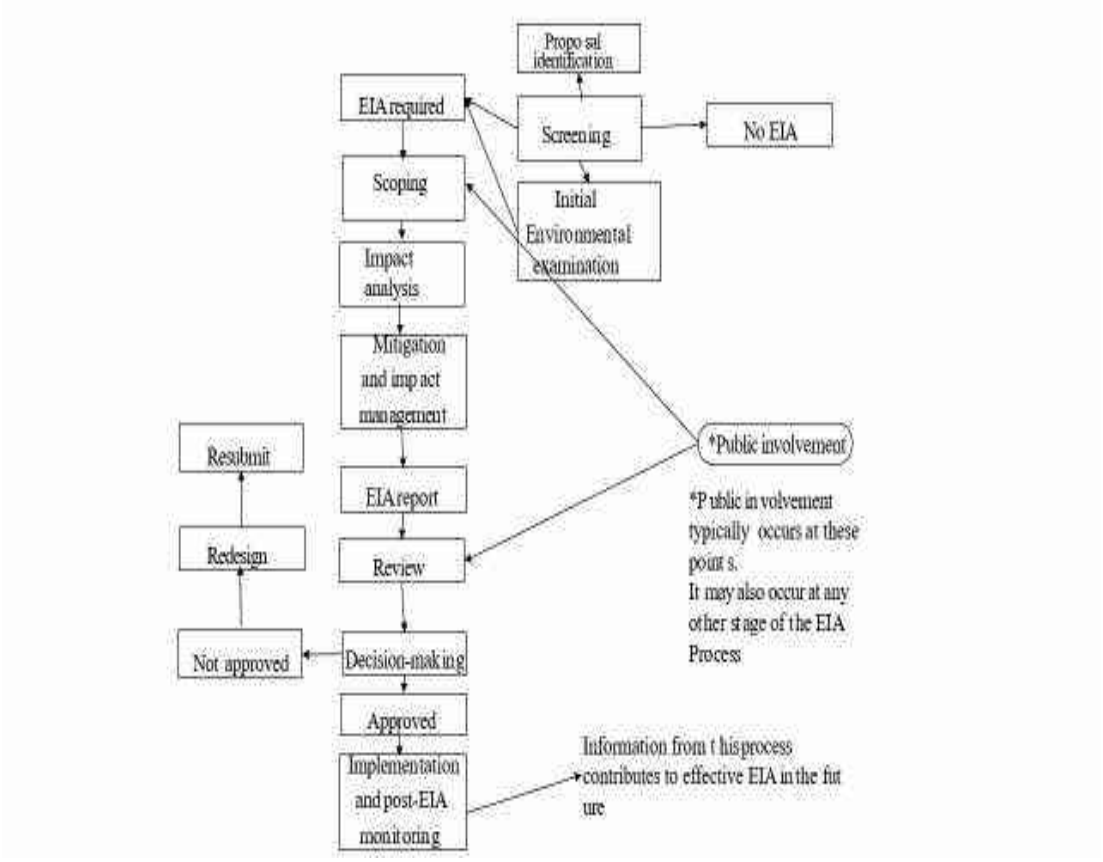
- The decision on environmental clearance is arrived at through a number of steps including evaluation of EIA and Environmental management plan.

10. Monitoring the Clearance Conditions

- Monitoring should be done during both construction and operation phases of a project.
- This is not only to ensure that the commitments made are compiled with but also to observe where the predictions made in the EIA reports were correct or not.
- Where the impacts exceed the predicted levels, corrective action should be taken.
- Monitoring will enable the regulatory agency to review the validity of predictions and the conditions of implementation of the Environmental Management Plan (EMP).

11. Post Monitoring (EIA Audit)

- This stage comes to play once the project is commissioned.
- It checks to ensure that the impacts of the project do not exceed the legal standards and implementation of the mitigation measures are in the manner as described in the EIA report.



Generalized EIA process flow chart

TOR or Terms of Reference

- TOR or Terms of Reference is a document produced by the authority conducting the EIA study.
- It is formed during Scoping, the second stage in the EIA process. All the stakeholders are invited to submit their concerns regarding the project during a public hearing organized by the EIA committee, which is followed by discussions and deliberations.
- The finalized list of this stage of EIA is submitted to the Ministry in the form of TOR.
- TOR is an important document in the process of EIA because it sets the guidelines for the study.
- It is important that the TOR be drawn up exhaustively to ensure that the EIA study carried out is effective in warding off as much environmental damage as possible.
- TORs take about 45 days to prepare in today's EIA studies.
- Under the Ministry of Environment, Forests and Climate Change guidelines**,** reference TORs for the most common developmental projects have been drawn up in the ministry website.
- This reference document lists out the most important aspects and impacts of large, common developmental projects.
- This eases the burden on the EIA committees working to conduct EIA of large projects. They take most of the information to be mentioned in the TOR from this reference.
- All that is included from their side are site specific issues that arise for each individual project; for example, the presence of a unique ecosystem in the area (mangroves etc), presence of protected areas in the project vicinity, etc.
- A TOR is drawn up with the following questions in mind.

1. The purpose of the study/project.
2. The extent of the study.
3. The stakeholders' requirements; each stakeholder looks at different aspects of the project differently. Complex information needs to be explained appropriately.

Content of TOR

TOR highlights the points that need to be covered (the TOR itself does not elaborate on these points unless required) during the EIA study, which include:

- A description of the project, its purposes and extent.
- All the agencies responsible in the developmental project and the EIA study.
- A description of the existing environmental conditions in the project site and surrounding areas.
- The stakeholders that will be benefited and harmed by the fulfilment of the project.
- The environmental aspects the project is likely to affect.
- The impacts, both positive and negative, the project will have on the environmental and social aspects of the project area. This is undertaken through checklists, matrices, networks. A list/description of the species endemic to the area, which are likely to be effected.
- How in-depth does the EIA study need to be: whether baseline data is available or whether the study be sourced from secondary data.
- Possible alternatives for the project in terms of design, site, technology, implementation, etc.
- The legal requirements of the project and future legislation that need to be drafted.
- If the project site comes under special categories, and the legislation regarding the same.
- Recommended mitigation strategies.
- The expertise required for the EIA study.
- The expected time limit for the entire EIA study.
- Natural Resource Valuation (NRV), if possible.
- The budget of the study, also called cost-benefit analysis.

Key Elements in 2006 EIA (Govt. of India) Notification

Revised Environmental Clearance Procedure in India

- As the utility of EIA became clear, there was need to establish project clearance procedure.
- In 1994 a clearance procedure was issued that followed EIA Notification 1994.
- There were some constraints in the procedure that include:

a) Burdensome procedure

b) Disproportionate details sought with applications

c) Delay in appraisal meetings

d) Time consuming and requiring undue effort

e) Reopening of technical issues during various stages of appraisal

f) Poor quality of EIA studies by consultants

g) Delays by other concerned agencies

h) Due to these reasons re-engineering was done of the EIA process implementation based on project chosen.

- Background of this re-engineering is that; MoEF conducted a review on previous EC process which is comprehensive under the Environmental Management Capacity Building Project in 2001, reformation in investment approvals and implementation procedures was set up by central government with the help of Govindarajan committee.
- Due to consistency in studies with both the organizations there was a strong necessity for reforms in the EIA notification 1994.

Objectives of EIA notification 2006

- To formulate a transparent, decentralized and efficient regulatory mechanism.
- Incorporate necessary environmental safeguards at planning stage.
- Involve stakeholders in the public consultation process.
- Identify developmental projects based on impact potential instead of the investment criteria.
- It also stated that; all new projects listed in schedule, expansion and modernisation of existing projects and those activities that show change in product mix require environmental clearance before setting up.

Differences between the EIA notification 1994 and 2006

- No NOC for environment clearance (EC)
- Revised Schedule based on potential impacts instead of investment criteria
- Categorization of projects into category A and category B1 & B2
- Category A should get clearance from Central level, Category B1, B2 at State Level (with exceptions)

- Check-list information in Form-1/Form-1-A
- Scoping to determine Terms of reference (TOR)s for EIA, if required;
- Finality of TORs
- Scoping stage incorporate site clearance – No separate site clearance is required.
- Public consultation structured; to be conducted by SPCB and presided by DM (within 45 days); proceedings to be video graphed; MoEF to intervene if Public Hearing not held in time.
- State Level Environment Impact Assessment Authority (SEIAA) is an independent body members of which should be notified by MoEF on receiving nominations from all concerned states and UTs.
- Chairman and other member shall be experts fulfilling the eligibility criteria given in Appendix VI of Notification 2006.
- Chairman shall be an expert in EIA process. Member Secretary familiar with environmental laws shall be a serving officer of the State Government.
- MoEF must notify SEIAAs within a time limit of 30 days from the date of receipt of nominations. Time period for Authority defined (3 years).
- Decision of the Authority shall be on the basis of consensus and lastly there would not be any funding from MoEF.
- Steps in prior Environmental clearance process include Screening, Scoping, Public consultation, and Appraisal.

MODULE II

AIR POLLUTION: Primary and Secondary Types of Pollutants, sulfur dioxide- nitrogen dioxide, carbon monoxide

WATER POLLUTION: Point and Non-point Source of Pollution, Major Pollutants of Water, Impact of pollutants

AIR POLLUTION

Definition

- Air pollution is the presence of one or more chemicals in the atmosphere in sufficient quantities and duration to cause harm to humans, vegetation etc.
- It is the transfer of harmful and/or of Natural/Synthetic materials into the atmosphere as a direct/indirect consequences of human activity.
- Air pollution results from human activities such as burning fossil fuels (oil, coal, and gasoline) to create electricity and power automobiles, and manufacture industrial products such as chemicals and plastic.
- The air Pollutants are particulates, HC, CO2, CO, NO, NO_2, SO_3 -- source may be industrial, automobiles etc
- The increased carbon dioxide in the atmosphere contributes to the warming of the global climate, the so-called "greenhouse effect"
- The increased Chloro-fluorocarbons in the atmosphere has been depleting stratospheric ozone.

Sources of Air pollution

1. **Stationary sources**

   Those that are fixed in location.

   - **Point sources**

     A single identifiable source.

     e.g. smoke stacks, 14% air pollution from plants generating electricity;

   - **Fugitive sources**

     Which produces particulate matter.

e.g. construction sites, exposed areas;

- **Area sources**

  e.g. dense urban community or agricultural area

2. **Mobile sources**

Those that move while polluting

e.g. trucks, cars, busses etc. (60% of air pollution from motor vehicles. 80-88% in major cities)

Types of Sources:

1. Point source

- Single, identifiable source
- Point-source pollution is easy to identify.
- Factories and power plants can be a source of point-source pollution.
- Eg: smokestack
- Smokestacks may spew carbon monoxide, heavy metal, sulfur dioxide, nitrogen dioxide, or "particulate matter" (small particles) into the air.

2. Non-point source

- Dispersed source
- Nonpoint-source pollution is harder to identify and harder to address.
- It is pollution that comes from many places, all at once.
- Airborne pollutants are major contributors to acid rain.
- It forms in the atmosphere when sulfur dioxide and nitrogen oxides combine with water. Because acid rain results from the long-range movement of those pollutants from many factories and power plants, it is considered non-point-source pollution.
- Non-point source air pollution affects air quality, from sources such as smokestacks or car tailpipes.
- Although these pollutants have originated from a point source, the long-range transport ability and multiple sources of the pollutant make it a nonpoint source of pollution

Types of Air Pollution

Personal air exposure

- It refers to exposure to dust, fumes and gases to which an individual exposes himself when he indulge himself in smoking.

Occupational air exposure

- It represents the type of exposure of individuals to potentially harmful concentration of aerosols, vapors, and gases in their working environment.

Community air exposure

- This is most serious, complex, consists of varieties of assortment of pollution sources, meteorological factors, and wide variety of adverse social, economical, and health effects.

Main Categories of Air Pollutants

Primary Pollutants

- Those emitted directly into the air.
- Pollutants that are emitted directly from identifiable sources i.e., produced by both natural events and human activities.
- e.g. sulfur dioxide (SO_2), carbon monoxide (CO), nitric oxide (NO), nitrogen dioxide (NO_2)
- Indoor air pollutants are primary air pollutants. The most important indoor air pollutant is radon gas.

Sources (causes) of indoor air pollutants:

- Radon gas is emitted from the building materials like bricks, concrete, tiles, etc., which are arrived from soil containing radium.
- It is also present in natural gas &ground water and is emitted indoors while using them.
- Burning of fuels in the kitchen, cigarette smoke, liberates the pollutions like CO, SO_2, formaldehyde, BAP (benzo-a-pyrene)

Primary Air Pollutants

Five major materials released directly into the atmosphere in unmodified forms.

1. Carbon monoxide
2. Sulfur dioxide
3. Nitrogen oxides
4. Hydrocarbons
5. Particulate matter

Carbon Monoxide

- Produced by burning of organic material (coal, gas, wood, trash, etc.)
- Automobiles biggest source (80%)
- Cigarette smoke another major source
- Toxic because binds to hemoglobin, reduces oxygen in blood
- Not a persistent pollutant, combines with oxygen to form CO_2
- Most communities now meet EPA standards, but rush hour traffic can produce high CO levels

Human sources

- Cigarette smoking, incomplete burning of fossil fuels.
- About 77%comes from motor vehicle exhaust.

Health effects

- React with haemoglobin in red blood cells & reduce the ability of blood to bring oxygen to body cells & tissues, which causes headache & anaemia.
- At high levels it causes coma, irreversible brain cell damage & death.

Environmental effects

- **-** It increases the global temperature

Sulfur Dioxide

- Produced by burning sulfur containing fossil fuels (coal, oil)
- Coal-burning power plants major source

- Reacts in atmosphere to produce acids
- One of the major components of acid rain
- When inhaled, can be very corrosive to lung tissue
- London
  - 1952 “killer fog”: 4,000 people died in 4 weeks
  -tied to sulfur compounds in smog

Human Source

Coal burning in power plants and industrial process.

Health effects

Breathing problems.

Environment effect

Reduce visibility, H_2SO_4 damages trees, soil and aquatic life.

Nitrogen Oxides

- Produced from burning of fossil fuels
- Contributes to acid rain, smog
- Automobile engine main source
- New engine technology has helped reduce, but many more cars

Source control

- Use only unleaded petrol.
- Use petroleum products and other fuels that have low sulphur and ash content.
- Plant trees along busy streets because they remove particulates and carbon monoxide and absorb noise.
- Industries and waste disposal sites should be situated outside the city centre.
- Use catalytic converters to help control the emissions of carbon monoxide and hydrocarbons.

Control measures in Industrial centres

- Emission rates should be restricted to permissible levels
- Incorporation of air pollution control equipments in the design of the plant lay out.

Hydrocarbons

- Hydrocarbons - organic compounds with hydrogen, carbon
- From incomplete burning or evaporated from fuel supplies
- Major source is automobiles, but some from industry
- Contribute to smog
- Improvements in engine design have helped reduce hydrocarbon emissions

Particulates

- Particulates - small pieces of solid materials and liquid droplets
- 2.5 mm and 10 mm
- Examples: ash from fires, asbestos from brakes and insulation, dust
- Easily noticed: e.g. smokestacks
- Can accumulate in lungs and interfere with the ability of lungs to exchange gases.
- Some particulates are known carcinogens
- Those working in dusty conditions at highest risk (e.g., miners)
- Respirable Suspended Particulate Matter (RSPM)
- -PM1 having size <= 1µm: effects in alveoli
  -PM2.5 having size <= 2.5µm: effects trachea
  -PM10 having size <= 10µm: effects in nasal part only

Human Sources

Burning coal in power and industrial plants. Burning diesel and other fuels in vehicle, agriculture, unpaved roads construction.

Health Effect

Nose and throat irritation, lung damage, asthma, reproductive problems and cancer.

Environment effect

Reduce visibility, acid deposition & H2SO4 droplets damage trees.

Secondary Pollutants

- Those that form as a result of a chemical reaction of the primary pollutant with a natural component of the environment.
- e.g. ozone, sulfuric and nitric acids.

Secondary Air Pollutants

1. Ozone
2. PAN (peroxy acetyl nitrate)
3. Photochemical smog
4. Aerosols and mists (H2SO4)

Ozone

- Ozone (O3) is a highly reactive gas composed of three oxygen atoms.
- It is both a natural and a man-made product that occurs in the Earth's upper atmosphere (the stratosphere) and lower atmosphere (the troposphere).
- Tropospheric ozone – what we breathe -- is formed primarily from photochemical reactions between two major classes of air pollutants, volatile organic compounds (VOC) and nitrogen oxides (NOX).

Human Source

- Chemical reactions with volatile organic compounds and nitrogen oxides.

Health Effect

- Breathing ozone results in respiratory distress, headaches.

Environment effect

- Moderates the climate

PAN

- Smog is caused by the interaction of some hydrocarbons and oxidants under the influence of sunlight giving rise to dangerous peroxy acetyl nitrate (PAN).

Photochemical smog

- Photochemical smog is a mixture of pollutants which includes particulates, nitrogen oxides, ozone, aldehydes, Peroxyacetyl nitrate (PAN), unreacted hydrocarbons, etc.
- Smog is a kind of air pollution, originally named for the mixture of smoke and fog in the air.
- HC and NO react in presence of sunlight to produce ozone and PAN (peroxy acetyl nitrate)
- Nitrogen oxides + hydrocarbons + Ultraviolet radiation -----> Peroxyacetyl nitrate (PAN) + O3 ozone.
- The smog often has a brown haze due to the presence of nitrogen dioxide.

Health Effect

- Breathing problems, cough, ENT irritation, heart diseases etc.,
- It causes painful eyes.
- PAH's poly nuclear aromatic hydrocarbons - carcinogenic.

Environment effect

- Smog can reduce visibility.
- PAN damages plants

Aerosols and mists (H_2SO_4)

- Aerosols and mists are very fine liquid droplets that cannot be effectively removed using traditional packed scrubbers.
- These droplets can be formed from gas phase hydrolysis of halogenated acids (HCl, HF, HBr), metal halides, organohalides, sulfur trioxide (SO3), and phosphorous pentoxide (P_2O_5).

Carbon monoxide, Nitrogen dioxide, sulfur dioxide

Pollutant	Sources	Effects
Carbon Monoxide - A gas that comes from burning fossil fuels, mostly in cars. It cannot be seen or smelled.	Carbon Monoxide is released when engines burn fossil fuels. Emissions are higher when engines are not tuned properly and when fuel is not completely burned. Cars emit a lot of carbon monoxide found outdoors. Furnaces and heaters in the home can emit high concentrations of carbon monoxide, if they are not properly maintained.	Carbon Monoxide makes it harder for body parts to get oxygen they need to function correctly. Exposure to carbon monoxide makes people dizzy and tired and gives them headaches. In high concentrations, it is fatal. Elderly people with heart diseases are hospitalized more often when they are exposed to higher amounts of carbon monoxide.
Nitrogen Dioxide – A reddish brown gas that comes from the burning of fossil fuels. It has strong smells at high levels.	Nitrogen dioxide mostly comes from power plants and cars. Nitrogen dioxide is formed in two ways – when nitrogen in the fuel is burned or when nitrogen in air reacts with oxygen at very high temperatures. Nitrogen dioxide can also react in atmosphere to form ozone, acid rain and particles.	High levels of nitrogen exposure can give people coughs and can make them feel short of breath. People who are exposed to nitrogen dioxide for a long term can have a higher chance of getting respiratory infections. Nitrogen dioxide reacts in atmosphere to form acid rain, which can harm plants and animals.

Sulfur dioxide - A corrosive gas that cannot be seen or smelled at low level but can have a rotten egg smell at high levels.	Burning of coal or oil in power plants. Comes from factories that make chemicals, paper or fuel.	Reacts with atmosphere to form acid rain. Exposure can affect people who have asthma by making it more difficult for them to breathe. It can also irritate people's eyes, noses and throat. It can harm trees, crops, damage buildings and make it harder for people to see long distances.

Effects of Air Pollution on humans, vegetation and environment

- Reduces visual range and atmospheric clarity, less contrast, less visibility.
- Damage to vegetation, including leaves, fruit, growth rate.
- Degradation of human health, from mild problems to severe e.g. eye irritation to respiratory disease asthma, bronchitis, emphysema, cancer.
- CO, carbon monoxide, 90% natural, 10% from incomplete combustion, cigarettes, combines with haemoglobin and reduces bloods ability to carry oxygen
- Degradation of vertebrate health, aquatic life, with impacts on respiration, bones, teeth, reproduction; increase lake acidity, degradation of soil and water, when air pollutants settle, toxic metals in soil, soils leached deterioration of man-made structures, break down car paint, roofing; acid rain chemically dissolves marble statues and other building materials.
- Air pollutants can overload or break down the natural defences such as hair in our nose, sticky mucus in the lining of the upper respiratory tract causing diseases like lung cancer, asthma, chronic bronchitis etc.
- Nitrogen oxides and suspended particles both can irritate lungs, aggravate asthma or chronic bronchitis and increase respiratory infections.

- Many volatile organic compounds such as benzene and formaldehyde and toxic particulates such as lead and cadmium can cause mutations, reproductive problems and cancer, breathlessness and irritation of the eye, nose and throat.
- Sulphur dioxide irritates respiratory tissues and chronic exposure causes bronchitis.
- Sulphur dioxide also reacts with water, oxygen and other materials to form sulphur containing acids – The acids can become attached to particles which when inhaled are very corrosive to the lung.
- Chronic exposure of the leaves to air pollutants can break down the waxy coating that helps prevent excessive water loss and leads to damage from diseases, pests, drought and frost.
- It also affects photosynthesis, respiration and other metabolisms.

Control of Air Pollution

Controlling at the sources:

- Use only unleaded petrol
- Use fuels that have low sulphurs and ash containing.
- Plant trees along busy streets because they remove particulates and CO and absorb noise
- Industries and waste disposal should be outside the city area.
- Use catalytic converters to control the emission of CO and hydrocarbon.

Control Measures in industries:

- Emission rates should be restricted to permissible levels in all industries.
- Air pollution control equipment should be incorporated in plant layout
- Monitoring of the atmosphere for the pollutants should be carried out continuously to know the emission levels.
- Scrubber, cyclone separator, bag house filter and electrostatic precipitators must be used in manufacturing process to retain harmful materials that must be disposed of safely.
- The disposal of the collected air pollutants are equally important for controlling air pollution.

WATER POLLUTION

Definition

- Water pollution is defined as "The presence of some foreign substances or impurities organic, inorganic, biological or radioactive in water in such quantity so as to constitute a health hazard by lowering the water quality and making it unfit for use."
- Water pollution is the contamination of water bodies (e.g. lakes, rivers, oceans, aquifers and groundwater), very often by human activities.
- It occurs when pollutants (particles, chemicals or substances that make water contaminated) are discharged directly or indirectly into water bodies without enough treatment to get rid of harmful compounds.
- Pollutants get into water mainly by human causes or factors.
- Water pollution is the second most imperative environmental concern along with air pollution.
- Any change or modification in the physical, chemical and biological properties of water that will have a detrimental consequence on living things is water pollution.

Sources of Water Pollution

There are various classifications of water pollution. The two chief sources of water pollution can be seen as Point and Non-Point.

1. Point Source

- Point refer to the pollutants that belong to a single source. An example of this would be emissions from factories into the water.
- Point source pollution refers to contaminants that enter a waterway through a discrete conveyance, such as a pipe or ditch.
- Examples-
    - discharges from a sewage treatment plant, a factory, a city storm drain.
    - Discharge from domestic, commercial and small industrial waste water into sewer.
    - Wastewater generated from industries e.g. dye, textile, pulp and paper, oil, refineries, food processing etc.

- It has both organic and inorganic matter (Organic Pollutants: Carbohydrates, proteins, oils, fats, cellulose, phenols etc and Inorganic Pollutants: Chlorides, sulphates, metals, oxides of metals, acids and alkalis etc).

2. Non-Point Source

- Non-Point on the other hand means pollutants emitted from multiple sources.
- Non-point source (NPS) pollution refers to diffuse contamination that does not originate from a single discrete source.
- NPS pollution is often accumulative effect of small amounts of contaminants gathered from a large area
- The leaching out of nitrogen compounds from agricultural land which has been fertilized is a typical example.
- Contaminated water after rains that has travelled through several regions may also be considered as a Non-point source of pollution.
- The pollutants scattered on the ground ultimately reach the water source and cause water pollution.
- E.g. Runoff from agricultural fields eventually enters streams, rivers, lakes and the ocean.
- Air pollution gets dissolved in rain water and contaminates the ground water as well as surface water sources.

3. Natural Sources

- An increase in the concentration of naturally occurring substances is also termed pollution.
- The sources of such an increase are called natural sources. Siltation (which includes soil, sand and mineral particles) is one such natural source.
- It is a common natural phenomenon, which occurs in most water bodies.
- Indiscriminate deforestation makes soil loose and flood waters bring silt from mountains into streams, rivers and lakes.

4. Anthropogenic Sources

- On the other hand, the human activities that result into the pollution of water are called anthropogenic or man -made sources of water pollution.

- For example, domestic (sewage and waste water), industrial and agricultural wastes that goes into the rivers, lakes, streams and seas are anthropogenic sources.
- Certain materials that are leached from the land by run-off water and enter the various water bodies also belong to this category.

Types of water Pollution

There are many types of water pollution because water comes from many sources. Here are a few types of water pollution:

1. **Nutrients Pollution**

Some wastewater, fertilizers and sewage contain high levels of nutrients. If they end up in water bodies, they encourage algae and weed growth in the water. This will make the water undrinkable, and even clog filters. Too much algae will also use up all the oxygen in the water, and other water organisms in the water will die out of oxygen starvation.

2. **Surface water pollution**

Surface water includes natural water found on the earth's surface, like rivers, lakes, lagoons and oceans. Hazardous substances coming into contact with this surface water, dissolving or mixing physically with the water can be called surface water pollution.

3. **Oxygen Depleting**

Water bodies have micro-organisms. These include aerobic and anaerobic organisms. When too much biodegradable matter (things that easily decay) end up in water, it encourages more microorganism growth, and they use up more oxygen in the water. If oxygen is depleted, aerobic organisms die, and anaerobic organism grow more to produce harmful toxins such as ammonia and sulfides.

4**. Ground water pollution**

When humans apply pesticides and chemicals to soils, they are washed deep into the ground by rain water. This gets to underground water, causing pollution underground. This means when we dig wells and bore holes to get water from underground, it needs to be checked for water pollution.

5. **Microbiological**

In many communities in the world, people drink untreated water (straight from a river or stream). Sometimes there is natural pollution caused by micro-organisms like viruses, bacteria and protozoa. This natural pollution can cause fishes and other water life to die. They can also cause serious illness to humans who drink from such waters.

6. **Suspended Matter**

Some pollutants (substances, particles and chemicals) do not easily dissolve in water. This kind of material is called particulate matter. Some suspended pollutants later settle under the water body. This can harm and even kill aquatic life that live at the floor of water bodies.

7. **Chemical Water Pollution**

Many industries and farmers work with chemicals that end up in water. This is common with Point-source Pollution. These include chemicals that are used to control weeds, insects and pests. Metals and solvents from industries can pollute water bodies. These are poisonous to many forms of aquatic life and may slow their development, make them infertile and kill them.

8. **Oil Spillage**

Oil spills usually have only a localized effect on wildlife but can spread for miles. The oil can cause the death to many fish and get stuck to the feathers of seabirds causing them to lose their ability to fly.

Industrial causes of water pollution

Industrial waste

Industries cause huge water pollution with their activities. These come mainly from: Sulphur – This is a non-metallic substance that is harmful for marine life.

Oil Pollution by Oil Industries

Routine shipping, run-offs and dumping of oils on the ocean surfaces happen every day. Oil spills cause major problems, and can be extremely harmful to local marine wildlife such as fish, birds and sea otters and other aquatic life. Because oil does not dissolve, it stays on

the water surface and suffocates fish. Oil also gets caught in the feathers of sea birds, making it difficult for them to fly. Some animals die as a result.

Other causes of water pollution

Sewage and waste water

Sewage is the term used for wastewater that often contains faeces, urine and laundry waste. The sewage and waste water that is produced by each household is chemically treated and released in to sea with fresh water. The sewage water carries harmful bacteria and chemicals that can cause serious health problems. Pathogens are known as a common water pollutant.

Mining activities

Mining is the process of crushing the rock and extracting coal and other minerals from underground. These elements when extracted in the raw form contains harmful chemicals and can increase the amount of toxic elements when mixed up with water which may result in health problems.

Ocean and marine dumping

Again, think of the rubbish we all make each day. Paper waste, food waste, plastic, rubber, metallic and aluminium waste. In some countries, they are deposited into the sea. All these waste types take time to decompose.

Underground storage and tube leakages

Many liquid products (petroleum products) are stored in metal and steel tubes underground. Other sewage systems run in underground tubes. Overtime, they rust and begin to leak. If that happens, they contaminate the soils, and the liquids in them end up in many nearby water bodies.

Types of Water Pollutants and their Impacts

The various types of pollutants can be broadly put under the following types: (i) Sewage Pollutants (Domestic and Municipal Waste) (ii) Industrial Pollutants (iii) Agricultural Pollutants (iv) Physical Pollutants

(i) Domestic and Municipal Pollutants

The sewage contains garbage, soaps, detergents, waste food and human excreta and is the single largest sources of water pollution. Pathogenic (disease causing) microorganisms (bacteria, fungi, protozoa, algae) enter the water system through sewage making it infected. Typhoid, cholera, gastroenteritis and dysentery are commonly caused by drinking infected water. Water polluted by sewage may carry certain other bacteria and viruses cannot grow by themselves, but reproduce in the cells of host organisms. They cause a number of diseases, such as, polio, viral hepatitis and may be cancer which are resistant to like the organic matter are oxygen demanding substances. They are responsible for deoxygenation of water-bodies which is harmful for aquatic life. Other ingredients which enter the various water bodies are the plant nutrients, i.e., nitrates and phosphates. They support growth of algae, commonly called algal bloom (blue-green species). This process is called eutrophication.

(ii) Industrial Pollutants

Many industries are located near rivers or fresh water streams. These are responsible for discharging their untreated effluents into rivers like highly toxic heavy metals such as chromium, arsenic, lead, mercury, etc. along with hazardous organic and inorganic wastes (e.g., acids, alkalies, cyanides, chlorides, etc.). Factories manufacturing plastic, caustic soda and some fungicides and pesticides release mercury (a heavy metal) along with other effluents in nearby water body. Mercury enters the food chain through bacteria, algae, fish and finally into the human body.

(iii) Agricultural Waste

Manure, fertilizers, pesticides, wastes form farms, slaughterhouse, poultry farms, salts and silt are drained as run-off from agricultural lands. The water body receiving large quantities of fertilizers (phosphates and nitrates or manures becomes rich in nutrients which leads to eutrophication and consequent depletion of dissolved oxygen. Consumption of water rich in nitrates is bad for human health especially for small children. Pesticides (DDT, dieldrin, aldrin, malathion, carbaryl etc.) are used to kill insect and rodent pests. Toxic pesticide residues enter the human body through drinking water or through food chain (bio magnification). These compounds have low solubility in water but are highly soluble in fats.

(iv) Physical Pollutants

Physical pollutants can be of different types. Some of them are discussed below:

(**a) Radioactive Wastes**

Radionuclides found in water are radium and potassium-40. These isotopes originate from natural sources due to leaching from minerals. Water bodies are also polluted by accidental leakage of waste material from uranium and thorium mines, nuclear power plants and industries, research laboratories and hospitals which use radioisotopes. Radioactive materials enter human body through water and food, and may be accumulated in blood and certain vital organs. They cause tumours and cancer.

(b) Thermal Sources

Various industries, nuclear power plants and thermal plants require water for cooling and the resultant hot water is often discharged into rivers or lakes. This results in thermal pollution and leads to the imbalance in the ecology of the water body. Higher temperature lowers the dissolved oxygen level (which is very essential for marine life) by decreasing the solubility of oxygen in water. Fish and other aquatic organism can get affected by a sudden change in water temperatures.

(c) Sediments

Soil particles carried to streams, lakes or oceans form the sediments. The sediment become polluting due to their large amount. Soil erosion defined as the soil carried by flood water from crop land, is responsible for sedimentation. The sediments may damage the water body by introducing a large amount of nutrient matter.

(v) Petroleum Products

Petroleum products are widely used for fuel, lubrication, plastics manufacturing, etc. and happen to be poisonous in nature. Crude oil and other related products generally get into water by accidental spillage from ships, tankers, pipelines etc. Besides these accidental spills, oil refineries, oil exploration sites and automobile service centres pollute different water bodies. Oil slick which floats on the water surface causes death of marine life and severely affects the ecosystem of the ocean.

Effects of Water Pollution

- The effects of water pollution are varied and depend on what chemicals are dumped and in which locations.
- Many water bodies near urban areas (cities and towns) are highly polluted.
- This is the result of both garbage dumped by individuals and dangerous chemicals legally or illegally dumped by manufacturing industries, health centres, schools and market places.

1. Death of aquatic (water) animals

The main problem caused by water pollution is that it kills life that depends on these water bodies. Dead fish, crabs, birds and sea gulls, dolphins, and many other animals often wind up on beaches, killed by pollutants in their habitat (living environment).

2. Disruption of food-chains

Pollution disrupts the natural food chain as well. Pollutants such as lead and cadmium are eaten by tiny animals. Later, these animals are consumed by fish and shellfish, and the food chain continues to be disrupted at all higher levels.

3. Diseases

Eventually, humans are affected by this process as well. People can get diseases such as hepatitis by eating seafood that has been poisoned. In many poor nations, there is always outbreak of cholera and diseases as a result of poor drinking water treatment from contaminated waters.

4. Destruction of ecosystems

Ecosystems (the interaction of living things in a place, depending on each other for life) can be severely changed or destroyed by water pollution. Many areas are now being affected by careless human pollution, and this pollution is coming back to hurt humans in many ways.

Control measures/Prevention of Water Pollution

Dealing with water pollution is something that everyone (including governments and local councils) needs to get involved with. Here are a few things you can do to help:

- Never throw rubbish away. Always look for the correct waste bin. If there is none around, please take it home and put it in your trash can.
- Use water wisely. Do not keep the tap running when not in use. Also, you can reduce the amount of water you use in washing and bathing.
- Do not throw chemicals, oils, paints and medicines down the sink drain, or the toilet. In many cities, your local environment office can help with the disposal of medicines and chemicals.
- Buy more environmentally safe cleaning liquids for use at home and other public places. They are less dangerous to the environment.
- If you use chemicals and pesticides for your gardens and farms, be mindful not to overuse pesticides and fertilizers. This will reduce runoffs of the chemical into nearby water sources. Start looking at options of composting and using organic manure instead.
- If you live close to a water body, try to plant lots of trees and flowers around your home, so that when it rains, chemicals from your home does not easily drain into the water.
- Encourage wastewater (liquid waste from flushing the toilet, bathing, washing) treatment.
- The administration of water pollution should be in the hands of state or central government.
- Industrial plants should be based on recycling operations, because it will not only stop the discharge of industrial wastes into natural water sources but by products can be extracted from the wastes.
- Plants, trees and forests control pollution and they acts as natural air conditioners.
- Highly qualified and experienced persons should be consulted from time to time for effective control of water pollution.
- Basic and applied research in public health engineering should be encouraged.

MODULE 3

SOLID WASTE: Classification and sources of Solid Waste, Characteristics, Effects, E – waste, Effects of urbanization on land degradation, Pesticide pollution

NOISE POLLUTION: Sources of Noise, Effects of Noise, Control Measures

What is solid waste?

Any material that we can discard, that is not liquid or gas, is a solid waste.

Solid wastes are the organic and inorganic waste materials such as product packaging, grass clippings, furniture, clothing, bottles, kitchen refuse, paper, appliances, paint cans, batteries, etc., produced in a society, which do not generally carry any value to the first user(s).

CLASSIFICATION OF SOLID WASTES

- Solid wastes, thus, encompass both a heterogeneous mass of wastes from the urban community as well as a more homogeneous accumulation of agricultural, industrial and mineral wastes.
- While wastes have little or no value in one setting or to the one who wants to dispose them, the discharged wastes may gain significant value in another setting.
- Knowledge of the sources and types of solid wastes as well as the information on composition and the rate at which wastes are generated/ disposed is, therefore, essential for the design and operation of the functional elements associated with the management of solid wastes.

Solid wastes are classified on the basis of source of generation and type.

Source-based classification

Historically, the sources of solid wastes have been consistent, dependent on sectors and activities, and these include the following:

(i) **Residential:** This refers to wastes from dwellings, apartments, etc., and consists of leftover food, vegetable peels, plastic, clothes, ashes, etc.

(ii) **Commercial:** This refers to wastes consisting of leftover food, glasses, metals, ashes, etc., generated from stores, restaurants, markets, hotels, motels, auto-repair shops, medical facilities, etc.

(iii) **Institutional:** This mainly consists of paper, plastic, glasses, etc., generated from educational, administrative and public buildings such as schools, colleges, offices, prisons, etc.

(iv) **Municipal:** This includes dust, leafy matter, building debris, treatment plant residual sludge, etc., generated from various municipal activities like construction and demolition, street cleaning, landscaping, etc.

(v) **Industrial:** This mainly consists of process wastes, ashes, demolition and construction wastes, hazardous wastes, etc., due to industrial activities.

(vi) **Agricultural:** This mainly consists of spoiled food grains and vegetables, agricultural remains, litter, etc., generated from fields, orchards, vineyards, farms, etc.

(vii) Open areas: this includes wastes from areas such as Streets, alleys, parks, vacant lots, playgrounds, beaches, highways, recreational areas, etc.

It is important to define the various types of solid wastes that are generated from various sources.

Type-based classification

Classification of wastes based on types, i.e., physical, chemical, and biological characteristics of wastes, is as follows:

(i) **Garbage:** This refers to animal and vegetable wastes resulting from the handling, sale, and storage, preparation, cooking and serving of food. Garbage comprising these wastes contains putrescible (rotting) organic matter, which produces an obnoxious odour and attracts rats and other vermin. It, therefore, requires special attention in storage, handling and disposal.

(ii) **Ashes and residues:** These are substances remaining from the burning of wood, coal, charcoal, coke and other combustible materials for cooking and heating in houses, institutions and small industrial establishments. When produced in large quantities, as in power-generation plants and factories, these are classified as industrial wastes. Ashes consist of fine powdery residue, cinders and clinker often mixed with small pieces of metal and glass. Since ashes and residues are almost entirely inorganic, they are valuable in landfills.

(iii) **Combustible and non-combustible wastes:** These consist of wastes generated from households, institutions, commercial activities, etc., excluding food wastes and other highly putrescible material. Typically, while *combustible material* consists of paper, cardboard, textile, rubber, garden trimmings, etc., *non-combustible material* consists of such items as glass, crockery, tin and aluminium cans, ferrous and non-ferrous material and dirt.

(iv) **Bulky wastes:** These include large household appliances such as refrigerators, washing machines, furniture, crates, vehicle parts, tyres, wood, trees and branches. Since these

household wastes cannot be accommodated in normal storage containers, they require a special collection mechanism.

(v) **Street wastes:** These refer to wastes that are collected from streets, walkways, alleys, parks and vacant plots, and include paper, cardboard, plastics, dirt, leaves and other vegetable matter. Littering in public places is indeed a widespread and acute problem in many countries including India, and a solid waste management system must address this menace appropriately.

(vi) **Biodegradable and non-biodegradable wastes:** *Biodegradable wastes* mainly refer to substances consisting of organic matter such as leftover food, vegetable and fruit peels, paper, textile, wood, etc., generated from various household and industrial activities. Because of the action of micro-organisms, these wastes are degraded from complex to simpler compounds. *Non-biodegradable* wastes consist of inorganic and recyclable materials such as plastic, glass, cans, metals, etc. Table below shows a comparison of biodegradable and non-biodegradable wastes with their degeneration time, i.e., the time required to break from a complex to a simple biological form:

Biodegradable and Non-Biodegradable Wastes: Degeneration Time

Categorty	**Type Of Waste**	**Approximate Time Taken To Degenerate**
Biodegradable	Organic waste such as vegetables and fruit peels, leftover food stuffs etc	A week or two
	Paper	10-30 days
	Cotton cloth	2-5 months
	Woollen item	1 year
	Wood	10-15 years
Non-biodegradable	Tin, aluminium and other metals such as cans	100-500 yrs
	Plastic bags	One million yrs
	Glass bottles	Undetermined

From Table, we can easily deduce the environmental consequences associated with non-biodegradable wastes such as plastics, glass, etc.

(vii) **Dead animals:** With regard to municipal wastes, dead animals are those that die naturally or are accidentally killed on the road. Note that this category does not include carcasses and animal parts from slaughter-houses, which are regarded as industrial wastes. Dead animals are divided into two groups – large and small. Among the large animals are horses, cows, goats, sheep, pigs, etc., and among the small ones are dogs, cats, rabbits, rats, etc. The reason for this differentiation is that large animals require special equipment for lifting and handling when they are removed. If not collected promptly, dead animals pose a threat to public health since they attract flies and other vermin as they decay. Their presence in public places is particularly offensive from the aesthetic point of view as well.

(viii) **Abandoned vehicles:** This category includes automobiles, trucks and trailers that are abandoned on streets and other public places. However, abandoned vehicles have significant scrap value for their metal, and their value to collectors is highly variable.

(ix) **Construction and demolition wastes:** These are wastes generated as a result of construction, refurbishment, repair and demolition of houses, commercial buildings and other structures. They consist mainly of earth, stones, and concrete, bricks, lumber, roofing and plumbing materials, heating systems and electrical wires and parts of the general municipal waste stream.

(x) **Farm wastes:** These wastes result from diverse agricultural activities such as planting, harvesting, production of milk, rearing of animals for slaughter and the operation of feedlots. In many areas, the disposal of animal waste has become a critical problem, especially from feedlots, poultry farms and dairies.

(xi) **Hazardous wastes:** Hazardous wastes are those defined as wastes of industrial, institutional or consumer origin that are potentially dangerous either immediately or over a period of time to human beings and the environment. This is due to their physical, chemical and biological or radioactive characteristics like ignitability, corrosivity, reactivity and toxicity. Note that in some cases, the active agents may be liquid or gaseous hazardous wastes. These are, nevertheless, classified as solid wastes as they are confined in solid containers. Typical examples of hazardous wastes are empty containers of solvents, paints and pesticides, which are frequently mixed with municipal wastes and become part of the urban waste stream. Certain hazardous wastes may cause explosions in incinerators and fires at landfill sites. Others such as pathological wastes from hospitals and radioactive wastes also require special handling. Effective management practices should ensure that hazardous wastes are stored, collected,

transported and disposed of separately, preferably after suitable treatment to render them harmless.

(xii) **Sewage wastes:** The solid by-products of sewage treatment are classified as sewage wastes. They are mostly organic and derived from the treatment of organic sludge separated from both raw and treated sewages. The inorganic fraction of raw sewage such as grit and eggshells is separated at the preliminary stage of treatment, as it may entrain putrescible organic matter with pathogens and must be buried without delay. The bulk of treated, dewatered sludge is useful as a soil conditioner but is invariably uneconomical. Solid sludge, therefore, enters the stream of municipal wastes, unless special arrangements are made for its disposal.

Classification of Solid Wastes

	Type	Description	Sources
Solid Wastes	Garbage	Food waste: wastes from the preparation, cooking and serving of food. Market refuse, waste from the handling, storage, and sale of produce and meat.	Households, institutions and commercial concerns such as hotels, stores, restaurants, markets, etc.
	Combustible and non–combustible	Combustible (primary organic) paper, cardboard, cartons, wood, boxes, plastic, rags, cloth, bedding, leather, rubber, grass, leaves, yard trimmings, etc.	
		Non-combustible (primary inorganic) metals, tin, cans, glass bottles, crockery, stones, etc.	
	Ashes	Residue from fires used for cooking and for heating building cinders	
	Bulky wastes	Large auto parts, tyres, stoves, refrigerators other large appliances, furniture, large crates, trees, branches, stumps, etc.	Streets, sidewalks, alleys, vacant lots, etc.
	Street wastes	Street sweepings, dirt, leaves, etc.	
	Dead animals	Dogs, cats, rats, donkeys, etc.	
	Abandoned vehicles	Automobiles and spare parts	
	Construction and demolition wastes	Roofing, and sheathing scraps, rubble, broken concrete, plaster, conduit pipe, wire, insulation, etc.	Construction and demolition sites.
	Industrial wastes	Solid wastes resulting from industry processes and manufacturing operations, such as, food processing wastes, boiler house cinders, wood, plastic and metal scraps, shavings, etc	Factories, power plants, etc.
	Hazardous wastes	Pathological wastes, explosives, radioactive materials, etc.	Households, hospitals, institutions, stores, industry, etc.
	Animal and agricultural wastes	Manure, crop residues, etc.	Livestock, farms, feedlots and agriculture
	Sewage treatment residue	Coarse screening grit, septic tank sludge, dewatered sludge.	Sewage treatment plants and septic tanks.

CHARACTERISTICS SOLID WASTE

In order to identify the exact characteristics of municipal wastes, it is necessary that we analyse them using physical, chemical and biological characteristics.

Physical characteristics

- Information and data on the physical characteristics of solid wastes are important for the selection and operation of equipment and for the analysis and design of disposal facilities.
- The required information and data include the following:

(i) **Density:** Density of waste, i.e., its mass per unit volume (kg/m^3), is a critical factor in the design of a SWM system, e.g., the design of sanitary landfills, storage, types of collection and transport vehicles, etc. To explain, an efficient operation of a landfill demands compaction of wastes to optimum density. Any normal compaction equipment can achieve reduction in volume of wastes by 75%, which increases an initial density of 100 kg/m^3 to 400 kg/m^3. In other words, a waste collection vehicle can haul four times the weight of waste in its compacted state than when it is uncompacted. A high initial density of waste precludes the achievement of a high compaction ratio and the compaction ratio achieved is no greater than 1.5:1. Significant changes in density occur spontaneously as the waste moves from source to disposal, due to scavenging, handling, wetting and drying by the weather, vibration in the collection vehicle and decomposition. Note that:

- the effect of increasing the moisture content of the waste is detrimental in the sense that dry density decreases at higher moisture levels;
- soil-cover plays an important role in containing the waste;
- there is an upper limit to the density, and the conservative estimate of in-place density for waste in a sanitary landfill is about 600 kg/m^3.

(ii) **Moisture content:** Moisture content is defined as the ratio of the weight of water (wet weight - dry weight) to the total weight of the wet waste. Moisture increases the weight of solid wastes, and thereby, the cost of collection and transport. In addition, moisture content is a critical determinant in the economic feasibility of waste treatment by incineration, because wet waste consumes energy for evaporation of water and in raising the temperature of water vapour. In the main, wastes should be insulated from rainfall or other extraneous water. We can calculate the moisture percentage, using the formula given below: A typical range of moisture

content is 20 to 40%, representing the extremes of wastes in an arid climate and in the wet season of a region of high precipitation. However, values greater than 40% are not uncommon.

$$\text{Moisture content } (\%) = = \frac{\textbf{wet weight} - \textbf{dry weight}}{\textbf{wet weight}} \text{ x } 100$$

(iii) **Size:** Measurement of size distribution of particles in waste stream is important because of its significance in the design of mechanical separators and shredders. Generally, the results of size distribution analysis are expressed in the manner used for soil particle analysis. That is to say, they are expressed as a plot of particle size (mm) against percentage, less than a given value.

- $S_c = l$
- $S_c = \frac{l+w}{2}$
- $S_c = \frac{l+w+h}{3}$
- $S_c = \sqrt{l \, x \, w}$
- $S_c = \sqrt[3]{l \, x \, w \, x \, h}$

Where, S_c = size of component in mm w = width in mm

h = height in mm l = length in mm

The physical properties that are essential to analyse wastes disposed at landfills are:

I. Field capacity: The field capacity of MSW is the total amount of moisture which can be retained in a waste sample subject to gravitational pull. It is a critical measure because water in excess of field capacity will form leachate, and leachate can be a major problem in landfills. Field capacity varies with the degree of applied pressure and the state of decomposition of the wastes.

II. Permeability and Porosity of compacted wastes: The hydraulic conductivity of compacted wastes is an important physical property because it governs the movement of liquids and gases in a landfill. Permeability depends on the other properties of the solid material include pore size distribution, surface area and porosity.

Porosity: It represents the amount of voids per unit overall volume of material. The porosity of MSW varies typically from 0.40 to 0.67 depending on the compaction and composition of the waste.

Porosity of solid waste, n= e/ (1+e), Where "e" is void ratio of solid waste

III. Compressibility of MSW: Degree of physical changes of the suspended solids or filter cake when subjected to pressure.

$$\Delta HT = \Delta Hi + \Delta Hc + \Delta H\alpha$$

[ΔHT= total settlement; ΔHi=immediate settlement; ΔHc = consolidation settlement; ΔHα = secondary compression or creep]

Chemical characteristics

- Knowledge of the classification of chemical compounds and their characteristics is essential for the proper understanding of the behaviour of waste, as it moves through the waste management system.
- The products of decomposition and heating values are two examples of chemical characteristics.
- If solid wastes are to be used as fuel, or are used for any other purpose, we must know their chemical characteristics, including the following:

(i) **Lipids:** This class of compounds includes fats, oils and grease, and the principal sources of lipids are garbage, cooking oils and fats. Lipids have high heating values, about 38,000 kJ/kg (kilojoules per kilogram), which makes waste with high lipid content suitable for energy recovery. Since lipids become liquid at temperatures slightly above ambient, they add to the liquid content during waste decomposition. Though they are biodegradable, the rate of biodegradation is relatively slow because lipids have a low solubility in water.

(ii) **Carbohydrates:** These are found primarily in food and yard wastes, which encompass sugar and polymer of sugars (e.g., starch, cellulose, etc.) with general formula $(CH_2O)x$. Carbohydrates are readily biodegraded to products such as carbon dioxide, water and methane. Decomposing carbohydrates attract flies and rats, and therefore, should not be left exposed for long duration.

(iii) **Proteins:** These are compounds containing carbon, hydrogen, oxygen and nitrogen, and consist of an organic acid with a substituted amine group (NH_2). They are mainly found in food

and garden wastes. The partial decomposition of these compounds can result in the production of amines that have unpleasant odours.

(iv) **Natural fibres:** These are found in paper products, food and yard wastes and include the natural compounds, cellulose and lignin, that are resistant to biodegradation. (Note that paper is almost 100% cellulose, cotton over 95% and wood products over 40%.) Because they are a highly combustible solid waste, having a high proportion of paper and wood products, they are suitable for incineration. Calorific values of oven-dried paper products are in the range of 12,000 -18,000 kJ/kg and of wood about 20,000 kJ/kg, i.e., about half that for fuel oil, which is 44,200 kJ/kg.

(v) **Synthetic organic material (Plastics):** Accounting for 1 – 10%, plastics have become a significant component of solid waste in recent years. They are highly resistant to biodegradation and, therefore, are objectionable and of special concern in SWM. Hence the increasing attention being paid to the recycling of plastics to reduce the proportion of this waste component at disposal sites. Plastics have a high heating value, about 32,000 kJ/kg, which makes them very suitable for incineration. But, you must note that polyvinyl chloride (PVC), when burnt, produces dioxin and acid gas. The latter increases corrosion in the combustion system and is responsible for acid rain.

(vi) **Non-combustibles:** This class includes glass, ceramics, metals, dust and ashes, and accounts for 12 – 25% of dry solids.

(vii) **Energy Content of Solid waste Components**: The energy content of organic components in MSW can be determined by

1) Using a full scale boiler as a calorimeter
2) Using a laboratory bomb calorimeter
3) Calculation , if elemental composition is known

Because of difficulty in instrumenting a full scale boiler, most of the data on energy content of organic components of MSW are based on results of bomb calorimeter tests.

1. Heating value:

An evaluation of the potential of waste material for use as fuel for incineration requires a determination of its heating value, expressed as kilojoules per kilogram (kJ/kg). The heating value is determined experimentally using the Bomb calorimeter test, in which the heat

generated, at a constant temperature of 25^0C from the combustion of a dry sample is measured. Since the test temperature is below the boiling point of water (100^0C), the combustion water remains in the liquid state. However, during combustion, the temperature of the combustion gases reaches above 100^0C, and the resultant water is in the vapour form. Table shows the typical inert residue and heating values for the components of municipal solid waste.

Typical Heating and Inert Residue Values

Component	**Inert Residue %**		**Heating Value (kJ/kg)**	
	Range	**Typical**	**Range**	**Typical**
Food wastes	2-8	5	3500-7000	4500
Paper	4-8	6	11500-18500	16500
Cardboard	3-6	5	14000-17500	16000
Plastics	2-20	10	28000-37000	32500
Textiles	2-4	2.5	15000-20000	17500

2. **Ultimate analysis:** This refers to an analysis of waste to determine the proportion of carbon, hydrogen, oxygen, nitrogen and sulphur, and the analysis is done to make mass balance calculation for a chemical or thermal process. Besides, it is necessary to determine ash fraction because of its potentially harmful environmental effects, brought about by the presence of toxic metals such as cadmium, chromium, mercury, nickel, lead, tin and zinc. Note that other metals (e.g., iron, magnesium, etc.) may also be present but they are non-toxic. Table shows the result of ultimate analysis of a typical municipal solid waste:

Municipal Solid Waste: A Typical Ultimate Analysis

Element	**Range (%dry weight)**
Carbon	25-30
Hydrogen	2.5-6.0
Oxygen	15-30
Nitrogen	0.25-1.2
Sulphur	0.02-0.12
Ash	12-30

3. **Proximate analysis:** This is important in evaluating the combustion properties of wastes or a waste or refuse derived fuel. The fractions of interest are:

- moisture content, which adds weight to the waste without increasing its heating value, and the evaporation of water reduces the heat released from the fuel;
- ash, which adds weight without generating any heat during combustion;
- volatile matter, i.e., that portion of the waste that is converted to gases before and during combustion;
- Fixed carbon, which represents the carbon remaining on the surface grates as charcoal. A waste or fuel with a high proportion of fixed carbon requires a longer retention time on the furnace grates to achieve complete combustion than a waste or fuel with a low proportion of fixed carbon.

Municipal Solid Waste: A Typical Proximate Analysis

Components		**Value, percent**
	Range	**Typical**
Moisture	15-40	20
Volatile matter	40-60	53
Fixed carbon	5-12	7
Glass, metal, ash	15-30	20

4. Fusing Point of Ash: It is the temperature at which ash resulting from the burning of a waste will form a solid clinker by fusion and agglomeration.

Biological Characteristics

- Biodegradability of waste
- Odours
- Breeding of flies

The most important biological characteristic of the organic fraction of MSW is that almost all of the organic components can be converted biologically to gases and relatively inert organic and inorganic solids. The production of odours and the generation of flies are also related to the putrescible nature of the organic materials found in MSW (e.g., food wastes).

Excluding plastic, rubber and leather components, the organic fraction of most MSW can be classified as follows:

- Water-soluble constituents such as sugars, starches, amino acids, and various organic acids.
- Hemicelluloses, a condensation product of five- and six-carbon sugars
- Cellulose, a condensation product of the six-carbon sugar glucose
- Fats, oils, and waxes which are esters of alcohols and long-chain fatty Acids
- Lignin, a polymeric material containing aromatic rings with methoxyl groups
- Lignocelluloses, a combination of lignin and cellulose
- Proteins, which are composed of chains of amino acids

Biodegradability of Organic Waste Components:

- Volatile solids (VS) content, determined by ignition at 550^0 C, is often used as a measure of the biodegradability of the organic fraction of MSW.
- Estimate the biodegradable fraction, using the following relationship:

  BF = 0.83 – 0.028 LC

Where,

BF= biodegradable fraction expressed on a volatile solids (VS) basis

0.83 = empirical constant

0.028 = empirical constant

LC = lignin content of VS expressed as a percent of dry weight

- Wastes with high lignin contents, such as newsprint, are significantly less biodegradable than the other organic wastes found in MSW.

EFFECTS OF SOLID WASTE

An effective solid waste management system is necessary to avoid public health disasters, spread of disease by insects and vectors and adverse effect on water and air.

Public health effect

The volume of waste is increasing rapidly as a result of increasing population and improving economic conditions in various localities. This increased volume of wastes is posing serious problems due to insufficient workforce and other constraints in disposing of it properly.

(i) Disease vectors and pathways: Wastes dumped indiscriminately provide the food and environment for thriving populations of vermin, which are the agents of various diseases. The pathways of pathogen transmission from wastes to humans are mostly indirect through insects – flies, mosquitoes and roaches and animals – rodents and pigs.

(ii) Flies: Most common in this category is the housefly, which transmits typhoid, salmonellosis, gastro-enteritis and dysentery. Covering solid wastes with a layer of earth at landfill sites at the end of every day arrests the problem of fly breeding at the final stage.

(iii) Mosquitoes: They transmit diseases such as malaria, filaria and dengue fever. Since they breed in stagnant water, control measures should centre on the elimination of breeding places such as tins, cans, tyres, etc. Proper sanitary practices and general cleanliness in the community help eliminate the mosquito problems caused by the mismanagement of solid waste.

(iv) Roaches: These cause infection by physical contact and can transmit typhoid, cholera and amoebiasis. The problems of roaches are associated with the poor storage of solid waste.

(v) Rodents: Rodents (rats) proliferate in uncontrolled deposits of solid wastes, which provide a source of food as well as shelter. They are responsible for the spread of diseases such as plague, murine typhus, leptospirosis, histoplasmosis, rat bite fever, dalmonelosis, trichinosis, etc. The fleas, which rats carry, also cause many diseases

(vi) Occupational hazards: Workers handling wastes are at risk of accidents related to the nature of material and lack of safety precautions. The infections associated with waste handling, include: skin and blood infections resulting from direct contact with waste and from infected wounds; eye and respiratory infections resulting from exposure to infected dust, especially during landfill operations; diseases that result from the bites of animals feeding on the waste; intestinal infections that are transmitted by flies feeding on the waste; chronic respiratory diseases, including cancers resulting from exposure to dust and hazardous compounds.

(vii) Animals: Apart from rodents, some animals (e.g., dogs, cats, pigs, etc.) also act as carriers of disease.

Environmental Effect

Inadequate and improper waste management causes adverse environmental effects such as the following:

(i) Air pollution: Burning of solid wastes in open dumps or in improperly designed incinerators emit pollutants (gaseous and particulate matters) to the atmosphere. Studies show that the environmental consequences of open burning are greater than incinerators, especially with respect to aldehydes and particulates. Emissions from an uncontrolled incinerator system include particulate matter, sulphur oxides, nitrogen oxides, hydrogen chloride, carbon monoxide, lead and mercury. Discharge of arsenic, cadmium and selenium is to be controlled, since they are toxic at relatively low exposure levels. Polychlorinated dibenzofurans (PCDFs), commonly called dioxins and furans, are of concern because of their toxicity, carcinogenicity and possible mutagenicity.

(ii) Water and land pollution: Water pollution results from dumping in open areas and storm water drains, and improper design, construction and/or operation of a sanitary landfill. Control of infiltration from rainfall and surface runoff is essential in order to minimise the production of leachate.

(iii) Visual pollution: The aesthetic sensibility is offended by the unsightliness of piles of wastes on the roadside. The situation is made worse by the presence of scavengers rummaging in the waste. Waste carelessly and irresponsibly discarded in public thoroughfares, along roads and highways and around communal bins (i.e., makeshift containers, without lids, used for the storage of residential, commercial and institutional wastes) gives easy access to animals scavenging for food.

(iv) Noise pollution: Undesirable noise is a nuisance associated with operations at landfills, incinerators, transfer stations and sites used for recycling. This is due to the movement of vehicles, the operation of large machines and the diverse operations at an incinerator site. The impacts of noise pollution may be reduced by careful siting of SWM operations and by the use of noise barriers.

(v) Odour pollution: Obnoxious odours due to the presence of decaying organic matter are characteristic of open dumps. They arise from anaerobic decomposition processes and their major constituents are particularly offensive. Proper landfill covering eliminates this nuisance.

(vi) Explosion hazards: Landfill gas, which is released during anaerobic decomposition processes, contains a high proportion of methane (35 – 73%). It can migrate through the soil over a considerable distance, leaving the buildings in the vicinity of sanitary landfill sites at risk, even after the closure of landfills. Several methods are available for control of landfill gas, such as venting, flaring and the use of impermeable barriers.

E- WASTES

Electronic waste or e-waste may be defined as discarded computers, office electronic equipment, entertainment device electronics, mobile phones, television sets, and refrigerators. This includes used electronics which are destined for reuse, resale, salvage, recycling, or disposal as well as re-usables (working and repairable electronics) and secondary scraps (copper, steel, plastic, etc.). The term "waste" is reserved for residue or material which is dumped by the buyer rather than recycled, including residue from reuse and recycling operations, because of loads of surplus electronics (good, recyclable, and non-recyclable).

Several public policy advocates apply the term "e-waste" and "e-scrap" broadly to all surplus electronics. Electronic waste or e-waste describes discarded electrical or electronic devices. Used electronics which are destined for reuse, resale, salvage, recycling, or disposal are also considered e-waste. Informal processing of e-waste in developing countries can lead to adverse human health effects and environmental pollution. Electronic scrap components, such as CPUs, contain potentially harmful materials such as lead, cadmium and beryllium. Recycling and disposal of e-waste may involve significant risk to health of workers and communities in developed countries and great care must be taken to avoid unsafe exposure in recycling operations and leaking of materials such as heavy metals from landfills and incinerator ashes.

E-waste or electronic waste is created when an electronic product is discarded after the end of its useful life. The rapid expansion of technology means that a very large amount of e-waste is created every minute.

Electronic waste or e-waste may be defined as discarded computers, office electronic equipment, entertainment device electronics, mobile phones, television sets, and refrigerators. This includes used electronics which are destined for reuse, resale, salvage, recycling, or disposal as well as re-usables (working and repairable electronics) and secondary scraps (copper, steel, plastic, etc.). The term "waste" is reserved for residue or material which is dumped by the buyer rather than recycled, including residue from reuse and recycling operations, because loads of surplus electronics are frequently commingled (good, recyclable, and non-recyclable). Several public policy advocates apply the term "e-waste" and "e-scrap" broadly to all surplus electronics. Cathode ray tubes(CRTs) are considered one of the hardest types to recycle.

E-WASTE: EFFECTS ON ENVIRONMENT AND HUMAN HEALTH

Environmental impact of E waste

E-Waste Component	Process Used	Potential Environmental Hazard
Cathode ray tubes (used in TVs, computer monitors, ATM, video cameras, and more)	Breaking and removal of yoke, then dumping	Lead, barium and other heavy metals leaching into the ground water and release of toxic phosphor
Printed circuit board (image behind table – a thin plate on which chips and other electronic components are placed)	De-soldering and removal of computer chips; open burning and acid baths to remove metals after chips are removed.	Air emissions and discharge into rivers of glass dust, tin, lead, brominated dioxin, beryllium cadmium, and mercury
Chips and other gold plated components	Chemical stripping using nitric and hydrochloric acid and burning of chips	PAHs, heavy metals, brominated flame retardants discharged directly into rivers acidifying fish and flora. Tin and lead contamination of surface and groundwater. Air emissions of brominated dioxins, heavy metals, and PAHs
Plastics from printers, keyboards, monitors, etc.	Shredding and low temp melting to be reused	Emissions of brominated dioxins, heavy metals, and hydrocarbons
Computer wires	Open burning and stripping to remove copper	PAHs released into air, water, and soil.

Health impacts of e-waste

E-Waste Component	**Electric Appliances in which they are found**	**Adverse Health Effects**
Americium	The radioactive source in smoke alarms.	It is known to be carcinogenic.
Lead	Solder, CRT monitor glass, lead-acid batteries, some formulations of PVC. A typical 15-inch cathode ray tube may contain 1.5 pounds of lead, but other CRTs have been estimated as having up to 8 pounds of lead.	Adverse effects of lead exposure include impaired cognitive function, behavioral disturbances, attention deficits, hyperactivity, conduct problems, and lower IQ. These effects are most damaging to children whose developing nervous systems are very susceptible to damage caused by lead, cadmium, and mercury.
Mercury	Found in fluorescent tubes (numerous applications), tilt switches (mechanical doorbells, thermostats), and ccfl backlights in flat screen monitors.	Health effects include sensory impairment, dermatitis, memory loss, and muscle weakness. Exposure in-utero causes fetal deficits in motor function, attention, and verbal domains.Environmental effects in animals include death, reduced fertility, and slower growth and development.
Cadmium	Found in light-sensitive resistors, corrosion-resistant alloys for marine and aviation environments, and nickel-cadmium batteries. The most common form of cadmium is found in Nickel-cadmium rechargeable batteries. These batteries tend to contain between 6 and 18% cadmium. The sale of Nickel-Cadmium	The inhalation of cadmium can cause severe damage to the lungs and is also known to cause kidney damage.Cadmium is also associated with deficits in cognition, learning, behavior, and neuromotor skills in children.

	batteries has been banned in the European Union except for medical use. When not properly recycled it can leach into the soil, harming microorganisms and disrupting the soil ecosystem. Exposure is caused by proximity to hazardous waste sites and factories and workers in the metal refining industry.	
Hexavalent chromium	Used in metal coatings to protect from corrosion.	A known carcinogen after occupational inhalation exposure. There is also evidence of cytotoxic and genotoxic effects of some chemicals, which have been shown to inhibit cell proliferation, cause cell membrane lesion, cause DNA single-strand breaks, and elevate Reactive Oxygen Species (ROS) levels.
Sulphur	Found in lead-acid batteries.	Health effects include liver damage, kidney damage, heart damage, eye and throat irritation. When released into the environment, it can create sulphuric acid through sulphur dioxide.
Brominated Flame Retardants (BFRs)	Used as flame retardants in plastics in most electronics. Includes PBBs, PBDE, Deca BDE, OctaBDE, PentaBDE.	Health effects include impaired development of the nervous system, thyroid problems, liver problems.Environmental effects: similar effects as in animals as humans. PBBs were banned from 1973 to 1977 on. PCBs were banned during the 1980s.
Perfluorooctanoic acid	Used as an antistatic additive in industrial applications and	Studies in mice have found the following health effects: Hepatotoxicity,

(PFOA)	found in electronics, also found in non-stick cookware (PTFE). PFOAs are formed synthetically through environmental degradation.	developmental toxicity, immune toxicity, hormonal effects and carcinogenic effects. Studies have found increased maternal PFOA levels to be associated with an increased risk of spontaneous abortion (miscarriage) and stillbirth. Increased maternal levels of PFOA are also associated with decreases in mean gestational age (preterm birth), mean birth weight (low birth weight), mean birth length (small for gestational age), and mean APGAR score.
Beryllium oxide	Filler in some thermal interface materials such as thermal grease used on heat sinks for CPUs and power transistors, magnetrons, X-ray-transparent ceramic windows, heat transfer fins in vacuum tubes, and gas lasers.	Occupational exposures associated with lung cancer, other common adverse health effects are beryllium sensitization, chronic beryllium disease, and acute beryllium disease.
Polyvinyl chloride (PVC)	Commonly found in electronics and is typically used as insulation for electrical cables.	In the manufacturing phase, toxic and hazardous raw material, including dioxins are released. PVC such as chlorine tend to bioaccumulate. Over time, the compounds that contain chlorine can become pollutants in the air, water, and soil. This poses a problem as human and animals can ingest them. Additionally, exposure to toxins can result in reproductive and developmental health effects.

Disposal of e-wastes is a particular problem faced in many regions across the globe.

- Computer wastes that are landfilled produces contaminated leachates which eventually pollute the groundwater.
- Acids and sludge obtained from melting computer chips, if disposed on the ground causes acidification of soil. For example, Guiyu, Hong Kong a thriving area of illegal e-waste recycling is facing acute water shortages due to the contamination of water resources. This is due to disposal of recycling wastes such as acids, sludges etc. in rivers.
- Incineration of e-wastes can emit toxic fumes and gases, thereby polluting the surrounding air.
- Improperly monitored landfills can cause environmental hazards.
- Mercury will leach when certain electronic devices, such as circuit breakers are destroyed. The same is true for polychlorinated biphenyls (PCBs) from condensers.
- When brominated flame retardant plastic or cadmium containing plastics are landfilled, both polybrominated diphenyl ethers (PBDE) and cadmium may leach into the soil and groundwater.
- It has been found that significant amounts of lead ion are dissolved from broken lead containing glass, such as the cone glass of cathode ray tubes, gets mixed with acid waters and are a common occurrence in landfills.
- The vaporization of metallic mercury and dimethylene mercury, both part of Waste Electrical and Electronic Equipment (WEEE) is also of concern.
- Uncontrolled fires may arise at landfills and this could be a frequent occurrence in many countries. When exposed to fire, metals and other chemical substances, such as the extremely toxic dioxins and furans (TCDD tetrachloro dibenzo-dioxin, PCDDs-polychlorinated dibenzodioxins. PBDDs-polybrominated dibenzo-dioxin and PCDFspoly chlorinated dibenzo furans) from halogenated flame retardant products and PCB containing condensers can be emitted.
- The most dangerous form of burning e-waste is the open-air burning of plastics in order to recover copper and other metals. The toxic fall-out from open air burning affects both the local environment and broader global air currents, depositing highly toxic by products in many places throughout the world.

MANAGEMENT OF E-WASTES

It is estimated that 75% of electronic items are stored due to uncertainty of how to manage it. These electronic junks lie unattended in houses, offices, warehouses etc. and normally mixed with household wastes, which are finally disposed off at landfills. This necessitates implementable management measures.

In industries management of e-waste should begin at the point of generation. This can be done by waste minimization techniques and by sustainable product design. Waste minimization in industries involves adopting:

- inventory management,
- production-process modification,
- volume reduction,
- recovery and reuse.

Recycling and Reuse of e- waste

- Computer monitors are typically packed into low stacks on wooden pallets for recycling and then shrink-wrapped.
- Recycling is an essential element of e-waste management. Properly carried out, it should greatly reduce the leakage of toxic materials into the environment and mitigate against the exhaustion of natural resources. However, it does need to be encouraged by local authorities and through community education.
- One of the major challenges is recycling the printed circuit boards from the electronic wastes. The circuit boards contain such precious metals as gold, silver, platinum, etc. and such base metals as copper, iron, aluminum, etc. One way e-waste is processed is by melting circuit boards, burning cable sheathing to recover copper wire and open- pit acid leaching for separating metals of value. Conventional method employed is mechanical shredding and separation but the recycling efficiency is low. Alternative methods such as cryogenic decomposition have been studied for printed circuit board recycling, and some other methods are still under investigation.
- Properly disposing of or reusing electronics can help prevent health problems, reduce greenhouse-gas emissions, and create jobs. Reuse and refurbishing offer a more environmentally friendly.

- In many developed countries, electronic waste processing usually first involves dismantling the equipment into various parts (metal frames, power supplies, circuit boards, plastics), often by hand, but increasingly by automated shredding equipment.
- An ideal electronic waste recycling plant combines dismantling for component recovery with increased cost-effective processing of bulk electronic waste.
- Reuse is an alternative option to recycling because it extends the lifespan of a device. Devices still need eventual recycling, but by allowing others to purchase used electronics, recycling can be postponed and value gained from device use.

Benefits of recycling

- Recycling raw materials from end-of-life electronics is the most effective solution to the growing e-waste problem.
- Most electronic devices contain a variety of materials, including metals that can be recovered for future uses.
- By dismantling and providing reuse possibilities, intact natural resources are conserved and air and water pollution caused by hazardous disposal is avoided.
- Additionally, recycling reduces the amount of greenhouse gas emissions caused by the manufacturing of new products.
- Another benefit of recycling e-waste is that many of the materials can be recycled and re-used again.
- Materials that can be recycled include "ferrous (iron-based) and non-ferrous metals, glass, and various types of plastic." “Non-ferrous metals, mainly aluminum and copper can all be re-smelted and re-manufactured. Ferrous metals such as steel and iron can be also be re-used."
- Due to the recent surge in popularity in 3D printing, certain 3D printers have been designed to produce waste that can be easily recycled which decreases the amount of harmful pollutants in the atmosphere. The excess plastic from these printers that comes out as a byproduct can also be reused to create new 3D printed creations.
- Benefits of recycling are extended when responsible recycling methods are used. In the U.S., responsible recycling aims to minimize the dangers to human health and the environment that disposed and dismantled electronics can create. Responsible recycling ensures best management practices of the electronics being recycled, worker health and safety, and consideration for the environment locally and abroad.

- In Europe, metals that are recycled are returned to companies of origin at a reduced cost.
- Through a committed recycling system, manufacturers in Japan have been pushed to make their products more sustainable. Since many companies were responsible for the recycling of their own products, this imposed responsibility on manufacturers requiring many to redesign their infrastructure. As a result, manufacturers in Japan have the added option to sell the recycled metals.

Repair

- One of the factors which exacerbate the e-waste problem is the diminishing lifetime of many electrical and electronic goods.
- Firstly, consumer demand for low cost products mitigates against product quality and results in short product lifetimes.
- On the other, manufacturers in some sectors encourage a regular upgrade cycle, and may even enforce it though restricted availability of spare parts, service manuals and software updates, or through planned obsolescence.
- Consumer dissatisfaction with this state of affairs has led to a growing repair movement.
- Often, this is at a community level such as through repair cafes or the "restart parties" promoted by the Restart Project.

EFFECTS OF URBANIZATION ON LAND DEGRADATION

Urbanization is the increased number of inhabitants in the urban areas. The trend of urbanization has been in its greatest boom since 1980's. Presently more and more people flock towards cities for better living conditions and facilities.

This immediate drift towards urbanization has created various environmental issues. Some of the major effects include

1. **Soil erosion:** Conversion of agricultural land and forest, as well as reclaiming of wetlands, for urban uses and infrastructure, are associated with widespread removal of vegetation to support urban ecosystem which in turn led to soil erosion. The conversion of Earth's land surface to urban uses is one of the most irreversible human impacts on the global biosphere. It drives the loss of farmland, affects local climate, fragments habitats, and threatens biodiversity.
2. **Landslides:** The stability of slopes (both natural and artificial) determines the

vulnerability of landslides or slope failures Encroachment of urban land into nearby forested or vegetated areas, and the expansion of built up areas and transportation networks into steeper terrain destabilizing slopes lead to slope failures

3. **Effect on Climate:** The conversion of Earth's land surface to urban uses leads to loss in the forest cover of Earth which in turn going to affect the amount of rain.
4. **Improper waste disposal:** Urban activities generate large quantities of city wastes including several biodegradable materials (like vegetables, animal wastes, papers, wooden pieces, carcasses, plant twigs, leaves, cloth wastes as well as sweepings) and many non-biodegradable materials (such as plastic bags, plastic bottles, plastic wastes, glass bottles, glass pieces, stone / cement pieces). Uncollected and improperly handled solid waste can have serious health consequences.

- Clogging of drains Causing serious drainage problems including the burst / leakage of drainage lines leading to health problems.
- Barrier to movement of water -Solid wastes have seriously damaged the normal movement of water thus creating problem of inundation, damage to foundation of buildings as well as public health hazards.
- Foul smell - generated by dumping the wastes at a place.
- Increased microbial activities Microbial decomposition of organic wastes generate large quantities of methane besides many chemicals to pollute the soil and water flowing on its surface hospital waste.
- Create many health problems - as they may have dangerous pathogen within them besides dangerous medicines, injections.
- Pollution of underground soil.
- Chemicals released by industrial wastes, Decomposed and partially decomposed materials of sanitary wastes.

5. **Decrease in food production:** As the world population and land degradation increase, world food security decrease.

PESTICIDE POLLUTION

Classification of pesticide

1. Herbicide
2. Insecticide
3. Rodenticide
4. Nematicide
5. Molluscicide
6. Fungicide
7. Algaecides
8. Bactericide
9. Piscicide

Pathways of pesticide movement

- Absorbed by crops
- Vapourises to atmosphere
- Degraded by UV light (Photo degradation)
- Deposited by rainfall
- Surface runoff to lakes and rivers
- Leaching and breakdown in soil.
- Leaching and degradation by microbes

Hazards of Pesticides

1) Adverse environmental Impact

- Pesticides causes pollution of soil, water and air.
- The pesticidal residue washed along with rain water, is added to the nearby

water resources making it unfit for drinking.

- Decreases the soil fertility.
- Pesticides are persistant organic pollutants and cause soil pollution.

They enter the food chain and cause problem of biomagnifications.

- Several pesticides kill not only the target species but also several beneficial not target organisms in the soil.
- They are non-biodegradable and affects the balance of the ecosystem.

2) Health issues.

- Health issues such as cancer, birth defects, neurological disorders etc which results from long term exposure to pesticides as well as from food cycle.

3) Development of pest resistance

- Due to overuse of these harmful chemicals, pests have developed resistance to them. The species that have survived can reproduce a large number of pesticide resistant offspring within a short span of time. These highly resistant pests are called "superpests“

CONTROL OF PESTICIDE POLLUTION

- Mechanical methods
- Biological methods
- Environmental methods
- Chemical methods

1) Mechanical methods:

- **Hand picking:** Method of choice when pests are slowly crawling and are not able to fly e.g caterpillars
- **Trapping:** Is used for flying pests which cant be picked by hand or burned.
- **Burning:** Is used for flying pests which cant be picked by hand and can cause damage. Pests are burned and waste is removed frequently

2) Biological control:

Unlike chemical method, biological methods will not leave any toxic material in the soil. In biological pest control method, some natural predators, parasites, viruses and bacteria are introduced in soil. These control the population of pests that are harmful to us.

3) Environmental methods:

The surrounding of the pest is changed in such a way it becomes unfavorable for its growth. It can be achieved by removing food stuff needed for the growth of the pest.

4) Chemical Methods:

In this method, certain chemicals are used for controlling pests.

E.g. Rodenticides, Insecticides, Herbicides, fungicides

NOISE POLLUTION

Definition:

Sound, a normal feature of our life, is the means of communication and entertainment in most animals, including human beings. It is also a very effective alarm system. A low sound is pleasant whereas a loud sound is unpleasant and is commonly referred to as 'noise'. Noise can be defined as an unpleasant and unwanted sound. Noise is a type of sound and is defined as unwanted, annoying, unpleasant or loud.

Whether a given sound is as pleasant as music or as unpleasant as noise depends on its loudness, duration, rhythm and the mood of the person. But loudness is definitely the most significant criterion which converts sound into noise. Exposure to loud noise is indeed annoying and harmful too.

Noise is a physical form of pollution and is not directly harmful to the life supporting systems namely air, soil and water. Its effects are more directly on the receiver i.e. man. Noise pollution is the result of modern industrialized urban life and congestion due to over population.

Even though noise pollution is not fatal to human life, yet its importance cannot be overlooked because repeated exposure to noise reduces the sleeping hours and productivity or efficiency of a human being. It affects the peace of mind and invades the privacy of a human being. The importance of noise pollution as environmental problem is being recognised as the ill effects of noise on human health and environment are becoming evident with each passing day.

Types of Noise

1. Continuous noise

Continuous noise is exactly what it says on the tin: it's noise that is produced continuously, for example, by machinery that keeps running without interruption. This could come from factory equipment, engine noise, or heating and ventilation systems.

You can measure continuous noise for just a few minutes with a sound level meter to get a sufficient representation of the noise level.

2. Intermittent noise

Intermittent noise is a noise level that increases and decreases rapidly. This might be caused by a train passing by, factory equipment that operates in cycles, or aircraft flying above your house.

We measure intermittent noise in a similar way to continuous noise, with a sound level meter. However, you also need to know the duration of each occurrence and the time between each one. To gain a more reliable estimate of the noise level, you should measure over multiple occurrences to calculate an average.

3. Impulsive noise

Impulsive noise is most commonly associated with the construction and demolition industry. These sudden bursts of noise can startle you by their fast and surprising nature. Impulsive noises are commonly created by explosions or construction equipment, such as pile drivers

To measure impulsive noise, you will need a sound level meter or a personal noise dosimeter that can calculate Peak values.

4. Low-frequency noise

Low-frequency noise makes up part of the fabric of our daily soundscape. Whether it's the low background hum of a nearby power station or the roaring of large diesel engines, we're exposed to low-frequency noise constantly. It also happens to be the hardest type of noise to reduce at source, so it can easily spread for miles around.

For low-frequency noise, you should be using a sound level meter with third octave band analysis, so you can analyse the low frequencies that make up the noise.

Sources of Noise Pollution:

Major causes / sources of noise pollution are:

(i) Industrial Sources:

Progress in technology (industrialization) has resulted in creating noise pollution. Textile mills, printing presses, engineering establishments and metal works etc. contribute heavily towards

noise pollution. In industrial cities like Kolkata, Ludhiana, Kanpur etc., often the industrial zones are not separated from the residential zones of the city especially in the case of small scale industries.

These operate from workshops located on the ground floors of the residential areas and cause annoyance, discomfort and irritation to the residents exposed to the noise that is inevitably produced. The situation is much better in modern planned cities like Chandigarh where the industrial area is kept away from the residential areas and both are separated from each other by a sufficiently wide green belt.

(ii) Transport Vehicles:

Automobile revolution in urban centres has proved to be a big source of noise pollution. Increasing traffic has given rise to traffic jams in congested areas where the repeated hooting of horns by impatient drivers pierce the ears of all road users. Noise from airplanes constitutes an increasing serious problem in big cities like Delhi & Mumbai. Airport situated in the vicinity of population centres and the air planes pass over residential areas. Heavy trucks, buses trains, jet-planes, motor-cycles, scooters, mopeds, jeeps—the list of vehicles is endless but the outcome is same — noise pollution.

(iii) Household:

The household is an industry in itself and is a source of many indoor noises such as the banging of doors, noise of playing children, crying of infants, moving of furniture, loud conversation of the inhabitants etc. Besides these are the entertainment equipment in the house, namely the radio, record-players and television sets. Domestic gadgets like the mixer-grinders, pressure cookers, desert coolers, air- conditioners, exhaust fans, vacuum cleaners, sewing and washing machines are all indoor sources of noise pollution.

(iv) Public Address System:

In India people need only the slightest of an excuse for using loud speakers. The reason may be a religious function, birth, death, marriage, elections, demonstration, or just commercial advertising. Public system, therefore, contributes in its own way towards noise pollution.

(v) Agricultural Machines:

Tractors, thrashers, harvesters, tube wells, powered tillers etc. have all made agriculture highly mechanical but at the same time highly noisy.

(vi) Defence Equipment:

A lot of noise pollution is added to the atmosphere by artillery, tanks, launching of rockets, explosions, exercising of military airplanes and shooting practices. Screams of jet engines and

sonic booms have a deafening impact on the ears and in extreme cases have been known to shatter the window panes and old dilapidated buildings.

(vii) Miscellaneous Sources:

The automobile repair shops, construction-works, blasting, bulldozing, stone crushing etc. are other sources of noise pollution.

EFFECTS OF NOISE

Noise is generally harmful and a serious health hazard. It has far-reaching consequences and has many physical, physiological as well as psychological effects on human beings.

(i) Physical Effects:

The physical manifestation of noise pollution is the effect on hearing ability. Repeated exposure to noise may result in temporary or permanent shifting of the hearing threshold of a person depending upon the level and duration of exposure. The immediate and acute effect of noise pollution is impairment of hearing (i.e. total deafness.) Human ears have sensory cells for hearing. If these cells are subjected to repeated sounds of high intensity before they have an opportunity to recover fully, they can become permanently damaged leading to impairment of hearing. Besides the sensory cells, the delicate tympanic membrane or the ear drum can also be permanently damaged by a sudden loud noise such as an explosion.

(ii) Physiological Effects:

The physiological manifestations of noise pollution are several as mentioned below:

(a) Headache by dilating blood vessels of the brain.

(b) Increase in the rate of heart-beat.

(c) Narrowing of arteries.

(d) Fluctuations in the arterial blood pressure by increasing the level of cholesterol in the blood.

(e) Decrease in heart output.

(f) Pain in the heart.

(g) Digestive spasms through anxiety and dilation of the pupil of the eye, thereby causing eye-strain.

(h) Impairment of night vision.

(i) Decrease in the rate of colour perception.

(j) Lowering of concentration and effect on memory,

(k) Muscular strain and nervous breakdown.

(iii) Psychological Effect:

The psychological manifestations of noise pollution are:

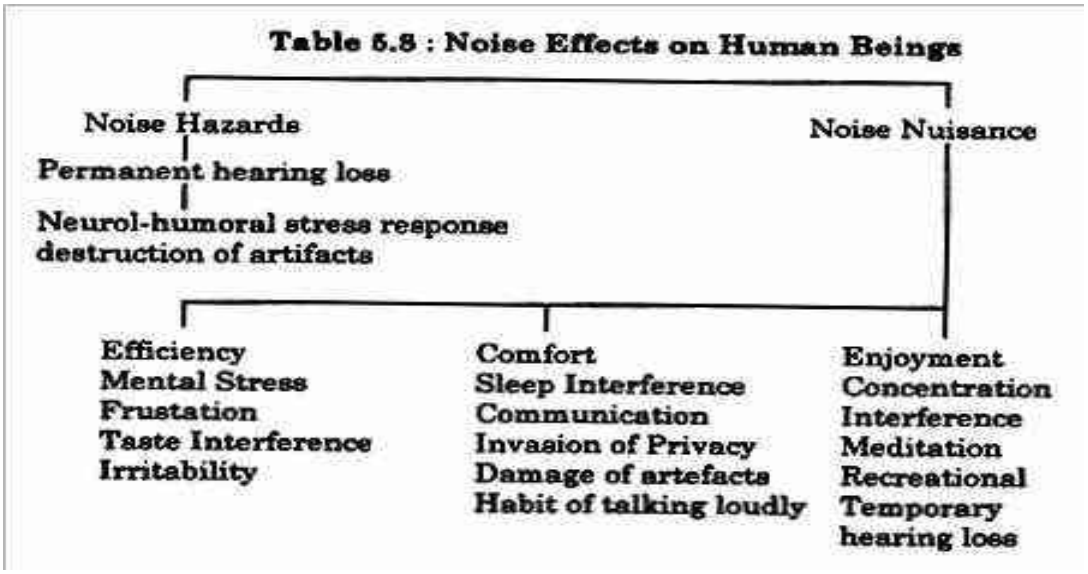
(a) Depression and fatigue which considerably reduces the efficiency of a person.

(b) Insomnia as a result of lack of undisturbed and refreshing sleep

(c) Straining of senses and annoyance as a result of slow but persistent noise from motorcycles, alarm clocks, call bells, telephone rings etc.

(d) Affecting of psychomotor performance of a person by a sudden loud sound

(e) Emotional disturbance



Noise Pollution Level and its Harmful Effects:

Level (in db)	**Effects**
up to 23	No disturbance
30—60	Stress, tension, psychological (illness, heart attack) effects especially at upper range.
60—90	Damage to health, psychological and vegetative (disturbance in stomach-gall function, pains in muscles, high blood pressure, disturbance in sleeping)
60—120	Damages to health and ontological (ear diseases) effects
Above 120	Painful effects in long run.

NOISE CONTROL MEASURES

Some of the ways to control noise pollution are as follows:

(1) Control at Receiver's End

(2) Suppression of Noise at Source

(3) Acoustic Zoning

(4) Sound Insulation at Construction Stages

(5) Planting of Trees

(6) Legislative Measures.

(1) Control at Receiver's End:

For people working in noisy installations, ear-protection aids like ear-plugs, ear-muffs, noise helmets, headphones etc. must be provided to reduce occupational exposure.

(2) Suppression of Noise at Source:

This is possible if working methods are improved by:

(a) Designing, fabricating and using quieter machines to replace the noisy ones.

(b) Proper lubrication and better maintenance of machines.

(c) Installing noisy machines in sound proof chambers.

(d) Covering noise-producing machine parts with sound-absorbing materials to check noise production.

(e) Reducing the noise produced from a vibrating machine by vibration damping i.e. making a layer of damping material (rubber, neoprene, cork or plastic) beneath the machine.

(f) Using silencers to control noise from automobiles, ducts, exhausts etc. and convey systems with ends opening into the atmosphere.

(g) Using glass wool or mineral wool covered with a sheet of perforated metal for the purpose of mechanical protection.

(3) Acoustic Zoning:

Increased distance between source and receiver by zoning of noisy industrial areas, bus terminals and railway stations, aerodromes etc. away from the residential areas would go a long way in minimising noise pollution. There should be silence zones near the residential areas, educational institutions and above all, near hospitals.

(4) Sound Insulation at Construction Stages:

(a) Sound travels through the cracks that get left between the door and the wall. For reducing noise, this space (jamb frame gap) should be packed with sound absorbing material.

(b) Sound insulation can be done by constructing windows with double or triple panes of glass and filling the gaps with sound absorbing materials.

(c) Acoustical tiles, hair felt, perforated plywood etc. can be fixed on walls, ceilings, floors etc. to reduce noise (especially for sound proof recording rooms etc.)

(5) Planting of Trees:

Planting green trees and shrubs along roads, hospitals, educational institutions etc. help in noise reduction to a considerable extent.

(6) Legislative Measures:

Strict legislative measures need to be enforced to curb the menace of noise pollution. Some of these measures could be:

(a) Minimum use of loudspeakers and amplifiers especially near silence zones.

(b) Banning pressure horns in automobiles.

(c) Framing a separate Noise Pollution Act.

MODULE V

Impacts of pollutants, types, scale of impact- Global, local pollutants. Climate change, Ozone layer depletion, Deforestation, land degradation, Impact of development on vegetation and wild life

IMPACT OF POLLUTANTS

- Impacts due to Air pollution
- Impacts due to water pollution
- Impacts due to soil pollution
- Impacts due to noise pollution

Already discussed in previous modules

Impact of Pollutants on Human Health

- Adverse air quality can kill many organisms including humans.
- Ozone pollution can cause respiratory disease, cardiovascular disease, throat inflammation, chest pain, and congestion.
- Water pollution causes approximately 14,000 deaths per day, mostly due to contamination of drinking water by untreated sewage in developing countries.
- An estimated 500 million Indians have no access to a proper toilet, Over ten million people in India fell ill with waterborne illnesses in 2013, and 1,535 people died, most of them children.
- The WHO estimated in 2007 that air pollution causes half a million deaths per year in India.
- Oil spills can cause skin irritations and rashes.
- Noise pollution induces hearing loss, high blood pressure, stress, and sleep disturbance.
- Mercury has been linked to developmental deficits in children and neurologic symptoms.
- Older people are majorly exposed to diseases induced by air pollution.
- Those with heart or lung disorders are at additional risk.
- Children and infants are also at serious risk.
- Lead and other heavy metals have been shown to cause neurological problems.
- Chemical and radioactive substances can cause cancer and as well as birth defects.

Impact of Pollutants on Environment

There are a number of effects on environment:

- Bio magnification describes situations where toxins (such as heavy metals) may pass through trophic levels, becoming exponentially more concentrated in the process.
- Carbon dioxide emissions cause ocean acidification, the ongoing decrease in the pH of the Earth's oceans as CO_2 becomes dissolved.
- The emission of greenhouse gases leads to global warming which affects ecosystems in many ways.
- Invasive species can out compete native species and reduce biodiversity. Invasive plants can contribute debris and biomolecules that can alter soil and chemical compositions of an environment, often reducing native species competitiveness.
- Nitrogen oxides are removed from the air by rain and fertilise land which can change the species composition of ecosystems.
- Smog and haze can reduce the amount of sunlight received by plants to carry out photosynthesis and leads to the production of tropospheric ozone which damages plants.
- Soil can become infertile and unsuitable for plants. This will affect other organisms in the food web.
- Sulphur dioxide and nitrogen oxides can cause acid rain which lowers the pH value of soil.
- Organic pollution of watercourses can deplete oxygen levels and reduce species diversity.

IMPACT OF POLLUTANTS GASEOUS POLLUTANTS

Pollutants like carbon dioxide (CO2), carbon monoxide (CO), sulphur dioxide (SO2), nitrous oxide (NO) and nitrogen dioxide (NO2) are collectively called as Inorganic gaseous pollutants. These are the major contributors to the indoor air pollution.

1. SULPHUR DIOXIDE (SO2):

It is a colourless gas with a sharp pungent smell produced by volcanoes and in various industrial processes. The primary threat of SO2 to urban atmosphere may arises not from SO2 itself but from the changes it undergoes in the atmosphere, such as the formation of H2SO4 and sulphate aerosols. Effects on:

i) Environment and property

- Causes acid rain
- Corrosion to metals
- Damage to agriculture

ii) Human health

- It causes cardiac disease
- Respiratory disease like Asthma
- Eye irritation
- Throat trouble

2. NITROGEN OXIDES (NOX)

NOx are emitted as nitrogen oxide which is rapidly oxidized to more toxic nitrogen dioxide (NO2). NO2 is colourless, odourless gas present in atmosphere.

Effects on:

i) Environment and property

- Precursor of ozone formed in the troposphere

ii) Human health

- Irritation to nose and throat
- It leads to irritation of eyes and even lung blocking
- Respiratory illness among children has been reported in areas containing high NO2.

3. OZONE (O3)

Ozone is a pale blue gas, soluble in water and non-polar solvent with specific sharp odor. Effects on:

i) Environment and property

- Ozone causes crack in car tires

- Ozone present in upper troposphere acts as greenhouse gas

ii) Human health

- Aggravation of asthma
- Inflammation and damage to lungs

4. CARBON MONOXIDE (CO)

It is also called as carbonous oxide, it is a colorless, odorless and tasteless gas which is slightly lighter then air.

Effect on:

i) Environment and property

- Causes global warming

ii) Human health

- It causes headache, visual difficulty, paralysis and even death in human beings.
- Persons with heart disease are sensitive to CO poisoning and may experience chest pain.
- CO enters the bloodstream through lungs and combines with hemoglobin forms carboxyhemoglobin. This condition is known as anoxemia, which inhibits blood's oxygen carrying capacity to organs and tissues.

5. HYDROCARBONS (HC)

Aromatic hydrocarbons are more reactive then aliphatic ones and causes eye irritation. Aliphatic hydrocarbons produce undesirable effects at concentration 102 to103 times higher than those usually found in the atmosphere. Hydrocarbons undergoes chemical reaction in presence of sunlight and nitrogen oxide Effects on:

i) Environment and property

- Cracking of rubber Extensive damage to plant life
- Causes damage to buildings, sculpture and paints

ii) Human health

- photochemical smog which results in reduced visibility, irritation to eyes and lungs
- Decreases lung function
- Chronic bronchitis
- Premature death in people with heart or lung disease

6. PARTICULATE MATTER

Air born particles smaller than 2.5 µm called fine particles. Composed mainly of carbonaceous materials, inorganic compounds and trace metal compounds.

Effects on:

i) Environment and property

- Fly ash reduces pH balance and portability of water
- Particulates accelerate corrosion of metals
- Causes damage to buildings, sculpture and paints

ii) Human health

- Decreases lung function
- Chronic bronchitis
- Premature death in people with heart or lung disease

7. OTHERS: LEAD, NICKEL, CADMIUM, MERCURY, ASBESTOS.

Pollutant	**Level (ppm) and exposure**	**Effects**
SO_2	0.3 to 0.5 for several days	Bleached spots, chronic injury to spinach and other leafy vegetables
NO_2	0.5 for 10-12 days	Suppressed growth of tomatoes
Ozone	0.03 for 8 hours	Fleck on upper surface of leaves
Peroxyacetyl nitrate	0.01 to 0.05 for few hours	Glazing or bronzing of underside of leaf, damage to sensitive plants

TYPES OF IMPACTS

Some of the environmental impacts are:

1. **Direct Impact,**
2. **Indirect Impact,**
3. **Cumulative impacts and**
4. **Induced Impact**

Direct Impacts:

Direct impacts occur through direct interaction of an activity with an environmental, social, or economic component.For example, a discharge of any industry or an effluent from the Effluent Treatment Plant (ETP) from the industrial estates into a river may lead to a decline in water quality in terms of high biological oxygen demand (BOD) or dissolved oxygen (DO) or rise of water toxins.

Indirect Impacts:

Indirect impacts on the environment are these which are not a direct result of the project, often produced away from or as a result of a complex impact pathway. The indirect impacts are also known as secondary or even third level impacts.

For example, ambient air SO_2 rise due to stack emissions may deposit on land as SO_4 and cause acidic soils. Another example of indirect impact is the decline in water quality due to rise in temperature of water bodies receiving cooling water discharge from the nearby industry.

This may, in turn, lead to a secondary indirect impact on aquatic flora in that water body and may further cause reduction in fish population. Reduction in fishing harvests, affecting the income of fishermen is a third level impact. Such impacts are characterized as socioeconomic (third level) impacts.

The indirect impacts may also include growth- inducing impacts and other effects related to induced changes to the pattern of land use or additional road network, population density or growth rate (e.g. around a power project). In the process, air, water and other natural systems including the ecosystem may also be affected.

Cumulative Impacts:

Cumulative impact consists of an impact that is created as a result of the combination of the project evaluated in the EIA together with other projects causing related impacts. These impacts occur when the incremental impact of the project is combined with the cumulative effects of other past, present and reasonably foreseeable future projects.

Induced Impacts:

The cumulative impacts can be, due to induced actions of projects and activities that may occur if the action under assessment is implemented such as growth inducing impacts and other effects related to induced changes to the pattern of future land use or additional road network, population density or growth rate. Induced actions may not be officially announced or be part of any official plan. Increase in workforce and nearby communities contributes to this effect.

They usually have no direct relationship with the action under assessment and represent the growth- inducing potential of an action. New roads leading from those constructed for a project, increased recreational activities, and construction of new service facilities are examples of induce actions.

However, the cumulative impacts due to induced development or third level or even secondary indirect impacts are difficult to be quantified. Because of higher levels' of uncertainties, these' impacts cannot be normally assessed over a long time horizon. An EIA practitioner usually can only guess as to what such induced impacts may be and the possible extent of their implications on the environmental factors.

SCALE OF IMPACT

Some examples of scale of impact due to global and local pollutants are given below:

1. Deterioration of Taj Mahal

- Mathura Oil Refinery – 40kms away from Taj Mahal
- Emits 25-30 tonnes of S02 daily
- Air pollution studies estimate that any increase in S02 conc. above present level of 1.25kg/m3 will result in acidic precipitation.
- This will covert S02 to sulphuric acid – "Stone cancer"

- This sulphuric acid will react with calcium carbonate in the marble to form calcium sulphate – pitting in Taj Mahal
- Discolouration of the white marble surface ie, appearance of a yellowish layer and yellow grey deposits or brown rust like stains on the white marble – chipping and breaking of edges of marble slabs and formation of cracks in the marbles are some of the examples of deterioration of Taj Mahal
- Many steps are being taken to save Taj from the deteriorating effects of environmental pollution

2. Ganga Pollution

- Ganga is the ninth largest river in the world with a length of 2525kms
- It is a popular belief that river Ganga is the purifier of all and its water is considered sacred
- Ganga is a perennial river serving as a source of irrigation and water supply in the fertile gangatic basin
- Twenty five towns on the river bank discharge 1340 million litres of sewage everyday into the Ganga
- Around 260 million litres of chemical effluents join the river in a day
- Hundreds of tanneries and dozens of paper mills, sugar and chemical industries discharge their wastes directly into river without treatment
- Around 35,000 dead bodies are dumped every year, 27 types of pathogens are detected in the water.
- We now led to the situation that action has to be taken to prevent pollution of river Ganga

3. The London Smog

- The London Smog incident took place in December (5th -9th) in 1952 in England
- A high pressure air mass created a temperature inversion formed a white fog over vast areas of London
- The fog became a thick black fog as the conc. of sulphur oxide and particulate pollutants increased owing to extensive combustion of fuel by automobiles and fossil fuel powered industries
- Increased conc. of pollutants caused nearly 4000 deaths due to suffocation

- Similar fog conditions occurred in London in January 1956 as well as in Los Angeles in 15th – 16th December 1966 resulting more death due to respiratory and heart diseases
- A harmonious relationship of man and nature can be achieved by modifying the current pattern od development which is responsible for the large scale environmental damages

GLOBAL AND LOCAL POLLUTANTS

In turning to global pollutants, the problems inherent in local pollutants will become worse. With local pollutants, we were dealing with problems of externalities within a country or state. We now have to consider externalities crossing national boundaries. In the case of global pollutants, we have even more trouble understanding the consequences of our actions and the potential solutions than local pollutants.

1. Transfer coefficients are hard to determine. Especially true for trace gases, i.e., gases that are a minor component in the atmosphere.

2. In the short term, trends are difficult to determine.

3. Cannot force other nations to abate their emissions as in the domestic case

Major issue:

- Ozone depletion and global warming.
- Concentration levels of GHGs and ODCs have been increasing

CLIMATE CHANGE

Climate change is a change in the statistical distribution of weather patterns when that change lasts for an extended period of time (i.e., decades to millions of years). Climate change may refer to a change in average weather conditions, or in the time variation of weather within the context of longer-term average conditions. Climate change is caused by factors such as biotic processes, variations in solar radiation received by Earth, plate tectonics, and volcanic eruptions. Certain human activities have been identified as primary causes of ongoing climate change, often referred to as global warming. There is no general agreement in scientific, media or policy documents as to the precise term to be used to refer to anthropogenic forced change; either "global warming" or "climate change" may be used.

Climate change occurs when changes in Earth's climate system result in new weather patterns that last for at least a few decades, and maybe for millions of years. The climate system is comprised of five interacting parts, the atmosphere, hydrosphere, cryosphere, biosphere, and

lithosphere. As the climate warms, it changes the nature of global rainfall, evaporation, snow, stream flow and other factors that affect water supply and quality. Specific impacts include: Warmer water temperatures affect water quality and accelerate water pollution.

Factors that can shape climate are called climate forcings or "forcing mechanisms". These can be either "internal" or "external". Internal forcing mechanisms are natural processes within the climate system itself (e.g., the thermohaline circulation). External forcing mechanisms can be either anthropogenic - caused by humans - (e.g. increased emissions of greenhouse gases and dust) or natural (e.g., changes in solar output, the earth's orbit, volcano eruptions).

Physical evidence to observe climate change includes a range of parameters. Global records of surface temperature are available beginning from the mid-late 19th century. For earlier periods, most of the evidence is indirect—climatic changes are inferred from changes in proxies, indicators that reflect climate, such as vegetation, ice cores, dendrochronology, sea level change, and glacial geology. Other physical evidence includes arctic sea ice decline, cloud cover and precipitation, vegetation, animals and historical and archaeological evidence.

GLOBAL WARMING

Global warming refers to surface temperature increases while climate change includes global warming and everything else that increasing greenhouse gas levels affect. Global warming is projected to have a number of effects on the oceans. Ongoing effects include rising sea levels due to thermal expansion and melting of glaciers and ice sheets, and warming of the ocean surface, leading to increased temperature stratification. Global warming is a long-term rise in the average temperature of the Earth's climate system, an aspect of climate change shown by temperature measurements and by multiple effects of the warming.

Global warming is the unusually rapid increase in Earth’s average surface temperature over the past century primarily due to the greenhouse gases released by people burning fossil fuels. Archaeological sites and some buildings have survived at least two periods of global warming and intervening cold periods. With international scientific evidence mounting and the reliability of future climate predictions increasing. Heritage commissioned research to gather evidence on climate change as a possible cause of environmental instability of cultural heritage and to inform present and future planning.

According to the report of WTO International Organization 2007 the following things are take place in the world and affecting the natural disaster. The biggest ice cap in the arctic region,

the ward hunt ice shelf broke into Fragments as a result of global warming, reported NASA. More average shoreline in Fiji receding by half a foot every year. Adelie penguin populations in Antarctica reduce in size by 33%. 20- 30% of the world's reefs wiped out. The above mentioned facts are the tip of the iceberg as far as disastrous effects of global warming.

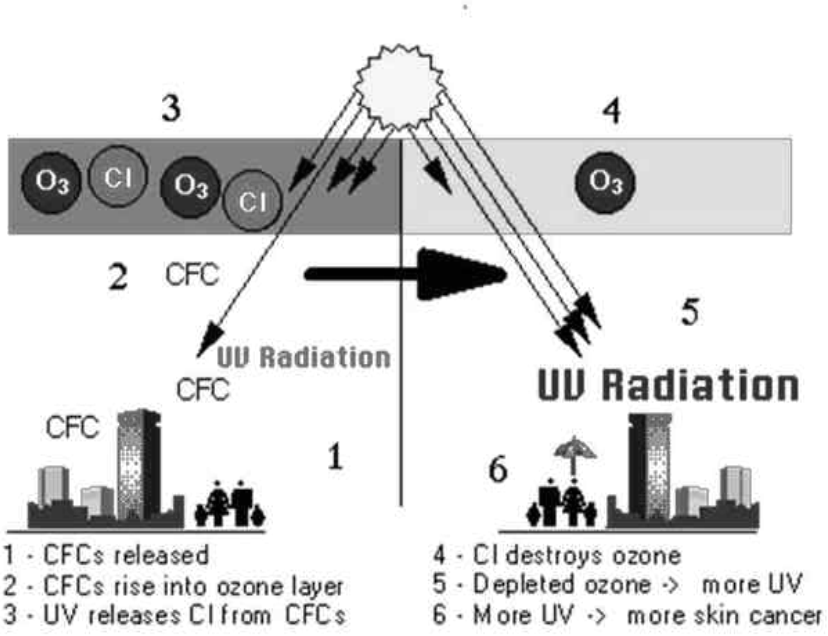
Effects of Global Warming in India

Elevated carbon dioxide emissions from industries, factories, vehicles etc. have contributed to the greenhouse effect, causing warmer weather that lasted long after the atmospheric shroud of dust and aerosols had cleared. Further climatic changes 20 million years ago, long after India had crashed into the Laurasian landmass, were severe enough to cause the extinction of many endemic Indian forms. The formation of the Himalayas resulted in blockage of frigid Central Asian air, preventing it from reaching India; this made its climate significantly warmer and more tropical in character than it would otherwise have been. Several effects of global warming, including steady sea level rise, increased cyclonic activity, and changes in ambient temperature and precipitation patterns, have affected or are projected to affect India. Ongoing sea level rises have submerged several low-lying islands in the Sundarbans, displacing thousands of people. Temperature rises on the Tibetan Plateau, which are causing Himalayan glaciers to retreat. The present rate of global warming could mean that many plants and animals currently living at lower elevations or at lower latitudes will progressively migrate to higher elevations and latitudes. Hence, in the long term, it may be expected that some of our currently important agricultural species will no longer be able to grow at their present lower latitudinal and lower elevation limits if the global temperate warms.

OZONE LAYER DEPLETION

Chlorofluorocarbons (CFCs) and other halogenated ozone depleting substances (ODS) are mainly responsible for man-made chemical ozone depletion. The total amount of effective halogens (chlorine and bromine) in the stratosphere can be calculated and are known as the equivalent effective stratospheric chlorine (EESC).

- Ozone destruction by UV rays-UV radiation from the sun releases the radicals Cl and ClO .Ozone is a highly unstable molecule so it readily donates its extra oxygen molecule to free radical species such as hydrogen, bromine, and chlorine. These compound species act as catalysts in the breakdown of ozone molecules.



- The ozone layer present in the stratosphere acts as a protective shield. It saves the earth from the harmful ultraviolet rays of the sun. The compounds containing CFCs (chlorofluorocarbons) are mainly responsible for ozone layer depletion as these compounds react with ozone in the presence of ultraviolet rays to form oxygen molecule and thus, destroying ozone. Scientists have already found an ozone hole over the South Pole. Once the ozone layer is depleted, ultraviolet rays will pass through the troposphere and eventually to earth. These rays cause aging of the skin, skin cancer, cataract and sunburn to humans as well as animals. Phytoplankton dies in the presence of ultraviolet rays which results in a decrease in fish productivity.

Causes & Effects of Ozone Layer Depletion

- The evaporation of surface water through the stomata of leaves increases, which results in decreased moisture content of the soil.
- The proteins cells in plants undergo harmful mutations, all due to ultraviolet radiations.
- Paints and fibers are also damaged by the increased levels of ultraviolet rays, causing them to fade faster.
- Chlorofluorocarbons and other halocarbons are held responsible for ozone layer depletion, but if we explore more about them we will find that these are major greenhouse gases.
- These gases absorb heat in the atmosphere and increase the earth's temperature, resulting in global warming.
- Increase in earth's temperature causes melting up of ice caps.

- This raises the water level of the oceans and seas.
- Coastal areas get flooded and area under land cover reduces.

The Ozone Hole

In the year 1980 scientists reported the depletion of ozone layer in the region of Antarctica which is commonly known as the ozone hole. Ozone layer depletion occurs due to unique sets of climatic conditions. In the summertime, nitrogen dioxide and methane react with chlorine monoxide and chlorine atoms which result in a shrinkage of chlorine and hence prevents ozone layer depletion.

$ClO\ (g) + NO2\ (g) \rightarrow ClONO2\ (g)$

$Cl\ (g) + CH4\ (g) \rightarrow CH3\ (g) + HCl\ (g)$

During winter, special types of clouds are formed over the Antarctic region. These clouds provide the surface for the hydrolysis of chlorine nitrate to form hypochlorous acid. Chlorine nitrate also reacts with hydrogen chloride thereby producing molecular chlorine.

$ClONO2\ (g) + H2O\ (g) \rightarrow HOCl\ (g) + HNO3\ (g)\ ClONO2\ (g) + HCl\ (g) \rightarrow Cl2\ (g) + HNO3(g)$

During spring, sunlight enters Antarctica and breaks up the clouds. Photolysis of HOCl and Cl2 occurs which forms chlorine radicals and this reaction initiates the ozone layer depletion.

Prevention and Measures

•**Private vehicle driving should be limited** – Vehicular emission results into smog, which harms the ozone layer. Carpooling, using public modes of transportation, walking, cycling etc should be promoted.

•**Avoid using pesticides** – Pesticides are used for getting rid of weeds but are very harmful to the ozone layer. Natural remedies should be used instead of pesticides.

•**Using eco-friendly products** – We can use eco-friendly cleaning products for domestic purposes and save the ozone from further deterioration.

•**Replacing CFC's used in air conditioners and refrigerators**- Hydro fluorocarbons (HFCs) have been identified as potential replacements for CFCs (which is the major cause of Ozone Layer Depletion) as they have an Ozone Depletion Potential of 0. Use of HFCs in place of CFCs will go a long way in protecting our Ozone layer from getting depleted.

•**Proper Waste disposal techniques**- Avoid burning waste materials like plastic and other materials. Give non-decomposable products for recycling or try and reuse them for other purposes.

DEFORESTATION

Deforestation, the clearing or thinning of forests by humans. Deforestation represents one of the largest issues in global land use. Estimates of deforestation traditionally are based on the area of forest cleared for human use, including removal of the trees for wood products and for croplands and grazing lands. In the practice of clear-cutting, all the trees are removed from the land, which completely destroys the forest. In some cases, however, even partial logging and accidental fires thin out the trees enough to change the forest structure dramatically.

What is Deforestation?

• Deforestation, clearance or clearing is the removal of a forest.

• Examples of deforestation include conversion of forestland to farms, ranches, or urban use.

Causes of Deforestation

(i) Shifting cultivation

- Most of the clearing of forest is done for agricultural purposes.
- Poor farmers cut down trees or burn it and start agriculture. Intensive or modern agriculture destroy the forest on a large scale.
- It is principal cause of deforestation in some countries like America(35%), Asia(50%),Africa(70%).

(ii) Commercial logging

- It involves cutting trees for sale as timber or pulp.
- It employs heavy machinery to remove cut trees and build roads.
- Logging roads enable people to access the interiors of the forest, which in results in deforestation .
- In Africa, 75% of land being cleared by poor farmers is land that has been previously logged.

(iii)Mining and dams

- Mining, industrial development and hydroelectric power plant projects are also causes of deforestation.
- Dams open the previously inaccessible forest and damage ecosystems.
- In Brazil, the grand carajas project occupies 90,000 km^2.
- It also affect 23 tribal groups and also cause the high soil, water and air pollution.

(iv) Other reasons

- Deforestation also occurs due to overgrazing and conversion of forest to pasture for domestic animals.
- Expansion of agribusiness that grows oil palm, rubber, fruit trees and ornamental plants has also resulted in deforestation.
- Governmental sponsored programs that resettle landless farmers on forested sites have contributed to deforestation all around the world.
- Other reasons includes fire, pest, etc.

Effects of Deforestation

1) **Soil Erosion**:- The soil gets washed away with rain water on sloppy area in the absence of trees leading to soil erosion.

2) **Expansion of Deserts**:- Due to action of strong wind mass of land gradually gets covered to sand deserts.

3) **Decrease in Rainfall**:- In the absence of forest, rainfall decreases considerably because forests bring rains and maintains high humidity in atmosphere.

4) **Loss of Fertile Land**:- Less rainfall results into the loss of fertile land owing to less natural vegetation growth.

5) **Effect on Climate**:- Deforestation includes regional and global climate change. Climate has become warmer due to the lack of humidity in deforestation regions and also patterns of rainfall has changed. Droughts have become common.

6) **Economic Losses**:- Deforestation will cause loss of industrial timber and non-timber products and loss of long term productivity on the site.

7) **Loss of Bio-diversity**:- Deforestation cause the biodiversity leading to disturbances in ecological balance world wild.

8) **Loss of medical Plants**:- There are many species of plants, which have been used in India for centuries as insecticide, fungicide, in medicine and in bio-fertilizers. Deforestation may lead to the extinction of these valuable plants.

9) **Environmental Changes**:- It will lead to increase in carbon dioxide concentration and other air pollutants. This would result in Global Warming.

10) **Change in living Habits**:- This may force indigenous people to live a new life which they are not prepared. Disturbance in forest eco-system may result in other eco-systems that may be separated by great distances.

Forest Degradation in India

• Depletion of forestry cover less than 90% is considered as forest degradation and more than 90% is considered as deforestation, according to Food and Agriculture Organisation (FAO) of the UN.

• Logging is considered as a forest degradation and not as a deforestation.

• In India timber is used for preparing plywood, veneer, boards, doors, windows and other furniture.

• Wood is also used for cooking and heating.

• Population, rapid development and men's dependency on forest are mainly responsible for Forest Degradation.

• India has lost 3.4 million hectares of forest cover from the period of 1951-1970.

• Nearly 1% of land is turning barren per year due to deforestation.

Control Measures of Deforestation

• **Reforestation:-**

Many countries in the world have started reforestation and forestry, and East Asian nations are leading in this regard. Many East Asian countries, including China, have successfully managed to reverse deforestation.

• **Legislation :-**

By making suitable changes in the law, so that cutting trees in a forest will not only lead to deforestation being controlled in a major way, but its flow may also be reversed.

• **Wildlife Sanctuaries :-**

Sanctuaries are very important, not only to save wildlife, but to save trees as well. Sanctuaries go a long way in protecting all wildlife.

• **Commercial Forest Plantations :-**

There can be special forest plantations for all the wood that is needed for the industry. This way the wood can be cut in a controlled and regulated environment.

• **Cities :-**

All cities, let alone new cities, have to be managed properly. Their expansion has to be curtailed or at least done in a systematic manner, so that there is enough green cover, and new trees are planted where ever possible.

•**Incentive to Corporate :-**

Tax cuts should be granted to corporations, to get them actively interested in reforestation.

•**Water Management :-**

Improper water management affects deforestation in a big way. If the wildlife doesn't have water, then the entire ecosystem will falter. The construction of new dams should be planned properly, so that any one area isn't deprived of water, while another area has abundance of it.

LAND DEGRADATION

- Land degradation is the most important environmental problem currently challenging sustainable development in many parts of the world.
- The change in the characteristic and quality of soil which adversely affect its fertility is called as Degradation.
- The problem is most acute where the environment is intrinsically vulnerable and where the population is losing control of its own resources.
- **Land Degradation means**

1. Loss of natural fertility of soil because of loss of nutrients.
2. Less vegetation cover
3. Changes in the characteristic of soil.
4. Pollution of water resources from the contamination of soil through which water sweeps into ground or runoff to the water bodies.
5. Changes in climatic conditions because of unbalance created in the environment.

Causes of Land Degradation

1) Deforestation and Soil erosion:

Deforestation carried out to create dry lands is one of the major concerns. Land that is once converted into a dry or barren land, can never be made fertile again. Exposed land and loosened soil may lead to soil erosion. Land conversion is another major cause,

meaning the alteration or modification of the original properties of the land to make it use worthy for a specific purpose.

2) Agricultural activities:

With growing human population, demand for food has increased considerably. Farmers often use highly toxic fertilizers and pesticides to get rid off insects, fungi and bacteria from their crops. With the over use of these chemicals, they result in contamination and poisoning of soil.

3) Industrialization:

Due to increase in demand for food, shelter and house, more goods are produced. This resulted in creation of more waste that needs to be disposed of. To meet the demand of the growing population, more industries were developed which led to deforestation.

4) Construction activities:

Due to urbanization, large amount of construction activities are taking place which has resulted in large waste articles like wood, metal, bricks, plastic etc

5) Nuclear waste:

Nuclear plants can produce huge amount of energy through nuclear fission and fusion. The left over radioactive material contains harmful and toxic chemicals that can affect human health. They are dumped beneath the earth to avoid any casualty.

6) Sewage treatment:

Large amount of solid waste is leftover once the sewage has been treated. The left over material is sent to landfill site which end up in polluting the environment.

7) Acid rain:

Acid rain is caused when pollutants present in the air mixes up with the rain and fall back on the ground. This polluted water could dissolve away some of the important nutrients found in soil and change the structure of the soil.

8) Accidental oil spills:

Chemicals in the fuel deteriorates the quality of soil and make them unsuitable for cultivation. These chemicals can enter into the groundwater through soil and make the water undrinkable.

9) Mining activities:

A source of land pollution. Huge holes are dug for mining and these holes can pose a hazard as they form deep mining pools. Metals like cadmium and lead will be deposited, which are toxic contaminating the soil. This will leave the mining land barren and unable to use again.

10) Shifting Cultivation

Forest is burnt to use the land for cultivation, until the soil loses it's fertility. Once the land becomes inadequate for crop production, it is left barren and hence leads to soil erosion.

Effects or Impacts:

1. Decline in the chemical, physical and/or biological properties of soil.

2. Reduced availability of potable water.

3. Lessened volumes of surface water.

4. Impacts on livestock and agriculture e.g. loss of animals due to dehydration, reduced yields.

5. Decline in productivity.

6. Water and food insecurity.

7. Biodiversity loss.

Prevention and Control Measures for Land Degradation:

Following are some practises for controlling land degradation:

1. Strip farming:

It is & practice in which cultivated crops are sown in alternative strips to prevent water movement.

2. Crop Rotation:

It is one of the agricultural practice in which different crops are grown in same area following a rotation system which helps in replenishment of the soil.

3. Ridge and Furrow Formation:

Soil erosion is one of the factors responsible for lad degradation. It can be prevented by formation of ridge and furrow during irrigation which lessens run off.

4. Construction of Dams:

This usually checks or reduces the velocity of run off so that soil support vegetation.

5. Contour Farming:

This type of farming is usually practiced across the hill side and is useful in collecting and diverting the run off to avoid erosion.

EFFECT OF POLLUTION ON ENVIRONMENT AND LIFE SUSTENANCE

- The contamination or degradation of soils impacts heavily on the health of plants.
- Humans are also affected in numerous ways either directly or indirectly.
- Polluted soil can harm humans by making contact with the soil or consuming vegetation produced from contaminated soils.

Some of the effects are detailed as follows.

1.Endangering Human Health

- More than 70% of the soil pollutants are carcinogenic in nature, intensifying the chances of developing cancer in the humans exposed to the polluted soils.
- Long term exposure to benzene and polychlorinated biphenyls (PCBs), resuts in the development of leukemia and liver cancer respectively.
- Soil pollutants can also cause skin diseases, muscular blockage, and central nervous system disorders.
- Humans can be affected indirectly due to bioaccumulation or food poisoning. It happens when people consume crops that are grown in the polluted soils or when they consume animal products that feed on plants from polluted soils.
- As a result, humans suffer from acute illnesses and may experience premature death.

2. Economic lossess

- The crops grown in the soils and the nearby lands are often poisoned with heavy metals and chemicals are, discarded after harvesting because of high toxicity levels.

- It is considered unfit for human consumption. Consequently, it leads to enormous economic losses.

3. Air and Water Contamination

- Polluted soil by natural means contributes to air contamination by discharging volatile compounds into the atmosphere.
- Soil pollution can also lead to water pollution if the toxic chemicals and materials like dangerous heavy metals leach into groundwater or contaminate storm water runoff, which reaches lakes, rivers, streams, or oceans.

4. Effects on Plant life

- When soils are repeatedly contaminated and accumulate large amounts of poisonous materials and chemicals, the soil reaches a point where it cannot support plant life.
- Soil pollutants interfere with soil chemistry, biology, and structure.
- When these changes occur, beneficial soil bacteria, soil microorganisms, soil nutrients, and soil chemical processes begin to deteriorate to an extent where they diminish soil fertility.
- The soil becomes unsuitable for crop survival or any other form of vegetation.
- The plants die and animals dependent on the plants will also die.
- This leads to migration of the larger animals and predators to other regions to find food supply, gradually leading to a reduction in wildlife and extinction.

5. Acidification

- Acid rain reduces soil chemistry and nutrients, which would further contribute to ecological balance disturbance and soil erosion.

6. Diminished soil fertility

- The most evident and crucial element of the soil is its fertility.
- The harmful chemicals and heavy metals in the soil decrease soil microbial and chemical activity.
- Once the soil is contaminated with chemicals and heavy metals or degraded due

to human activities such as mining, its fertility depreciates and might even be lost entirely.

7. Increase in soil salinity

The increase in soil salinity, salinization, is an effect of salt accumulation in the soil. Irrigation and agricultural processes that discharge nitrate and phosphate deposits in the soil are the primary contributors to increasing salt levels in the soil. Increased soil salinity makes it difficult for plants to absorb soil moisture and reduces groundwater quality. Crops and plants grown in these regions combined with other soil pollutant effects are highly poisonous and can cause severe health disorders when consumed.

GLOBAL ENVIRONMENTAL ISSUES

1. Environment Degradation: Environment is the first casualty for increase in pollution weather in air or water. The increase in the amount of CO2 in the atmosphere leads to smog which can restrict sunlight from reaching the earth. Thus, preventing plants in the process of photosynthesis. Gases like Sulfur dioxide and nitrogen oxide can cause acid rain. Water pollution in terms of Oil spill may lead to death of several wildlife species.

2. Global Warming: The emission of greenhouse gases particularly CO2 is leading to global warming. Every other day new industries are being set up, new vehicles come on roads and trees are cut to make way for new homes. All of them, in direct or indirect way lead to increase in CO2 in the environment. The increase in CO2 leads to melting of polar ice caps which increases the sea level and pose danger for the people living near coastal areas.

3. Ozone Layer Depletion: Ozone layer is the thin shield high up in the sky that stops ultra violet rays from reaching the earth. As a result of human activities, chemicals, such as chlorofluorocarbons (CFCs), were released it to the atmosphere which contributed to the depletion of ozone layer.

4. Climate change: Climate change has become more than obvious over the past decade, with nine years of the decade making it to the list of hottest years the planet has ever witnessed. The rise in temperature has also ensured that the equations on the planet have gone for a toss. Some of the most obvious signs of this include irregularities in weather, frequent storms, melting glaciers, rising levels of sea etc. Going by the prevailing conditions, it is not difficult to anticipate that the planet is heading for a dramatic climate change, some wherein, near, future.

5. Conservation of species: Yet another global environmental issue, species conservation basically deals with conservation of flora and fauna, in order to curb the extinction of species. Extinction of a single species of plant or animal results in a dramatic imbalance in the ecosystem, as a number of other species dependent on it directly or indirectly are also affected. Over the last century or so, several plants and animal species have become extinct thus resulting in a major loss for the biodiversity of the planet.

6. Energy crisis: The fact that we are largely dependent on fossil fuels for our energy requirements has made us significantly vulnerable to severe energy crisis. Though, quite a few renewable energy sources have been identified, none of them have been promising enough when it comes to replacement of fossil fuels as the major source of energy for mankind. Attempts to tap the full potential of these sources are in progress, and our future by and large depends on these attempts, as fossil fuels are on the verge of exhaustion.

7. Exploitation of natural resources: Our greed for more has left us empty handed in terms of natural resources in several parts of the world. Several human activities, including the likes of mining, agriculture, fishing etc., has resulted in drastic degradation of our natural resources. While mining and agriculture have triggered large-scale deforestation, over fishing has only resulted in the reduction of population of marine creatures inhabiting the planet. If the trends continue, we are bound to exhaust those natural resources on which we are dependent, and thus dig our own graves.

8. Land degradation: Land pollution, owing to human activities, and desertification, due to loss of vegetation has left the surface of the planet unsuitable for human use. Land degradation can be attributed to the fact that we have become too laid-back in terms preservation of the nature. Improper soil use, haphazard waste disposal, large-scale deforestation and other such human activities harmful for nature are on the rise, something which is invariably taking a toll on our natural surroundings.

9. Land use: Global environmental problems pertaining to the land are not just restricted to haphazard waste disposal or large-scale deforestation, but also to improper use of land. Natural environment is being destructed to make way for urban sprawl, which is indirectly resulting in loss of habitat for several species. Fragmentation of land owing to construction is also a major factor when it comes to improper land use. All these factors together result in several problems, including soil erosion, degradation of land and desertification.

10. Nuclear issues: Nuclear power does have high potential, but the problems associated with it are no less. Radioactive waste from nuclear power plants is one of the major problems we are likely to face, especially if safety regulations are not followed properly. Chernobyl tragedy has set an example of how nuclear waste can lead to disaster for mankind, and no one would like to see another Chernobyl happening. It doesn't end here as the threat of some nation diverting its nuclear power to produce nuclear arsenal is always looming over the mankind. And it won't take an Einstein to imagine the amount of damage these nuclear weapons would cause.

11. Overpopulation: Yet another major global environmental issue is overpopulation. As the population of world continues to soar at an alarming rate, the pressure on the resources of the planet is increasing. These problems associated with overpopulation range from food and water crisis to lack of space for natural burial. Overpopulation also results in various other demographic hazards. Incessant population growth will not just result in depletion of natural resources, but will also put more pressure on the economy. After all sustaining a huge population requires quite a mammoth effort for a nation, as far as finance is concerned.

12. Pollution: This is perhaps the most obvious, yet most ignored global environmental issue in this list of environmental problems. The term 'population' in itself have several other aspects, prominent ones among which include air pollution, water pollution and land pollution. On one hand air pollution can be attributed to the large amount of carbon dioxide pumped into the atmosphere by industries and vehicles, water pollution and land pollution is caused as a result of waste disposal from factories, oil-carrying vessels etc. Basically, mankind is to be blamed for this issue as our activities tend to hamper the environment at an alarming rate. If this trend continues, we will be very soon left without any fresh air to breathe, and clean water to drink.

13. Waste management: As population increases, human activities increase, which eventually increases the amount of waste produced. This waste doesn't just include those harmful gases let out in the atmosphere or toxic waste released in water bodies, but also includes nuclear waste, e-waste, medical waste (Abhijit Naik) and even the waste from our homes. With limited area available on the planet, and most of it being inhabited by us, we are left with no space to dispose this waste. The rate at which this waste is produced is far more than the rate at which it is being treated, and this just results in piling up of waste, which eventually pollutes the environment.

MODULE V

SYLLABUS: Socio-economic impacts - Impact assessment Methodologies, Overlays, Checklist, Matrices, Fault Tree Analysis and Event Tree Analysis- Role of an Environmental Engineer- Public Participation.

IMPACT INDICATOR

An impact indicator is an element or a parameter that provides a measure (in at least some qualitative sense) of the significance of the effect, i.e., the magnitude of an environmental impact.

Other impact indicators, however, can only be ranked as 'good', 'better', 'best' or 'acceptable', 'unacceptable', etc. The selection of a set of indicators is often a crucial step in the impact assessment process, requiring input from the decision-maker. The most widely used impact indicators are those within statutory laws, acts, i.e., indicators such as air and water quality standards that have statutory authority.

IMPACT SIGNIFICANCE ASSESSMENT

An impact, as defined by the international standard ISO14001:2004 is:

"Any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organization's environmental aspects"

Where "environmental aspect" is defined as:

"Element of an organisation's activities or products or services that can interact with the environment".

An impact is defined where an interaction occurs between a project activity and an environmental receptor.

The ESIA process ranks impacts according to their "significance" determined by considering project activity "event magnitude" and "receptor sensitivity". Determining event magnitude requires the identification and quantification (as far as practical) of the sources of potential environmental and socio-economic effects from routine and non-routine project activities. Determining receptor environmental sensitivity requires an understanding of the biophysical environment

SOCIO-ECONOMIC IMPACTS

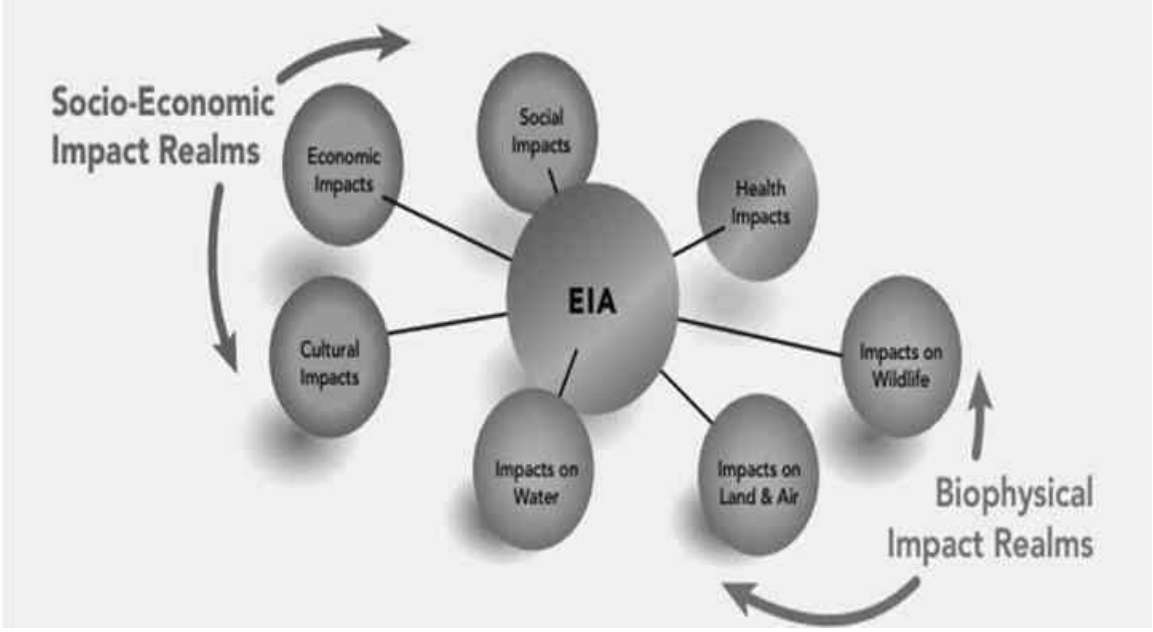
- The socio-economic impact assessment will use a semi-qualitative assessment approach to describe and evaluate impacts.
- Factors taken into account to establish impact significance will include probability, spatial extent, duration and magnitude of the impacts in addition to the sensitivity of

receptors (e.g. the groups of people or populations most likely to be affected and, in particular, whether impacts are likely to be disproportionately experienced by vulnerable groups).

- Indirect socio-economic impacts (i.e. Induced effects) will also be assessed using the same approach.

What is Socio-Economic Impact Assessment?

- SEIA is the systematic analysis used during EIA to identify and evaluate the potential socio-economic and cultural impacts of a proposed development on the lives and circumstances of people, their families and their communities.
- If such potential impacts are significant and adverse, SEIA can assist the developer, and other parties to the EIA process, find ways to reduce, remove or prevent these impacts from happening.
- Impacts are potential changes caused – directly or indirectly, in whole or in part, for better or for worse – by industrial development activities.
- In the past, EIA focused on direct and indirect biophysical impacts of proposed developments (i.e. impacts of development activities on water, air, land, flora and fauna).
- In recent years, the impacts of industrial development on society, culture and different forms of economic activity have gained equal importance in EIA.



Realms of Environmental Impact

- SEIA can identify and distinguish numerous measurable impacts of a proposed development but not every impact may be significant.
- The people who are impacted, directly or indirectly, have a say in whether impacts on valued socio-economic components are significant.
- While SEIA tends to focus on the avoidance of adverse impacts, SEIA also provides a forum for planning how to maximize the beneficial impacts of a proposed development.
- Beneficial impacts can include:
  - a better standard of living due to increased access to employment, business opportunities, training and education
  - greater access to and from a community
  - Increased funding to improve social infrastructure and cultural maintenance programs.
- Specifying how adverse impacts may interact with beneficial impacts, and identifying how to manage these impacts are important steps in SEIA.
- The Review Board definition of SEIA recognizes the importance of relationships between people, culture, economic activities and the biophysical environment.
- The Review Board pays particular attention to how these relationships affect original people who have based their economies on the area.
- The *SEIA Guidelines* address impacts on traditional economic activities such as hunting, fishing and trapping.
- These economic activities are inherently social, cultural and interrelated with the biophysical environment.

Valued Socio-Economic Component	Issues
Health and well-being	• Individual and population health • Community and cultural group cohesion • Family cohesion • Cultural maintenance
Sustainable wildlife harvesting, land access and use	• Hunting, trapping and gathering – traditional economy • Recreational and traditional economy – access to land • Value of alternative land uses (e.g. tourism vs. hunting vs. industry)
Protecting heritage and cultural resources	• The aesthetic, cultural, archaeological and/or spiritual value of places • Maintenance of traditional language, education, laws and traditions
Equitable business and employment opportunities	• Local, regional and territorial business competitiveness • Employment opportunities for local, regional and territorial residents • Training and career development for local, regional, territorial residents • Avoidance of boom and bust cycles (e.g. via economic diversification)
Population sustainability	• In- and out-migration effects • Change in social and cultural makeup of affected communities
Adequate services and infrastructure	• Pressures on social services such as health care, education, and justice • Housing pressures – affordability, availability, and appropriateness • Traffic and road safety – pressures on physical infrastructure
Adequate sustainable income and lifestyle	• Overall amount of money in the community • Uses of money in the community – effects of increased disposable income • Local and regional cost of living • Distribution of costs/benefits among affected people-impact equity • Adverse lifestyle changes – increased gambling, crime, substance abuse

Valued Socio-Economic Components

Considerations for Conducting SEIA

Considering the following is important when conducting and reviewing SEIA:

1. Matching the scale and focus of a SEIA with the characteristics of the proposed development, and the concerns of responsible authorities and potentially affected communities and individuals.
2. Minimizing adverse impacts while enhancing beneficial impacts.
3. Using the "Precautionary Principle" and other internationally-recognized SEIA principles.
4. Focusing on impacts that are at least partially attributable to the proposed development.
5. Involving various potentially affected communities in the SEIA early and extensively.
6. Conducting long-range, forward-looking studies that rely on the insight of past experiences.
7. Impact equity.
8. Using experts from the government, communities and social sciences.
9. Using reliable, appropriate and relevant information from primary and secondary sources.
10. Using appropriate indicators for the Mackenzie Valley.
11. Balancing traditional knowledge and scientific knowledge.
12. Following up and monitoring socio-economic and cultural mitigation measures.

EIA - IMPACT ANALYSIS

This stage of EIA identifies and predicts the likely Environmental and social impact of the proposed project and evaluates the significance

Methods for impact analysis include:

- Impact Identification
- Impact Prediction
- Impact Evaluation

Impact Identification

- Impact Identification attempts to answer the question, "what will happen when a project enters its operational stage?"
- A List of important impacts such as changes in ambient air quality, changes in water and soil qualities, noise levels, wildlife habitats, species diversity, social and cultural systems, employment levels etc. may be prepared.
- The important sources of impact like smoke emission, consumption of water, discharge of effluents etc. are identified.
- Impact identification brings together project characteristics and baseline environmental characteristics with the aim of ensuring that all potentially significant environmental

impacts (adverse or favourable) are identified and taken into account in the EIA process. A wide range of methods has been developed for the purpose.

- Many of the methods were developed in response to the NEPA and have since been expanded and refined. The simplest involves the use of lists of impacts to ensure that none has been left out. The most complex include the use of interactive computer programmes, networks showing energy flows and schemes to allocate significance weightings to various impacts.
- In choosing a method, however, the analyst needs to:
  - ensure compliance with regulations;
  - provide a comprehensive coverage of a full range of impacts including social, economic and physical;
  - distinguish between positive and negative, large and small, long-term and short-term, reversible and irreversible impacts;
  - identify secondary, indirect and cumulative impacts as well as direct impacts; distinguish between significant and insignificant impacts;
  - allow comparison of alternative developmental proposals;
  - Consider impacts within the constraints of an areas carrying capacity; incorporate qualitative as well as quantitative information;
  - be easy and economical to use; be unbiased and to give consistent results;
  - be of use in summarizing and presenting impacts in the EIS.
  -

Methods of impact identification/impact analysis/impact assessment methodologies:

There is no single "best" methodology for environmental impact assessment. Characteristics of a methodology such as the type of impacts or projects covered and the resources required may be virtues in one, but vices in another. Only the user can determine which tools may best fit a specific task.

In selecting the most appropriate tools, the following key considerations may be useful:

(i) Use: Is the analysis primarily a decision or an information document?

(A decision document is vital to determine the best course of action, while an information document is intended primarily to reveal the implications of a single, clearly best choice.) A decision document analysis will generally require a more comprehensive analysis concentrating on interpreting the significance of a broader spectrum of possible impacts.

(ii) Alternatives: Are alternatives fundamentally or incrementally different?

If differences are fundamental, such as preventing flood damage by levee construction as opposed to flood plain zoning, for example, then impact significance can better be measured against some absolute standard than by direct comparison of alternatives, since impacts will differ in kind as well as size. Fundamentally and incrementally different alternative sets require different levels of analysis to discriminate between alternatives and also require greater degree of quantification.

(iii) Public involvement: Does the anticipated role of the public in the analysis involve substantive preparation, token review, or vital review?

The first two roles allow the use of more complex techniques such as computer or statistical analysis that might be difficult to explain to a previously uninvolved but highly concerned public. A substantive preparation role will also allow a greater degree of quantification or weighting of impact significance through the direct incorporation of public values.

(iv) Resources: How much time, skill, money, data and computer facilities are available? Generally, more quantitative analysis requires more of everything.

(v) Familiarity: How familiar is the analyst with both the type of action contemplated and the physical site? Generally, familiarity will improve the validity of a more subjective analysis of impact significance.

(vi) Issue significance: How big is the issue in terms of controversy and scope?

All other things being equal, the bigger the issue the greater the need for explicitness, quantification, and identification of key issues and the less appropriate is the arbitrary significance weights or specific formulas for trading-off one type of impact (e.g., environmental) against another type (e.g., economic).

(vii) Administrative constraints: Are choices limited by the agency procedural or format requirements?

Specific agency policy or guidelines may rule out some tools by specifying the range of impacts to be addressed, the need for analysing trade-offs, or the time frame of analysis.

TYPES OF METHODOLOGIES

- Checklists
- Matrices
- Overlays

1. Checklists:

- Checklist means a listing of potential Environmental Impacts.
- A comprehensive and user friendly checklist is an invaluable aid for several activities of EIA, particularly scoping and defining baseline studies
- The checklist has been prepared for non-specialists and enables much time consuming work to be carried out in advance of expert data
- It includes extensive data collection sheets
- The collected data can then be used to answer a series of questions to identify major impacts and to identify shortages of data.
- This method is done to assess the nature of the impacts i.e. its type such as adverse /beneficial, short term or long term, no effect or significant impact, reversible or irreversible etc.
- These methodologies present a specific list of environmental parameters to be investigated for possible impacts, or a list of agency activities known to have caused environmental concern.
- They may have considerable value when many repetitive actions are carried out under similar circumstances.
- They do not, themselves, establish a direct cause- effect link, but merely suggest lines of examination.

Types of checklists:

- **Simple Checklists.**

Simple checklists are a list of parameters without guidelines regarding either interpretation or measurement of environmental parameters or specific data needs or impact prediction and assessment.

- **Descriptive Checklists.**

Descriptive checklists include list of environmental factors along with information on measurement, impact prediction and assessment.

- **Scaling and weighting Checklists.**

Scaling and weighting checklists facilitate decision making. Such checklists are strong in impact identification. While including the function of impact identification, they include a certain degree of interpretation and evaluation.

- **Questionnaire Checklists**

It based on a set of questions to be answered. Some of the questions may concern indirect impacts and possible mitigation measures. They may also provide a scale for classifying estimated impacts from highly adverse to highly beneficial

Advantages	**Disadvantages**
Simple to understand and use	Do not distinguish between direct and indirect impacts
Good for site selection and priority setting	Do not link action and impact
	Sometime it is a cumbersome task

Eg: Simple checklist for a bridge construction

	Yes	**No**
Proposed activities		
Dredging	√	
Blasting	√	
Pier construction	√	
Traffic diversion		√
Affected physical components		
Water quality	√	
Water quantity		√
Soil quality	√	
Soil quantity		√
Air quality	√	
Affected biological components		
Fish populations	√	
Spawning of fish	√	
Bird habitat		√
Wildlife habitat		√
Affected socio-economic components		
Employment		√
Noise	√	
Health	√	

2. Matrices:

- It was pioneer by Leopold et al (1971).
- Matrix indicates causes and effect by posting activities on the rows and environmental parameters on the column
- In this way, the impacts of individual components of projects as well as major alternatives can be compared
- Matrix and its variants provide us a framework of interaction of different actions /activities of a project with potential environmental impact (EI) caused by them.
- The matrix methodologies incorporates both a list of project activities and a checklist of potentially impacted environmental characteristics.
- It is a simple interaction matrix is formed where project actions are listed along one axis i.e. vertically and EI are listed along the other side i.e. horizontally.
- The two lists are then related in a matrix which identifies cause and effect relationships between specific activities and impacts.
- It lists about 100 project actions and about 88 environmental characteristic and condition.
- In a way, the matrix presents both alternatives from the checklist approach (i.e., both attributes and activities) to be considered simultaneously.
- Matrix methodologies may either specify which actions impact which environmental characteristics or may simply list the range of possible actions and characteristics in an open matrix to be completed by the analyst.

Advantages	**Disadvantages**
Link action to impact	Difficult to distinguish direct and indirect impacts
Good method for displaying EIA results	Significant potential for double-counting of impacts
	Qualitative

ENVIRONMENTAL FACTORS			PROJECT ACTIONS HAVING THE POTENTIAL TO CAUSE AN IMPACT																		
			Modification of industrial site	Modification of industrial buildings	Modification of property limits	Demolition of buildings	Construction of new buildings	Landfills and earth movements	Silting and drainage	Recycling of wastes	Transport of materials	Handling of hazardous radioactive or toxic materials	Emission of liquid and gaseous effluents	Use of rubble tips or solid inert waste tips	Storage of solid radioactive wastes	Fires	Releases or leakage of contaminating liquids or gases	Operating failures	Personnel accidents	Structural failures due to external events	Monitoring and control operations
			A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18	A19
PHYSICAL MEDIUM	E1	AIR				X	X	X			X		X			X	X			X	
	E2	LAND AND SOIL	X	X	X	X	X	X	X	X			X	X	X		X			X	
	E3	WATER							X				X	X	X		X			X	
	E4	FLORA											X	X	X		X			X	
	E5	FAUNA											X	X	X		X			X	
	E6	LANDSCAPE		X		X	X	X						X	X	X					
	E7	NOISE AND VIBRATION	X	X		X	X	X			X			X						X	
SOCIO-ECONOMIC MEDIUM	E8	LAND USE	X		X	X	X							X	X		X			X	
	E9	CULTURAL FACTORS	X																		
	E10	INFRASTRUCTURE									X										
	E11	HUMAN FACTORS				X	X	X			X	X	X	X	X	X	X	X	X	X	X
	E12	POPULATION AND ECONOMY	X							X										X	

3. Overlays:

- Overlays provide a technique for illustrating the geographical extent of different environmental impacts.
- Each overlay is a map of single impact
- These methodologies rely upon a set of maps of project area's environmental characteristics (physical, social, ecological, aesthetic).
- These maps are overlaid to produce a composite characterisation of the regional environment.
- Separate mapping of critical environmental features at the same scale as project's site plan.
- Impacts are identified by noting the congruence of inherently antagonistic environmental characteristics within the project boundaries.
- E.g. wetlands, steep slopes, soils, floodplains, bedrock outcrops, wildlife habitats, vegetative communities, and cultural resources.
- Older Technique: environmental features are mapped on transparent plastic in different colours, which is cumbersome.
- Newer Technique: **Geographic Information Systems (GIS)**, can make this technique particularly suitable for comparing options, pinpointing sensitive zones and proposing different areas or methods of land management.

Advantages	**Disadvantages**
Easy to understand and use	Address only direct impacts
Good display method	Do not address impact duration or probability
Good for site selection setting	

FAULT TREE ANALYSIS

- Fault Tree Analysis Fault Tree Analysis (FTA) is a deductive approach for resolving an undesired event (risk) back to its causes.
- It can be effectively applied to risk assessment and accident–incident analysis.
- FTA was developed by H. Watson and A. Mearns of Bell Laboratories in 1961 to evaluate the Minuteman Launch Control System.
- FTA is the conversion of the failure behaviour of a physical system into a visual form (logic diagram).

- The first step is to identify the risks or undesired events.
- Each identified event is resolved back to its immediate and basic causes.
- A logic diagram (fault tree) is constructed using logic symbols to depict the relationships between these events and causes.
- The constructed fault tree is then evaluated to quantify the failure probability. Addition, multiplication, algebraic functions, and Boolean functions aid the calculation of these probabilities.
- An action plan is developed to reduce the occurrence of these identified risks.
- FTA has been widely used in environmental applications, such as, risk analysis of drinking water systems, probability assessment of contaminant discharge from shipwrecks and analysis of pollution caused by vehicular emissions.

FTA analysis involves five steps:

Define the undesired event to study.

- Definition of the undesired event can be very hard to uncover, although some of the events are very easy and obvious to observe. An engineer with a wide knowledge of the design of the system is the best person to help define and number the undesired events. Undesired events are used then to make FTAs. Each FTA is limited to one undesired event.

Obtain an understanding of the system.

- Once the undesired event is selected, all causes with probabilities of affecting the undesired event of 0 or more are studied and analyzed. Getting exact numbers for the probabilities leading to the event is usually impossible for the reason that it may be very costly and time-consuming to do so. Computer software is used to study probabilities; this may lead to less costly system analysis.
- System analysts can help with understanding the overall system. System designers have full knowledge of the system and this knowledge is very important for not missing any cause affecting the undesired event. For the selected event all causes are then numbered and sequenced in the order of occurrence and then are used for the next step which is drawing or constructing the fault tree.

Construct the fault tree.

- After selecting the undesired event and having analyzed the system so that we know all the causing effects (and if possible their probabilities) we can now construct the fault tree.

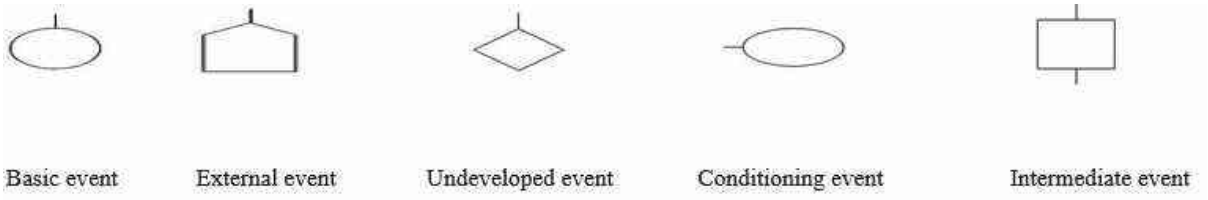
- Fault tree is based on AND and OR gates which define the major characteristics of the fault tree.

  Evaluate the fault tree.
- After the fault tree has been assembled for a specific undesired event, it is evaluated and analyzed for any possible improvement or in other words study the risk management and find ways for system improvement. A wide range of qualitative and quantitative analysis methods can be applied. This step is as an introduction for the final step which will be to control the hazards identified. In short, in this step we identify all possible hazards affecting the system in a direct or indirect way.

  Control the hazards identified.
- This step is very specific and differs largely from one system to another, but the main point will always be that after identifying the hazards all possible methods are pursued to decrease the probability of occurrence.

Event symbols

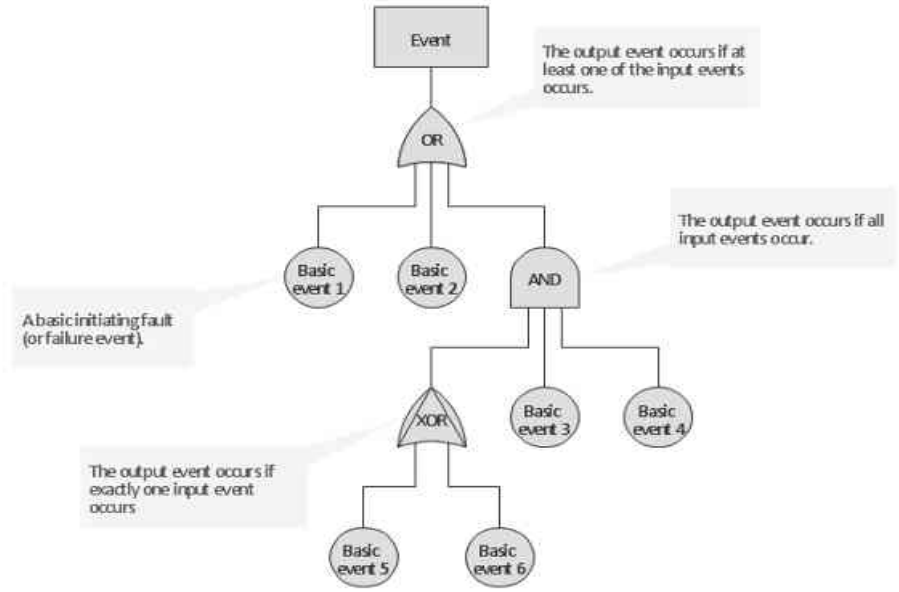
- Event symbols are used for *primary events* and *intermediate events*.
- Primary events are not further developed on the fault tree. Intermediate events are found at the output of a gate. The event symbols are shown below: The primary event symbols are typically used as follows:

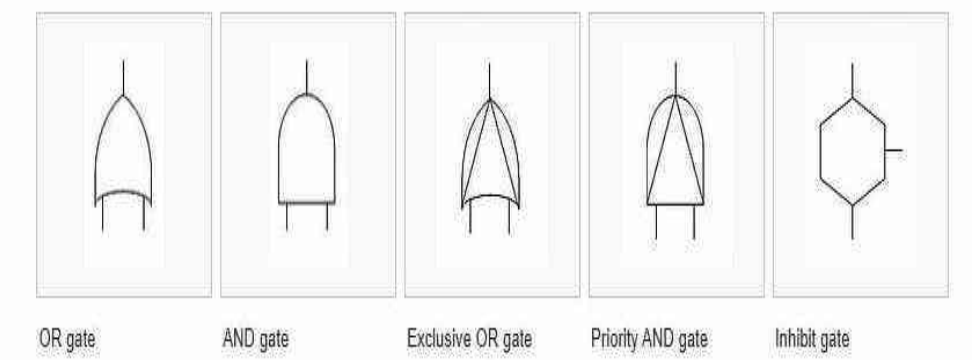


- **Basic event** - failure or error in a system component or element (example: switch stuck in open position)
- **External event** - normally expected to occur (not of itself a fault)
- **Undeveloped event** - an event about which insufficient information is available, or which is of no consequence
- **Conditioning event** - conditions that restrict or affect logic gates (example: mode of operation in effect)
- An intermediate event gate can be used immediately above a primary event to provide more room to type the event description.

Gate symbols:

- Gate symbols describe the relationship between input and output events. The symbols are derived from Boolean logic symbols:



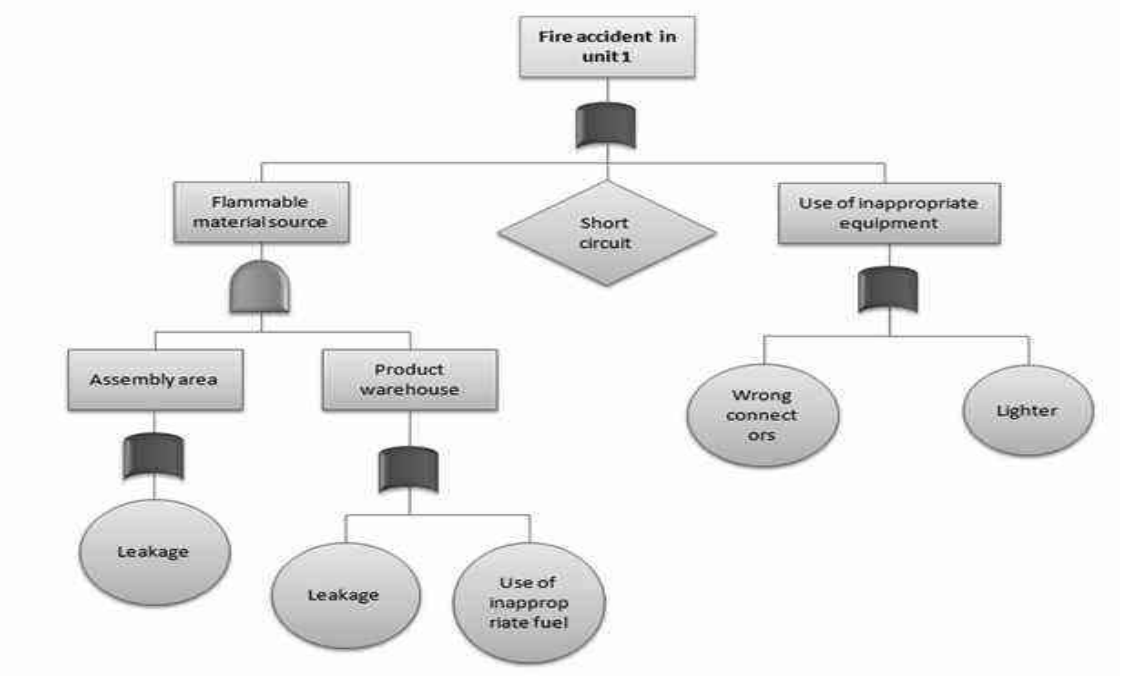


The gates work as follows:

- **OR gate** - the output occurs if any input occurs.
- **AND gate** - the output occurs only if all inputs occur (inputs are independent).
- **Exclusive OR gate** - the output occurs if exactly one input occurs.
- **Priority AND gate** - the output occurs if the inputs occur in a specific sequence specified by a conditioning event.
- **Inhibit gate** - the output occurs if the input occurs under an enabling condition specified by a conditioning event.

The Base-level event is typically color coded as follows:

- Red: Critical Risk
- Orange: High Risk
- Yellow: Minor Risk
- Green: Acceptable / Very Low Risk



Eg: for FTA

Fault tree analysis can be used to:

- understand the logic leading to the top event / undesired state.
- show compliance with the (input) system safety / reliability requirements.
- prioritize the contributors leading to the top event- creating the critical equipment/parts/events lists for different importance measures
- monitor and control the safety performance of the complex system (e.g., is a particular aircraft safe to fly when fuel valve *x* malfunctions? For how long is it allowed to fly with the valve malfunction?).
- minimize and optimize resources.
- assist in designing a system. The FTA can be used as a design tool that helps to create (output / lower level) requirements.
- function as a diagnostic tool to identify and correct causes of the top event. It can help with the creation of diagnostic manuals / processes.
- In brief, FTA identifies weaknesses in the system and the causes of a failure, assesses proposed design for safety and reliability, quantifies the failure probability, and optimizes the management actions.

However, demerits of the Fault Tree Analysis are as follows:

- FTA can embroil complex mathematics.
- Human errors can either undervalue or overvalue risks.
- It depends on specialist knowledge.

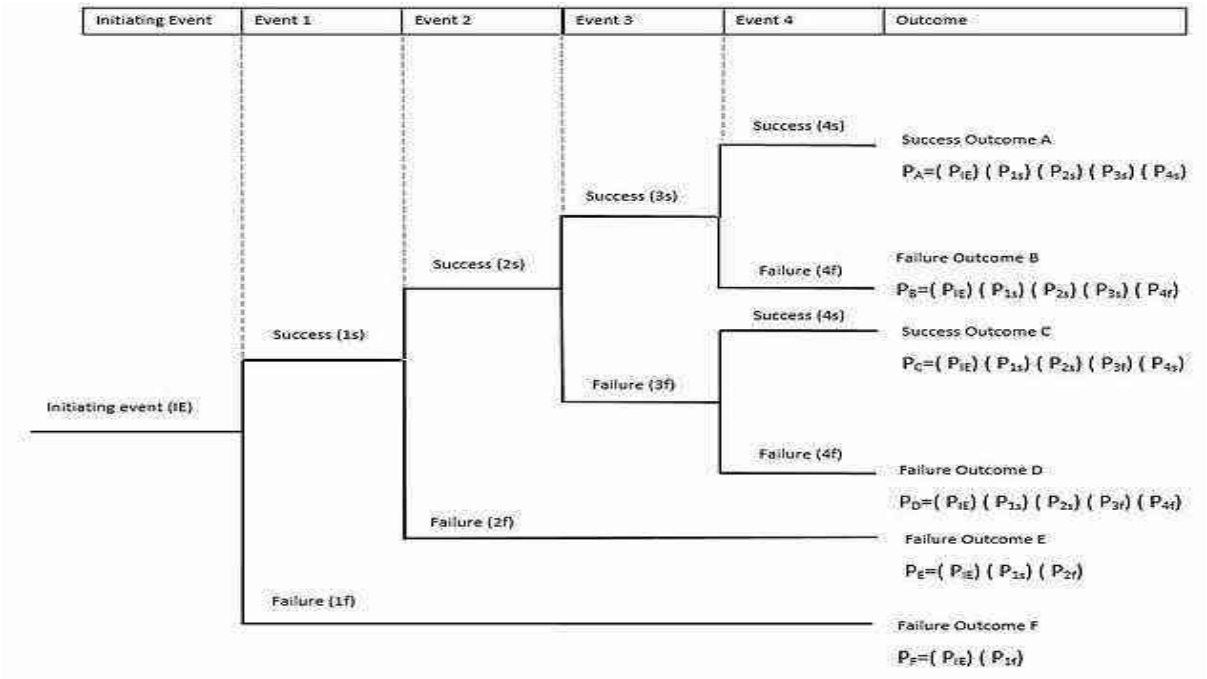
EVENT TREE ANALYSIS

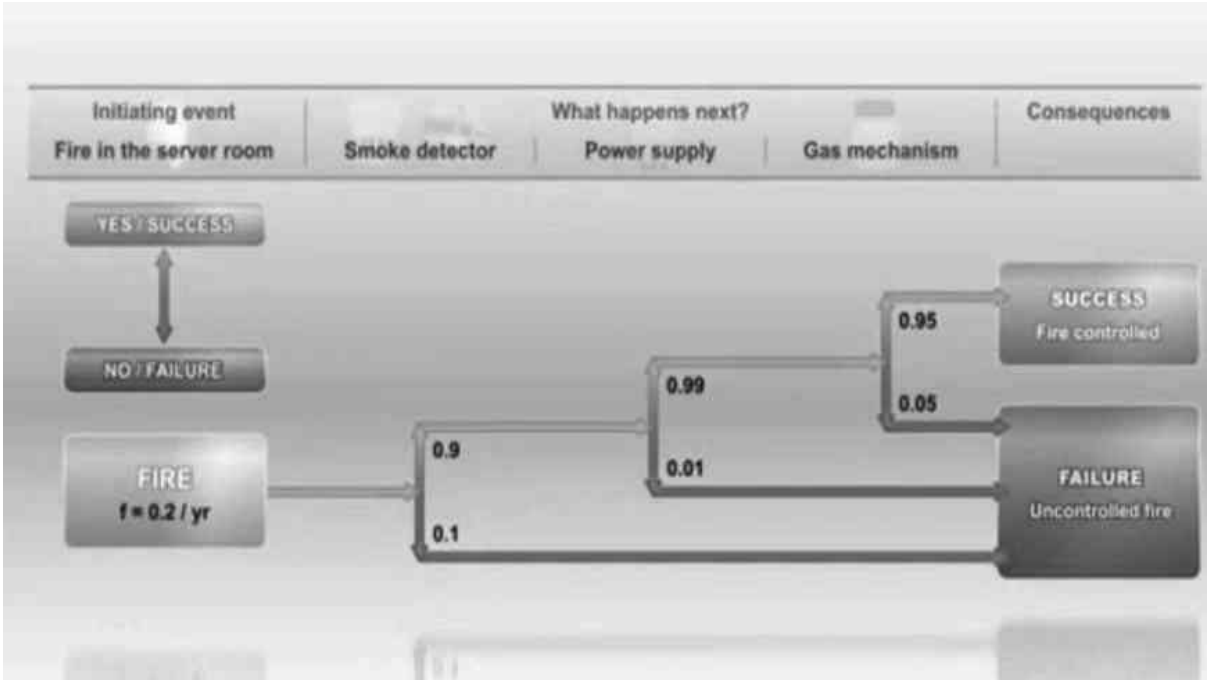
- The evolution of event trees was necessitated as fault trees were often too large and complicated to compute.
- Event Tree Analysis (ETA), also known as the pipeline risk assessment method, was developed in 1974 for the safety study of the WASH-1400 nuclear power plant in the USA.
- While FTA is a deductive approach, ETA is an inductive approach as it induces the consequences of an undesired event rather than deducing the causes for it (like in FTA).
- Event tree analysis (ETA) is a forward, logical modeling technique for both success and failure that explores responses through a single initiating event and lays a path for assessing probabilities of the outcomes and overall system analysis.
- This analysis technique is used to analyze the effects of functioning or failed systems given that an event has occurred.
- ETA is a powerful tool that will identify all consequences of a system that have a probability of occurring after an initiating event that can be applied to a wide range of systems including: nuclear power plants, spacecraft, and chemical plants.
- ETA analyses the effects of system failure supposing an undesired event has occurred.
- This technique may be applied to a system early in the design process to identify potential issues that may arise, rather than correcting the issues after they occur.
- With this forward logic process, use of ETA as a tool in risk assessment can help to prevent negative outcomes from occurring, by providing a risk assessor with the probability of occurrence.
- ETA uses a type of modeling technique called event tree, which branches events from one single event using Boolean logic.

- The first step in ETA is to identify the initiating-events, such as, equipment failure and process malfunction.
- A logic diagram (event tree) is generated, beginning with an initiating-event and developing the possible sequence of events, which may lead to potential accidents.
- The probability of each identified initiating-events that lead to a potential accident is evaluated by simple addition and multiplication of the probabilities of the sequential events.
- A management plan is developed with corrective actions to mitigate the risk associated with the undesired events.

Steps to perform an event tree analysis:

- Define the system: Define what needs to be involved or where to draw the boundaries.
- Identify the accident scenarios: Perform a system assessment to find hazards or accident scenarios within the system design.
- Identify the initiating events: Use a hazard analysis to define initiating events.
- Identify intermediate events: Identify countermeasures associated with the specific scenario.
- Build the event tree diagram
- Obtain event failure probabilities: If the failure probability can not be obtained use fault tree analysis to calculate it.
- Identify the outcome risk: Calculate the overall probability of the event paths and determine the risk.
- Evaluate the outcome risk: Evaluate the risk of each path and determine its acceptability.
- Recommend corrective action: If the outcome risk of a path is not acceptable develop design changes that change the risk.
- Document the ETA: Document the entire process on the event tree diagrams and update for new information as needed.





Eg: for ETA

Advantages:

- Enables the assessment of multiple, co-existing faults and failures
- Functions simultaneously in cases of failure and success
- No need to anticipate end events
- Work can be computerized

- Can be performed on various levels of details
- Visual cause and effect relationship
- Relatively easy to learn and execute
- Models complex systems into an understandable manner
- Combines hardware, software, environment, and human interaction
- Permits probability assessment
- Commercial software is available

Limitations

- It cannot be applied for complex processes.
- Accurate identification of initiating-events is a precursor for this analysis.
- Unidentified initiating events could lead to misleading results.
- Addresses only one initiating event at a time.
- The initiating challenge must be identified by the analyst
- Pathways must be identified by the analysis
- Level of loss for each pathway may not be distinguishable without further analysis
- Success or failure probabilities are difficult to find
- Can overlook subtle system differences
- Partial successes/failures are not distinguishable
- Requires an analyst with practical training and experience

ROLE OF ENVIRONMENTAL ENGINEER

- Environmental engineers are concerned with assessing and managing the effects of human and other activity on the natural and built environment.
- With so much focus on being green and preserving the environment for our futures, environmental engineers are becoming increasingly important.
- Environmental engineering specialists use principles of biology and chemistry to develop solutions to environmental problems.
- These workers are involved in matters such as recycling, waste disposal, water and air pollution control, and public health issues.
- Environmental engineers also research and try to minimize the effects of acid rain, global warming, automobile emissions, and ozone depletion issues.

- According to the Bureau of labour statistics (BLS), environmental engineers consider the earth's natural resources while applying physical, biological, and chemical principles to address local, regional, and global environmental issues.

Depending on their specialization, environmental engineers may work on any of the following projects throughout their careers:

- Air and water pollution monitoring and mitigation
- Creation and maintenance of recycling and waste disposal methods
- Development and maintenance of efficient fuel methods

PUBLIC PARTICIPATION

- It is being realised increasingly that those whose environment will be affected by development proposals have a right to participate in decision-making that may affect that environment.
- Annex 1 to Our Common Future recommends that "States shall inform in a timely manner all persons likely to be significantly affected by a planned activity and to grant them equal access in administrative and judicial proceedings".
- Principle 10 of the Rio Declaration insists that environmental issues are best handled with the participation of all concerned citizens, at the relevant level.
- Despite the positive trends towards greater public participation in the EIA process and improved communication of EIA findings, both are still underdeveloped in many parts of the world.
- The approach to be taken for public involvement is worthy of a great deal of consideration at the scoping stage, as it could make or break our EIA report.
- History shows that engineers are not very good at public involvement processes and they tend to be resistant to them.
- But, it is necessary to remember that:
- Public involvement is not public relations in the sense of "selling" the project. It is consultation with the public, and "consultation" means a genuine attempt to communicate information and to seek advice on the basis that the advice, if relevant,

will be acted upon. Public involvement is an area of the EIA reporting process that can be politically sensitive.

- Certain interests, even project sponsors, may seek to exercise control and influence on the process.

There will not be one public so far as a specific project is concerned. There may, in fact, be several publics as under:

- The experts within the community,
- The scientific organisations,
- The expert government agencies, university departments and expert professional groups.
- Local authorities, citizen groups and NGOs.
- The stakeholders, i.e., those with a direct interest in, or who are directly affected by, the project.
- Societies, cultural groups and individual citizens interested in, or affected by, the project.
- The general community.

MODULE VI

Syllabus: Standards for Water, Air and Noise Quality – Environmental Management Plan- EIA- Case studies of EIA

STANDARDS FOR WATER, AIR AND NOISE QUALITY

The Ministry of Environment, Forests and Climate Change (MoEFCC) of India has been in a great effort in Environmental Impact Assessment in India. The main laws in action are the Water Act (1974), the Indian Wildlife (Protection) Act (1972), the Air (Prevention and Control of Pollution) Act (1981) and the Environment (Protection) Act (1986), Biological Diversity Act (2002). The responsible body for this is the Central Pollution Control Board. Environmental Impact Assessment (EIA) studies need a significant amount of primary and secondary environmental data.

Primary data are those collected in the field to define the status of the environment (like air quality data, water quality data etc.). Secondary data are those collected over the years that can be used to understand the existing environmental scenario of the study area. The environmental impact assessment (EIA) studies are conducted over a short period of time and therefore the understanding of the environmental trends, based on a few months of primary data, has limitations. Ideally, the primary data must be considered along with the secondary data for complete understanding of the existing environmental status of the area. In many EIA studies, the secondary data needs could be as high as 80% of the total data requirement. EIC is the repository of one stop secondary data source for environmental impact assessment in India. The Environmental Impact Assessment (EIA) experience in India indicates that the lack of timely availability of reliable and authentic environmental data has been a major bottle neck in achieving the full benefits of EIA.

The environment being a multi-disciplinary subject, a multitude of agencies are involved in collection of environmental data. However, no single organization in India tracks available data from these agencies and makes it available in one place in a form required by environmental impact assessment practitioners. Further, environmental data is not available in enhanced forms that improve the quality of the EIA. This makes it harder and more time-consuming to generate environmental impact assessments and receive timely environmental clearances from regulators.

With this background, the Environmental Information Centre (EIC) has been set up to serve as a professionally managed clearing house of environmental information that can be

used by MoEF, project proponents, consultants, NGOs and other stakeholders involved in the process of environmental impact assessment in India. EIC caters to the need of creating and disseminating of organized environmental data for various developmental initiatives all over the country.

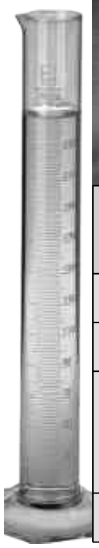
EIC stores data in GIS format and makes it available to all environmental impact assessment studies and to EIA stakeholders in a cost effective and timely manner. So that we can manage that in different proportions such as remedy measures etc.

WATER QUALITY STANDARDS

Indian Standard
Drinking Water Specifications
IS 10500 : 1991

Technical Terms

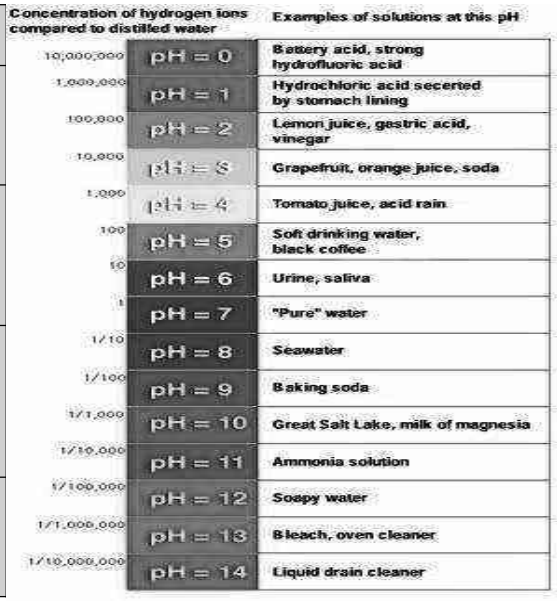
- BIS (Bureau of Indian Standards)
- Desirable Limits
- Permissible Limits
- PPM
- NTU
- Hazen Units



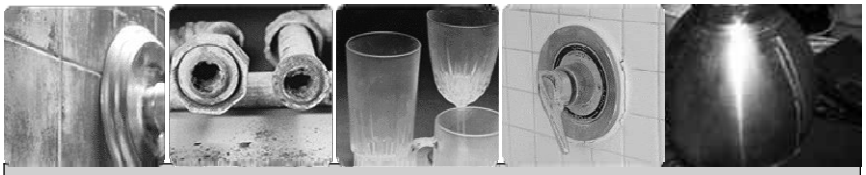
Colour, Hazen Units	
IS 10500-1991	Desirable : 5 Hz. , Permissible : 25 Hz.
Risks or effects	Visible tint, acceptance decreases
Sources	Tannins, Iron, Copper, Manganese Natural deposits
Treatment	Filtration, Distillation, Reverse osmosis, Ozonisation

Odour	
IS 10500-1991	Unobjectionable
Risks or effects	Rotten egg, Musty, Chemical
Sources	Chlorine, Hydrogen sulphide, Organic matter, Septic contamination, Methane gas
Treatment	Activated carbon, Air stripping, oxidation, Filtration

pH	
IS 10500-1991	Desirable :6.5 – 8.5, Permissible :No relaxation
Risks or effects	Low pH - corrosion, metallic taste High pH – bitter/soda taste, deposits
Sources	Natural
Treatment	Increase pH by soda ash Decrease pH with white vinegar / citric acid

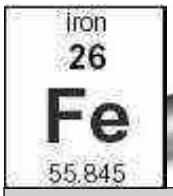


Total Dissolved Solids (TDS)	
IS 10500-1991	Desirable : 500 mg/l , Permissible : 2000 mg/l
Risks or effects	Hardness, scaly deposits, sediment, cloudy colored water, staining, salty or bitter taste, corrosion of pipes and fittings
Sources	Livestock waste, septic system Landfills, nature of soil Hazardous waste landfills Dissolved minerals, iron and manganese
Treatment	Reverse Osmosis, Distillation, deionization by ion exchange

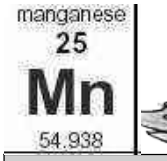


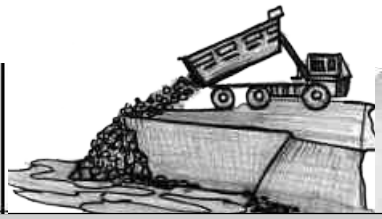
Hardness	
IS 10500-1991	Desirable :300 mg/l , Permissible : 600 mg/l
Risks or effects	Scale in utensils and hot water system, soap scums
Sources	Dissolved calcium and magnesium from soil and aquifer minerals containing limestone or dolomite
Treatment	Water Softener Ion Exchanger , Reverse Osmosis

Alkalinity	
IS 10500-1991	Desirable : 200 mg/l , Permissible : 600 mg/lit
Risks or effects	Low Alkalinity (i.e. high acidity) causes deterioration of plumbing and increases the chance for many heavy metals in water are present in pipes, solder or plumbing fixtures.
Sources	Pipes, landfills Hazardous waste landfills
Treatment	Neutralizing agent



Iron	
IS 10500-1991	Desirable : 0.3 mg/l , Permissible : 1.0 mg/l
Risks or effects	Brackish color, rusty sediment, bitter or metallic taste, brown-green stains, iron bacteria, discolored beverages
Sources	Leaching of cast iron pipes in water distribution systems Natural
Treatment	Oxidizing Filter , Green-sand Mechanical Filter





Manganese	
IS 10500-1991	Desirable : 0.1 mg/l , Permissible : 0.3 mg/l
Risks or effects	Brownish color, black stains on laundry and fixtures at .2 mg/l, bitter taste, altered taste of water-mixed beverages
Sources	Landfills Deposits in rock and soil
Treatment	Ion Exchange , Chlorination, Oxidizing Filter , Green-sand Mechanical Filter

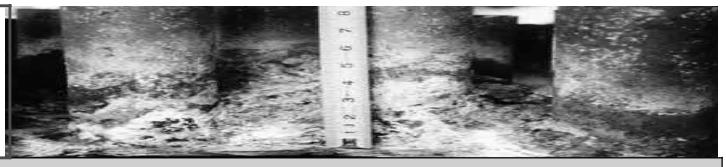
SO_4

Sulphate	
IS 10500-1991	Desirable : 200 mg/l, Permissible : 400 mg/l
Risks or effects	Bitter, medicinal taste, scaly deposits, corrosion, laxative effects, "rotten-egg" odour from hydrogen sulphide gas formation
Sources	Animal sewage, septic system, sewage By-product of coal mining, industrial waste Natural deposits or salt
Sulphate Treatment	Ion Exchange , Distillation , Reverse Osmosis

NO_{3-}

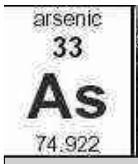
Nitrate	
IS 10500-1991	Desirable : 45 mg/l, Permissible : 100 mg/lit
Risks or effects	Methemoglobinemia or blue baby disease in infants
Sources	Livestock facilities, septic systems, manure lagoons, Household waste water, Fertilizers, Natural Deposits,
Treatment	Ion Exchange, Distillation, Reverse Osmosis

Cl



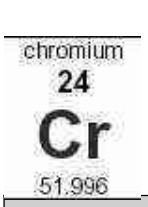
Chlor ide	
IS 10500-1991	Desirable : 250 mg/l , Permissible : 1000 mg/l
Risks or effects	High blood pressure, salty taste, corroded pipes, fixtures and appliances, blackening and pitting of stainless steel
Sources	Fertilizers Industrial wastes Minerals, seawater
Treatment	Reverse Osmosis , Distillation, Activated Carbon

Fluor ide	
IS 10500-1991	Desirable : 1.0 mg/l, Permissible : 1.5 mg/l
Risks or effects	Brownish discoloration of teeth, bone damage
Sources	Industrial waste Geological
Treatment	Activated Alumina, Distillation, Reverse Osmosis, Ion Exchange





Arsenic	
IS:10500-1991	Desirable: 0.05 mg/l Permissible: No relaxation
Risks or effects	Weight loss; Depression; Lack of energy; Skin and nervous system toxicity
Sources	Previously used in pesticides (orchards) Improper waste disposal or product storage of glass or electronics, Mining Rocks
Treatment	Activated Alumina Filtration, Reverse Osmosis, Distillation, Chemical Precipitation, Ion exchange, lime softening

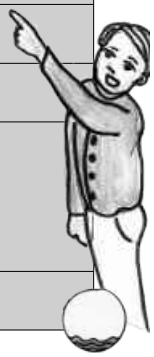


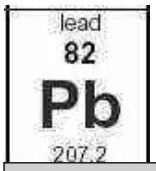


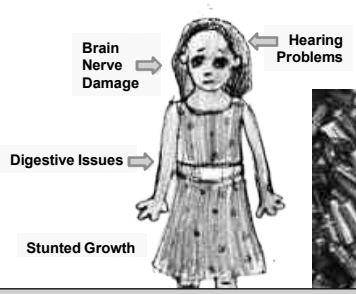
Chromium	
IS 10500-1991	Desirable : 0.05 mg/l, Permissible : No relaxation
Risks or effects	Skin irritation, skin and nasal ulcers, lung tumors, gastrointestinal effects, damage to the nervous system and circulatory system, accumulates in the spleen, bones, kidney and liver
Sources	Septic systems Industrial discharge, mining sites Geological
Treatment	Ion Exchange, Reverse Osmosis, Distillation

Copper	
IS 10500-1991	Desirable : 0.05 mg/l, Permissible : 1.5 mg/l
Risks or effects	Anemia, digestive disturbances, liver and kidney damage, gastrointestinal irritations, bitter or metallic taste; Blue-green stains on plumbing fixtures
Sources	Leaching from copper water pipes and tubing, algae treatment Industrial and mining waste, wood preservatives Natural deposits
Treatment	Ion Exchange, Reverse Osmosis, Distillation

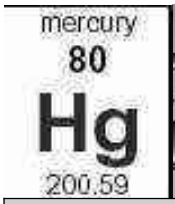
Cyani de	
IS 10500-1991	Desirable : 0.05 mg/l, Permissible : No relaxation
Risks or effects	Thyroid, nervous system damage
Sources	Fertilizer Electronics, steel, plastics mining
Treatment	Ion Exchange, Reverse Osmosis, Chlorination

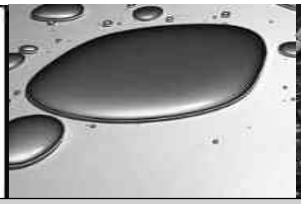






Lead	
IS 10500-1991	Desirable : 0.05 mg/l, Permissible : No relaxation
Risks or effects	Reduces mental capacity (mental retardation), interference with kidney and neurological functions, hearing loss, blood disorders, hypertension, death at high levels
Sources	Paint, diesel fuel combustion Pipes and solder, discarded batteries, paint, leaded gasoline Natural deposits
Treatment	Ion Exchange, Activated Carbon , Reverse Osmosis, Distillation





Mercury	
IS 10500-1991	Desirable : 0.001 mg/l, Permissible : No relaxation
Risks or effects	Loss of vision and hearing, intellectual deterioration, kidney and nervous system disorders, death at high levels
Sources	Fungicides Batteries, fungicides Mining, electrical equipment, plant, paper and vinyl chloride Natural deposits
Treatment	Reverse Osmosis, Distillation

Zi nc	
IS 10500-1991	Desirable :5 mg/l, Permissible : 15 mg/l
Risks or effects	Metallic taste
Sources	Leaching of galvanized pipes and fittings, paints, dyes Natural deposits
Treatment	Ion Exchange Water Softeners, Reverse Osmosis, Distillation

Tot al Col if or m Bac t er i a	
IS 10500-1991	95% of samples should not contain coliform in 100 ml 10 coliform / 100ml
Risks or effects	Gastrointestinal illness
Sources	Livestock facilities, septic systems, manure lagoons Household waste water Naturally occurring
Treatment	Chlorination , Ultraviolet, Distillation, Iodination



E. c ol if or m Bac t er i a	
IS 10500-1991	Nil / 100ml
Risks or effects	Gastrointestinal illness
Sources	Livestock facilities, septic systems, manure lagoons Household waste water Naturally occurring
Treatment	Chlorination , Ultraviolet, Distillation, Iodination

HEALTH EFFECTS OF CHEMICAL PARAMETERS

Parameter	BIS Guideline value (maximum allowable)	General & Health effect
Total dissolved solids	2000 mg/L	Undesirable taste; gastro intestinal irritations; corrosion or incrustation
PH	6.5-8.5	Affects mucous membrane; bitter taste; corrosion; affects aquatic life
Alkalinity	600 mg/L	Boiled rice turns yellowish
Hardness	600 mg/L	Poor lathering with soap; deterioration of the quality of clothes; scale forming; skin irritation; boiled meat and food become poor in quality
Calcium	200	Poor lathering and deterioration of the quality of clothes; incrustation in pipes; scale formation
Magnesium	100	Poor lathering and deterioration of clothes; with sulfate laxative
Iron	1.0	Poor or sometimes bitter taste, color and turbidity; staining of clothes materials; iron bacteria causing slime
Manganese	0.3	Poor taste, color and turbidity; staining; black slime

HEALTH EFFECTS OF CHEMICAL PARAMETERS

Parameter	BIS Guideline value (maximum allowable)	General & Health effect
Aluminum	0.2	Neurological disorders; Alzheimer's disease
Copper	1.5	Liver damage; mucosal irritation, renal damage and depression; restricts growth of aquatic plants
Zinc	15	Astringent taste; opalescence in water; gastro intestinal irritation; vomiting, dehydration, abdominal pain, nausea and dizziness
Ammonia	-	Indicates pollution; growth of algae
Nitrite	-	Forms nitrosoamines which are carcinogenic
Nitrate	100	Blue baby disease (methemoglobineamia); algal growth
Sulfate	400	Taste affected; laxative effect; gastro intestinal irritation
Chloride	1000	Taste affected; corrosive
Fluoride	1.5	Dental and skeletal fluorosis; non-skeletal

HEALTH EFFECTS OF CHEMICAL PARAMETERS

Parameter	BIS Guideline value (maximum allowable)	General & Health effect
Phosphate	**-**	**Algal growth**
Arsenic	**0.05**	**Toxic; bio-accumulation; central nervous system affected; carcinogenic**
Mercury	**0.001**	**Highly toxic; causes 'minamata' disease-neurological impairment and renal disturbances; mutagenic**
Cadmium	**0.01**	**Highly toxic; causes 'itai-itai' disease-painful rheumatic condition; cardio vascular system affected; gastro intestinal upsets and hyper tension**
Lead	**0.05**	**Causes plumbism-tiredness, lassitudes, abdominal discomfort, irritability, anaemia; bio-accumulation; impaired neurological and motor development, and damage to kidneys**
Chromium	**0.05**	**Carcinogenic; ulcerations, respiratory problems and skin**
Pesticide	**0.001**	**complaints Affects central nervous system**
Detergent	**-**	**Undesirable foaming**

AIR QUALITY STANDARDS

AMBIENT AIR QUALITY STANDARDS

- Ambient air quality refers to the condition or quality of air surrounding us in the outdoors.
- National Ambient Air Quality Standards are the standards for ambient air quality set by the Central Pollution Control Board that is applicable nationwide.
- The CPCB has been conferred this power by the Air (Prevention and Control of Pollution) Act, 1981.

Ambient Air Quality Standards in India

- The Air (Prevention and Control of Pollution) Act 1981 was enacted by the Central Government with the objective of arresting the deterioration of air quality.
- The Air (Prevention and Control of Pollution) Act 1981 describes the main functions of the Central Pollution Control Board (CPCB) as follows:
  - To advise the Central Government on any matter concerning the improvement of the quality the air and the prevention, control and abatement of air pollution.
  - To plan and cause to be executed a nation-wide programme for the prevention, control and abatement of air pollution.
  - To provide technical assistance and guidance to the State Pollution Control Board.
  - To carry out and sponsor investigations and research related to prevention, control and abatement of air pollution.
  - To collect, compile and publish technical and statistical data related to air pollution; and
  - To lay down and annul standards for the quality of air
- The mandate provided to the CPCB under the Air (Prevention and Control of Pollution) Act empowers it to set standards for the quality of air.

National Ambient Air Quality Standards

Pollutant	Time Weighted Average		Concentration in Ambient Air			
			Industrial, Residential, Rural and Other Areas		Ecologically Sensitive Area (notified by Central Government)	
Sulphur Dioxide (SO2), µg/m3	Annual*	24 hours**	50	80	20	80
Nitrogen Dioxide (NO2), µg/m3	Annual*	24 hours**	40	80	30	80
Particulate Matter (size less than 10 µm) or PM10 µg/m3	Annual*	24 hours**	60	100	60	100
Particulate Matter (size less than 2.5 µm) or PM2.5 µg/m3	Annual*	24 hours**	40	60	40	60
Ozone (O3) µg/m3	8 hours*	1 hour**	100	180	100	180
Lead (Pb) µg/m3	Annual*	24 hours**	0.50	1.0	0.50	1.0
Carbon Monoxide (CO) mg/m3	8 hours*	1 hour**	02	04	02	04
Ammonia (NH3) µg/m	Annual*	24 hours**	100	400	100	400
Benzene (C6H6) µg/m3	Annual*		5		5	
Benzo(a)Pyrene (BaP)-particulate phase only, ng/m3	Annual*		1		1	
Arsenic(As), ng/m3	Annual*		6		60	
Nickel (Ni), ng/m3	Annual*		20		20	

- * Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.
- ** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time, they may exceed the limits but not on two consecutive days of monitoring.

International Standards

- The 2005 World Health Organization's "WHO Air quality guidelines offer global guidance on thresholds and limits for 4 key air pollutants that pose health risks - particulate matter (PM), ozone (O3), nitrogen dioxide (NO2) and sulphur dioxide (SO2).

Guideline values prescribed by WHO are

- PM2.5
  - 10 µg/m3 annual mean
  - 25 µg/m3 24-hour mean
- PM10
  - 20 µg/m3 annual mean
  - 50 µg/m3 24-hour mean
- O3
  - 100 µg/m3 8-hour mean
- NO2
  - 40 µg/m3 annual mean
  - 200 µg/m3 1-hour mean
- SO2
  - 20 µg/m3 24-hour mean
  - 500 µg/m3 10-minute mean
- The WHO Guidelines indicate that by reducing particulate matter (PM10) pollution from 70 to 20 micrograms per cubic metre (µg/m), air pollution-related deaths can be cut by around 15%[1]. Indian Standards are slightly less stringent as compared to WHO guidelines.
- However, the world's average PM10 levels by region range from 26 to 208 µg/m3, with a world's average of 71 µg/m3 as per WHO estimates published in 2014.

NOISE QUALITY STANDARDS

Ambient Air Quality Standards in respect of Noise

Area code	Category of Area / Zone	Limits in dB(A) Leq*	
		Day Time	Night Time
(A)	Industrial area	75	70
(B)	Commercial area	65	55
(C)	Residential area	55	45
(D)	Silence Zone	50	40

Note:-

1. Day time shall mean from 6.00 a.m. to 10.00 p.m.
2. Night time shall mean from 10.00 p.m. to 6.00 a.m.
3. Silence zone is an area comprising not less than 100 metres around hospitals, educational institutions, courts, religious places or any other area which is declared as such by the competent authority
4. Mixed categories of areas may be declared as one of the four above mentioned categories by the competent authority.

- * dB(A) Leq denotes the time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.
- A “decibel” is a unit in which noise is measured.
- “A”, in dB(A) Leq, denotes the frequency weighting in the measurement of noise and corresponds to frequency response characteristics of the human ear.
- Leq: It is an energy mean of the noise level over a specified period

ENVIRONMENTAL MANAGEMENT PLAN

It is a plan or program that seeks to achieve a required end state and describes how activities, which have or could, have an adverse impact on the environment, will be mitigated, controlled, and monitored during the commissioning, mobilization, construction, operation, maintenance and decommissioning of a project; and that the positive benefits of the projects are enhanced.

EPA, 2005 states that EMP is the action an organization is taking to determine how it affects the environment, complies with regulations, keeps track of environmental management activities, and meets environmental goals and targets. It also documents key elements of environmental management including the environmental policy, responsibilities, applicable standard operating procedures and Best Management Practices (BMP), record keeping, reports, communication, training, monitoring, and corrective action.

- The EMP features the "Plan, Do, Check, Act" model (EPA, 2005) for ongoing improvement:
- Plan - Planning, including identifying environmental impacts and establishing environmental goals.
- Do - Implementing, including employee training and establishing operational controls.
- Check - Checking, including auditing, monitoring and taking corrective action.
- Act - Reviewing, including progress reviews and taking action to make needed changes.

Environmental management is easier if you have an EMP, because it will help you better track your environmental management activities and implement them in a more organized and streamlined manner. An EMP gives you a framework (EPA, 2005) in which to:

- Comply - Assist you in assessing compliance with environmental regulations
- Improve - Allow you to identify opportunities for improvement and cost savings
- Know - Decrease costly confusion for your employees by spelling out exactly what is expected of them.

Purpose of the EMP:

- Encourage good management practices through planning and commitment to environmental issues concerning any project;

- It tells how the management of the environment is reported and performance evaluated periodically;
- To provide rational and practical environmental guidelines that will assist in minimizing the potential environmental impact of activities;
- Helps in minimizing disturbance to the environment (physical, biological and ecological, socioeconomic, cultural, and archaeological,) ;
- Combat all forms of pollution through monitoring air, noise, land, water, waste, and energy and natural resources;
- Protection of sensitive and endangered flora and fauna;
- Prevent land degradation;
- Comply and adhere to all applicable laws, regulations, standards and guidelines for the protection of the environment;
- Adopt best practicable waste management for all types of waste (liquid and solid) with objective on prevention, minimization, recycling, treatment or disposal of wastes;
- Describe all monitoring procedures required to identify impacts on the environment;
- Train and bring awareness to employees and contractors with regard to environmental obligations and compliance.
- Reduce environmental risk and provide better Health, Safety and Environment (HS&E)
- Increase efficiency through minimum consumption and conservation of energy deplete-able resources
- An EMP also provides with a plan answering - what, where, when, how and who?
- Establishing the reporting system to be undertaken during the construction.
- The EMP also serves to highlight specific requirements that will be monitored during the development and should the environmental impacts not have been satisfactorily prevented or mitigated, corrective action will have to be taken

Preparation of environmental management plan is required for formulation, implementation and monitoring of environmental protection measures during and after commissioning of projects. The plans should indicate the details as to how various measures have been or are proposed to be taken including cost components as may be required. Cost of measures for environmental safeguards should be treated as an integral component of the project cost and environmental aspects should be taken into account at various stages of the projects:

- Conceptualization: preliminary environmental assessment

- Planning: detailed studies of environmental impacts and design of safeguards
- Execution: implementation of environmental safety measures
- Operation: monitoring of effectiveness of built-in safeguards

The management plans should be necessarily based on considerations of resource conservation and pollution abatement, some of which are:

- Liquid Effluents
- Air Pollution
- Solid Wastes
- Noise and Vibration
- Occupational Safety and Health
- Prevention, maintenance and operation of Environment Control Systems
- House-Keeping
- Human Settlements
- Transport Systems
- Recovery - reuse of waste products
- Vegetal Cover
- Disaster Planning
- Environment Management Cell

1. Liquid Effluents

- Effluents from the industrial plants should be treated well to the standards as prescribed by the Central/State Water Pollution Control Boards.
- Soil permeability studies should be made prior to effluents being discharged into holding tanks or impoundments and steps taken to prevent percolation and ground water contamination.
- Special precautions should be taken regarding flight patterns of birds in the area. Effluents containing toxic compounds, oil and grease have been known to cause extensive death of migratory birds. Location of plants should be prohibited in such type of sensitive areas.
- Deep well burial of toxic effluents should not be resorted to as it can result in re-surfacing and ground water contamination. Re-surfacing has been known to cause extensive damage to crop and livestocks.
- In all cases, efforts should be made for re-use of water and its conservation.

2. Air Pollution

- The emission levels of pollutants from the different stacks, should conform to the pollution control standards prescribed by Central or State Boards.
- Adequate control equipment should be installed for minimising the emission of pollutants from the various stacks.
- In-plant control measures should be taken to contain the fugitive emissions.
- Infrastructural facilities should be provided for monitoring the stack emissions and measuring the ambient air quality including micro-meteorological data(wherever required) in the area.
- Proper stack height as prescribed by the Central/State Pollution Control Boards should be provided for better dispersion of pollutants over a wider area to minimise the effect of pollution.
- Community buildings and townships should be built up-wind of plant with one-half to one kilometer greenbelt in addition to physiographical barrier.

3. Solid Wastes

- The site for waste disposal should be checked to verify permeability so that no contaminants percolate into the ground water or river/lake.
- Waste disposal areas should be planned down-wind of villages and townships.
- Reactive materials should be disposed of by immobilising the reactive materials with suitable additives.
- The pattern of filling disposal site should be planned to create better landscape and be approved by appropriate agency and the appropriately pretreated solid wastes should be disposed according to the approved plan.
- Intensive programs of tree plantation on disposal areas should be undertaken.

4. Noise and Vibration

- Adequate measures should be taken for control of noise and vibrations in the industry.

5. Occupational Safety and Health

- Proper precautionary measures for adopting occupational safety and health standards should be taken.

6. Prevention, maintenance and operation of Environment Control Systems

- Adequate safety precautions should be taken during preventive maintenance and shut down of the control systems.
- A system of inter-locking with the production equipment should be implemented where highly toxic compounds are involved.

7. House - Keeping

- Proper house-keeping and cleanliness should be maintained both inside and outside of the industry.

8. Human Settlements

- Residential colonies should be located away from the solid and liquid waste dumping areas. Meteorological and environmental conditions should be studied properly before selecting the site for residential areas in order to avoid air pollution problems.
- Persons who are displaced or have lost agricultural lands as a result of locating the industries in the area, should be properly rehabilitated.

9. Transport Systems

- Proper parking places should be provided for the trucks and other vehicles by the industries to avoid any congestion or blocking of roads.
- Siting of industries on the highways should be avoided as it may add to more road accidents because of substantial increase in the movements of heavy vehicles and unauthorised shops and settlements coming up around the industrial complex.
- Spillage of chemicals/substances on roads inside the plant may lead to accidents. Proper road safety signs both inside and outside the plant should be displayed for avoiding road accidents.

10. Recovery - reuse of waste products

- Efforts should be made to recycle or recover the waste materials to the extent possible. The treated liquid effluents can be conveniently and safely used for irrigation of lands, plants and fields for growing non-edible crops.

11. Vegetal Cover

- Industries should plant trees and ensure vegetal cover in their premises. This is particularly advisable for those industries having more than 10 acres of land.

12. Disaster Planning

- Proper disaster planning should be done to meet any emergency situation arising due to fire,explosion,sudden leakage of gas etc. Firefighting equipment and other safety appliances should be kept ready for use during disaster/emergency situation including natural calamities like earthquake/flood.

13. Environment Management Cell

- Each industry should identify within its setup a Department/Section/Cell with trained personnel to take up the model responsibility of environmental management as required for planning and implementation of the projects.

EIA

An environmental impact assessment (EIA) is an assessment of the possible positive or negative impact that a proposed project may have on the environment, considering natural, social and economic aspects.

Objective of EIA

- To identify, predict and evaluate the economic, environmental and social impact of development activities
- To provide information on the environmental consequences for decision making
- To promote environmentally sound and sustainable development through the identification of appropriate alternatives and mitigation measures.

EIA is widely accepted as a tool to ensure sustained development with minimum environmental degradation.

EIA has main three functions:

- To predict the environmental problems
- To find ways to avoid them
- To enhance positive effects

The main benefits and advantages of EIA are:

- Lower project costs in the long-term
- Increased project acceptance
- Improved project design
- Informed decision making
- Environmentally sensitive decisions
- Increased accountability and transparency
- Reduced environmental damage
- Improved integration of projects into their environmental and social settings

Which type of projects under go EIA?

- Agriculture
- Construction (Road networks, Malls, Townships, Dam etc)
- Industries
- Electrical projects
- Waste disposal
- Any developmental projects around Protected Areas / Nature Preserves
- Clean Development Mechanism CDM projects

Purpose of EIA

- To conserve the resources
- To minimise the waste
- To recover the by product
- To utilize the equipment efficiently

Importance of EIA:

- EIA is potentially a useful component of good environmental management.
- It is the Government policy that any industrial project has to obtain EIA clearance from the Ministry of Environment before approval by the planning commission.

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Benefits of EIA

- Facilitates informed decision making by providing clear, well-structured dispassionate analysis of the effect and consequences of proposed projects.
- Pre-emption or early withdrawal of unsound proposals.
- Assists in the selection of alternatives, including the selection of the best practicable and most environmentally friendly option.
- Results in best practice prediction and mitigation of adverse effects of projects.

- Influences both project selection and design by screening out environmentally unsound projects, as well as modifying feasible projects - Mitigation of negative environmental and social impacts.
- Guides formal approval, including the establishment of terms and conditions of project implementation and follow- up.
- Mitigation of negative environmental and social impacts.
- Serves as an adaptive, organizational learning process, in which the lessons of experience are feedback into policy, institutional and project design - Enhancement of positive aspects

Limitations of EIA

• EIA should be undertaken at the policy and planning level rather than at the project level.

• Range of Possible alternatives in the project EIA is often small.

• There is no criteria to decide what type of project are to undergo EIA. A lot of unnecessary expense and delay in project clearance could be avoided as there are many projects that do not require an in-depth EIA.

• Lack of comprehensive environment information base, limitation of time, manpower and financial resources make EIA very complicated and time consuming.

• More research and development of improved methodologies is required to overcome limitations relating to the uncertainties in data.

• EIA, reports are too academic, bureaucratic and lengthy containing too many tables of collected data without any data analysis, interpretation and environmental implications.

• In actual practice EIA ends immediately after project clearance, no follow up action is taken.

• It does not incorporate the strategies of preventing environmental intervention. The issue of resource conservation, waste minimization, by product recovery and improvement in efficiency of equipment, need to be pursued as the explicit goal in EIA.

EIA Clearance required Total EIA clearance is required for 32 categories of developmental works broadly categorized into following industrial sectors:

- Mining
- Thermal power plant

- River valley
- Infrastructure (Road, highway, ports, harbour, airports,
- Industries including very small electroplating or foundry units

Guiding Principles:

The entire process of EIA is governed by eight guiding principles**.**

1. Participation:

An appropriate and timely access to the process for all interested parties.

2. Transparency:

All assessment decisions and their basis should be open and accessible.

3. Certainty:

The process and timing of the assessment should be agreed by all participants in advance.

4. Accountability:

The decision makers of all parties are responsible for their action and decisions under the assessment process.

5. Credibility:

Assessment is undertaken with professionalism and objectivity.

6. Cost effectiveness:

The assessment process and its outcomes will ensure environmental protection at the least cost to the society.

7. Flexibility:

The assessment process should be able to deal efficiently with any proposal and decision making situation.

8. Practicality:

The information and outputs provided by the assessment process are readily usable in decision making and planning.

Participants in EIA Process:

1. Proponent:

Government or Private Agency which initiates the project.

2. Decision maker:

Designated individual or group.

3. Assessor:

Agency responsible for the preparation of EIS.

4. Reviewer:

Individual/Agency/Board.

5. Expert advisers, Media and Public, Environmental organisations etc.

ENVIRONMENTAL IMPACT STATEMENT (EIS)

EIS should contain the following information's/data:

1. Description of proposed action (construction, operation and shut down phase) and selection of alternatives to the proposed action.

2. Nature and magnitude of the likely environmental effects.

3. Possibility of earthquakes and cyclones.

4. Possible effects on surface and ground water quality, soil and air quality.

5. Effects on vegetation, wild life and endangered species.

6. Economic and demographic factors.

7. Identification of relevant human concerns.

8. Noise pollution. Efficient use of inputs.

9. Recycling and reduction of waste.

10. Risk analysis and disaster management.

The EIA Directive

The EIA Directive requires projects likely to have significant effects on the Environment by virtue of their nature, size or location to undergo an environmental assessment before the competent authority in question grants consent. The EIA Directive defines a project as the execution of construction works or of other installations or schemes, other interventions in the natural surroundings and landscape including those involving the extraction of mineral resources. The EIA should **identify**, **describe** and **assess** the **direct** and **indirect** effects of a project on the following factors:

- ✓ Human beings
- ✓ Fauna and flora
- ✓ Soil, Water & Air
- ✓ Climate and the landscape
- ✓ Material Assets

- ✓ Cultural Heritage
- ✓ Interaction between all above factors

EIA therefore should have a very strong social dimensions

CASE STUDIES OF EIA

Case Study 1 : Thermal Power Plant , Karnataka

Summary of project

Karnataka Power Corporation Limited (KPCL) has proposed to set up thermal power plant with capacity of 1 x 500 MW in the first stage at the proposed Vijayanagar Thermal Power Station located at 2.5 kms from Kudatini village, Bellary district. The proposed project covers an area of 1963.5 sq.km and includes Bellary and Chitradurga districts of Karnataka and Anantapur district of Andhra Pradesh.

Social and Environmental Features of the study area

The study area covers 25-km radius around the project site. The following sections describe the existing social and environmental setting within the project area.

Topography

The proposed project area is a flat terrain, located within Kudatini village of Bellary District and surrounded hill ranges on South, North and West sides. Tungabhadra is the major river of Bellary district, flows from southwest to the north east of the proposed project.

Forest and Wild animals

Forests in the area can be divided into two main categories: dry deciduous and scrub forests. No noticeable wild animals are available in the project area.

Climate and Rainfall

The coldest months in the project area is November to the end of February. The maximum temperature 37.50C and the lowest mean temperature of 22.6 0c in the month of December. The average rainfall in the area ranges from 492 mm to 846 mm.

Population Density

The maximum population density has been recorded at Hospet Taluk of 163.20 persons per sq. km.

Sex Ratio

The male dominates the female population and for 1000 males the number of females varies from 952 to 975.

Literacy

The maximum average literacy rate of 36.62% but it varies from 26 to 27%.

Infrastructure and other services facilities

- There are 8 government hospitals, 18 private hospital, 42 nursing homes and 24 health centers.
- Transport facilities and communication services of provided by the States have served byboth road and rail transport.
- Drinking water sources constitute wells; bore wells and water supply schemes.
- Backwardness, low agricultural output, lack of industrialization and irrigation facilities has worsened the economy of the project area.

EIA Study Results

- There will be marked increase in dust and NOX level during construction phase of project.
- During the construction phase the increase in Noise level is 80- 85 dB (A) due to the erection, construction and commissioning of equipments. During the operational phase the increase in the sound levels is mainly due to boilers, compressors, and turbines etc.
- The sources of water pollution are, ash pond, leaching from coal yard, and boiler blow down, and oil/water mixture from fuel oil system, sewage disposal and effluent treatment plant.
- Solid waste management issues during the construction and operational phase

Impact mitigation measures

- By properly implementing the environmental management plan, most of the impacts can be mitigated.
- Following mitigation measures adopted:

Management during construction phase

Following are the briefs measures suggested by EMP for the proposed project:

- Frequent water sprinkling in the vicinity of the construction activity to control the dust emission,
- Paving the exposed surface to control dust and erosion
- Plantation of bare and exposed area and development of green belts
- Adopt noise control devices, storing of fuels in safe place and dumping of debris and waste in proper sanitary landfill site

Management during the operational phase:

The measures to be taken during the operational phase of the plant are as follows:

Air pollution and proposed control measures

- Green belt will be provided around the project area and along the internal roads in the premises.

- On-line monitoring of stack emissions for SPM, SO2 and NOx should be carried out regularly to meet the statuary requirements.

Water pollution and proposed control measures

The pollution control measures are given below:

- Minimize quantity of effluents through reuse to maximum extent feasible.
- The cooling water chlorination will be carried out to the bare minimum requirement in order to have minimum impact on the receiving bodies.
- The effluent samples will be collected and analyzed at the inlet and the outlet daily to ascertain the efficiency of the treatment plants and to meet the statuary requirements.

Noise Pollution and Proposed Control Measures:

- All the equipment in the power plant will be designed to have a total noise level not exceeding 85-90 dB (A)
- Turbines will be housed in closed buildings, which will reduce the noise levels from the turbine generators.
- Vibration damping will be provided to reduce vibrations.
- Use of damping materials such as thin rubber / lead sheet for wrapping the work places like the turbine halls, compressor rooms, DG sets etc.
- Earplugs will be provided to the workers, and it should be enforced to be used by the workers.
- vegetated thickly with species of rich canopy in addition to green belt development.

Solid Waste pollution and Proposed Control Measures:

- Ash Disposal Plan will be prepared
- An attempt will be made to use fly ash for construction purposes.
- To sell fly ash to other consumers at a nominal price or free of cost.

Socio-economic Environment

Before taking up of the project, the local population will be educated and made to appreciate the implications of the setting of the project.

- The management will adopt nearby villages and undertake development activities to improve the standards of their Living.
- Dispensaries, schools, transport facilities, roads, streetlight, water supply etc., will be made available in these villages.
- Setting up of ancillary units and self-employment schemes should be encouraged.

Conclusions

- The impact identified by the case study can be properly mitigated by implementing the Environmental management plan.
- Ensure the implementation of EMP through post project monitoring

6.8 CASE STUDY OF EIA

The **Environment Impact Assessment** (EIA) reported on the **Narmada Sagar Project (NSP)** one of the largest dams in the Narmada Valley development project to be located in the Khandwa district of Madhya Pradesh, claimed that the project will wipe out many species of flora (plants) and fauna (animals).

The EIA reported that 31 species with considerable ethnobotonical value will face **extinction** because of habitat changes in the submergence zone and also in the adjacent residential forests. The report also pointed out that many of the species which face submergence cannot be compensated in the residual forest areas either in terms of quantity (or) quality.

The report claimed that high quality wildlife habitat of 420 sq.km will be lost due to the NSP dam and related constructions like hydroelectric generation units and canals. In some areas, animals like chital, sambar and nilgai will be further threatened by near absence of corridors between submergence zone and refuge areas in peripheral forests. Among aquatic lines, otters and turtles will be lost because of unsuitable refuge habitat and their inability to migrate.

There will be a great loss to bird species. The fish varieties will also decline due to inundation of natural water bodies.

The EIA report also pointed out that there will be inadequate rehabilitation of the villagers and it is impossible to compensate for the natural resources lost. The report has also recommended the following three protected areas in the residual forests.

1. The Naramada National Park
2. The Surmanya Sanctuary
3. Omkareshwar Sanctuary

The above three protected area covers 759 sq km of compact and rich wildlife habitat with low human pressure.

EIA of Silent Valley Hydel project

The silent valley hydroelectric project was proposed by Kerala government to utilize the water of Kunthipuzha to generate power. The Kerala State Electricity board justified that successful completion of the project would stabilize the voltage fluctuation in the region and cause for the development of this backward area. Also, the water could be used in the downstream areas for irrigation purpose.

But EIA has given the following reports.

1. Silent Valley is the habitat of many endangered species of plants and animals.
2. If a portion of forest is destroyed by submersion, then all the threatened plant and animal species are likely to be affected.
3. After jungle clearance and deforestation, the top soil will be washed away in a single monsoon resulting in the land degradation -ie making land unfit for future productive exploitation.
4. In the silent valley, the natural vegetation provides habitat for many wild life species. But, when this area is submerged due to this project, it would lead to the destruction of nesting sites of the various species of birds and destruction of spawning grounds of important fish species. This makes the wild animals to come out of forests into the fringes to raid the crops and cattle-lifting in the villages around the forests.

Many environmentalists noted that the alternate path ways available immediately for providing power, irrigation and jobs at no ecological risks will help to achieve the desired goals more speedily and economically.

The EIA had given a report that the project was **neither essential nor unavoidable**. It also stated that no safeguards could possibly protect the ecological balance of the Silent Valley Ecosystem. It is better to implement such projects in ecologically less valuable areas. The EIA has helped to achieve harmony between the 'present needs' and 'future generations' needs to achieve sustainable development. It has avoided the destruction of biological wealth of inestimatable value.