



# ENVIRONMENTAL IMPACT ASSESSMENT

Civil Engineering (Professional Elective-V) &  
(Open Elective-III)  
B.Tech (R18) (JNTU-Hyderabad)

## CONTENTS

### Introduction to the Subject

### Syllabus as per R18 Curriculum

<b>MID - I &amp; II (Objective Type &amp; Essay Questions with Key)</b>	<b>M.1 - M.18</b>
<b>Exam Question Papers with Solutions (Latest to Previous)</b>	<b>QP.1 - QP.4</b>
<b>Model Question Papers with Solutions (As per the New External Exam Pattern)</b>	
Model Paper-I	MP.1 - MP.2
Model Paper-II	MP.3 - MP.4
Model Paper-III	MP.5 - MP.6
<b>Guess Papers with Solutions</b>	<b>GP.1 - GP.4</b>

### UNIT-WISE SHORT & ESSAY QUESTIONS WITH SOLUTIONS

Unit No. Topic No.	Unit Name Topic Name	Question Nos.	Page Nos.
<b>UNIT - I</b>	<b>INTRODUCTION</b>	<b>Q1 - Q48</b>	<b>1 - 28</b>
<b>Part-A</b>	<b>SHORT QUESTIONS WITH SOLUTIONS</b>	<b>Q1 - Q9</b>	<b>2 - 4</b>
<b>Part-B</b>	<b>ESSAY QUESTIONS WITH SOLUTIONS</b>	<b>Q10 - Q48</b>	<b>5 - 28</b>
1.1	Need for EIA, Indian Policies Requiring EIA	Q10 - Q16	5
1.2	The EIA Cycle and Procedures, Screening, Scoping, Baseline Data, Impact Prediction, Assessment of Alternatives, Delineation of Mitigation Measure and EIA Report, Public Hearing, Decision Making, Monitoring The Clearance Conditions		
		<b>Q17 - Q36</b>	<b>8</b>

1.3	Components of EIA Roles in the EIA Process	Q37 - Q39	16
1.4	Government of India, Ministry of Environment and Forest Notification (2000)	Q40	17
1.5	List of Projects Requiring Environmental Clearance	Q41 - Q42	17
1.6	Application Form	Q43	18
1.7	Composition of Expert Committee	Q44	24
1.8	Ecological Sensitive Places	Q45 - Q47	25
1.9	International Agreements	Q48	27

#### FREQUENTLY ASKED AND IMPORTANT QUESTIONS

UNIT - II	EIA METHODOLOGIES	Q1 - Q56	29 - 64
Part-A	SHORT QUESTIONS WITH SOLUTIONS	Q1 - Q9	30 - 31
Part-B	ESSAY QUESTIONS WITH SOLUTIONS	Q10 - Q56	32 - 63
2.1	Environmental Attributes	Q10 - Q13	32
2.2	Criteria for the Selection of EIA Methodology Impact Identification, Impact Measurement, Impact Interpretation, and Evaluation, Impact Communication	Q14 - Q16	35
2.3	Methods – Adhoc Methods, Checklists Methods, Matrices Methods, Network Methods, Overlays Methods	Q17 - Q39	37
2.4	EIA Review – Baseline Conditions, Construction Stage Impacts, Post Project Impacts	Q40 - Q56	50

#### FREQUENTLY ASKED AND IMPORTANT QUESTIONS

UNIT - III	ENVIRONMENTAL MANAGEMENT PLAN	Q1 - Q63	65 - 104
Part-A	SHORT QUESTIONS WITH SOLUTIONS	Q1 - Q20	66 - 70
Part-B	ESSAY QUESTIONS WITH SOLUTIONS	Q21 - Q63	71 - 102
3.1	EMP Preparation, Monitoring Environmental Management Plan	Q21 - Q25	71
3.2	Identification of Significant or Unacceptable Impacts Requiring Mitigation	Q26 - Q50	75
3.3	Mitigation Plans and Relief and Rehabilitation, Stipulating the Conditions	Q51 - Q54	96
3.4	Monitoring Methods, Pre-Appraisal and Appraisal	Q55 - Q63	99

#### FREQUENTLY ASKED AND IMPORTANT QUESTIONS

<b>UNIT - IV ENVIRONMENTAL LEGISLATION AND LIFE CYCLE ASSESSMENT</b>		<b>Q1 - Q34</b>	<b>105 - 124</b>
<b>Part-A</b>	<b>SHORT QUESTIONS WITH SOLUTIONS</b>	<b>Q1 - Q13</b>	<b>106 - 107</b>
<b>Part-B</b>	<b>ESSAY QUESTIONS WITH SOLUTIONS</b>	<b>Q14 - Q34</b>	<b>108 - 123</b>
<b>4.1</b>	Environmental Laws and Protection Acts.	Q14	<b>108</b>
<b>4.2</b>	Constitutional Provisions – Powers and Functions of Central and State Government	Q15	<b>109</b>
<b>4.3</b>	The Environment Protection Act 1986	Q16	<b>110</b>
<b>4.4</b>	The Water Act, 1974	Q17	<b>111</b>
<b>4.5</b>	The Air Act, 1981	Q18	<b>112</b>
<b>4.6</b>	Wild Life Act, 1972	Q19	<b>113</b>
<b>4.7</b>	Guidelines for Control of Noise	Q20 - Q21	<b>115</b>
<b>4.8</b>	Loss of Biodiversity	Q22 - Q23	<b>116</b>
<b>4.9</b>	Solid and Hazardous Waste Management Rules	Q24 - Q31	<b>118</b>
<b>4.10</b>	Life Cycle Assessment: Life Cycle Analysis, Methodology, Management, Flow of Materials – Cost Criteria – Case Studies	Q32 - Q34	<b>121</b>
<b>FREQUENTLY ASKED AND IMPORTANT QUESTIONS</b>			<b>124</b>

<b>UNIT - V CASE STUDIES</b>		<b>Q1 - Q23</b>	<b>125 - 150</b>
<b>Part-A</b>	<b>SHORT QUESTIONS WITH SOLUTIONS</b>	<b>Q1 - Q6</b>	<b>126 - 127</b>
<b>Part-B</b>	<b>ESSAY QUESTIONS WITH SOLUTIONS</b>	<b>Q7 - Q23</b>	<b>128 - 149</b>
<b>5.1</b>	Preparation of EIA for Developmental Projects – Factors to be Considered in Making Assessment Decisions	Q7 - Q8	<b>128</b>
<b>5.2</b>	Water Resources Project, Pharmaceutical Industry, Thermal Plant, Nuclear Fuel Complex, Highway Project	Q9 - Q20	<b>128</b>
<b>5.3</b>	Sewage Treatment Plant	Q21	<b>142</b>
<b>5.4</b>	Municipal Solid Waste Processing Plant	Q22	<b>147</b>
<b>5.5</b>	Air Ports	Q23	<b>148</b>
<b>FREQUENTLY ASKED AND IMPORTANT QUESTIONS</b>			<b>150</b>

# UNIT

1

## Introduction



### Syllabus

**Introduction -** The Need for EIA, Indian Policies Requiring EIA, The EIA Cycle and Procedures, Screening, Scoping, Baseline Data, Impact Prediction, Assessment of Alternatives, Delineation of Mitigation Measure and EIA Report, Public Hearing, Decision Making, Monitoring the Clearance Conditions, Components of EIA, Roles in the EIA Process, Government of India Ministry of Environment and Forest Notification (2000), List of Projects Requiring Environmental Clearance, Application Form, Composition of Expert Committee, Ecological Sensitive Places, International Agreements.

### LEARNING OBJECTIVES

In this unit, you will learn the following concepts,

- ✓ Understand the concept and importance of EIA
- ✓ Familiarize with Indian policies needing EIA.
- ✓ Know the major key points in EIA process
- ✓ Identify the components in EIA
- ✓ Analyze the roles in EIA process
- ✓ Identify the projects that need clearance from the central government
- ✓ Design of the application form for applying for environmental clearance
- ✓ Learn about the composition of expert committee for EIA
- ✓ Characterize the ecologically sensitive places
- ✓ Information of the multilateral environment agreements for EIA.

### INTRODUCTION

This unit provides a broad overview of the assessment of impact of any developmental activity on the environment, which is popularly known as Environmental Impact Assessment. It focuses on the environmental factors along with the economic or social factors while considering the planning applications of a proposed project. The readers are guided through the steps to conducting an EIA: Screening, Scoping, Baseline Data, Impact Prediction, Assessment of Alternatives, Mitigation, EIA Report, Public Hearing, Decision Making, and Monitoring.

It also includes the components and role in the EIA, the notification issued by the Government of India, projects needing environment clearance, the application format for applying for EIA along with the international agreements related to EIA in India.

## PART-A SHORT QUESTIONS WITH SOLUTIONS

**Q1. What is EIA? Explain the features of EIA.**

Model Paper-I, Q1(a)

**Answer :**

### Environmental Impact Assessment

Environmental Impact Assessment, generally referred as EIA, is a study undertaken to assess the adverse impact on the local environment by any proposed policy, program or development project. The procedure lays strong emphasis on environmental factors along with economic or social factors while considering the planning applications of a proposed project.

The phrase Environmental Impact Assessment has been borrowed from Section 102(2) of the National Environmental Policy Act (NEPA), 1969, USA. In India, the environment was given serious thought with the active involvement of late Smt. Indira Gandhi in the U.N Conference on Human Environment in Stockholm in 1972. A National Committee on Environmental Planning and Coordination (NCEPC) was set up in the Department of Science and Technology. The Tiwari Committee (committee on review of legislative measures and administrative measures) has proposed the formation of a Department of Environment aimed at environmental protection, to carry out environmental impact assessment of proposed development projects and to have authority for pollution monitoring and control. The Ministry of Science and Technology included the subjects of wildlife and forestry with the Prime Minister holding its charge.

### Features of EIA

The salient features of EIA are as follows.

1. To identify both the positive and negative impacts of any project on the environment. The assessment is done for both short and long periods.
2. To plan the project in such a way that the negative impacts of the project on the environment are reduced to a considerable extent. The reduction of negative impact may be done either by considering an alternative project or by modifying the proposed project.
3. To check the implementation of a planned project and its effectiveness using a monitoring programme.

**Q2. Discuss objectives, merits and demerits of EIA.**

**Answer :**

The main goal of EIA is to identify, predict and to quantify or qualify the changes in the environmental parameters like air pollution, water pollution, noise pollution or the biodiversity, owing to construction activity related to the project.

Model Paper-II, Q1(a)

### Merits of EIA

1. The merits of EIA for the proposed developmental activity are, It contains the details of the developmental project, including the details of the physical features, the land use requirements, the nature, type and quantity of materials used for construction and operation, the type, nature and quantity of discharges (air, water, soil, noise pollution etc) during the developmental phases. Thus, the predicted adverse environmental and social impacts of the proposed project is specified.
2. The specific reasons for choosing such a project along with consideration of the environmental effects.
3. It gives an idea about the mitigation measures of the predicted environmental impacts.

### Demerits of EIA

- (a) **Scale**  
Several small projects accomplished in a short time or geographically concentrated are never considered in the study of environmental impact assessment.
- (b) **Time**  
When the EIA is applied on short projects, the changes in the environment are brought about after many years and decades which threaten our civilization. Moreover, EIA is only an aid to the decision-making process. However, the incompatible objectives of several groups can politicize the decision-making process.
- (c) **Scope**  
The scope of activities subject to EIA are limited. The EIAs look into the effect of manufacturing industries on the surroundings and propose alternative location or mitigation measures for any problem. But the environmental soundness is never taken into consideration.
- (d) **Methodology**  
Most of the countries across the globe face major problems with public participation and access of information to the public. Therefore, country-specific or region-specific methodologies and guidelines must be developed based on the local needs, conditions and constraints.

**Q3. Enumerate the limitations of EIA.****Answer :**

Environmental Impact Assessment (EIA) involves an investigation of the effects on the environment arising from a major activity (policy, plan or project). Such a study proposal means to mitigate or reduce the significant impacts on the environment. In this process, the effects of projects undertaken are analyzed first, the effects are recorded in a report, followed by consulting experts on the report and then making a final decision based on the experts comments and informing the public about the decision. All these activities contribute to sustainable development of the environment.

The study of environmental impact assessment should include a significant amount of primary and secondary environmental data. The primary data includes the data collected in the field regarding the status of the environment (like air quality, water quality etc.). The secondary data includes the data collected over the years, which can be used to understand the existing environmental scenario.

EIA has revealed a number of limitations as described below.

For answer refer Unit-I, Q2, Topic: Demerits of EIA.

**Q4. What are the factors affecting EIA evaluation and analysis?****Answer :****Model Paper-I, Q1(b)**

The other additional factors affecting EIA evaluation and analysis are,

- Population density.
- Extent of the developmental activity.
- Relocation/displacement of inhabitants of the area.
- Resource availability.
- Environmental resilience.
- Sustainability of the environment.
- Absorptive capacity of the environment.

The proposed developmental activity must have minimal negative impact on the environment, and deliver positive, social, environmental and economic outcomes and thus contribute to a healthy and resilient ecological system.

**Q5. Describe possible changes in the environment by various project activities.****Answer :**

The possible changes in the environment by various project activities are

- Changes in the land use.
- Encouragement into nature reserves.
- Loss of vegetation, as trees are chopped down to make way for the construction activity.
- Negative effect on the historical/cultural monuments.
- Complications due to resettlement and rehabilitation of people.
- Water pollution arising from improper disposal of construction waste.
- Soil contamination from accidental leakage and spillage of oil or fuel.
- Noise pollution from various equipment.
- Threats to local biodiversity.
- Pollution of the environment.

**Q6. What is inventory in EIA?****Answer :****Model Paper-II, Q1(b)**

Environmental inventory is a compilation of environmental parameters that include physical, chemical, biological, cultural, social and economical of a proposed area of action. It contains checklist of:

- Air environment
- Water environment
- Soil environment
- Biological environment
- Cultural environment
- Social and economical environment.

**4**

It also includes health impacts and also psychological impacts. Environmental inventory is necessary to study the potential impacts on the environment and it is the initial step in the environmental impact assessment process.

Environmental inventory is usually prepared in the range of 10 km radius of the proposed area. It helps to identify the habitat and possible rehabilitation of the environment.

**Q7. Write short notes on**

- (i) Direct impacts
- (ii) Indirect impacts

**Model Paper-III, Q1(a)****Answer :**

The direct impact of a developmental activity refers to the direct effect caused by the proposed action to the environment. For example, discharge of effluents by the Effluent Treatment Plant (ETP) from an industrial setup into the nearby water bodies may affect the water quality in terms of high concentration of toxic chemicals in water, high biological oxygen demand (BOD) or high dissolved oxygen.

The indirect impact of a developmental activity refers to the indirect effect caused by the proposed action to the environment. For example, the increased sediments in water bodies and loss of aquatic life caused by increased soil erosion due to devegetation.

**Q8. How is environmental inventory prepared and what is its role in baseline data acquisition?****Answer :**

Environment inventory is prepared by studying environmental parameters in the 10 km range of the proposed area. It is a review of existing status of the environmental parameters by collecting the data that is prepared by monitoring primary and secondary sources. This helps in baseline data acquisition to prepare Environmental Impact Statement.

**Q9. What is the importance of public hearing?****Answer :****Model Paper-III, Q1(b)**

Public hearing is a formal meeting conducted by the proponents of a developmental project and involves the general public to comment or give feedback on the proposal. Such meetings are an opportunity for the public to voice their opinions on the proposed projects.

The main objectives of such meetings are,

- (i) To discuss the various issues of the project.
- (ii) To provide/get clarifications regarding the project.
- (iii) To collect information about various issues.
- (iv) To include new members in the discussion.
- (v) To find solutions to the impending problems.
- (vi) To increase public awareness about the ongoing issues in the project.

## **PART-B ESSAY QUESTIONS WITH SOLUTIONS**

### **J.1 NEED FOR EIA, INDIAN POLICIES REQUIRING EIA**

**Q10. What is environmental impact assessment and its importance?**

**Answer :**

For answer refer Unit-1, Q1.

Model Paper-II, Q2(a) | July-21, (R16), Q8(b)

Environmental impact assessment, a study undertaken to assess the adverse impact on the local environment as a consequence of human intervention through proposed public and private developmental activities such as projects and programs, lays strong emphasis on the environmental factors.

EIA is very important for approving a project for the following reasons:

1. Protection, conservation and preservation of the environment and its resources.
2. Proper land and water management for a sustainable environment.
3. Preserving the ecological heritage for our future generations.
4. Promoting eco-friendly technologies.

**Q11. Discuss about the need of EIA for engineering projects.**

**Answer :**

The EIA for engineering projects is important for the following reasons,

- (i) To protect, conserve and preserve the environment and its resources.
- (ii) For proper land and water management for a sustainable environment.
- (iii) To preserve the ecological heritage for our future generations.
- (iv) To promote ecofriendly technologies.
- (v) To take strategic measures for afforestation of denuded waste lands.
- (vi) To help the government at local, state and national level to frame laws for environmental conservation.

**Q12. Enumerate the purpose of draft environmental impact notification, 2020.**

**Answer :**

The Ministry of Environment, Forest and Climate Change (MoEF & CC), Government of India, on March 23rd 2020, recommended the Draft Environmental Impact Assessment notification, 2020. The new draft was meant to replace the existing EIA notification, 2006.

The central government has emphasized the need for the new draft because the 2006 EIA Notification has undergone several modifications for nearly 55 times and 230 office memorandums (OMs) have been issued, which has caused a lot of confusion.

The main purpose of the draft EIA Notification is to include all the progressive amendments in the 2006 notification.

The major proposal of the Draft 2020 are,

**(i) Categorization of Projects**

All projects are broadly divided into three categories, namely A, B1 and B2.

Category A projects are appraised at the National level by Impact Assessment Agency (IAA) and the Expert Appraisal Committee (EAC). Projects belonging to category B are appraised at the state level. Category B projects are further divided into B1 (mandatorily requiring EIA) and B2 (not requiring EIA).

The projects considered in category B2 include offshore and onshore oil, gas and shale exploration, hydroelectric projects upto 25 MW, irrigation projects between 2,000 and 10,000 hectares of command area, all inland waterway projects, expansion or widening of highways between 25 km and 100 km with defined parameters, and specified building construction and area development projects.

**(ii) Reduced Time Period to Stakeholders for Public Hearing**

The interested stakeholders involved in the project include individuals, communities, recreational interest groups, expert groups, business affiliations, academic organizations, government agencies, private organizations and non-governmental organizations. These groups of people are given 30 days time to raise issues related to the preliminary report of the assessment.

The new draft strives to reduce the period to just 20 days.

(iii) **Post-Clearance Compliance**

Following the approval of the proposed project by the concerned authorities, the project proponents must uphold/follow the rules laid down in the EIA report to avoid causing harm to the environment.

(iv) **Submission of Annual Report**

According to the new draft EIA, the compliance report of the project must be submitted annually instead of every six months.

(v) **Exclusion of Public Reporting for Non-Compliance**

The EIA Notification 2020 does not include the reports about violations and non-compliance by the public.

(vi) **Post-Facto Clearance**

"Post facto clearance" is granted where a "project that has been operating without environmental clearance, can be regularized or allowed to apply for clearance".

(vii) **Penalty for Firms**

Project found violating the terms and conditions would be penalized suitably.

**Contentious Issues Associated with EIA Notification 2020**(i) **Ex Post Facto Environmental Clearance**

According to this rule, any industry violating the environment (protection) act can apply for clearance. The environmentalists are of the view that the non-compliant industries would continue with their operations and get established by paying the penalty amount.

(ii) **Empowers the Central Government but Weakens the Public**

The draft offers to strengthen the central government to declare certain projects as strategic and restrict the involvement of the public in protecting the environment.

(iii) **Easy Clearance for Strategic Projects**

The strategic projects are mostly related to national defence and security. However, the EIA Notification 2020 enables the government to decide on the strategic tag for other projects.

(iv) **Reduced Notice Period for Public Hearing Means Reduced Awareness**

Since the notice period for public hearing has been reduced from 30 days to 20 days, it would be hard to analyze the draft EIA report due to its non-availability in the regional language.

(v) **Non-Compliance to International Environmental Instruments**

India is a party to the United Nations (UN) conference on Human, Environment and Development in Stockholm in 1972, the Rio Summit in 1992, the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Climate Accord.

Being committed to such international frameworks and conventions and on the contrary undermining the EIA regime at the domestic level would weaken India's position as a world leader in environmental governance and climate politics.

**Answer :**

Environmental impacts may be broadly classified into three different ways:

**Positive (Beneficial) or Negative (Adverse) Impacts**

When a proposed project brings physical benefits to the environment, then it is said to have a positive impact, for example, afforestation projects and coastal management projects. And when the new developments produce harmful wastes, it is referred to as having a negative environmental impact. For instance, construction of a mass rapid transport system has some negative impacts on the environment like change of land-use, loss of trees forest, utility/drainage problems and loss of historical and cultural monuments.

Tourism activities have both beneficial and adverse effects on the environment. The impacts from construction of infrastructure facilities like roads, airports, resorts, hotels, restaurants, shops, can have positive impacts by raising awareness of environmental values and serve as a medium to finance protection of natural areas and increase their economic importance. Uncontrolled tourism can lead to adverse effects like soil erosion, increased pollution (air, noise, solid waste and littering sewage, oil and chemicals, architectural/visual pollution) discharges into the sea, natural habitat loss, extinction of species, depletion of water resources etc.

**Temporary (Short-Term) or Permanent (Long Lasting) Impacts**

The construction of a multistorey complex in a prime location has short-term construction related impacts and long-term unavoidable impacts on the local environment. The short-term or temporary impacts are the construction, traffic, noise, dust, disruption of vehicle and pedestrian traffic. The long-lasting or permanent impacts are the consumption of energy resources, generation of waste, increase in impervious surface leading to increased stormwater runoff.

**Reversible or Irreversible Impacts**

Based on the severity of potential impact by any proposed project, the impact may be either reversible or irreversible. The impact of noise due to construction activities is reversible. The harm to the environment due to more infrastructural facilities like transport, trade, commerce and service sector is irreversible. Other examples are – large-scale industrial plants, large-scale land clearance and leveling, mineral development, port and harbour development, reclamation of new land development, thermal and hydropower development.

The other ways of categorization of environmental impacts are,

- ❖ Accidental impacts or planned impacts.
- ❖ Direct or primary impacts or indirect or secondary impacts.
- ❖ Cumulative impact or single impact.
- ❖ Constructional phase impact or operational phase impact.
- ❖ Reparable via management practices or irreparable.
- ❖ Local, regional, national or global impact.

#### **Q14. What are the positive and negative environmental impacts of the metro rail project activity?**

**Answer :**

##### **Positive Impacts**

The positive impacts of metro rail project activity are:

- (a) Reduced travel time for commuting from one place to the other.
- (b) Safe and comfortable mode of transportation.
- (c) Increased accessibility at workplace.
- (d) Decrease in congestion on roads.
- (e) Reduced fuel consumption, as it uses renewable sources of energy.
- (f) Reduced vehicular emissions, as people prefer to use metro rail.
- (g) Reduction in road accidents due to less congestion of roads.
- (h) Increase in employability or job/employment opportunities.

##### **Negative Impacts**

The negative impacts of metro rail project activity include:

- (a) Changes in the land use.
- (b) Encroachment into nature reserves.
- (c) Loss of vegetation, as trees are chopped down to make way for laying railway lines.
- (d) Negative effect on the historical/cultural monuments.
- (e) Complications due to resettlement and rehabilitation of people.
- (f) Diversion of traffic on the main arterial roads.
- (g) Health risks due to use of a large number of excavators and dumper trucks to transport the excavate (rock, sandy silt, mica, etc.,) to specific disposal sites.
- (h) Water pollution arising from improper disposal of construction waste.
- (i) Soil contamination from accidental leakage and spillage of oil or fuel.
- (j) Noise pollution from various equipment.

#### **Q15. Write about rapid EIA and comprehensive EIA studies, highlighting the difference between them.**

**Answer :**

Rapid EIA refers to the rapid/quick assessment of the potential impact on the various components of the environment, viz air, noise, water, land, biological parameters, due to the proposed developmental project.

##### **Example of Rapid EIA**

Displacement of a large population due to the construction of a multipurpose project, resulting in the disruption of the lifestyle and productive system of people.

Comprehensive EIA refers to the assessment of the potential impact on the various components of the environment for a long period of time.

##### **Example of Comprehensive EIA**

The Comprehensive Environmental Impact Assessment of Mumbai-Ahmedabad High Speed Railway Project depicts the following,

- (i) Permanent change in the local topography.
- (ii) Loss of vegetation, tree cover.
- (iii) Rise in sea-level in coastal regions.
- (iv) Greenhouse gas emissions.
- (v) Noise, air and water pollution.

#### **Q16. Discuss about cumulative and induced environmental impacts.**

**Answer :**

##### **Cumulative Environmental Impact**

The U.S. Council on Environmental Quality (CEQ) has defined cumulative impact as "the impact on the environment that results from the incremental impact of the action when added to other past, present and reasonably foreseeable future actions, regardless of which agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time".

In a simpler sense, cumulative impacts are the incremental or collective impacts on the environmental resources caused by the activities in the past, present and the foreseeable future. The Cumulative Impact Assessment provides an overview of the impact of proposed developmental activities on common resources.

##### **Induced Environmental Impact**

Induced Environmental Impact is said to be indirect impact/secondary impact on the environment, caused by implementation of any developmental activity. For instance:

- (i) Changes in the surface and groundwater quality and quantity
- (ii) Ambient air quality
- (iii) Ambient noise levels
- (iv) Impact on sensitive areas such as wetlands, wildlife habitats, etc.

**Examples****1. Proposed Action: Construction of Railway Line****Example of a Direct Impact**

Loss of natural habitat caused by laying of railway track.

**Example of an Indirect Impact**

Habitat loss caused by loss of natural habitat.

**Example of Cumulative Impact**

Habitat loss caused by various other commercial developmental activities in a region.

**2. Proposed Action: Construction of a Thermal Power Plant****Example of a Direct Impact**

Water contamination, as the water body receives the cooling water discharge from the power plant.

**Example of an Indirect Impact**

Water contamination affects aquatic life. The stress on certain aquatic life forms can cause death, resulting in a negative effect on the food chain and causing an entire ecosystem to fail.

**Example of Cumulative Impact**

Devegetation causes soil to be eroded into the water bodies. The muddy water thus formed, absorbs more sunlight, which raises the temperature of water. Aquatic plants, such as algae, thrive well in warmer water temperatures resulting in the growth of large amounts of algae and plants. The process of decomposition of plant material by bacteria uses a lot of oxygen. This can add to the stress on fish and other aquatic organisms, which might get killed.

## **I.2 THE EIA CYCLE AND PROCEDURES, SCREENING, SCOPING, BASELINE DATA, IMPACT PREDICTION, ASSESSMENT OF ALTERNATIVES, DELINEATION OF MITIGATION MEASURE AND EIA REPORT, PUBLIC HEARING, DECISION MAKING, MONITORING THE CLEARANCE CONDITIONS**

**Q17. What are the steps involved in the EIA process?****Answer :**

Model Paper-I, Q2(a) | July-21, (R16), Q1(b)

The complete EIA procedure can be divided into two corresponding functions,

**(a) Initial Environmental Examination (IEE)**

It is the first phase of the EIA process, carried out to review the potential impact (both positive and negative) on the environment caused by the proposed development project. It contains a brief information of the major environmental issues based on the readily available recorded information to be used in the decision-making process of project planning. The impacts of the project activities need to be analyzed and identify those which are worthy of a detailed study.

**(b) Detailed Environmental Impact Assessment**

It contains detailed information of the proposed project which is reported formally as Environmental Impact Assessment (EIS).

EIS is known by several names,

- Environmental impact assessment report
- Environmental impact statement
- Environmental statement
- Environmental assessment report
- Environmental effects statement.

A typical EIS should provide the following information,

**1. General Information about the Project**

This section contains the title of the project, name and address of project proponents, location of the project and the contact person.

**2. Project Description**

It contains the plan/design of the project.

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3. **Description of Existing Conditions of the Site**  
This section contains the description of physical, biological and socioeconomic conditions of the proposed site.
4. **Prediction of Impacts and Mitigation/Abatement Measures**  
It contains the likelihood of the occurrence of impact at various stages of the project development.
5. **Pictures of the Project Location**  
This section contains the photographs of the proposed project construction site.
6. **Environment Management Plan**  
Environmental management refers to management of all components of the biophysical environment, including the living (biotic) and the non-living (abiotic) factors. Environmental Management Plan (EMP) also called an impact management plan, is a part of EIA reporting. It explains the several mitigation and monitoring measures that needs specific action to be carried out by the proponent during project construction and operation for a sustainable environment.
7. **Environmental Monitoring Plan**  
Environmental monitoring plans involve paying close attention to monitoring and supervision of local conditions to assess the effectiveness of development interventions. The process involves discussions among project managers, government officials and researchers for accurate prediction of impacts or changes in the impact trends. It can even warn the project proponents of unexpected adverse impacts and the effectiveness of implemented mitigation measures.
8. **Abandonment Plan/Residual Impacts**  
This section gives an overview of any residual adverse environmental effects following the implementation of mitigation measures.
9. Accountability statement of preparer and proponent.
10. Attachments/other supporting documents.

**Q18. Write the difference between screening and scoping in EIA process.** July-21, (R16), Q1(a)

**OR**

**Write in brief the components of environmental impact assessment (EIA).**

**Answer :**

Model Paper-III, Q2(a)

The key components in the environmental impact assessment of a developmental activity include the following,

1. **Screening**  
Screening of development programs is usually done by an EIA authority/environmental consultant/government agency constituting a variety of experts as a multidisciplinary team like environmental science, engineers, ecologists, botanists, zoologists, agricultural scientists, economists and sociologists. This component is thus quick, easy to use and considered to be the best method of decision making.

2. **Scoping**  
This step recognizes the important issues of concern at a preliminary level of the planning process. It helps in site selection, possible technical options and avoid all kinds of delays that arise during the project. This step of the development process involves the developer, planning or environmental agencies, local communities and other stakeholders. In essence, the scoping process should be focused, comprehensive, flexible but systematic, as well as provide sufficient information to the public about the proposed project and understand the project and issues.
3. **Assessment**  
The assessment is based on data collection, field visits and consultations with stakeholders. The EIA authority or environmental consultants must record the construction, operation and maintenance plans of the proposed project and its impact on the ecological and socio-economic environment, suggest alternatives for site selection for development, solutions, techniques and their impacts.
4. **Alternatives**  
Alternatives are included in the EIA to identify and evaluate alternative actions that can be undertaken to achieve similar goals and promote sustainable development.  
Some of the features of alternatives in an EIA are,
  - (a) **Feasibility**  
The proposed alternatives should be economically feasible with least adverse environmental impacts.
  - (b) **Diverse**  
A proposed action must have diverse alternatives that include both design and sites/routes for development.
  - (c) **Scheduling**  
The proposed alternatives should be timely presented to encourage more environmentally sound and publicly acceptable solutions.
  - (d) **Involvement of Public**  
Public participation should be encouraged to integrate citizens into the environmental decision making process by arranging public meetings and hearings, open houses, networking, hotlines, responsive publication, surveys, forming advisory councils to generate new alternatives.
5. **Mitigation Measures**  
This step includes the modifications in the proposals to prevent, avoid or minimize the potential significant effects of a project. It may also include substitution of an alternative technology or give up certain aspects of the project. If the project appears to have an adverse impact on the environment, then the proposal should be rejected.

### 6. Environmental Impact Statement (EIS)

The findings of the environmental assessment are reported as Environmental Impact Statement (EIS). It is a comprehensive, clear and concise non-technical summary of the description of the project, including location, design, scale, size, mitigating measures and a more detailed section on the technical aspects of the assessment.

EIS should contain specific information describing the effect on the environment due to the proposed development along with the impact on humans, flora, fauna, soil, water, air, climate and cultural heritage.

### 7. Reviewing and Decision-making

This step begins when the working document of the proposed project reaches the decision-maker who will consider its implications for project implementation.

### 8. Continuous Monitoring

Continuous monitoring of the environmental impact by project implementation is essential especially during the construction and operation phases of a project. This component of EIA ensures effective environmental management and protection.

### Q19. Explain the purpose and the process of screening in EIA.

**Answer :**

Model Paper-II, Q2(b)

Screening is the initial step for conducting an EIA. It helps in the decision making process, whether to conduct the assessment or not to conduct it.

The process of conducting screening in EIA involves the preliminary determination of EIA requirements for a project prior to beginning the construction and operation. Thus, the expected impact of a proposed project on the environment is determined in this step. The responsibility of the screening step lies with the competent EIA authority. The process of screening has to be done at the earliest possible so that the project proponents and participants are aware of EIA formalities.

The following set of questions may be assessed as a part of the screening process :

- (i) Will the proposed project affect the surrounding environment?
- (ii) Will the effect stretch to a large area?
- (iii) The number of people affected by the project.
- (iv) The effect of the project on the flora, fauna, businesses and facilities.
- (v) The impact of the project on the valuable or scarce resources.
- (vi) Will the impact have a positive or adverse effect?
- (vii) Will the impact be temporary or permanent?
- (viii) Will the project have a reversible or irreversible effect?

The screening process can have one of the following consequences :

- (i) EIA is not needed.
- (ii) A comprehensive EIA is needed.
- (iii) A preliminary EIA is needed.
- (iv) An extended study needed to determine the level of EIA (referred as Initial Environmental Examination).

### Q20. What is a base map?

**Answer :**

Model Paper-I, Q2(b)

A base map is an aerial photograph, which simply means the photograph taken from air, with the help of an air-borne camera fitted to a light aircraft/helicopter/drones/microdrones. Such special survey aircraft consist of flight management systems with 2-3 technicians or specialists, aerial-metric camera, aerial film photogrammetric scanner, plotter, software, etc. The cameras used are film-based, single-lens frame cameras. The photogrammetric scanner enables the conversion of analog images into digital files and represented as pixels.

Environmental Base Map (EBM) is one of the important stages of a project development activity. It contains the plan and final design of the proposed construction in the form of schematic drawing. It also includes the basic information of the project site such as the environmental situation, population distribution (demographics), soil conditions, meteorology and air quality, topography, surface and groundwater hydrology, land quality, land use seismicity and ecological resources. It provides information on the existing status of the ecosystem potentially threatened by the developmental activities.

The Environmental Base Map is prepared by using computer aided AutoCAD Map 3D environment or the other powerful technologies such as Geographic Information System (GIS) software.

### Q21. What is impact prediction?

**Answer :**

#### Impact Prediction

The quantification of anticipated impacts of a proposed project on different environmental factors is known as impact prediction.

The accurate impact prediction is not easy because of the dynamic and complex nature of various ecosystems.

The prediction of impacts is usually ascertained by case studies as examples or analogies studies, related to quantitative mathematical models, statistical models, pilot models and experiments.

The potential environmental impacts, during the construction and operation of the project, can be broadly categorized into the following types,

**(a) Primary Impact**

Such as release of air pollutants, release of heat, changes in the ambient noise levels.

**(b) Secondary Impact**

Such as changes in the air quality, impact on visibility, deposition of particulates on water and land, climate change.

**(c) Tertiary Impact**

Such as impact on human health, impact on aesthetics, agricultural productivity, effect on flora and fauna, economic output and the socio-cultural environment.

**Q22. What is the impact of mining activity on the soil?**

**Answer :**

The process of extracting minerals and their ores from the earth's crust by digging is known as mining. The process of mining poses a threat to the environment and also to the workers working in mines. The impact of the mining activities on the soil are as mentioned below,

1. Mining leads to deforestation due to the diversion of forest land for mining purpose. This is because large areas of land are needed so that miners can dig into the earth.
2. Apart from large scale deforestation, the vegetation of the surrounding areas has to be cleared to lay roads and construct residential facilities for the mine workers.
3. Large scale deforestation leads to loss of biodiversity due to loss of habitat of the animal species.
4. Mining operations cause ground compaction due to the heavy machinery operations, traffic and storage activities etc.
5. The mining dust causes change in the texture of the parent soil, the soil components like soil horizons, soil structure, soil microbe population, nutrient cycles.
6. Wash off toxic metals into nearby land surfaces reduces soil fertility.
7. Loss of vegetation may enhance weathering (both physical and chemical). The rain-bearing clouds formed in the mined areas pick up carbondioxide from the atmosphere and form a weak acid. When the rain falls, the weak acid attacks the exposed rock surface and causes its weathering.
8. The immediate impact of mining activity is Acid Mine Drainage (AMD)/ Acid Rock Drainage (ARD). It is the outflow of acidic water from coal mines or abandoned mines of metals. This usually occurs when the sulphide minerals are uncovered during the process of mining. Acid Mine Drainage is hazardous to the environment as it disrupts the cycle of nature. It also forms a blanket over the water bodies, usually streams and rivers and prevents the entry of sunlight, thus photosynthesis does not occur. This leads to the death of the aquatic plants, thus disturbing the aquatic ecosystem.

9. Change in natural drainage. The groundwater recharge through the surface reduces, because reduced infiltration results in increased surface runoff, leading into sedimentation ponds which can then overflow into the nearby streams.

10. Distruption in the aesthetics of the landscape.

**Q23. Discuss various guidelines for mitigating soil erosion.**

**Answer :**

Erosion of soil by various agents can be reduced by adopting the following methods

- (i) By minimizing the amount of soil bare through reduced vegetation.
- (ii) By retaining the stubble of the crops in the soil.
- (iii) By retaining vegetation in sensitive areas.
- (iv) By construction of physical structures to stabilize the slipping away of soil.
- (v) By retaining vegetation in sensitive areas.
- (vi) By promoting the growth of macroscopic and microscopic soil organisms.
- (vii) By promoting the use of anthropogenic chemicals in the soil.
- (viii) By encouraging extensive plantation of trees.

**Q24. Discuss in brief the anticipated environmental impact owing to a developmental project.**

**Answer :**

The potential environmental impacts, during the construction and operation of the project, can be broadly categorized into the following types,

**(a) Primary Impact**

- (i) Release of air pollutants
- (ii) Release of heat
- (iii) Changes in ambient noise levels.

**(b) Secondary Impact**

- (i) Changes in air quality
- (ii) Impact on visibility
- (iii) Particulates deposition on water and land
- (iv) Climate change.

**(c) Tertiary Impact**

- (i) Impact on human health
- (ii) Impact on aesthetics
- (iii) Impact on agricultural productivity
- (iv) Impact on flora and fauna
- (v) Impact on economic output
- (vi) Impact on socio-cultural environment.

**Anticipated Environmental Impacts**

- The anticipated impacts due to construction activity are,
- Soil compaction by earth movers and other heavy equipment
  - Soil erosion
  - Overexploitation of agricultural soil
  - Soil salinization and soil acidification
  - Dust pollution by brick, silica and asbestos
  - Noise pollution by construction equipment, diesel generator operations
  - Damage to environment
  - Damage to the health of construction workers.

The positive impacts include creation of employment opportunities, infrastructure development, business output (or sales volume), wealth generation, revenue flow and taxes, leading to a considerable boost for the local retail economy. The additional workforce may demand for health, education and housing services which may lead to additional construction activities.

**Q25. What is delineation?**

OR

**What is the necessity of delineation of study areas for EIA?****Answer :**

The term delineation refers to the identification of the site where a proposed developmental activity is planned.

Delineation is essential for the following reasons :

- It is helpful to determine land use activities.
- It enables the identification of sensitive areas for protection.
- It helps to identify the less sensitive areas for developmental activities.
- It enables proper management of the environment and natural resources.
- It helps in understanding the ecology, geography, geology and cultural features of the site.

**Q26. List the steps to delineate the study area for soil quality assessment.**

Dec.-20, (R16), Q5(b)

OR

**What is the procedure for delineation of study area for EIA?****Answer :**

Model Paper-III, Q2(b)

Environmental site assessment (or pre-acquisition site assessment), where a proposed action is planned is essential to define the characteristics of the area, which is likely to be significantly affected by the proposed project. This step should include the land-use map, land-use policies, zoning and details of the development project to be undertaken.

- The land-use map should depict the following:
- Residential area
  - Commercial areas
  - Industrial areas
  - Institutional, parks or recreation area
  - Infrastructure or built up land (roads, railways, mining/quarrying sites, etc.)
  - Dump sites.
  - Natural areas (forest land, agricultural land, wet marshy/salt pans, grazing land, wildlife sanctuaries, national park, wastelands, wildlife corridor, water bodies).

**Characteristics of the Study Area**

The different characteristics of the study area considered for EIA are,

- Geology - Nature of rock, soil and geological resources.
- Topography - Land features.
- Soils - Type of soil in the project area, black, yellow.
- Groundwater resources - Quality of groundwater, deep wells and subsurface aquifers.
- Surface water resources - Waterbodies, water courses, drainage basins, subbasins, water quality.
- Terrestrial botanical and zoological communities - Vegetation, wildlife, genetic resources, endangered species, threatened species.
- Aquatic communities - Nature of aquatic habitats and aquatic communities, species abundance.
- Environmentally sensitive area - Include wetlands, plains, slopes, agricultural lands and mines.
- Air quality - Existing air quality in the project site.
- Landuse - Landuse pattern of the project site including the area covered for residential, commercial, industrial, recreation, transportation, agriculture, waterbodies.
- Demographic profile - Total population in the area, average sex ratio, average family size, age groups, literacy levels, occupational patterns, traditional skills, sources of livelihood.
- Sound levels - Noise generated from construction activities, operation of construction equipment.
- Socio-economic condition - Population, occupation status, demographics, employment pattern, social amenities, health conditions.
- Infrastructural services - Schools, offices, shopping complexes.
- Transportation - Highways, roadways, railways, airports.
- Cultural resources - Archaeological, historical, cultural areas.
- Project economics - Economic costs and benefits of the proposed project activity.

## Q27. What are the points to be considered in delineating the study area for mining project?

**Answer :**

Some of the points to be considered for delineating the study area for the mining project are,

- (i) Impact of the mining activity on the natural geographic features such as watershed boundaries.
- (ii) Influence of mining on natural resources.
- (iii) Impacts on aquatic ecosystem integrity.
- (iv) Habitat loss, leading to increase in competition, alterations in the predator/prey relationship.
- (v) Impact of mining on the wilderness areas.
- (vi) Disturbance caused by transportation of personnel and equipment (machinery, tractors, suppliers) to and from the mine sites.
- (vii) Disturbance to the aesthetic qualities of solitude and the natural environment.
- (viii) Reduced opportunities for viewing and photographing wildlife.

## Q28. How to prepare the environmental audit report?

July-21, (R16), Q5(b)

**OR**

**Write a short note on preparation of an environmental report.**

**Answer :**

Model Paper-I, Q3(a)

### Environmental Impact Statement

The findings of the environmental assessment are reported as Environmental Impact Statement (EIS). It is a comprehensive, clear and concise, non-technical summary of the description of the project, including location, design, scale, size, mitigation measures to minimize or avoid the potential adverse impacts of a project and a more detailed section on the technical aspects of the assessment.

Environmental Impact Statement should contain specific information describing the effect on the environment due to the proposed development along with the impact on humans, flora, fauna, soil, water, air, climate and cultural heritage.

### Preparation of EIS

The EIS is prepared in two stages - draft and final. A Draft Environmental Impact Statement (DEIS) refers to the report on the environmental impact of proposed alternatives.

### Draft Environmental Impact Statements

The principle components of DEIS are,

- (a) Analyses of environmental issues related to a proposed action and its alternatives.
- (b) Comparative account of all proposed alternatives and their potential environmental impacts which includes aesthetic, historic, cultural, economic, social, health and ecological impacts (such as impact on the natural resources, structure and functioning of the ecosystem).
- (c) Purpose and need for the proposed action.
- (d) Contains inputs of the public and agency (or their consultants) so that the decision maker takes the public's environmental concerns into consideration during the decision-making process.

- (e) Explanation of the EIS's framework and methodology.
- (f) Identification and evaluation of significant environmental impacts, as well as mitigation measures related to a proposed action.
- (g) Identification of unavoidable adverse environmental impacts and cumulative impacts.

### Final Environmental Impact Statement

FEIS contains information necessary, agency officials to make decisions based on the environmental consequences of proposed actions. Final Environmental Impact Statement is a revised version of the Draft EIS as viewed by most people. But, on the contrary, a DEIS and FEIS may contain very different information unless and until the FEIS includes the DEIS.

If there are minor modifications in a Draft EIS, FEIS may consist of an errata sheet containing corrections and revisions to the Draft EIS, public comments on DEIS and the agency's responses to public comments. Such a practice avoids wastage of resources – money, time, energy and paper.

There are other agencies who prefer to rewrite and republish the changes made in Draft EIS as a Final EIS in order to make it easy to refer to just one document after the completion of the EIS process.

## Q29. Explain the measures to be taken for mitigation of adverse environmental impacts during operational phases of an engineering project.

**Answer :**

The measures to be taken for mitigation of adverse environmental impacts during operational phases of an engineering project are,

- (i) Decrease in the height at which the construction material is loaded or unloaded.
- (ii) Influencing the ground vehicles to reduce emissions.
- (iii) Use of silencers on construction equipment for noise abatement.
- (iv) Use of noise barriers to prevent the noise emanating from the construction equipment from the sensitive receivers.
- (v) Energy management systems to monitor and reduce overall energy use includes,
  - ❖ Use of renewable energy sources such as solar photovoltaic panels or wind turbines.
  - ❖ Burning of municipal solid waste to produce electricity.
  - ❖ Encourage the use of low-emission rental cars, taxis, shuttles.
- (vi) Implement water conservation measures such as installation of automatic shut off and low-flow plumbing fixtures, water reuse programs.
- (vii) Preventing soil compaction caused by the weight of vehicles and machinery by restricting the vehicular movement to defined tracts and avoid its use outside the construction zone.
- (viii) Preventing the entry of construction material into surface water to prevent the adverse impacts on drinking water supplies, irrigation systems, river ecology, etc.
- (ix) Prevent the entry of sediments into surface waters by implementing runoff control measures, mechanical sediment control measures, grassed filter strips, mulching and soil bioengineering practices.

**Q30. Discuss the importance, procedure, advantages and disadvantages of the public hearing process in EIA.**

**Answer :**

#### Importance of Public Hearing Process in EIA

The public hearing process in EIA is a formal meeting conducted by the proponents of a developmental project and involving the general public to comment or give feedback on the proposal. Such meetings are an opportunity for the public to voice their opinion on the proposed projects. Such meetings are important for the following reasons:

- To discuss the various issues about the project.
- To provide/get clarifications regarding the project.
- To collect information about various issues.
- To include new members in the discussion.
- To find solutions to the impending problems.
- To increase public awareness about the ongoing issues in the project.

#### Procedure

Public participation should be encouraged to integrate citizens into the environmental decision making process by arranging public meetings and hearings, open houses, networking, hotlines, responsive publication, surveys, forming advisory councils to generate new alternatives.

#### Advantages

- The awareness about environmental impacts enables each one of us to learn to make our world a better place to live.
- Gain a better understanding of the status of environmental impacts.
- Provide an opportunity for educators to network and form links for future collaboration.
- Act as a tool in the management of the environment.
- Increase the knowledge and attitudes of the people.
- Strive towards increased skills and practical application of environmental knowledge through positive environmental behaviour.

#### Disadvantages

The project proponents may find it difficult to convince people to participate in such meetings.

When the draft of the proposed action is ready, it is sent for approval from government agencies. This requires notification in newspapers and media to let the general public know about it.

The process involves preparing questions for a survey to be carried out on various aspects of the proposed action.

The public decides if the proposed action is beneficial to them both geographically, aesthetically and economically.

The entire process is systematic, time bound and carried out in a transparent manner ensuring possible public participation at the project site.

The comments, opinions and suggestions from the public are analyzed and reviewed by the implementing agency.

**Q31. Explain the role of stakeholders in the EIA preparation.**

**Answer :**

#### Stakeholders

The stakeholders related to the environment are category of people who have keen interest in the activities related to the environment. They include the project proponent, EIA authority, individuals, communities, government agencies, private organizations, non-governmental organizations and academic institutions.

According to Howlett and Nagu, stakeholders are "All those people and institutions who have an interest in the successful design, implementation and sustainability of the project".

The role of stakeholders in EIA preparation are mentioned below.

- Participate in the screening of development programs.
- Manage the assessment procedures conducted by the developers.
- Monitor the implementation of environmental protection measures.
- Hire experts in various fields to undertake EIA studies.
- Assist in the preparation of the EIA report.
- Design mitigation measures.
- Management and protection of environmental resources in a sustainable manner.
- Participation in identifying and solving environmental problems.
- Provide compensation for adverse environmental impacts.
- Arrange for funds needed for carrying out the project.

**Q32. Write a short note on the EIA process.**

**Answer :**

For answer refer Unit-I, Q17.

**Q33. Explain about draft and final environmental impact statements.**

**Answer :**

For answer refer Unit-I, Q28, Topic: Draft Environmental Impact Statements and Final Environmental Impact Statement.

**Q34. Write a brief note on the factors affecting the EIA.**

**Answer :**

The study on the factors affecting the EIA process helps to evaluate, analyze and report on the environmental conditions from the activities resulting from several developments. An EIA should include details of the following aspects at the proposed project site,

Model Paper-II, Q34

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**1. Meteorology and Air Quality**

It includes:

- The effect of temperature.
- Precipitation, relative humidity, evaporation and fog conditions.
- Wind patterns.
- Severe weather (such as hurricanes, volcanoes).
- Air quality and odour levels.
- Sound levels and sources of sound at the proposed project development site.

These studies are carried out with the help of computer models, satellite data and climate theories.

**2. Topography**

It includes the local and regional geology studies, major land formations, geologic structure and resources, and seismic hazards.

**3. Water**

The quality of surface water and groundwater along with hydrological studies.

**4. Demographics**

This refers to the population distribution, change in population numbers, population characteristics (such as sex-ratio, age structure, rate of migration), municipal services (such as demand for social services, hospital beds, school places, housing etc.).

**5. Land Use**

This includes the purpose for which the land is used, namely agricultural activities, industrial activities or mining activities, regional planning for future use, zoning etc.

**6. Soil Conditions**

Type/classification of soil, properties of soil, soil mapping.

**7. Mineral Resources/Activities**

The mineral resources available at the proposed project development site. Examples: Uranium, coal, other minerals, oil and gas etc.

**8. Ecological studies involving data on type and dominant species of flora, fauna, avifauna, aquatic biota, reptiles, amphibians, endangered species, threatened species, man introduced species, timber value densities and distribution of species, habitat, migratory species and species of commercial importance.**

The other additional factors affecting EIA evaluation and analysis are:

- Population density
- Extent of the developmental activity.
- Relocation/displacement of inhabitants of the area.
- Resource availability
- Environmental resilience
- Sustainability of the environment
- Absorptive capacity of the environment.

The proposed developmental activity must have minimal negative impact on the environment, and deliver positive, social, environmental and economic outcomes and thus contribute to healthy and resilient ecological system.

All these factors have to be taken into consideration during the EIA process to enable better design of buildings, plan heating and cooling systems, as well as practicing sustainable agricultural activities.

**Q35. Write a short note on decision making in EIA.****Answer :**

Decision making is an important step in the EIA process, to decide whether to approve the project or not, under the given set of conditions.

The competent authorities take decisions whether to approve or reject a project. They comprise ministries of the central government, local self-government bodies in whose territory the project is proposed, traditional decision making bodies, councils, private sector organization (trade association, chambers of commerce and industries); and non government organization.

Environmental considerations have now become an important part of industries everyday reality. The top management of various industrial organizations should take a proactive role in environmental decision making and implement them, thus contributing to the environmental performance and productivity of the industries.

**Q36. What are the steps involved in the EIA clearance process?**

Sep.-20, (R16), Q2(a)

**OR**

**Write an account on the procedure for environmental clearance (EC) to developmental projects.****Answer :**

Model Paper-I, Q3(b)

The Environmental Clearance (EC) to developmental projects is mandatory in various parts of the world. The EC has been made compulsory by the EIA notification issued under Environment Protection Act, 1986.

**Aim of Environmental Clearance**

The main objective of environmental clearance (EC) is to analyze the impact of the proposed project on the environment and living things, and put forth efforts to decrease the same to the maximum extent possible.

**Steps Involved in Obtaining an EC**

The different steps involved in obtaining an EC to a developmental project includes:

**(i) Screening**

This step involves the identification of the location of the proposed developmental project as applied by the entrepreneur.

**(ii) Scoping**

In this step, the entrepreneur assesses if the site is listed under the environmental clearance according to the Government of India notification. If so, then an EIA is conducted either directly or through a consultant.

- The operating principles of EIA process should be applied:
- To enable quick decision-making.
  - To all development activities that may have significant effects on the environment.
  - To enable each one of us, a life of sustainable environment.
  - To promote eco-friendly technologies.
  - To provide for the involvement of men, women, children and NGOs in all the environment related activities.

**Q39. What are the limitations of environmental impact assessment?**

**Answer :**

For answer refer Unit-I, Q3.

Sep.-20, (R16), Q1(b)

## 1.4 GOVERNMENT OF INDIA MINISTRY OF ENVIRONMENT AND FOREST NOTIFICATION (2000)

**Q40. Write in brief on the draft EIA notification 2020.**

**Answer :**

Model Paper-III, Q3(b)

The Ministry of Environment, Forest and Climate Change (MoEF and CC) has published a new draft Environment Impact Assessment (EIA) 2020 on March 12<sup>th</sup>, 2020, with the aim to replace the existing EIA Notification, 2006 under the Environment (Protection) Act, 1986.

The main proposals of the 2020 EIA draft are as mentioned below.

- Reduced notice period for public hearings from 30 days to 20 days.
- Many projects have been exempted from public scrutiny.

The projects belonging to category A and B1 require mandatory Environmental Clearance (EC).

The category A projects are scrutinized by the central agencies whereas the category B1 projects are evaluated by the state agencies.

However, the projects belonging to category B2 do not need mandatory Environmental Clearance (EC).

The exempted projects include the following:

- Offshore and onshore oil, gas and shale exploration.
- Hydroelectric projects upto 25MW
- Irrigation projects between 2,000 and 10,000 hectares of command area.
- Small and medium cement plants.
- Acids other than phosphoric or ammonia and sulphuric acid.
- MSMEs in dye and dye intermediates, bulk drugs, synthetic rubbers, medium-sized paint units.
- All inland waterway projects and expansion or widening of highways between 25 km and 100 km with defined parameters. These include roads that cut through forests and dredging of major rivers.

- Aerial ropeways in ecologically sensitive areas.
- Specified building construction and area development projects; built-up area upto 1,50,000 sq.m.
- Projects having implication for 'national defence and security' or having 'strategic consideration' will be decided by the central government, and are exempt from public hearing.
- 'Linear projects' like pipelines and highways in border areas, "falling within 100 kilometers aerial distance from the Line of Actual Control" are exempt from public hearing.
- Post-clearance compliance involves adherence to rules laid down in the EIA report, to prevent environmental damage.
- Submission of compliance reports annually, instead of every six months.
- The project compliance report must be prepared by the project proponents only, before its submission to the agencies.
- Reporting of violations and non-compliance by the public is excluded.
- The government will take note of reports only from the violator-promoter, government authority, Appraisal Committee or Regulatory Authority.
- Granting post-facto clearance to those projects that have been operating without environmental clearance, can be regularized or allowed to apply for clearance.
- Firms found violating the terms of their establishment would be penalized appropriately.

## 1.5 LIST OF PROJECTS REQUIRING ENVIRONMENTAL CLEARANCE

**Q41. Provide a list of project that need EIA study.**

**Answer :**

The categories of projects that need an EIA are enlisted below,

- Mining of minerals
- Offshore and onshore oil and gas exploration
- River valley projects
- Thermal power plants
- Nuclear power projects
- Metallurgical industries
- Cement plants
- Petroleum refining industry
- Leather/skin/hide processing industry
- Pesticides industry
- Chemical fertilizers
- Textile plants
- Paint industry
- Paper and pulp manufacturing industry
- Sugar factory
- Airports

17. Ship breaking yards
18. Industrial estates/parks/complexes/areas
19. Export processing zones
20. Biotechnology parks
21. Special economic zones
22. Hazardous waste treatment plants
23. Ports
24. Harbours
25. State highways and national highways
26. Effluent treatment plants
27. Municipal solid waste management facility
28. Building and construction projects.

**Q42. Provide a list of projects that need clearance from the central government.**

**Answer :**

All the projects that need environmental clearance from the central government are broadly categorized into the following groups.

- (i) Industries
- (ii) Mining projects
- (iii) Thermal power plants
- (iv) River valley projects
- (v) Infrastructure and Coastal Regulation Zone
- (vi) Nuclear Power Projects.

The list of projects that need clearance from the central government include the following,

1. Nuclear Power and related projects such as heavy water plants, nuclear fuel complex and rare earths.
2. River valley projects includes hydel power, major irrigation and their combination including flood control.
3. Ports, harbours, airports (except minor ports and harbours)
4. Petroleum refineries including crude and product pipelines.
5. Chemical fertilizers (nitrogenous and phosphatic other than single superphosphate).
6. Pesticides (technical).
7. Petrochemical complexes (both olefinic and aromatic) and petrochemical intermediates such as DMT, caprolactam, LAB etc. and production of basic plastics such as LLDPE, HDPE, PP, PVC.
8. Bulk drugs and pharmaceuticals.
9. Exploration for oil and gas and their production, transportation and storage.
10. Synthetic rubber.
11. Asbestos and asbestos products.
12. Hydrocyanic acid and its derivatives.
13. (a) Primary metallurgical industries (such as production of iron and steel, aluminium, copper, zinc, lead and ferro alloys).  
(b) Electric arc furnaces (mini steel plants).

14. Chlor alkali industry.
15. Integrated paint complex including manufacture of resins and basic raw materials required in the manufacture of paints.
16. Viscose staple fibre and filament yarn.
17. Storage batteries integrated with manufacture of lead and lead antimony alloys.
18. All tourism projects between 200m - 500 metres of water line and at locations with an elevation of more than 1000 metres with investment of more than Rs. 5 crores.
19. Thermal power plants.
20. Mining projects (major minerals) with leases more than hectares.
21. Highway projects except projects relating to improvement work including widening and strengthening of roads and marginal land acquisition along the existing alignment provided it does not pass through ecologically sensitive areas such as national parks, sanctuaries, tiger reserves, reserve forests.
22. Tarred roads in the Himalayas and or forest areas.
23. Distilleries.
24. Raw skins and hides.
25. Pulp, paper and newsprint.
26. Dyes.
27. Cement.
28. Foundries (individual).
29. Electroplating.
30. Meta amino phenol.

The Environment Impact Assessment Notification (EIA) section 2 states that:

"Any person who desires to undertake any project in part of India or modernization of any existing industry or project listed in the above list shall submit an application to the Secretary, Ministry of Environment and Forests, New Delhi, in the necessary proforma with sufficient and adequate data".

## 1.6 APPLICATION FORM

**Q43. Provide a sample application form to be filled for EIA study of a developmental project.**

**Answer :**

Given below is the application form to be filled for EIA study of a development project as issued by the Government of India.

- (I) Basic Information

S.No.	Item	Details
1.	Name of the Project/s	
2.	S. No. in the Schedule	
3.	Proposed capacity/area/length/tonnage to be handled/command area/lease area/ number of wells to be drilled	
4.	New/Expansion/Modernization	
5.	Existing Capacity/Area etc.	
6.	Category of project i.e., 'A' or 'B'	
7.	Does it attract the general condition? If yes, please specify.	
8.	Does it attract the specific condition? If yes, please specify.	
9.	Location Plot/Survey/Khasra No. Village Tehsil District State	
10.	Nearest railway station/airport along with distance in kms.	
11.	Nearest Town, City, District Headquarters along with distance in kms.	
12.	Village Panchayats, Zila Parishad, Municipal Corporation, Local body (complete postal addresses with telephone nos. to be given)	
13.	Name of the applicant	
14.	Registered Address	
15.	Address for correspondence: Name Designation (Owner/Partner/CEO) Address Pin code E-mail Telephone No. Fax No.	
16.	Details of alternative sites examined, if any. Location of these sites should be shown on a toposheet	Village-District-State 1. 2. 3.
17.	Interlinked Projects	
18.	Whether separate application of interlinked projects has been submitted?	
19.	If Yes, date of submission	
20.	If No, reason	
21.	Whether the proposal involves approval/ clearance under : if yes, details of the same and their status to be given. (a) The Forest (Conservation Act, 1980? (b) The Wildlife (Protection)Act, 1972? (c) The C.R.Z. Notification 1991?	
22.	Whether there is any Government Order/ Policy relevant/relating to the site?	
23.	Forest land involved (hectares)	
24.	Whether there is any litigation pending against the Project and/or land in which the project is proposed to be set up? (a) Name of the Court (b) Case No. (c) Orders/directions of the Court, if any and its relevance with the proposed project.	

## (II) Activity

1. Construction operation or decommissioning of the Project involving actions, which will cause physical changes in the locality (topography, land use, changes in water bodies, etc).

S. No.	Information/ Checklist confirmation	Yes/No	Details thereof (with approximate quantities/rates, wherever possible) with source of information data
1.1	Permanent or temporary change in land use, land cover or topography including increase in intensity of land use (with respect to local land use plan)		
1.2	Clearance of existing land, vegetation and buildings?		
1.3	Creation of new land uses?		
1.4	Pre-construction investigations e.g. bore, houses, soil, testing?		
1.5	Construction works?		
1.6	Demolition works?		
1.7	Temporary sites used for construction works or housing of construction workers?		
1.8	Above ground buildings, structures or earthworks including linear structures, cut and fill or excavations		
1.9	Underground works including mining or tunneling?		
1.10	Reclamation works?		
1.11	Dredging?		
1.12	Offshore structures?		
1.13	Production and manufacturing processes?		
1.14	Facilities for storage of goods or materials?		
1.15	Facilities for treatment or disposal of solid waste or liquid effluents?		
1.16	Facilities for long term housing of operational workers?		
1.17	New road, rail or sea traffic during construction or operation?		
1.18	New road, rail, air, waterborne or other transport infrastructure including new or altered routes and stations, ports, airports etc?		
1.19	Closure or diversion of existing transport routes or infrastructure leading to changes in traffic movements?		
1.20	New or diverted transmission lines or pipelines?		
1.21	Impoundment, damming, culverting, realignment or other changes to the hydrology of watercourses or aquifers?		
1.22	Stream crossings?		
1.23	Abstraction or transfers of water from ground or surface waters?		
1.24	Changes in water bodies or the land surface affecting drainage or run-off?		
1.25	Transport of personnel or materials for construction, operation or decommissioning?		
1.26	Long-term dismantling or decommissioning or restoration works?		
1.27	Ongoing activity during decommissioning which could have an impact on the environment?		
1.28	Influx of people to an area in either temporarily or permanently?		
1.29	Introduction of alien species?		
1.30	Loss of native species or genetic diversity?		
1.31	Any other actions?		

**UNIT 1** Introduction

**Use of natural resources for construction or operation of the Project (such as land, water, materials or energy, especially any resources which are non-renewable or in short supply):**

S.No.	Information/ Checklist confirmation	Yes/No	Details thereof (with approximate quantities/rates, wherever possible) with source of information data
2.1	Land especially undeveloped or agricultural land (ha)		
2.2	Water (expected source and competing users) unit: KLD		
2.3	Minerals (MT)		
2.4	Construction material – stone, aggregates, and / soil (excepted source – MT)		
2.5	Forests and timber (source – MT)		
2.6	Energy including electricity and fuels (source, competing users) Unit: fuel (MT), energy (MW)		
2.7	Any other natural resources (Use appropriate standard units)		

**Use, storage, transport, handling or production of substances or materials, which could be harmful to human health or the environment or raise concerns about actual or perceived risks to human health.**

S.No.	Information/ Checklist confirmation	Yes/No	Details thereof (with approximate quantities/rates, wherever possible) with sources of information data
3.1	Use of substances or materials, which are hazardous (as per MSIHC rules) to human health or the environment (flora, fauna and water supplies)		
3.2	Changes in occurrence of disease or affect disease vectors (e.g. insect or water borne diseases)		
3.3	Affect the welfare of people e.g. by changing living conditions?		
3.4	Vulnerable groups of people who could be affected by the project e.g. hospital patients, children, the elderly etc.		
3.5	Any other causes		

**Production of solid wastes during construction or operation or decommissioning (MT/months)**

S.No.	Information/ Checklist confirmation	Yes/No	Details thereof (with approximate quantities/rates, wherever possible) with sources of information data
4.1	Spoil, overburden or mine wastes		
4.2	Municipal waste (domestic and or commercial wastes)		
4.3	Hazardous wastes (as per Hazardous Waste Management Rules)		
4.4	Other industrial process wastes		
4.5	Surplus product		
4.6	Sewage sludge or other sludge from effluent treatment		
4.7	Construction or demolition wastes		
4.8	Redundant machinery or equipment		
4.9	Contaminated soils or other materials		
4.10	Agricultural wastes		
4.11	Other solid wastes		

**5. Release of pollutants or any hazardous, toxic and noxious substances to air (Kg/hr)**

S.No.	Information/ Checklist confirmation	Yes/No	Details thereof (with approximate quantities/rates, wherever possible) with sources of information data
5.1	Emissions from combustion of fossil fuels from stationary or mobile sources		
5.2	Emissions from production processes		
5.3	Emissions from materials handling including storage or transport		
5.4	Emissions from construction activities including plant and equipment		
5.5	Dust or odours from handling of materials including construction materials, sewage and waste		
5.6	Emissions from incineration of waste		
5.7	Emissions from burning of waste in open air (e.g. slash materials, construction debris)		
5.8	Emissions from any other sources		

**6. Generation of Noise and Vibration and Emissions of Light and Heat:**

S.No.	Information/ Checklist confirmation	Yes/No	Details thereof (with approximate quantities/rates, wherever possible) with sources of information data
6.1	From operation of equipment e.g. engines, ventilation plant, crushers		
6.2	From industrial or similar processes		
6.3	From construction or demolition		
6.4	From blasting or piling		
6.5	From construction or operational traffic		
6.6	From lighting or cooling systems		
6.7	From any other sources		

**7. Risks of contamination of land or water from releases of pollutants into the ground or into sewers, surface water, groundwater, coastal waters or the sea:**

S.No.	Information/ Checklist confirmation	Yes/No	Details thereof (with approximate quantities/rates, wherever possible) with sources of information data
7.1	From handling, storage, use or spillage of hazardous materials		
7.2	From discharge or sewage or other effluents to water or the land (expected mode and place of discharge)		
7.3	By deposition of pollutants emitted to air into the land or into water		
7.4	From any other sources		
7.5	Is there a risk of long term build up of pollutants in the environment from these sources?		

**8. Risk of accidents during construction or operation of the Project, which could affect human health or the environment:**

S.No.	Information/ Checklist confirmation	Yes/No	Details thereof (with approximate quantities/rates, wherever possible) with sources of information data
8.1	From explosions, spillages, fires etc from storage, handling, use or production of hazardous substances		
8.2	From any other causes		
8.3	Could the project be affected by natural disasters causing environmental damage (e.g. floods, earthquakes, landslides, cloudburst etc)?		

**UNIT-1 Introduction**

9. Factor which should be considered (such as consequential development) which could lead to environmental effects or the potential for cumulative impacts with other existing or planned activities in the locality

S.No.	Information/ Checklist confirmation	Yes/No	Details thereof (with approximate quantities/rates, wherever possible) with sources of information data
9.1	Lead to development of supporting activities, ancillary development or development stimulated by the project which could have impact on the environment e.g: Supporting infrastructure (roads, power supply, waste or waste water treatment, etc.) Housing development Extractive industries Supply industries Other		
9.2	Lead to after-use of the site, which could have an impact on the environment		
9.3	Set a precedent for later developments		
9.4	Have cumulative effects due to proximity to other existing or planned projects with similar effects		

**(III) Environmental Sensitivity**

S.No.	Areas	Name/Identify	Aerial distance (within 15 km) Proposed project location boundary
1	Areas protected under international conventions, national or local legislation for their ecological, landscape, cultural or other related value		
2	Areas which are important or sensitive for ecological reasons – wetlands, watercourses or other water bodies, coastal zone, biospheres, mountains, forests		
3	Areas used by protected, important or sensitive species of flora or fauna for breeding, nesting, foraging, resting, overwintering, migration		
4	Inland, coastal, marine or underground waters		
5	State, National boundaries		
6	Routes or facilities used by the public for access to recreation or other tourists, pilgrim areas		
7	Defence installations		
8	Densely populated or built-up area		
9	Area occupied by sensitive man-made land uses ( <i>hospitals, schools, places of worship, community facilities</i> )		
10	Area containing important, high quality or scarce resources ( <i>ground water resources, surface resources, forestry, agriculture, fisheries, tourism, minerals</i> )		
11	Areas already subjected to pollution or environmental damage. ( <i>those where existing legal environmental standards are exceeded</i> )		
12.	Areas susceptible to natural hazard which could cause the project to present environmental problems ( <i>earthquakes, subsidence, landslides, erosion, flooding or extreme or adverse climatic conditions</i> )		

(IV) **Proposed Terms of Reference for EIA Studies**

I hereby give undertaking that the data and information given in the application and enclosures are true to the best of my knowledge and belief and I am aware that if any part of the data and information submitted is found to be false or misleading at any stage, the project will be rejected and clearance given, if any to the project will be revoked at our risk and cost.

Date:

Place:

Signature of the applicant

With name and full address

(Project Proponent/ Authorized Signatory)

**NOTE:**

1. The project involving clearances under Coastal Regulation Zone Notification, 1991 shall submit with the application a CRZ map duly demarcated by one of the authorized agencies, showing the project activities, w.r.t C.R.Z (at the stage of ToR) and the recommendations of the State Coastal Zone Management Authority (at the stage of EC). Simultaneous action shall also be taken to obtain the requisite clearance under the provisions of the C.R.Z. Notification, 1991 for the activities to be located in the CRZ.
2. The project to be located within 10 km of the National Parks, Sanctuaries, Biosphere Reserves, Migratory Corridors of Wild Animals, the project proponent shall submit the map duly authenticated by Chief Wildlife Warden showing these features vis-a-vis the project location and the recommendation or comments of the Chief Wildlife Warden thereon (at the stage of EC).
3. All correspondence with the Ministry of Environment and Forests including submission of application for TOR / Environmental Clearance, subsequent clarification, as may be required from time to time, participation in the EAC Meeting on behalf of the project proponent shall be made by the authorized signatory only. The authorized signatory should also submit a document in support of his claim of being an authorized signatory for the specific project.

**I.7 COMPOSITION OF EXPERT COMMITTEE****Q44. Write in short about the composition of the expert committee for environmental impact assessment.****Answer :**

1. The advisory committee consists of experts in various fields.
  - (i) Eco-system Management
  - (ii) Air/Water Pollution Control
  - (iii) Water Resources Management
  - (iv) Flora/Fauna Conservation and Management
  - (v) Land Use Planning
  - (vi) Social Sciences/Rehabilitation
  - (vii) Project Appraisal
  - (viii) Ecology
  - (ix) Environmental Health
  - (x) Subject Area Specialists
  - (xi) Representatives of NGOs/persons concerned with environmental issues.
2. The Chairman will be an outstanding and experienced ecologist or environmentalist or technical professional with wide managerial experience in the relevant development sector.
3. The representative of Impact Assessment Agency will act as a Member Secretary.
4. Chairman and Members will serve in their individual capacities except those specifically nominated as representatives.
5. The Membership of a Committee shall not exceed 15.

## 1.8 ECOLOGICAL SENSITIVE PLACES

**Q45. What are the areas to be avoided for the siting of industries?**

**Answer :**

The areas to be avoided for setting up of industries are as mentioned below.

- (i) Industrial development is allowed at a distance of 25 km away from the ecologically sensitive areas.
- (ii) In the coastal region, the industries should be 500 m away from the high tides.
- (iii) About 500 m away from the flood-prone regions.
- (iv) Nearly 500 m away from the highway and railway.
- (v) Nearly 30 to 50 km away from the residential areas.

**Q46. Enumerate the ecological sensitive areas in India.**

**Answer :**

The ecologically sensitive areas include the following.

1. Religious and historic places.
2. Archaeological monuments.
3. Scenic areas.
4. Hill and beach resorts.
5. Coastal areas
6. Estuaries
7. Biosphere reserves
8. National parks
9. National sanctuaries
10. Seismic zones
11. Airports
12. Defence installations etc.

Some of the ecologically sensitive places have been discussed in brief.

### 1. Forests

The total forest cover in India is approximately 7.74 lakh square kms, of which 3.99 is classified as reserved and 2.38 as protected and 1.3 lakh square kms as unclassified forest area.

### 2. Mangroves

The major mangroves include,

- (i) Northern Andaman and Nicobar Islands
- (ii) Sundarbans – West Bengal
- (iii) Bhitar Kanika
- (iv) Godavari and Krishna Delta, Andhra Pradesh
- (v) Pichavaram, Point Calimari – Tamil Nadu
- (vi) Coondapur – Karnataka
- (vii) Ratnagiri – Maharashtra
- (viii) Vembanad, Kerala
- (ix) Goa
- (x) Gulf of Kachchh.

### 3. Biosphere Reserves

- (i) Nilgiris
- (ii) Nanda Devi
- (iii) Nokrek
- (iv) Great Nicobar
- (v) Gulf of Mannar
- (vi) Manas
- (vii) Sundarbans
- (viii) Simlipal
- (ix) Dibru Saikhowa
- (x) Panch Marhi
- (xi) Dihang-Dibang
- (xii) Kanchenjunga.

### 4. Wetlands

Wetlands are the areas where the terrestrial (land) areas and aquatic areas intersect with each other. These ecosystems are a home to a myriad web of plants and animals, which interact with each other.

These areas generally receive water from groundwater recharge or precipitation.

The wetlands in India include,

- (i) Chilka Lake (Odisha)
- (ii) Keoladeo Ghana National Park (Rajasthan)
- (iii) Wular Lake (Kashmir)
- (iv) Harik Lake (Punjab)
- (v) Loktak Lake (Manipur)
- (vi) Sambhar Lake (Rajasthan).

### 5. Coral Reefs

Coral reefs are hardened structures or ridges formed by the secretions of calcium carbonate by millions of corals. They are generally found throughout the oceans from the deep, cold water to shallow, warm waters. The coral reefs in India are found in Gulf of Kutch, Mandapam group of islands in Gulf of Mannar, Andaman and Nicobar Islands and Lakshadweep Islands.

### 6. Coastal Areas

Setting up of industries in the Coastal Regulation Zones is strictly prohibited.

#### Types of Coastal Regulation Zones

##### (i) Coastal Regulation Zone I (CRZ I)

This zone includes ecologically sensitive and important areas, along with areas between low tide line and high tide line.

## (ii) Coastal Regulation Zone II (CRZ II)

This zone includes the areas close to the shore, especially the urban or built up areas.

## (iii) Coastal Regulation Zone III (CRZ III)

This zone includes the undistributed areas and those areas which do not belong to either category I or II.

## (iv) Coastal Regulation Zone IV (CRZ IV)

This zone includes the coastal stretches of Andaman, Nicobar, Lakshadweep and small islands.

## 7. Natural Hazard Prone Areas

Some regions of the country are vulnerable to natural hazards like earthquakes, cyclones, drought, floods and tsunamis.

The low lying plains of the coastal regions of Andhra Pradesh, Orissa and West Bengal experience cyclones originating in the Bay of Bengal.

The natural hazards in the coastal areas such as severe waves, storm surges, tsunamis and coastal earthquakes, cause flooding in the coastal areas and cause enormous damage to coastline, property and homes.

Drought is an environmental condition that arises from too little precipitation (rain and snow) for an extended period of time. The drought prone regions in India include some districts of Gujarat, Rajasthan and interior parts of the peninsula in the south.

Few districts of Orissa, Madhya Pradesh, Uttar Pradesh, Uttarakhand, Bihar, Jharkhand, West Bengal and Jammu and Kashmir.

## 8. World Heritage Sites

World Heritage Sites are natural historical wonders that have been identified by the United Nations Educational, Scientific and Cultural Organization (UNESCO). They need to be preserved well as they are of great universal value to humanity for the present as well as generations to come.

Some of the important world heritage sites of our country include Ajanta Caves, Ellora Caves, Agra Fort, Taj Mahal, the Sun Temple (Konark), Mahabalipuram monuments, Sanchi, Hampi monuments, Fatehpur Sikri, Elephanta caves, Brihadisvara Temple, Churches of Goa, Khajuraho group of monuments, Qutb Minar, Humayun's Tomb at Delhi, Keoladeo National Park in Rajasthan, Manas and Kaziranga in Assam, Sunderbans Biosphere Reserve in West Bengal.

## Conclusion

The ecologically sensitive areas are threatened by various developmental activities and large infrastructure developments. This may cause irreversible damage to its beauty, significance and diversity. Hence appropriate policies need to be framed to offer protection to these priceless and irreplaceable assets.

## Q47. What are the guiding principles for green belt development?

**Answer :**

Model Paper-II, Q3(b) | Sep.-21, (R16), 240

The concept of green belt development means regeneration of green canopy by afforestation activities. The purpose of green belt development are,

- Protection of sensitive areas to maintain ecological balance.
- To enrich the biodiversity and its propagation through gene pools and seed banks.
- The green cover acts as a sink for the harmful gasses released by vehicles and industries operating in the urban areas to reduce air pollution, to absorb sound, to prevent soil erosion and to maintain aesthetic beauty.
- Land regeneration and water management by intensive agricultural development, dense plantation of trees, development of ornamental gardens, growing economic value fruit trees.
- Waste water treatment and recycling, solid waste management.
- Production of alternate energy through use of biomass and wastes.
- Provide recreational facilities for people residing near the green belt zone.

**General Considerations Involved in Green Belt Development**  
The general considerations involved in green belt development are,  
Trees growing to a height of 10 mts and above should be planted.

The growth rate of the plants should be high, therefore, a fast growing indigenous species should be planted.  
The plants should have a thick canopy of perennial and evergreen leaves.

The plants should have a large leaf area index. They should be efficient to absorb pollutants without affecting the plant growth.

Shrubs should be grown alongside the trees as the tree trunks are usually devoid of forage upto a height of 3 meters.

The tree species generally selected in green belt development are teak, shivan (*Gmelina arborea*), Shisham (*Dalbergia sissoo*), Shiris (*Albizia lebbbeck*), white Shiris (*Albizia procera*), banyan (*Ficus benghalensis*), Peepal (*Ficus religiosa*), Amala (*Emblica officinalis*), Tamarind (*Tamarindus indica*), Jambulena (*Syzygium cumini*), Guava (*Psidium guava*), Neem (*Azadirachta indica*), Casuarina (*casuarina equisetifolia*), Pongamia (*Derris indica*), jackfruit (*Artocarpus heterophyllus*), bamboo (*Dendrocalamus strictus*), cashew (*Anacardium occidentale*), Mango (*Mangifera indica*), Bengali abul (*Acacia auriculiformis*), Khair (*Acacia catechu*), Kashid (*Cassia siamea*), Silk cotton (*Bombax ceiba*), coral tree (*Erythrina variegata*) along with many other fruit and flowering species to attract wildlife.

Green belt/zone is vital to the psychological and physical health of people employed in industries.

Green spaces and gardens should be seen as a fundamental health resource. Many researchers and environmentalists showed in laboratory studies that plants have the ability to reduce the level of chemical compounds in the air, thus serving as powerful air purifiers.

Due to increased urbanisation and population densification, more people are forced to live in less green residential environments. The low income group especially, cannot afford to move to greener areas outside the cities thus leading to environmental injustice concerning the accessibility to public green space. The policy makers should realize the importance of green space on health, well-being and safety, and consider it as a basic necessity rather than a luxury.

The environmental psychologists are of the view that the well-being and levels of psychological and physiological stress are influenced by our surroundings. A visual contact with green spaces and gardens can foster restoration from the detrimental effects of commuting, work pressure and other stressors which most urbanites encounter everyday. Besides reducing stress, exposures to greenery may reduce feelings of anger, frustration, aggression and criminal activity. These green spaces may improve the well-being by enhancing satisfaction, attachment, sense of responsibility and social cohesion by informal social interaction and social bondings.

It is, therefore, important to increase the amount of green space around us for better health and well being.

## 1.9 INTERNATIONAL AGREEMENTS

**Q48. Enumerate the International environmental agreements and India.**

**Answer :**

The important international environmental agreements are listed below.

- (i) The 1992 Helsinki Convention on the protection and use of trans boundary watercourses and international lakes.
- (ii) The 1973 Convention for Prevention of Pollution from ships (MARPOL).
- (iii) The 1982 UN Convention on the Law of the Sea (UNCLOS).
- (iv) The 1992 Paris Convention for the protection of the marine environment of the North-East Atlantic.
- (v) The 1979 ECE Convention on long range transboundary air pollution protocols on sulfur dioxide ( $\text{SO}_2$ ) nitrogen oxides ( $\text{NO}_x$ ) and volatile organic compounds (VOCs).
- (vi) The 1985 Vienna Convention for the protection of the ozone layer (Montreal Protocol and London and Copenhagen Amendments).
- (vii) The 1992 UN Convention on Climate Change.
- (viii) The 1989 Basel Convention on the control of transboundary movements of hazardous wastes and their disposal.
- (ix) The 1991 Bamako Convention on the ban of the import into Africa and the control of transboundary movement and management of hazardous wastes within Africa.
- (x) The 1986 IAEA Convention on early notification of a nuclear accident.
- (xi) The 1986 IAEA Convention on assistance in the case of a nuclear accident.
- (xii) The 1994 IAEA Convention on Nuclear safety.
- (xiii) The 1991 ECE Convention on environmental impact assessment in a transboundary context.
- (xiv) The 1992 UN Convention on biological diversity.
- (xv) UN Framework Convention on Climate Change (UNFCCC), 1992.
- (xvi) Convention of Biological Diversity, 1992.
- (xvii) UN Convention on Desertification, 1994.

## FREQUENTLY ASKED AND IMPORTANT QUESTIONS

**Q1. Discuss objectives, merits and demerits of EIA.**

Important Question

**Answer :**

For answer refer Unit-I, Q2.

**Q2. What is environmental impact assessment and its importance?**

Important Question | July-21, (R16), Q8(a)

**Answer :**

For answer refer Unit-I, Q10.

**Q3. What are the steps involved in the EIA process?**

Important Question | July-21, (R16), Q1(b)

**Answer :**

For answer refer Unit-I, Q17.

**Q4. Write the difference between screening and scoping in EIA process.**

**OR**

**Write in brief the components of environmental impact assessment (EIA).**

Important Question | July-21, (R16), Q1(a)

**Answer :**

For answer refer Unit-I, Q18.

**Q5. List the steps to delineate the study area for soil quality assessment.**

Important Question | Dec.-20, (R16), Q5(b)

**Answer :**

For answer refer Unit-I, Q26.

**Q6. How to prepare the environmental audit report?**

**OR**

**Write a short note on preparation of an environmental report.**

Important Question | July-21, (R16), Q5(b)

**Answer :**

For answer refer Unit-I, Q28.

**Q7. What are the steps involved in the EIA clearance process?**

Important Question | Sep.-20, (R16), Q2(a)

**Answer :**

For answer refer Unit-I, Q36.

**Q8. What are the limitations of environmental impact assessment?**

Important Question | Sep.-20, (R16), Q1(b)

**Answer :**

For answer refer Unit-I, Q39.

# UNIT

## 2

### EIA Methodologies



#### Syllabus

**EIA Methodologies** - Environmental Attributes – Criteria for the Selection of EIA Methodology, Impact Identification, Impact Measurement, Impact Interpretation and Evaluation, Impact Communication, Methods-Adhoc Methods, Checklists Methods, Matrices Methods, Networks Methods, Overlays Methods. EIA Review-Baseline Conditions – Construction Stage Impacts, Post Project Impacts

#### LEARNING OBJECTIVES

In this unit, you will learn the following concepts,

- ✓ Review the list of methodologies for EIA
- ✓ Check how different methodologies are used in EIA study
- ✓ Choice of EIA methods
- ✓ Objective criteria for selecting an EIA method
- ✓ Evaluate the environmental impacts of the planned projects
- ✓ Develop skills in measurement, evaluation and communication of the impact
- ✓ Familiarize with the construction stage impacts and post project impacts.

#### INTRODUCTION

This unit will enable the readers to develop their knowledge and skills in impact assessment so that they understand the major methodologies used for EIA study, namely, the adhoc method, checklists method, matrices method, network method, overlays method and modeling methods. All these simple methodologies for EIA have been devised to aid in identification, prediction and assessment of impacts. Further, this information helps one to choose the most appropriate method for a given situation. Each of these methods require different kinds of data, different data formats, different levels of expertise and sophisticated technology to interpret with precision and certainty.

## PART-A SHORT QUESTIONS WITH SOLUTIONS

**Q1. What is EIS?**

**Answer :**

The findings of the environmental assessment are reported as Environmental Impact Statement (EIS). It is a comprehensive, clear and concise, non-technical summary of the description of the project, including location, design, scale, size, mitigation measures to minimize or avoid the potential adverse impacts of a project and a more detailed section on the technical aspects of the assessment. EIS should contain specific information describing the effect on the environment due to the proposed development along with the impact on humans, flora, fauna, soil, water, air, climate and cultural heritage.

**Q2. Discuss about monitoring stations.**

**Answer :**

Monitoring stations contain instruments to measure various parameters in air. They are setup in select areas, such as the project area to record the baseline condition of the impacted area. These include the environmental parameters that are sensitive for the project under consideration. The ambient pollution data, meteorological data, air quality data, water quality data, noise levels, site specific data parameters are recorded before the commencement of the project and post-development stage. The monitoring stations should be located while keeping in mind, the following parameters, such as:

- (i) Direction of wind
- (ii) Topography of the area
- (iii) Location of water bodies
- (iv) Location of residential areas
- (v) Location of environmentally sensitive areas
- (vi) Location of polluted areas
- (vii) Availability of power and security to the monitoring station.

**Q3. Enumerate the major methodologies for EIA.**

**Answer :**

The major methodologies for EIA are,

- (i) Adhoc method
- (ii) Checklists method
- (iii) Matrices method
- (iv) Networks method
- (v) Overlays method
- (vi) Modelling method.

Model Paper-I, Q1(c)

**Q4. Explain the need for different methodologies for EIA.**

**Answer :**

The Environmental Impact Assessment (EIA) team consists of at least 20 members organized specifically for the environmental impact study. The members of the EIA team comprise of a team leader, a hydrologist, irrigation/drainage engineer, soil conservation expert, fisheries biologist/ecologist, an economist, an environmental scientist, agronomist/pesticide expert, a social scientist, a health scientist (epidemiologist), planner, consultants, wildlife biologist, a transportation engineer, air quality specialist, archaeologist and other experts in their respective fields. The members of the EIA team form an important technical part of EIA procedure to identify, predict and to quantify or qualify the changes in the environmental parameters like air, water pollution and noise pollution or the biodiversity owing to any developmental activity.

Model Paper-II, Q1(c)

The EIA methodologies help the reviewers to understand the results and the manner in which they were obtained. Further, it helps to prevent the harmful environmental impacts owing to the project activity.

**Q5. What is the quality index method?**

**Answer :**

Environmental Quality Index method is a standard protocol to study the quality of the environment along with its effects on human health. In this method, five domains, namely air, water, land, built environment and sociodemography are taken into consideration.

Model Paper-II, Q1(d)

**UNIT-2 EIA Methodologies****Q6. What are the uses of checklists?****Answer :**

The checklist method of EIA covers all the environmental aspects to be investigated. It helps to organize the work and identify important issues related to the environment. This method is sufficient for small scale projects.

It helps to assess the nature of the impacts, for instance - adverse/beneficial, short term/long term, no impact/significant impact, reversible/irreversible.

Further, this method encourages discussion on environmental issues during the early stages of the project.

**Q7. State the importance of predictive methods in EIA.****Model Paper-III, Q1(c)****Answer :**

Many techniques are used for impact prediction of an area. These include the following

1. Informal Modelling/Expert Judgement
2. Mechanistic or Mathematical Models.
3. Physical Model
4. Mass Balance Model
5. Geographical Models
6. Task Specific Computer Model
7. Laboratory Experimental Methods.

Each of these predictions need expertise in each field of impact.

According to Glasson *et al*, 2005, "the objective of impact prediction is to identify the magnitude and other dimensions of identified change in the environment with the project or action in comparison with the situation without the project or action. It also provides the basis for the assessment of significance."

The predictive methods in EIA give an idea of the following aspects.

- (i) Probability of occurrence,
- (ii) Extent of spatio-temporal impacts,
- (iii) Scaling of impact by use of an alphabet or numerical score,
- (iv) Severity and reversibility of potential impacts,
- (v) Cumulative and/or immediate effects.

**Q8. Differentiate between adhoc and overlay methods.****Model Paper-III, Q1(d)****Answer :**

S.No.	<b>Ad-hoc Method</b>	<b>Overlay Method</b>
1.	It provides poor guidance for an impact assessment of a proposed activity.	It provides detailed guidance for an impact assessment of a proposed activity.
2.	The method is dependent on the expertise of EIA panel.	The method depends on the physical or electronic maps.
3.	The method is incomprehensive and lacks consistency.	The method provides a comprehensive and consistent analysis.
4.	The conclusions are based on the experience, training and intuition of professionals involved in the analysis.	The conclusions are based on direct impacts.

**Q9. Discuss the cost benefit analysis in EIA.****Answer :**

The cost benefit analysis method of EIA identifies the benefits of various development activities, specifies the costs and benefits, quantifies them and assigns economic values to the same. The economic value of an environmental impact can be analyzed by asking people whether they are Willing To Pay (known as WTP) to reduce the concentration of the pollutant. There is yet another technique, called Willingness To Accept (WTA), wherein the public is asked about the extent to which they would be willing to accept the change in environmental services.

**2.1 ENVIRONMENTAL ATTRIBUTES**

**Q10. Explain the systematic approach for using EIA as a planning tool for major project activities.**

Model Paper-I, Q4(b)

**Answer :**

The systematic approach for using EIA as a planning tool involves the following phases:

- (i) Planning
- (ii) Final design or construction
- (iii) Project operations.

Planning	Final Design or Construction	Project operations
<ul style="list-style-type: none"> <li>❖ Initial project proposal</li> <li>❖ Project feasibility study</li> <li>❖ Preliminary</li> </ul>	<ul style="list-style-type: none"> <li>❖ Review and selection of project alternative for implementation</li> </ul>	<ul style="list-style-type: none"> <li>❖ Environmental monitoring</li> </ul>

1. An environmental base map is prepared showing all the information including essential background information on the environmental situation such as land use, ground water, demography, ecological resources, cultural, archaeological and meteorological conditions. It details information in a simple manner with schematic representation.
2. The study area varies according to the project and includes land, water bodies, vegetation and population. Surrounding environment also has an impact on the study area. Meteorological conditions are also considered in the study area along with other environmental parameters.
3. Environmental parameters may be physical, chemical, biological or economical or social or cultural.
4. The study requires a large team that gives inputs individually depending on the discipline.
5. A preliminary evaluation of the situation is carried out to prepare terms of reference.
6. Preparation of an EIA report is carried out with any one of available possible techniques. A standard format of an organization is recommended that includes,
  - (i) The description of the proposed project.
  - (ii) The description of the existing environment.
  - (iii) Selection of impact indicators.
  - (iv) Predict the nature and extent of environmental effects.
  - (v) Identification of human concerns.
  - (vi) Assessment of significant impact.
  - (vii) Incorporation of mitigating and abatement measures into the project plan.
  - (viii) Identification of environmental costs and benefits of the project.
  - (ix) Report on the assessment.

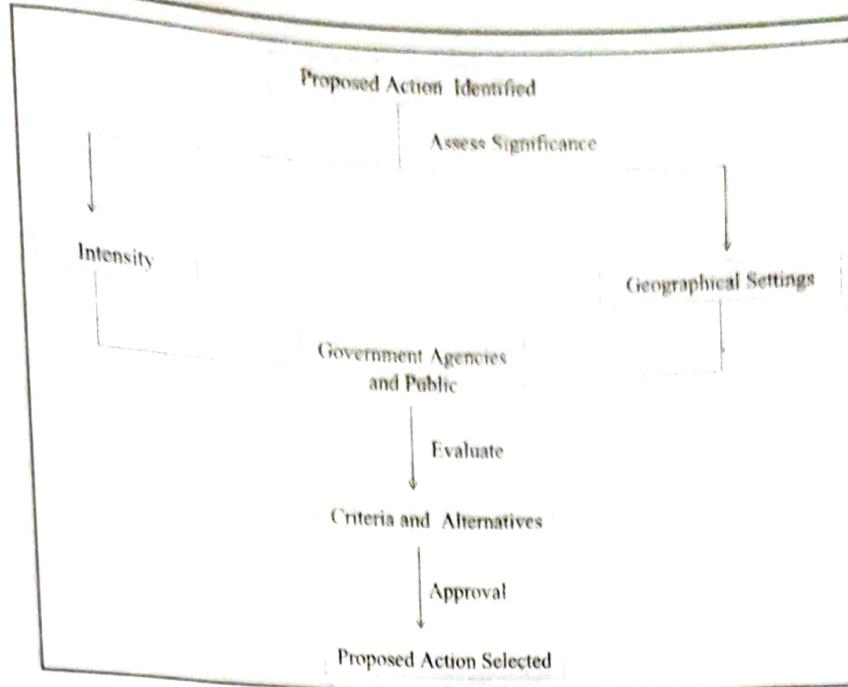
**Q11. How is a proposed action selected for carrying out the project.?**

**Answer :**

After the assessment procedure of various steps involved in preparing a statement, selection of the proposed action is done. It involves understanding the significance of proposed action in terms of intensity and geographical settings of the proposed action area.

The assessments involve contributions from various sectors and requires coordination of various members of a team. The alternatives having least impact on the environment are selected, in a way, a comparison is carried out. It involves government agencies and their approval in coordination with general public. Decisions made are evaluated with the required criteria and alternatives prior to final approval.

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**Figure: Overview of the Proposed Action Selected for Setting up the Project**

The format of the report as per CPCB is,

- Introduction
- Description of the project
- Description of the existing environment
- Anticipated environmental impacts and mitigation measures
- Environmental monitoring programme
- Additional studies
- Project benefits
- Environmental management plan
- Summary and conclusion.

Environmental monitoring and management plans should be developed for constant monitoring that includes monitoring of environmental parameters and includes environmental resources.

- ❖ Draft and final environmental impact statements contain final results of environmental studies of proposed alternatives available for public and agency views. It acts like a tool for the decision making process. It includes environmental inventory and findings of environmental assessments.
- ❖ Impact analysis is included which details direct, indirect, cumulative, long term and short term effects.
- ❖ Impact analysis should include components like table of contents, list of agencies and persons involved with simple and clear language.
- ❖ The report is then processed for public hearing with the help of government agencies. It is modified according to the opinion received from the public by the responsible agency before preparing the final statement. At the end of the document, public hearing responses and comments are included.

#### **Q12. Explain the process of selecting a preferred alternative for EIA process.**

**Answer :**

A preferred alternative is selected after collecting and analyzing the suggestions and comments received from the survey.

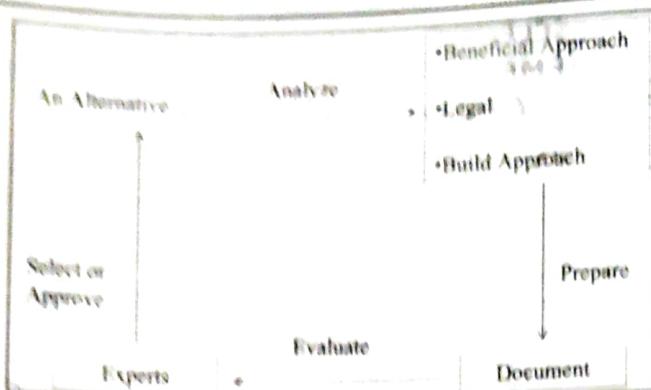
The selected alternative is compared to all other alternatives using the evaluation criteria and measurement parameters.

Documentation is prepared detailing all aspects of the decision selected, including reasons. It involves a collective decision with each member of the team preparing a summary of impacts and comments received that are finalized in a meeting. The analysis includes pros and cons of the alternatives preferred.

An alternative suggesting position output, having a good approach to build and complete the action is selected. An alternative having a less beneficial approach is eliminated. Thus, step by step, the least beneficial approaches are eliminated.

The legislative and regulatory aspects are considered next. An alternative not meeting the legal criteria is eliminated.

The build approach is considered which includes cost analysis as well as implementing agencies.



**Figure: Overview of Preferred Alternatives for EIA Process**

**Q13. Explain how the potential impacts of EIA are identified.**

**Answer :**

Identification of impact is one of the preliminary steps to carry out an EIA. It involves reviewing proposed project alternatives and pertaining questions.

The first step is to identify the type of project i.e., if it is residential or commercial project. Then, the study area characteristics are analyzed, if they are natural or man-made.

The potential impact due to significant changes proposed are assessed and the impact of alternate strategies adopted are analyzed. Based on the analysis, subsequent decisions are made to carry out with appropriateness.

Some examples of various impacts are:

#### **Physical**

- Air – Degradation, type of emissions released
- Water – Availability, quality, use, pollution, etc
- Solid waste – Excess generation, etc
- Natural Resources – Effects on natural resources etc
- Soil – Effects on stability of soils, etc
- Geology – Availability of energy sources etc
- Man made facilities – Structures, transportation, etc
- Physical Amenities – National parks, monuments, etc
- Technology – Hazards, safety measures, etc
- Processes – Floods, erosion, deposition, etc.

#### **Biological**

- Vegetation – Destruction of forest cover, changes in species, diversity, etc
- Health – Free from natural disasters, etc
- Ecological – Food chain, diseases, etc
- Psychological – Stress, challenges, etc.

#### **Economical**

- Economic and occupational – Displacement of population services, distribution pattern, etc.

#### **Social**

- Cultural – Leisure, fashion, etc
- Lifestyle – Food, housing, recreation, etc
- Relationships – Family life, feelings, etc
- Amenities – Hospitals, schools, etc
- Traditional belief – Symbols, values, etc
- Aesthetic – Visual physical challenges, moral conduct, etc
- Legal – Public policy, change in taxes, etc
- Political – Authority, structure of decisions, etc
- Statutory Laws – Quality standards, bye laws, etc.

## 2.2 CRITERIA FOR THE SELECTION OF EIA METHODOLOGY, IMPACT IDENTIFICATION, IMPACT MEASUREMENT, IMPACT INTERPRETATION, AND EVALUATION, IMPACT COMMUNICATION.

**Q14. State the objectives of EIA.**

**Answer :**

- A wide range of techniques and methods have been developed for use in the EIA study, with the following objectives,
- Model Paper-III, Q4(a)**
- (a) To develop an understanding ability of the natural environment and designate a tract of land for the proposed project and suggest possible alternatives.
  - (b) To determine the evaluation and assessment objectives.
  - (c) Initial identification of impacts and scoping.
  - (d) Baseline studies prior to setting up of the project.
  - (e) Prediction and assessment of impacts on the environment due to the proposed project and provide a comparison of alternatives.
  - (f) Mitigation of negative impacts of the proposed development on the environment.
  - (g) Provide mitigation and monitoring measures that needs specific action to be carried out by the proponent during project construction and operation.
  - (h) Organize the voluminous data pertaining to environmental parameters or components and the suitable action taken.
  - (i) Accede to data summarization.
  - (j) Assemble the recorded data into smaller sets with minimal loss of information.
  - (k) Present the raw information and the derived data in a direct and suitable manner.

**Q15. Discuss about the criteria for the selection of EIA methodology.**

**Answer :**

**Model Paper-I, Q4(a) | July-21, (R16), Q2(b)**

- The criteria for the selection of EIA methodology are broadly categorized into four components. They are,
- (a) Impact identification
  - (b) Impact measurement
  - (c) Impact interpretation
  - (d) Impact communication.

### **(a) Impact Identification**

Impact identification should include the following criteria,

#### **(i) Comprehensiveness**

The EIA method should contain exhaustive information about the impact in order to facilitate effective decision-making.

#### **(ii) Specificity**

The methodology should be able to describe the specific parameters which could be affected by the impact.

#### **(iii) Discriminative**

The methodology should be able to distinguish the impact of project activities and the possibility of environmental changes that are likely to occur in future.

#### **(iv) Temporal and Spatial Dimension**

The methodology should be able to identify the impacts on a temporal and spatial scale.

### **(b) Impact Measurement**

Impact measurement should include the following criteria,

#### **(i) Commensurate**

A comparison between alternative EIA methodologies is enabled with the help of commensurate units.

The methodology  
measure of the impact.

(iii) **Measurable Indicator**

The methodology should provide the magnitude of measurable changes of impact.

(iv) **Objective**

The methodology should lay emphasis on the objective rather than subjective measurement.

(c) **Impact Interpretation**

The impact interpretation should include the following criteria,

(i) **Significance**

The methodology should be able to evaluate the significance of impact on a local, regional and national scale.

(ii) **Explicit Criteria**

The methodology should be able to provide direct/straightforward expression of the impact significance.

(iii) **Uncertainty**

The unpredictable nature of an impact on the environment is a major problem which should be emphasized in any methodology.

(iv) **Risk**

Increased attention should be given to evaluate the probability or likelihood that adverse ecological effects will occur as a result of exposure of the environment to various stressors from anthropogenic activities.

(v) **Alternatives Comparison**

The method should be able to provide comparison of the proposal and the alternatives to it based on activity, location, process, demand, scheduling, inputs, routing, site layout, scale, as well as design of the project.

(vi) **Aggregation of Information**

The method should provide in-depth information on impact measurement and analysis.

(vii) **Public Involvement**

The method should include inputs by the public apart from developers, consultants, decision-making authorities, environmental authorities and consulters for the analysis of impact significance.

(d) **Impact Communication**

The impact communication should include the following criteria,

(i) **Affected Parties**

A good communication about the environmental impact should be established to indicate the affected parties.

(iii) The method of presentation of the project to the public.

(iv) **Key Issues**

The methodology should highlight the key issues identified in the assessment process.

(v) **Legal Compliance**

The methodology should lay special emphasis on the legal requirements of project impacts.

**Q16. Briefly discuss the role of impact evolution and analysis in the EIA processes.**

**Answer :**

Environmental impact evaluation is one of the complicated steps in an EIA process. The project related environmental impacts first need to be predicted based on the scientific understanding of cause-effect relationship. Experts in this field are of the view that different approaches are used to evaluate the impact significance.

The magnitude of an impact and its characteristics can be determined by the following criteria:

- The nature of impact, whether it is positive, negative, or neutral.
- The extent to which the impact has spread and its distribution.
- Intensity of impact, whether it is low, moderate or severe.
- Duration of impact, whether it is temporary or permanent, continuous or intermittent.
- The possibility of mitigation of negative impact and to what extent.
- Is the impact reversible or irreversible?
- The changes of occurrence of impact.

When there are other projects which are either in the development stage or completed, the result would be a cumulative impact prediction. However, prediction of impacts are usually ascertained by case studies as examples or analogies, studies related to quantitative mathematical models, statistical models, pilot models and experiments.

Following the identification and prediction of impacts, interpretation of impact is carried out to find out alternatives so that appropriate decisions are taken to reduce the environmental impact.

Some of the several evaluation methodologies (also referred as 'tools') for evaluation of environmental impacts from human activities include the following:

### 1. Risk Assessment Methodology

This methodology involves the following steps:

- (a) Hazard identification
- (b) Risk estimation
- (c) Risk communication.

All these steps aim at identifying the risks and reducing their impact to an acceptable level.

The objectives of risk assessment during any project activity (for instance, construction activity) are:

- (i) Identification of chemical and physical sources of contaminants and pollutants of the environment.
- (ii) Identification of specific construction activities that generate pollutants.
- (iii) Identification and adoption of pollutant control methods.
- (iv) Identify the locations where the inhabitants are likely to encounter air-borne pollutants.

### 2. Cost-Benefit Analysis (CBA)

This method identifies the benefits of various development activities, specifies the costs and benefits, quantifies them and assigns economic values to the same. The economic value of an environmental impact can be analyzed by asking people whether they are Willing To Pay (known as WTP) to lower the concentration of pollutants.

There is yet another technique, called Willingness To Accept (known as WTA), wherein, the public is asked regarding the extent to which they would be willing to accept the change in environmental services.

### 3. Hedonic Method

The Hedonic method is used by environmental economists to value environmental goods and services. When people desire to reside in better localities, the price of land and housing increases due to the environmental quality and environmental amenities (such as aesthetic views, recreational facilities and visual amenities). Essentially, the hedonic method attempts to establish a relationship between the residential property values and environmental attributes of the neighbourhood.

Other methods used for environmental impact evaluation are – environmental cost accounting, environmental accounting, Life Cycle Costing (LCC), under the field of environmental economics.

### 2.3 METHODS - ADHOC METHODS, CHECKLISTS METHODS, MATRICES METHODS, NETWORK METHODS, OVERLAYS METHODS

#### Q17. Describe the EIA methodologies.

**Model Paper-II, Q4(a)**

##### Answer :

The environmental impacts of proposed projects are evaluated and assessed by some of the methods discussed below,

#### 1. Adhoc Method

In this method, a team of experts sit together to conduct the total impact assessment and suggest the broad areas of possible impacts. The conclusions are based on the experience, training and intuition of experts involved in the discussion.

#### 2. Checklist Method

This method consists of boxes or cells that must be filled with information about the nature of the impact. Thus, the information is well organized and ensured that no potential impact is overlooked. So, a summarized information about the project is made available to the specialists and decision-makers.

Checklists are of four types,

##### (i) Simple Checklist

It consists of a simple list of generalized knowledge of environmental parameters likely to be affected.

##### (ii) Descriptive Checklist

It consists of guidelines on the methods to collect data on particular environmental parameters.

##### (iii) Scaling Checklist

It consists of data on environmental parameters with additional information on subjective scaling of the parameters.

##### (iv) Scaling Weighting Checklist

It consists of detailed information of subjective evaluation of each environmental parameter.

#### 3. Matrix Method

This method consists of a list of various project actions and environmental parameters as well as components that might be affected by project activities. In general, it consists of columns and rows corresponding to the project actions and environmental conditions respectively. Combining the columns and rows provides an analysis of cause-effect relationships between specific activities and its environmental impacts.

Matrices are of two types. They are,

##### (i) Simple Interaction Matrices

They are used in scoping the environmental impact assessment, for identifying the interactions between project activities and specific environmental components.

##### (ii) Significance or Importance Rated Matrices

This method needs in-depth information and expertise about various environmental impacts.

#### 4. Overlay Method

This method is based on a set of maps depicting the environmental characteristics of the project area. The characteristics are recorded on a series of maps, one for each variable. The maps thus generated are then overlaid to produce composite characteristics (including physical, social, ecological, land use features, etc.) of the area's environment.

#### 5. Network Method

This method consists of a list of project activities to produce the cause-condition-effect networks. It gives an insight into the identification of primary, secondary, tertiary and higher order impacts.

A network consists of several aspects of the project, for instance, the different types of primary impacts, primary impact areas, the secondary impact areas, the different types of secondary impacts etc. The method includes identifying the first order changes in environmental components, followed by identifying the second order changes resulting from the first order changes and then, the third order changes resulting from second order changes and so on. Thus, this method helps in analyzing the underlying relationship between a number of activities, components and the causes for environmental impacts.

#### Q18. Explain the adhoc method in context of EIA.

Model Paper-II, Q4(b)

##### Answer :

The ad hoc method for carrying out EIA involves a team of professionals, based on their expertise, to identify the possible environmental impacts of a proposed project merely on experience, training and intuition. The expert's opinions are put together into a report. Thus, the conclusions are based on experience, training and intuition of professionals involved in the discussion. The primary advantage in this method is the possibility to modify it according to specific circumstances. The information provided in this method can be easily understood by the lay person.

An illustration of the adhoc method for a hypothetical highway road project is as given below.

Impact Area	No Effect	Positive Effect	Negative Effect	Adverse	Beneficial	Problematic	Short Term	Long Term	Reversible	Irreversible
Wildlife			x						x	x
Endangered sps			x						x	x
Natural vegetation							x			x
Exotic species				x		x			x	x
Soil characteristics	x									
Natural drainage	x									
Groundwater	x									
Noise				x		x				
Paved surface		x								
Recreation	x									
Air quality			x							
Disruption of sensitive visual landscape			x					x		x
Open space	x									
Health, safety and welfare	x									
Public facilities		x								
Public amenities		x								
Employment opportunities		x								

Table: Illustration of Adhoc Method of a Highway Road Project

'x' indicates potential for the type of impact.

## UNIT-2 EIA Methodologies

### Drawbacks of Adhoc Method

- Some of the drawbacks in this method are,
- This method provides little or no guidance for an impact assessment.
- The EIA report may not include all the relevant impacts.
- It is difficult to identify and include a proper panel of experts to assess each type of impact.
- The EIA by adhoc method suggests a broad area of possible impacts but lacks information about cause-effect relationships.
- The detailed scientific investigation of environmental impact of project is not taken into consideration.
- This method is considered very poor for identification, prediction and analysis of impact.

**Q19. Write a short note on a simple checklist and a descriptive checklist.**

**Answer:**

### Simple Checklists

In simple checklists a valid approach to provide systemization to an EIS is represented. A list of environmental factors assumed in construction and operational phases is shown in the table below.

S.No.	Environmental Factor	Phase of Construction			Phase of Operation		
		Beneficial Effect	Adverse Effect	No Effect	Beneficial Effect	Adverse Effect	No Effect
1.	<b>Land Transportation and Construction</b>						
	(i) Compaction and settlement						
	(ii) Erosion						
	(iii) Ground cover						
	(iv) Deposition						
	(v) Stability						
	(vi) Stress-strain						
	(vii) Floods						
	(viii) Waste control						
	(ix) Drilling and blasting						
	(x) Operational failure						
2.	<b>Land Use</b>						
	(i) Open space						
	(ii) Recreational failure						
	(iii) Residential						
	(iv) Industrial						
	(v) Agricultural						
	(vi) Commercial						
3.	<b>Air Quality</b>						
	(i) Oxides						
	(ii) Chemical						
	(iii) Gases						
	(iv) Particulate matter						
	(v) Odours						
4.	<b>Water Resources</b>						
	(i) Quality						
	(ii) Groundwater						
	(iii) Irrigation						

5.	<b>Biological Conditions</b> (i) Wildlife (ii) Grasses (iii) Trees, shrubs					
6.	<b>Service System</b> (i) Police (ii) Schools (iii) Water and power system (iv) Sewerage system (v) Fire protection (vi) Reuse disposal					
7.	<b>Aesthetics</b> (i) Scenery (ii) Structures					
8.	<b>Transportation Systems</b> (i) Automobiles (ii) Trucking (iii) Safety (iv) Movement					
9.	<b>Noise and Vibration</b> (i) On-site (ii) Off-site					

**(b) Descriptive Checklists**

Descriptive checklist involves recognizing the environmental parameters and guidelines regarding the methodology of collecting data on specific parameters. It consists of convincing information of whether the impact would occur or not along with the nature and magnitude of impacts, owing to a developmental activity.

For instance, noise pollution in a particular area can be assessed by the current noise levels, sources of noise, movement of vehicular traffic, noise mitigation measures, models used for study of noise propagation, conducting surveys, the number of people affected by the noise, etc.

There are several descriptive checklists for the use of water resources projects. Several environmental factors are suggested by Canter and Hill for project evaluation. For each and every factor, information is included on its prediction of impacts, functional curves for data interpretation and its definition and measurement.

**Q20. Write the important characteristics of simple and descriptive checklists.****Answer :**

The important characteristics of simple and descriptive checklists are as follows,

- When simple and descriptive checklists are adopted for a specific project, then the environmental factors or impacts are evaluated for planning and conducting of EIS.
- Project specific checklists adopt professional credibility and usability which indicate the collective professional knowledge and judgement of their developers.
- Under Environmental Impact Studies (EIS), key impacts or environmental factors are identified through structural approach provided by checklists.
- At the time of planning, conducting or summarization of environmental impact studies, checklists are used to facilitate interdisciplinary team discussions.
- This checklist carefully defines the usage of spatial boundaries and environmental factors along with the special codes used within the checklist.
- The key factors or impacts identified through rational basics are accomplished. This accomplished rational basics are documented by determining the factor-impact quantification and comparing to pertinent standards.
- The key factors or impacts evaluated from the checklist (i.e., simple or descriptive) are grouped together in order to explain the secondary and tertiary impacts on environmental system interrelationship.
- Key factors or impacts are allotted (given) with important weight with clear indication of rationale and methodology.
- Systematic usage of checklists identify mitigated key impacts.

## UNIT-II EIA Methodologies

**Q17.2 Explain how do you use checklist method for EIA? What are the advantages of checklist method over adhoc method?**

**Answer:**

For answer refer Unit-II, Q17, Topic: Checklist Method, Q20.

### Advantages of Checklist Method Over Adhoc Method

Advantages of checklist method over adhoc method are as mentioned below:

The information related to the environmental impacts of the proposed project comprises the environmental components, projects, characteristics, the potential impacts and the mitigation measures. The information is filled in boxes or cells in a well-organized manner to ensure that no potential impact is overlooked.

The project proponents may be made aware of the expected possibilities while assessing a proposed project.

Increased awareness of the environmental aspects of a project can be generated.

The scaling weighting checklist method helps in quantifying the impacts very well.

### Differentiate between simple checklist and descriptive checklist.

**Answer:** The differences between the simple check lists and descriptive checklists are indicated below.

Simple Checklist	Descriptive Checklist
1. The simple checklist consists of a simple list of generalized knowledge of environmental parameters likely to be affected.	The descriptive checklist consists of guidelines on the methods to collect data on particular environmental parameters.
2. It does not need information on the magnitude or importance of impacts.	The information on specific variables such as magnitude and importance of impacts is necessary.
3. It has a simple list of parameters without the guidelines about the manner in which the environmental effects are to be measured.	It also includes detailed information about the projects, such as social impacts, economic impacts and physical impacts.
4. It does not include the specific data needs, methods for measurement, impact prediction and assessment.	It has information on measurement and impact prediction and assessment.

### Write short note on scaling checklist and weighting scaling checklist.

**Answer:**

#### Scaling Checklists

The most fundamental function of an EIA is impact identification and for this process, all types of checklists do well. But Oregon scaling checklist methods go ahead and give an idea of impact nature by assigning long-term direct i.e., textual rating impact. In impact measurement, this process is not suitable and it provides very less in the decision-making process.

In latter types, the scaling and weighting element which is inherent makes it easy in decision-making. These checklists strong in impact identification and the impact measurement functions are incorporated to a certain degree those of evaluation interpretation.

#### Weighting and Scaling Checklists

To select alternatives, various methods were developed based on the following,

The measurement units for each and every factor have to be estimated.

The aggregation method is established across all the factors produced.

The important environmental factors for the activity for which EIA has to be done are fixed.

The fixed unit data with respect to different sets of environmental factors have to be collected.

For each and every environmental factor, the interval scale must be fixed and the conversion of data into an environmental factor index.

**Q24. Describe matrix method in detail.****Answer :****Matrix Method**

In this method, a two-dimensional table is used to assess the possible impact arising from the interaction between project activities and components of the environment. Matrices are of the following types,

**(i) Leopold Matrix (LM)**

Leopold matrix is considered to be the most popular method for evaluation of the effect or impact of a proposed development on the environment. It is so named in honour of Dr. Luna Leopold, the developer of this method.

The Leopold matrix consists of many interaction cells which result from nearly 100 development activities of the proposed project arrayed along the horizontal axis and nearly 88-90 environmental parameters (or components), including physical, chemical, biological and socio-economic factors, along the vertical axis. This provides a total of 8800 to 9000 interactions.

Whenever an impact on the environment is expected, the cell is marked with a diagonal line, with the Magnitude (M) of the possible impact in the upper section in the cell and Importance (I) of the possible impact in the lower section in the cell.

The numerical value entries in the cells of the matrix range from one to ten, the value of ten means the greatest magnitude of impact, and the value of one means the least magnitude of impact.

Similarly, the lower section of the cell containing the importance of environmental impact is assigned numerical value from one to ten. High numerical value means high importance and low numerical value means low importance. A plus/ '+' sign indicates positive impact and a negative/ '-' sign indicates a negative impact.

A representation of the Leopold Matrix (LM) is as given below.

		Project actions				
		a	b	c	d	e
Characteristics and conditions	A	2 4				-9 5
	B	3 2				
	C	2 2	-8 8	3 1		

**Figure: Representation of Leopold Matrix Method**

Some important aspects of this methodology are,

- The Leopold matrix is considered to be an excellent basic tool.

- It gives a clear picture of the possible environmental impacts of a project development on the environment.
- The positive and negative impacts, owing to the project development activity, are also known by this method.

**(ii) Modified Graded Matrix (MGM)**

The modified graded matrix method was developed by Lohani and Thanh, wherein, each developmental activity that is undertaken is allocated a relative weight. The developmental activities are placed in the vertical column, whereas the interactions are placed in horizontal rows. The horizontal values are summed up. The sum of the values in the vertical column are multiplied by the priority value. The value thus obtained is used to assess the possible environmental impact due to a proposed developmental activity.

**(iii) Impact Summary Matrix (ISM)**

Impact summary matrix method provides a summary of the impact assessment by determining the potential impact areas, by anticipating the degree or intensity of environmental impact, by indicating the mitigation measures, by identification of agencies (ministries and departments) or interested groups or individuals responsible for implementing mitigation measures.

**Q25. What are the salient features of the matrix method.****Answer :**

- Following are the salient features of matrix methods.
  - In the matrix method, spatial boundaries of environmental factors are required to define whether the project should be related with temporal phases and specific actions and the matrix should use impact rating or summarization scale.
  - A matrix along with a key factor acts as a tool for analyzing and explaining the rationale use of impact rating allotted to given temporal phase, project action, spatial boundary and environmental factor.
  - The potential environmental impacts of a proposed action are discussed by developing one or more preliminary matrices. Therefore, each team member in the early stage understands the implication of the project and develops detailed plans.
  - If a proposed project observes large differences in spatial boundaries and temporal phases, then impact rating should be interpreted carefully.
  - Interaction matrices are used to indicate the impacts of projects. It includes the impact of present, other past, future actions and potential positive effects of mitigation measures.
  - Interaction matrices indicate the comparisons between various alternatives. It is required to adopt the same matrix in terms of spatial boundaries, environmental factors, temporal phases and project actions for each analyzed alternative.

- The impact rating for various project actions and environmental factors are assigned through a valuable basis provided by impact qualification and comparisons to relevant standards.
- In the anticipated impacts, color codes are used for displaying and communicating information, whereas the impact matrices are adopted without incorporation of number, letter, color rating.
- In the interaction matrices, project action and environmental factors are considered separately but in the matrix group of actions, factors or impacts are identified together in order to allow the delineation of preliminary and secondary effects of projects.
- The development of the preliminary interaction matrix is used as an internal working tool in the study, planning and development of EIS.
- In a simple interaction matrix, it is possible to use important weights for environmental factors and project actions. Interaction matrix prevents the overriding attention provided to one particular action of environmental factor.

#### **Q26. What are the interaction matrix methods? Discuss with reference to the leopold matrix method.**

**Answer :**

Interaction matrix method displays the project action (or) activities on one axis and suitable environmental factor on the other axis, whenever a particular activity causes an effect to environmental factors then their effect will be observed at the intersection point in the matrix. This effect also includes the magnitude of separate or combined effects and their significant considerations.

Leopold developed a simple interaction matrix method which examines 100 specified actions and 90 environmental factors approximately. In this method, the number of actions and environmental factors can be increased or decreased respectively.

Leopold gave a procedure for determining the environmental impact of development projects. It is an environmental matrix, which shows possible interaction between development activities and a set of environmental characteristics. Leopold matrix is used to identify impacts at different temporal phases of project. It also explains the association of impacts with various spatial boundaries at the site and in the region. Leopold matrix adopts appropriate designators (like plus and minus sign) in order to identify beneficial as well as detrimental impacts.

The simple interaction matrix developed by Leopold is utilized for analyzing the impacts on other types of projects like flood control, highway transmission line, offshore oil lease, power plant, coal mine, industrial plant, pipeline, housing development and coastal development projects.

#### **Q27. Describe how the matrix method is used for the EIA of a mining project.**

**Answer :**

The matrix method consists of a list of various project actions and environmental parameters, as well as components that might be affected by project activities. In this method, a two-dimensional table is used to assess the possible impact arising from the interaction between project activities and components of the environment.

The mining projects, for instance coal mines, occupy vast stretches of land. The environmental issues related with coal mining operations include air and water pollution hazards, land subsidence, environmental deterioration, disturbance to the social and ecological structure, etc.

The process of extracting minerals and their ores from the earth's crust by digging is known as mining. The process of mining poses a threat to the environment and also to the workers working in mines. The impact of the mining activities on the soil are as mentioned below,

1. Mining leads to deforestation due to the diversion of forest land for mining purposes. This is because large areas of land are needed so that miners can dig into the earth.
2. Apart from large scale deforestation, the vegetation of the surrounding areas has to be cleared to lay roads and construct residential facilities for the mine workers.
3. Large scale deforestation leads to loss of biodiversity due to loss of habitat of the animal species.
4. Mining operations cause ground compaction due to the heavy machinery operations, traffic and storage activities etc.
5. The mining dust causes change in the texture of the parent soil, the soil components like soil horizons, soil structure, soil microbe population, nutrient cycles.
6. Washing off toxic metals into nearby land surfaces reduces soil fertility.
7. Loss of vegetation may enhance weathering (both physical and chemical). The rain-bearing clouds formed in the mined areas pick up carbon dioxide from the atmosphere and form a weak acid. When the rain falls, the weak acid attacks the exposed rock surface and causes its weathering.

8. The immediate impact of mining activity is Acid Mine Drainage (AMD). Acid Rock Drainage (ARD). It is the outflow of acidic water from coal mines or abandoned mines of metals. This usually occurs when the sulphide minerals are uncovered during the process of mining. Acid Mine Drainage is hazardous to the environment as it disrupts the cycle of nature. It also forms a blanket over the water bodies, usually streams and rivers and prevents the entry of sunlight, thus photosynthesis does not occur. This leads to the death of the aquatic plants, thus disturbing the aquatic ecosystem.
9. Change in natural drainage. The groundwater recharge through the surface reduces, because reduced infiltration results in increased surface runoff, leading into sedimentation ponds which can then overflow into the nearby streams.
10. Disruption in the aesthetics of the landscape.

A hypothetical example of simple matrix of mining project is presented below :

Environmental Factors	Project Activities					
	Denuding of Vegetation	Blasting of rocks	Stripping of overburden	Coal extraction	Coking coal washeries	Transportation of coal
Air		✓			✓	
Water				✓	✓	
Soil	✓	✓	✓			
Landform			✓			
Vegetation	✓					
Forestry	✓					
Socio-economic benefits					✓	
Human health	✓	✓	✓	✓		✓
Noise		✓				

Table: Tabular Representation of Simple Matrix of Mining Project

The matrix method for coal mining activities given above provides a list of project activities or actions with a list of environmental factors that may be affected. Such a representation enables us to identify the cause-effect relationships between specific activities and impacts.

#### Q28. Outline the advantages and disadvantages of the matrix method of EIA.

**Answer :**

##### Advantages of Matrix Method in EIA

The advantages of the matrix method in EIA are,

- (i) It is an excellent basic tool which gives a clear picture of the possible environmental impacts of a project development on the environment.
- (ii) The positive and negative impacts, owing to the project development activity, are also known by this method.
- (iii) The matrix method is easy to perform, to present the facts of a project early in the design phase.
- (iv) It contains a wealth of information about the different types of impacts owing to the implementation of developmental projects.
- (v) Less resources are needed to carry out the matrix method.

##### Disadvantages of Matrix Method in EIA

The drawbacks matrix method of EIA are as mentioned below:

- (i) The direct and indirect impacts of a proposed developmental project are indistinguishable.
- (ii) There is a tendency for repeat counting of the impacts.
- (iii) This method provides only the qualitative nature of the project. It does not mention the quantity of impact due to the proposed project.

#### Q29. Explain the leopold matrix in detailed with suitable examples.

**Answer :**

For answer refer Unit-II, Q24 and Q25, Topic: Leopold Matrix (LM) and Q287.

Sep.-20, (R16), Q1(a)

**WARNING:** Xerox/Photocopying of this book is a CRIMINAL act. Anyone found guilty is LIABLE to face LEGAL proceedings.

**Q12. Describe the adhoc and matrix methods for EIA process.**

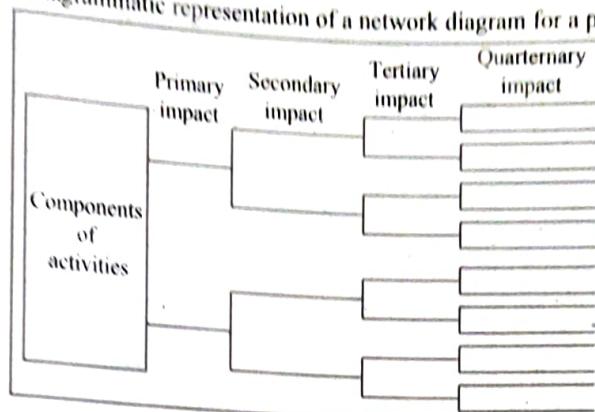
July-21, (R16), Q2(a)

**Answer :**  
For answer refer Unit-II, Q18 and Q24.

**Q13. Explain about the network method environment media.**

**Answer :**  
Network method is used in predicting the potential impact by using directional diagrams in an easy-to-understand manner. This method was developed by Sorenson in 1971. In this method, the different types of possible impacts (namely, the primary, secondary and tertiary impacts) resulting from developmental activities are envisioned and the web of environmental relationships are depicted in the form of a network.

The figure given below is a diagrammatic representation of a network diagram for a proposed developmental activity.



**Figure: Diagrammatic representation of a network for a proposed developmental activity**

An example of network analysis showing impact of groundwater depletion is given below.

Primary Impacts	Secondary Impacts	Tertiary Impacts	Quaternary Impacts
Decline in groundwater in summer season	<ul style="list-style-type: none"> <li>→ Decrease in the water level of surface waterbodies.</li> <li>→ Loss of income and water withdrawal from underground resources.</li> </ul>	<ul style="list-style-type: none"> <li>→ Mortality of aquatic life.</li> <li>→ Loss in fish capture.</li> <li>→ Loss of wet land.</li> <li>→ Navigation facilities hampered</li> <li>→ Availability of poor quality of water.</li> <li>→ Expenses incurred to purchase water from other sources.</li> <li>→ Travel to distant places to get water.</li> </ul>	<ul style="list-style-type: none"> <li>→ Loss of biodiversity.</li> <li>→ Loss of protein intake.</li> <li>→ Increase in transportation costs.</li> <li>→ Increase in incidence of diseases.</li> <li>→ Reduced income.</li> <li>→ Reduced quality of life.</li> </ul>

**Q14. Write about the quality index method for carrying out EIA.**

**OR**

**Q15. How do you estimate index for a parameter.**

**Refer Only Topic:** Air Pollution Index/Air Quality Index

**Answer :**

Impacts of underconstruction and operation phases of the development activity on the environment are identified and analyzed using several methods. Some of them are mentioned below,

**Delphi Method**

The Delphi method, developed by Olaf Helmer and Norman Dalkey in 1963, is a widely accepted method to study the environmental impact assessment.

**Q30. Describe the adhoc and matrix methods for EIA process.**

**Answer :**

For answer refer Unit-II, Q18 and Q24.

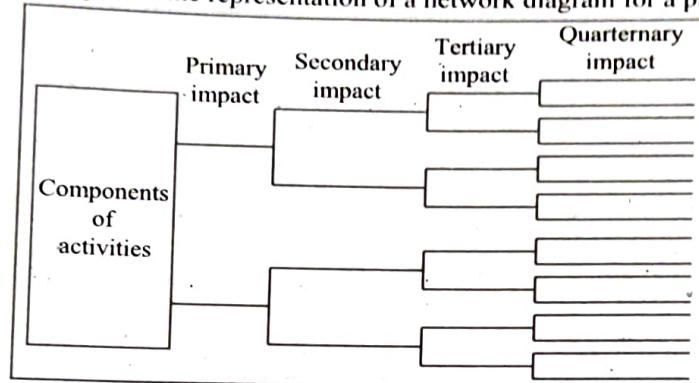
July-21, (R16), Q2(a)

**Q31. Explain about the network method environment media.**

**Answer :**

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**Q32. Write about the quality index method for carrying out EIA.**

**OR**

**How do you estimate index for a parameter.**

*Refer Only Topic: Air Pollution Index/Air Quality Index*

**Answer :**

Impacts of underconstruction and operation phases of the development activity on the environment are identified and analyzed using several methods. Some of them are mentioned below,

**Delphi Method**

The Delphi method, developed by Olaf Helmer and Norman Dalkey in 1963, is a widely accepted method to study the environmental impact assessment.

The technique involves the opinion of a group of experts, with a working knowledge of the project, especially planners, tourism officers, councillors, employees, academics, local residents and traders. All these experts form a panel to identify the important impacts (positive and negative) on the environment, and then arrive at a group consensus.

The method involves the use of a series of questionnaires in an iterative process. Iterative process is a repetitive process to achieve a desired goal, target or result. Several reports have indicated that 3 to 4 iterations are sufficient to collect information related to the environment and reach a group consensus.

The steps involved in the Delphi method are given below,

- A clear description of the project.
- Evaluate the likely impacts of the project in different areas.
- Select a panel of members with expertise in their respective fields.
- Provide a questionnaire to the panel experts. The questionnaire should contain queries pertaining to the subject related to the project. A specific date should be mentioned to receive the questionnaires from the panel experts.
- Evaluate the responses received from the panel experts.
- A second document (or a second round questionnaire) is sent to the panel experts in the absence of an acceptable response.
- The procedure mentioned in steps 'd' to 'f' are repeated till a satisfactory response (consensus) is reached.

2.

### Air Pollution Index/Air Quality Index

Air pollution index/air quality index is an integral part of environmental quality index. Some of the important methods used to calculate the air pollution index are mentioned below,

#### (a) The Percent Method

In this method, a comparison is drawn between individual pollutants with the ambient air quality standards, followed by calculation of the Air Pollution Index (API), using their average value. For instance, in case of three pollutants in air, API is calculated using the mathematical expression,

$$\text{API} = \frac{1}{3} \sum_{p=1}^3 A_p$$

Where,

$$A_p = \frac{C_p}{S_p} \times 100$$

$C_p$  - Concentration of pollutant  $p$

$S_p$  - Standard value of pollutant  $p$  in ambient air.

#### (b) The Ratio Method

In this method, the ratio between the air pollutants and their respective air quality standard values are calculated. Then, the sum of their average is multiplied by 100.

In this method, API is calculated using the mathematical expression,

$$\text{API} = \frac{1}{3} \left( \frac{I_{CO}}{S_{CO}} + \frac{I_{SO_2}}{S_{SO_2}} + \frac{I_{PM}}{S_{PM}} \right) \times 100$$

Where,

$I_{CO}$  - Individual value of Carbonmonoxide.

$I_{SO_2}$  - Individual value of Sulphurdioxide.

$I_{PM}$  - Individual value of particulate matter.

$S_{CO}$  - Ambient air quality standard values of Carbonmonoxide.

$S_{SO_2}$  - Ambient air quality standard values of sulphurdioxide.

$S_{PM}$  - Ambient air quality standard values of particulate matter.

#### (c) Single Parameter Index

In this method, the single most important parameter is taken into consideration. The pollution index is calculated using the mathematical expression,

$$\text{API} = \frac{I_{SO_2}}{S_{SO_2}} \times 100$$

Where,

$I_{SO_2}$  - Measured concentration of  $SO_2$  in the sample.

$S_{SO_2}$  - Standard concentration of  $SO_2$  in the ambient air.

All the above mentioned methods of calculating air pollution index are in percentage values. The air pollution index evaluated from the analytical values indicates the air quality as mentioned in tabular form.

Index Range	Description of Air Quality	General Health Effects
0 - 25	Clean air	Good
26 - 50	Mild air pollution	Average
51 - 75	Average air pollution	Average
76 - 100	Increased air pollution	Average
> 100	Serious air pollution	Unhealthy

Table: Air Pollution Index and Air Quality

### Pollution Standard Index

Pollution Standard Index (PSI) is used to assess the ambient air quality of any region on a daily basis. An increase in the values of PSI is a cause of concern for the health and well-being of the inhabitants of a region. The PSI values and the general health effects are tabulated below,

Pollution Standard Index (PSI) Value	General Health Effects
$\leq 50$	Good
50 - 100	Average
100 - 200	Unhealthy
200 - 300	Seriously unhealthy
300 and above	Hazardous for health

Table: Pollution Standard Index

### Water Quality Index (WQI)

Water quality index provides important information to the concerned citizens and policy makers regarding the several water quality parameters at a particular region and time. This information is based on selected physical, chemical, biological and microbiological indicators.

The different types of chemical or physical tests needed to calculate the Water Quality Index (WQI) are,

1. Dissolved oxygen
2. Fecal coliform
3. pH
4. Biological oxygen demand
5. Temperature change
6. Total phosphates
7. Nitrates
8. Turbidity
9. Total dissolved solids.

All the above mentioned parameters occur in different ranges and expressed in different units.

The mathematical expression for calculating the water quality index is,

$$WQI = \sum_{i=1}^n W_i q_i$$

Where,

$q_i$  - Quality of the  $i^{th}$  parameter, the value ranges between 0 and 100.

$W_i$  - Unit weight of  $i^{th}$  parameter, the value ranges from 0 to 100.

$n$  - Number of parameters.

Some of the other models for calculating the WQI are as mentioned below.

- Weighted arithmetic mean
- Weighted geometric mean
- Un-weighted harmonic square mean.
- Fuzzy logic model
- Baseline comparative model.

The value of WQI ranges from 0 to 100. Higher the values of WQI, the more clear and potable is the water concerned.

Model Paper-III, Q4

### Q33. What is the overlay method of EIA?

**Answer :**

#### Overlay Method (also known as McHarg's Method)

This method was proposed by Dr. Ian McHarg at the University of Pennsylvania. In this method, the environmental impacts are displayed pictorially on transparent maps. A diagrammatic representation of the overlay method is given below.

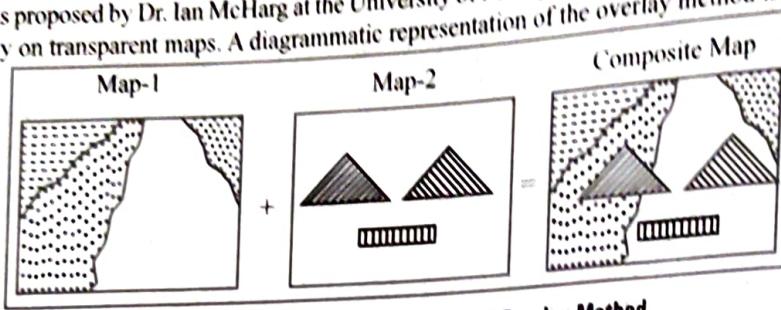


Figure: Diagrammatic Representation of Overlay Method

Each overlay map consists of a pictorial depiction of the area's physical features, social factors, ecological characteristics such as vegetation, settlements, forest cover, wetlands, steep slopes, soils, flood plains, bedrock, wildlife habitats, vegetative communities, biodiversity, cultural resources, engineering structures and other environmental considerations about the area where the proposed development is likely to take place. These maps are then overlaid on the project map and a composite map is obtained which emphasizes the regions with high environmental sensitivity.

Consider an example, where a highway has to be constructed across a region where there are population and other vegetation (for instance, natural forest and agricultural land) that should be taken into consideration. Now, in order to fix a route for the highway with least disturbance to the people and landscape, the overlay method is used in the following manner,

- A map showing the forested region.
- A map showing the agricultural land.
- A map showing the topographic features of the study area.
- A map showing the roads connecting to the nearby towns and cities.

The four maps are placed one over another and a composite map is prepared to determine the best possible route for highway construction. This method is used to assess the changes in the land before and after a construction activity.

This method is not given much importance as it lacks explanation about the cause of impacts. However, it is still considered as an important tool for initial evaluation of the project activity.

A modern method of overlay technique is the computer-based Geographic Information System (GIS). It is used as an important decision-making tool to analyze the geographic features and events on the earth's surface in a digital form. It is information-intensive and provides accurate, reliable and up-to-date information of good quality. With the help of GIS, information on spatial datasets of soil type, vegetation, geology, groundwater, surface water and many other features can be mapped and the digitized information is stored in the GIS database.

### Q34. What are the major methodologies of EIA? Explain any two methods.

**Answer :**

For answer refer Unit-II, Q17, Q18 and Q19.

Model Paper-III, Q5 | Sep.-20, (R16), Q1

### Q35. Explain the following EIA methodologies.

- Adhoc method
- Network method
- Matrix method.

**Answer :**

For answer refer Unit-II, Q18, Q31 and Q24.

Model Paper-I, Q5

**Q36.** List out the impact identification methods of EIA. Explain network method, overlay method and adhoc method.

**Answer :**

For answer refer Unit-II, Q15, Topic: Impact Identification, Q31, Q33 and Q18.

Dec.-20, (R16), Q2

**Q37.** Describe stepped up matrix and network methods.

**Answer :**

A stepped-up matrix, also known as Cross Impact Matrix, is used to analyze/address the secondary and tertiary impacts of project activities. According to Coats, 1976, "in cross-impact analysis individual components are not only evaluated independently but also in relation to each other".

The stepped matrix comprises of rows and columns, wherein the environmental factors are placed against other environmental factors. The entry in the matrix is ascertained a magnitude on a scale of 1 to 6, or with an alphabet, to show the importance of an interaction. It also represents the probability of occurrence of the impact as mentioned below.

A - Detrimental, occurs very frequently

B - Detrimental, generally occurs

C - Detrimental, occurs less frequently

M - Not required

X - Advantageous/favourable, occurs very frequently

Y - Advantageous/favourable, generally occurs

Z - Advantageous/favourable, occurs sometimes

1 - Perpetual/enduring

2 - Moderately enduring

3 - Minor

4 - Robust/powerful

5 - Moderately powerful

6 - Less powerful

Blank - No impact.

**Q38.** Discuss the following terms in the context of EIA.

(a) Network method      (b) Overlay method

**Answer :**

(a) Network Method

For answer refer Unit-II, Q31.

An example of network analysis showing impact of groundwater depletion is given below:

Primary Impacts	Secondary Impacts	Tertiary Impacts	Quaternary Impacts
Decline in groundwater in summer season	Decrease in the water level of surface waterbodies.  Loss of income and water withdrawal from underground resources.	Mortality of aquatic life.  Loss in fish capture.  Loss of wet land.  Navigation facilities hampered  Availability of poor quality of water.  Expenses incurred to purchase water from other sources.  Travel to distant places to get water.	Loss of biodiversity.  Loss of protein intake.  Loss of biodiversity.  Increase in transportation costs.  Increase in incidence of diseases.  Reduced income.  Reduced quality of life.

## (b) Overlay Method

For answer refer Unit-II, Q33.

## Q39. What is the significance of cost benefit analysis in EIA?

Sep.-20, (R16), Q2(b)

OR

## Explain about cost benefit analysis.

**Answer :**

Model Paper-II, Q5(a)

The cost-benefit analysis of the highway road project enables us to make a comparison of the individual projects and give priority to the competing projects on a monetary basis. The Road Authority and Transport Department must use the available resources efficiently, keeping in mind the welfare of the environment and its inhabitants.

Provision for service roads/alternate road connectivity, two-laning/ four-laning/ six-laning, riding quality, bypasses and over-bridges, bridges amenities. Based on these factors, the investment needs can be calculated.

**Road Authority Costs**

The road authority costs include the expenditure involved in the construction and maintenance of roads, acquiring the land from the land owners and providing appropriate compensation, expenses incurred in setting up fences, landscaping and construction of noise barriers to reduce the sound entering the residential locality by absorbing, transmitting or reflecting the sound.

**Cost Components of Highway Roads**

The cost components of the highway roads include the following:

(a) **Agency Cost**

This includes the expenses incurred by the government or private agency for construction and maintenance of highway roads.

The construction cost includes:

- (i) Expenses incurred in surveying, planning and designing.
- (ii) Purchasing land from the land owners to lay the road
- (iii) Construction of road.
- (iv) Installation of electric poles, traffic control equipment.
- (v) Administrative cost involved in supervising the traffic.

The maintenance cost includes:

- (i) Periodic repair of the damaged roads.
- (ii) Relocation and rehabilitation of the displaced people.
- (iii) Expenses incurred in maintaining and operating the traffic related equipment.

(b) **User Cost**

This includes the cost incurred in vehicle operation and cost due to the unavoidable accidents.

Costs incurred in vehicle operation are the cost of fuel, spare parts, wearout of the tyres, lubricants, labour costs, crews' wages, registration charges, insurance expenses, road tax, road permit charges, etc.

Cost due to traffic congestion is caused by renovation of the damaged roads, traffic diversion, or reduction in speed or complete closure of roads for movement.

Cost due to an accident involves the loss of precious lives, cost of treating the injured, the loss of vehicle due to the damage caused by the accident on the highway road.

**Benefit Component of Highway Road**

A well-maintained highway road provides efficient and safe transportation to the road users. The benefits include savings in travel time, improvement in health, education, agriculture, industry, trade and various other fields. The cost benefit analysis is calculated as the ratio of net annual benefits to the net annual expenses (cost).

Benefit-cost Ratio = Benefits in the reference year  
Annual costs incurred.

**2.4 EIAREVIEW-BASELINE CONDITIONS, CONSTRUCTION STAGE IMPACTS, POST PROJECT IMPACTS**

## Q40. What is meant by baseline data acquisition?

**Answer :**

A baseline data refers to the collection of information and data before a project begins. It is actually the description of the proposed project. It should include the project purpose, technical aspects such as engineering and design with proper visuals such as maps, figures, tables and graphs to communicate the technical information. The project description should be clear, understandable, concise and with relevance for decision making.

The baseline data is used to provide a comparison for assessing program impact. This is important to enable the policy makers, government officials, development managers, civil society and beneficiaries to monitor and track changes.

A baseline data is important, firstly, to set future targets of the project and secondly, to estimate the changes during the progress of the project. When proper baseline data is not collected, it indicates the following:

- (i) Insufficient project planning and oversight
- (ii) Budget constraints
- (iii) Time constraints
- (iv) Lack of political will
- (v) Disinterest by the management and decision-makers

**Q41. Explain environment baseline monitoring. What are the types of monitoring activities?**

**Answer :**

Environmental baseline monitoring refers to analyzing the existing environment of a proposed area that is likely to be changed. It includes all necessary parameters required to prepare an environmental inventory to be included in the environmental impact assessment report.

It is helpful in creating the required strategy to be adopted and framing laws and policies of environmental standards. It includes only necessary parameters that are to be included in the environmental assessment report. It basically monitors the causes that have an influence on the proposed area repetitively.

The three different types of monitoring activities are,

#### **Baseline Monitoring**

(a) It is carried out prior to carrying out the project to establish the reference systems that are likely to undergo changes.

#### **Effects Monitoring**

It is implemented during the project progress to determine the accuracy of predictions and effectiveness of mitigation strategies. Feedback received from experts and the general public are considered during this phase for necessary improvements.

#### **Compliance Monitoring**

It is assessed to verify the standards and regulations framed to control untimely hazards or disasters.

**Q42. Describe the methodology for baseline data generation.**

**Answer :**

The methodology for baseline data generation consists of:

- (a) Review of baseline environmental status.
- (b) Identification, prediction and evaluation of the impacts of the proposed project on the environment.
- (c) Environmental management plan to reduce thus caused impacts.

Review of environmental status involves monitoring data from primary and secondary sources through an environmental survey of the study area in variable climate conditions.

The likely impacts are thereby evaluated by measuring the significance and magnitude of the impact with the help of simulation models.

An environmental management plan is developed based on the data. It includes consideration of control policies, measures and abatement methods.

**Q43. Explain briefly the activities that cause changes in the baseline data and hence impact the air environment.**

**Answer :**

The emission of smoke and dust, burning of waste and the chemical impurities emission such as acid, toxic gases and heavy metals. The main effects are on adjacent land uses, aesthetic value, human health, humidity changes and temperature modifications. The major impacts are because of poor visibility due to smoke, vapour, gas or dust emission. High amount of heat emission at ground level will create catabolic winds and the conditions are raised in favour of thermal inversions. The concentration of impurities by inversion layers is in the ground level or atmosphere. Some localities are highly susceptible to temperature inversion than others. The local wind patterns and the topographic character of the area are the important factors of contributing.

The wind patterns are modified by tall buildings, highways and major earthworks. The wind tunnelling effect is produced by fire breaks in forests. The wind, the water bodies and large paved areas can generate thermal updrafts.

**Q44. What are the requirements for preparation of an environmental base map?**

**Answer :**

A base map is an aerial photograph, which simply means the photograph taken from air, with the help of an air-borne camera fitted to a light aircraft/helicopter/drones/microdrones. Such special survey aircraft consists of flight management system with 2-3 technicians or specialists, aerial-metric camera, aerial film photogrammetric scanner, plotter, software, etc. The cameras used are film-based, single-lens frame cameras. The photogrammetric scanner enables the conversion of analog images into digital files and represented as pixels.

Environmental Base Map (EBM) is one of the important stages of a project development activity. It contains the plan and final design of the proposed construction in the form of a schematic drawing. It also includes the basic information of the project site such as the environmental situation, population distribution (demographics), soil conditions, meteorology and air quality, topography, surface and groundwater hydrology, land quality, land use seismicity and ecological resources. It provides information on the existing status of the ecosystem potentially threatened by the developmental activities.

The Environmental Base Map is prepared by using computer-aided AutoCAD Map 3D environment or the other powerful technologies such as Geographic Information System (GIS) software.

**Q45. How many environmental parameters are classified. What are they?**

**Answer :**

Dec.-20, (R16), Q1  
The environmental data at the site, where a particular proposed action is being considered for an EIA study, is collected by the EIA team members, comprising of administrators, biologists, local politicians, geologists, journalists, sociologists, economists and engineers. The environmental parameters are broadly categorized into the following types,

**(a) Land**

The following details of the land are necessary,

- (i) Land ownership
- (ii) Land tenure
- (iii) Existing land use
- (iv) Crop productivity
- (v) Natural vegetation.

The land data enables less adverse social impacts on the indigenous people to provide equitable benefits to local communities.

**(b) Climatic Profile**

The climatic profile of the site, where a particular proposed action is being considered, should include data on rainfall, evaporation, wind speed and direction, relative humidity, minimum and maximum temperature, barometric pressure etc.

**(c) Flora**

The study of flora at the proposed development site should include,

- (i) Inventory of terrestrial and aquatic flora
- (ii) Population of different types of vegetation
- (iii) Density data of different types of vegetation
- (iv) Identification of valuable species
- (v) Identification of rare/endangered species.

**(d) Fauna**

The study of fauna at the proposed development site should include,

- (i) Inventory of terrestrial, aquatic and arboreal fauna
- (ii) Population of different types of fauna
- (iii) Density data of different types of fauna
- (iv) Data on permanent and migratory population
- (v) Data on endangered species.

**(e) Terrain Analysis**

The study of terrain analysis at the proposed construction site should include,

- (i) Geology and geomorphology
- (ii) Classification of land (such as arable land, grazing land, wetland and wilderness land)
- (iii) Drainage
- (iv) Hydrogeology
- (v) Soil classification, characteristics like fertility of soil, erodibility, depth, etc.
- (vi) Erosion potential.

**(f) Air Quality Studies**

This includes,

- (i) The amount of suspended particulate matter, and fallout dust in air
- (ii) Concentration of gaseous emissions like sulphur dioxide, noxious fumes, etc.

**(g) Water Quality Studies**

This study should include,

- (i) The quality of surface water and ground water resources.
- (ii) Temperature, pH, turbidity, conductivity, total dissolved solids, hardness, total alkalinity, acidity, contents of calcium, magnesium, dissolved oxygen, dissolved carbon dioxide, chloride, sulfate, silica, iron, copper, manganese, sodium, potassium, carbonate, bicarbonate, hydroxide, total cations, total anions, suspended solids, sulphites, chlorine, fluoride, phosphate, silica, suspended solids, biological oxygen demand and chemical oxygen demand.

## PARAMETERS TO CONDUCT EIA STUDY

LAND	CLIMATE	AIR QUALITY	FLORA	TERRAIN	WATER QUALITY	FAUNA
<ul style="list-style-type: none"> <li>• Ownership</li> <li>• Land use</li> <li>• Vegetation</li> <li>• Crop Productivity</li> </ul>	<ul style="list-style-type: none"> <li>• Rainfall</li> <li>• Evaporation</li> <li>• Wind Speed</li> <li>• Wind Direction</li> <li>• Relative Humidity</li> <li>• Pressure</li> <li>• Temperature</li> </ul>	<ul style="list-style-type: none"> <li>• Quantity of Suspended Particulate Matter and Dust</li> <li>• Concentration of Gaseous Emissions</li> </ul>	<ul style="list-style-type: none"> <li>• Inventory</li> <li>• Population</li> <li>• Density</li> <li>• Endangered Species</li> <li>• Valuable Species</li> </ul>	<ul style="list-style-type: none"> <li>• Geology and Geomorphology</li> <li>• Drainage</li> <li>• Soil classification</li> <li>• Soil Erosion Potential</li> <li>• Hydrogeology</li> <li>• Type of land</li> </ul>	<ul style="list-style-type: none"> <li>• Quality of surface water</li> <li>• Quality of ground water</li> <li>• Temperature</li> <li>• pH</li> <li>• Turbidity</li> <li>• Dissolved Oxygen, etc.</li> </ul>	<ul style="list-style-type: none"> <li>• Inventory</li> <li>• Population</li> <li>• Density</li> <li>• Migratory Population</li> <li>• Endangered species</li> </ul>

Figure: Various Parameters for EIA Study

Some examples of various impacts are:

## Physical

Air – Degradation, type of emissions released

Water – Availability, quality, use, pollution, etc

Solid waste – Excess generation, etc

Natural Resources – Effects on natural resources etc

Soil – Effects on stability of soils, etc

Geology – Availability of energy sources etc

Man made facilities – Structures, transportation, etc

Physical Amenities – National parks, monuments, etc

Technology – Hazards, safety measures, etc

Processes – Floods, erosion, deposition, etc.

## Biological

Vegetation – Destruction of forest cover, changes in species, diversity, etc.

Health – Free from natural disasters, etc.

Ecological – Food chain, diseases, etc

Psychological – Stress, challenges, etc.

## Economical

Economic and occupational – Displacement of population services, distribution pattern, etc.

## Social

Cultural – Leisure, fashion, etc.

Lifestyle – Food, housing, recreation, etc.

Relationships – Family life, feelings, etc.

Amenities – Hospitals, schools, etc.

Traditional belief – Symbols, values, etc.

Aesthetic – Visual physical challenges, moral conduct, etc.

Legal – Public policy, change in taxes, etc.

Political – Authority, structure of decisions, etc.

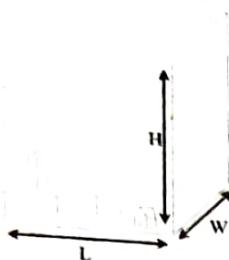
Statutory Laws – Quality standards, bye laws, etc.

**Q46. Explain the box model approaches for prediction of various environmental impacts for engineering projects.**

**Answer :**

Box model is the simplest approach commonly used for prediction of various environmental impacts for engineering projects in a city. This model is based on the following assumptions,

- (a) It assumes that the city under study is in the shape of a rectangular box with dimensions such as width (W), Length (L) and height (H).



- (b) The direction of wind flow is parallel to one side of the box.
- (c) The air pollutants are dispersed homogeneously inside the box.
- (d) The instability in the atmosphere produced must not cross above the height of the box.
- (e) The dispersed pollutants have uniform concentration in the whole volume of air and does not change with time.
- (f) The wind blows at constant velocity in the direction of the length or width of the box.
- (g) The concentration of the pollutant must be constant anywhere within the box and should not leave the box from any side.

The average concentration of the gas or particulate matter dispersed in the box is given by the following mathematical expression,

$$C = \frac{R \times T}{L \times W \times H}$$

Where,

*C* - Average concentration of the gas or particulate matter.

*R* - Release rate of pollutant  $\mu\text{g/sec}$ .

*T* - Time period needed for uniform distribution of the pollutant.

*L* - Along-wind dimension/length of the box in meters.

*W* - Cross-wind dimension/width of the box.

*H* - Vertical dimension of the box in meters.

#### **Q47. Explain the mass balance approach for prediction of environmental impacts for engineering projects.**

**Answer :**

The mass balance model (also referred as material balance) for prediction of environmental impacts of engineering projects is a technique for assessing the potential risks on the environment owing to a developmental activity. This approach needs a detailed knowledge of the inputs and outputs of the several components during the construction and operation phases of the project activity.

Thus, it helps to evaluate the situation and identify the options. According to the principle of conservation of mass, the mass of a body remains the same throughout a process or an operation. The same principle is applicable to the mass balance concept. The rate of change of mass is given by the formula proposed by Mc Kay, Peterson, Lohani et al.

$$\frac{dt}{dM} = (I + D + F + J) - (X + R + T)$$

Where,

*I* - Rate of mass inflow into the compartment.

*D* - Rate of discharge into the compartment.

*F* - Rate of mass formation due to the biochemical activity.

*J* - Rate of transfer from other compartments.

*X* - Rate of outflow from the compartment.

*R* - Rate of the degrading reaction.

*T* - Rate of transfer to other compartments.

#### **Q48. Explain the different methods used for prediction of various environmental impacts for engineering projects.**

**Answer :**

The role of impact prediction of a project activity is to understand the consequences of the proposed development, the extent of changes that can affect the environment, so that the decision-makers can identify the most important issues.

Impact prediction involves the scientific characterization of the cause and effect of impacts on the environment and the local community. While predicting an impact, the physical, biological, socio-economic aspects, anthropological data and techniques are taken into consideration. For instance, when a toxic liquid effluent is discharged irresponsibly into the environment, the potential impacts with regard to surface water hydrology includes the following :

- (i) Reduced water quality parameters of the receiving streams.
- (ii) Change in the ecology of the banks of the water bodies.
- (iii) Loss of land resources and livelihoods due to allied developments.
- (iv) Effects on the economy of the fishing community.
- (v) Socio-cultural effects as the indigenous people, living in and around the proposed project areas, are rendered homeless due to invasion by land speculators.
- (vi) The potential earnings from the ecotourism market may also suffer.

For remaining answer refer Unit-II, Q46 and Q47.

**Q49.** Discuss in detail the direct and indirect impacts that are likely to occur for land clearing and road construction activity.

**Answer :**

The direct and indirect impacts that are likely to occur for land clearing and road construction activity include the following.

**(a) Changes in the Land Use Pattern**

The potential impacts on the changes in the landuse pattern due to land clearing and road construction activity are,

- (i) Habitat loss and fragmentation,
- (ii) Increase in sediment loading,
- (iii) Loss of biodiversity,
- (iv) Increase in turbidity,
- (v) Changes in the climate and weather at the local, regional as global level.

**(b) Encroachments into Natural Reserves**

The encroachments into natural vegetation causes loss, fragmentation and degradation of habitat and the natural vegetation.

**(c) Loss of Vegetation**

The loss of vegetation due to land clearing can result in climate change, desertification, soil erosion, increase in greenhouse gases and much more.

**(d) Noise and Air Pollution**

The land clearing activities involving the operation of diesel engines, demolition equipment give out large amount of emissions and noise, thus contributing to noise and air pollution. The poor air quality may result in serious health problems such as respiratory diseases, cardiovascular diseases, cancer, increase in stress levels, disturbances in sleep pattern, high blood pressure, hearing loss, etc.

**(e) Potential Loss of Living Quality, Wildlife and Plants**

Land clearing for any developmental activity causes mortality of animals due to physical injuries and pathologic conditions as they struggle to survive in cleared land. The spread of noxious weeds and displacement of native foliage are the other effects.

**(f) Habitat Destruction, Fragmentation of Ecosystem**

Habitat destruction and fragmentation of ecosystems is considered to be one of the greatest primary threats to species. The increasing habitat loss eliminates the ability of the species to move and survive in the altered conditions.

**(g) Draining or Contamination of Wetlands**

Increase in land clearance activities have caused increased erosion in elevated lands resulting in increased sedimentation in low lying areas.

**(h) Compaction of Soil Caused by Construction Vehicles can Impact both Plants and Animal Species**

The compaction of soil caused by heavy machinery (such as graders and rollers) leads to loss of soil porosity. The soil is unable to absorb or drain water resulting in water logging.

**(i) Clearing of Vegetation Exposes Top Soil to Erosion**

Destruction of vegetation incurs loss of protective cover for the soil. The top soil becomes vulnerable to wind and water erosion. The surface water runoff increases, resulting in higher rate of soil erosion and soil leaching into the local creeks and waterbodies with significant increase in the incidence of flooding.

**(j) Exposure to Dust Pollution**

Exposure to dust pollution can lead to a variety of health effects, including increased respiratory symptoms, irregular heart beats, non-fatal heart attacks, heart or lung disease, bacterial and fungal infections, fibrosis, cancer, etc.

**(k) Noise Pollution**

Exposure to noise gives rise to general annoyance, irritability, increased susceptibility to heart disease and high blood pressure, impaired hearing, nervousness, digestive tract symptoms, etc.

**Q50. Discuss various phases involved using a six step conceptual model for the study of biological impacts of any developmental activity.**

**Answer :**

The various phases involved in the study of biological impacts of any developmental activity is described below:

**Step 1: Identification of the Biological Environment at the Site of Proposed Project**

This step involves the determination of baseline data using primary and secondary data on flora and fauna, forests and the ecosystem functions.

The important areas related to important ecosystem services include:

- (i) Protected areas, and the valuable genetic resources.
- (ii) Areas containing threatened ecosystems.
- (iii) Areas with threatened species that might suffer significant damage.
- (iv) Areas that provide provisioning services (eg. land occupied by indigenous and local people, fish breeding grounds, etc).
- (v) Areas that provide cultural services such as scenic landscapes, heritage sites, sacred places, etc.

**Step 2: Preparation of a List of Biological Entities Inhabiting the Project Site**

The step includes the preparation of a list of flora and fauna of the proposed project site. It should contain the number of plants (including forest trees), animals, flowering plants, insects, molluscs, invertebrates, fishes, amphibians, reptiles, birds and mammals. It should include all kinds of threatened or endangered animals and plants.

**Step 3: Acquire the relevant Laws, Regulations or Criteria, and Guidelines to the Biological Environment****Step 4: Prediction of Impact on the Biological Environment**

The potential impact on the biological environment that is likely to occur as a result of the proposed developmental activity depends on several factors, such as:

- (i) Direction of the impact
- (ii) Magnitude of the impact
- (iii) Duration of environmental impact
- (iv) Geographical extent
- (v) Probability of impact occurrence.

Mathematical modeling approach and physical modelling approach may be used to study the impact prediction.

The project activity may affect the terrestrial ecology and biodiversity due to the following:

- (i) Creation of access roads
- (ii) Transport and equipment use.
- (iii) Excavation and earth works for civil works.
- (iv) Waste disposal during construction.
- (v) Accidental (non-routine) events-spills, leaks, inappropriate disposal of solids, fire and explosion.
- (vi) Loss of feeding areas.
- (vii) Loss of green cover and nesting of fauna.
- (viii) Effect on community health and safety.
- (ix) Harmful air emissions cause damage to the foliage, inhibit their growth, with resultant loss of particular species.
- (x) Migration of fauna away from the source of noise and pollution.

**Step 5: Analysis of Biological Impact Significance**

Depending on the types and extent of the proposed developmental project, the type of biological resources affected can be ascertained. The information thus obtained can be used to make informed decisions on whether to proceed with the project or not. It may also be used for the identification and evaluation of alternatives if the proposed project has a significant impact on the community.

**Step 6: Identification and Incorporation of Mitigation Measures**

Some general mitigation measures should be practiced/followed:

- (a) Revegetation and tree plantations near the proposed construction site.
- (b) Relocation of fauna to an approved site with suitable habitat.
- (c) The EIA professionals (including the biologists, engineers, planners, geographers, landscape architects, archaeologists) should endeavor to avoid construction activities during the breeding season of birds.

By incorporating the above mentioned mitigation measures, the impacts upon the biological environment would be less than significant.

**Q51. Discuss the biological environmental impact analysis of any proposed development project along with mitigation measures.**

**Answer :**

- The biological environmental impact analysis of any proposed development project includes the following:
- (a) Effect of proposed developmental activity on the threatened, endangered or protected species.
  - (b) Effect on rare or unique vegetation types.
  - (c) Effect on migration corridors for wildlife.
  - (d) Effect on the highly productive wildlife habitat or wildlife species of sport, spectator, commercial or educational value.
  - (e) Habitat fragmentation.
  - (f) Increased potential for occurrence of wildfires.

The cumulative biological environment impact of the proposed project would be generally additive and this is reported to be generally directly proportional to the area of ground disturbed.

### Mitigation Measures

The mitigation measures recommended to reduce the potential impacts on the biological environment are:

Designing and implementation of a habitat restoration plan.

Construction of new access roads should be avoided.

The existing roadways should not be widened.

Construction activities should be avoided in sensitive areas.

Habitat fragmentation can be reduced by carrying out construction activities only in the designated corridors.

**Q52. Give the list of different project activities which will impact the air environment.**

**ANSWER :**

The different project activities that impact the air environment are:

1. Conventional power plants, which produce electricity by burning fossil fuels such as coal, gas and oil.

2. Use of insecticides, pesticides and fertilizers in agricultural activities release harmful gases into the air.

3. Exhaust from manufacturing industries and factories. These include metal industries, petroleum refineries, cement factories, plastic industries, industrial boilers, phosphate processing plants, pulp and paper mills, municipal incinerators, chemical industries.

### 4. Mining Operations

The extraction of minerals from the earth's interior releases dust and chemicals into the air causing massive air pollution.

### 5. Indoor Air Pollution

Indoor air pollution is caused by cooking and heating with solid fuels like wood, dung, agricultural residues on open fires or traditional stoves, pesticides, household care products, perfumes, hair sprays, furniture polish, glues, air fresheners, moth repellents, wood preservatives, tobacco smoke etc.

**Q53. What are the potential impacts during the construction and operation phase of the proposed project with regard to surface water hydrology?**

**ANSWER :**

The steps involved in the evaluation of impacts of various developmental activities on surface water environment are as mentioned below,

#### Step 1: Identification of Surface Water Quantity or Quality Impacts of Proposed Projects

The water quality defined in terms of physical, chemical and biological constituents of surface water is discussed below.

The physical parameters of water include the temperature, colour, conductivity, turbidity, total suspended solids, total dissolved solids, oil and grease, etc. The chemical parameters of water are broadly categorized into,

- Organic content of water - It includes the Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Organic Carbon (TOC), Total Oxygen Demand (TOD).
- Inorganic content of water - It includes the salinity, hardness, acidity, alkalinity, pH, cations such as Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Mo, Na, Ni, P, Pb, Sb, Se, Si, Sr, Th, T, V, U, Anions such as Cl, F, SO<sub>4</sub>, CN.
- Biological components of water include total coliform count and faecal coliform count (Faecal Streptococci and Salmonella spp).

The samples of water are collected for quality analysis in the upstream and downstream of the proposed development site, prior to the onset of any potential impacts arising from the development activity. The water samples collected are stored in containers containing ice-packs to maintain the cool state of the sample. The collected samples are shipped to the laboratories for qualitative analysis. The parameters to be measured at the site are pH, temperature, electrical conductivity, dissolved oxygen, oxidation-reduction potential, total dissolved solids. The field observations are documented by the field staff. Any unacceptable changes in the water quality parameter should be readily detected and timely action needs to be taken to rectify the situation.

### Source of Pollutants in Water

The source of pollutants in water are categorized as.

#### (i) Non Point Sources

Pollutants come from many different sources.

Example: Urban runoff, poor irrigation practices, poorly managed construction sites, abandoned mines.

#### (ii) Point Sources

The pollutants come from one source.

Example: Factory/industrial plants, direct dumping of toxic waste into water. The water quality parameters are intrinsically linked to water quantity due to the fact that changes in water quantity are likely to affect the dilution of pollutants.

The contaminants in water and their impact on water quality and quantity are tabulated below.

S.No.	Contaminants in Water	Effect on Water
1.	Suspended solids (colloidal materials such as clay, silt, finely divided organic and inorganic matter, plankton/microscopic organisms).	Turbidity, algal blooms, decrease in primary productivity, reduced biomass, survival and reproduction of invertebrates impaired, elimination of aquatic population, physical damage to gills of fish, mortality of aquatic organisms.
2.	Biodegradable organics (proteins, carbohydrates, fats).	Reduction in the availability of oxygen in water leading to severe asphyxiation, organic pollutants may settle at the bottom of the waterbody and alter its characteristics.
3.	Pathogens (Bacteria, Viruses, Protozoa, Helminths).	Increase in the risk of incidence of diseases.
4.	Nutrients (Nitrates and Nitrites).	Degradation in water quality, massive blooms of planktonic algae.
5.	Priority pollutants (Arsenic, Asbestos, Barium, Beryllium, Selenium, Silver).	Toxic, carcinogenic, mutagenic and teratogenic in nature elimination of entire aquatic communities.
6.	Refractory organics (Chlorinated alkanes, chlorinated ethanes, PAH, Pesticides Monodichlorobenzenes).	Carcinogenic in nature, toxic to aquatic life, biological degradation is affected, refractory substances in water interfere with gas exchange process between the waterbody and atmosphere, decreased light penetration, impacts on human health include retardation of growth, decrease in longevity, neurological disorders, tumour formation, gastrointestinal disorders.
7.	Heavy metals. (As, Cd, Fe, Co, Cr, Cu, Mn, Hg, Mb, Ni, Pb, Se, Zn).	Bioaccumulative, toxic at high concentration, carcinogenic and neurological impacts.
8.	Dissolved inorganics.	Health-related problems.

The potential water quality impacts due to construction phase includes,

- (a) Runoff from general construction activities related to the project at the site.
- (b) Construction runoff and drainage.
- (c) Production of sewage effluents from the on-site construction workforce.
- (d) Increased load of suspended solids and contaminants from site surface and drainage channels.
- (e) Pollutants such as fuel, oil, diesel, lubricants and solvents generated from vehicles and equipment used for construction activities, can enter the surrounding waterbodies.

### Step 2: Analysis of the Potential Impacts of the Development Project on the Surface-water Conditions

This step is accomplished by the use of several mathematical models to determine the changes in water quantity, quality and flow patterns. Mathematically sophisticated and computerized modelling softwares are also used wherein the methodologies have been automated.

Some mathematical models commonly used in EIA are mentioned below.

- (a) Fundamental runoff formula for predicting surface water runoff.
- (b) Rational formula - This is used to compute the peak discharge flow rate.
- (c) Navier-Stokes equation - This is used to determine the water-flow patterns.
- (d) Streeter-Phelps equation :- (also known as the "dissolved oxygen sag" equation).

This is used for evaluating dissolved oxygen in water.

Advection transport formulation

Dispersive transport formulation

Surface heat budget formulation

Dissolved oxygen saturation formulation

Hydrological transport model.

### Step 3: Collection of Significant Information Related to Quantity and Quality of Surface Water

The aquatic environment in a waterbody provides diverse habitat for aquatic life, clean water for animals and humans. Therefore, it is imperative to understand the surface water quality. Several factors that contribute significantly to the water quality are climate and precipitation, soil type, geology, vegetation, groundwater flow conditions. Human activities too contribute to the water quality. The pollutants generated by anthropogenic activities are carried to far off places by atmospheric processes and deposited on land and waterbodies.

Water is essential to sustain life. Its other uses are for domestic/residential use, commercial water use, industrial water use, irrigation water use, livestock water use, mining, public supply, thermoelectric power water use and many more.

The Bureau of Indian Standards specification ISO : 10500 - 1991 governs the quality of drinking water supplies in India. This is based on international standards for drinking water quality issued by the WHO. A number of government agencies are responsible to foresee the availability of drinking water of adequate quantity and potable quality. The government agencies include the Ministry of Water Resources, the Ministry of Urban Development and poverty Alleviation, the Ministry of Rural Development, the Ministry of Environment and Forests and the Ministry of Health.

The water quality standards in India recommended by the Bureau of Indian Standards are shown in tabular form.

S.No.	Characteristics	Permissible Limit
1.	Colour	5 - 25 Hazen units
2.	Odour	No objectionable odour
3.	Taste	No objectionable taste
4.	Turbidity	5 - 10 NTU
5.	pH value	6.5 - 8.5
6.	Total hardness	300 - 600 mg/l
7.	Iron	0.3 - 1.0 mg/l
8.	Chlorides	250 - 1000 mg/l
9.	Residual free chlorine	0.2 mg/l
10.	Calcium	75 - 200 mg/l
11.	Magnesium	30 - 75 mg/l
12.	Copper	0.05 - 1.5 mg/l
13.	Manganese	0.1 - 0.3 mg/l
14.	Sulphate	200 - 400 mg/l
15.	Nitrate	45 - 100 mg/l
16.	Fluoride	1 - 1.5 mg/l
17.	Phenolic compounds	0.001 - 0.002 mg/l
18.	Mercury	0.001 mg/ml
19.	Cadmium	0.01 mg/l
20.	Selenium	0.01 mg/l
21.	Arsenic	0.05 mg/l
22.	Cyanide	0.05 mg/l
23.	Lead	0.05 mg/l
24.	Chromium	0.05 mg/l
25.	Mineral oil	0.01 mg/l
26.	Alkalinity	200 mg/l
27.	Aluminium	0.03 mg/l
28.	Boron	1 mg/l

**Step 4: Evaluation and Prediction of Impact on Surface-water**

The potential surface water impacts that are likely to occur as a result of the proposed developmental activity depends on several factors.

**(a) Direction of the Impact**

The types of impact may have positive, negative or neutral effects on the environment.

**(b) Magnitude of the Impact**

The magnitude of impact may be categorized as non/negligible, low, moderate or high.

**(c) Duration of Environmental Impact**

The duration of the environmental impact may be transient, short-term, medium-term, long-term, or permanent.

**(d) Geographical Extent**

It refers to the extent to which the proposed activity is likely to affect - whether it is local, regional, national or international.

**(e) Probability of Impact Occurrence**

It refers to the chances of occurrence of impact. It can be of the following types,

- Least probable/improbable - (< 5% chance)
- Low probability - (5% to 40% chance)
- Medium probability - (40% to 60% chance)
- High probability - (60% to 90% chance)
- Definite - (Impact will occur definitely).

The potential impact during the construction and operation phase of proposed project with regard to surface water hydrology includes the following,

- Increase in the erosion and sedimentation due to stripping of vegetation in and around the proposed construction site.
- The construction of river crossings would alter the ecology of river banks and river beds.
- Increase in erosion and sedimentation due to the construction of diversion channels for directing the river water in another direction.
- Increase in polluted discharges affect the water quality of the receiving streams.

The different types of project activities and their potential impact on the environment are tabulated below,

<b>Project Activity</b>	<b>Potential Impact</b>
1. Construction of roads	1. Runoff pollution into waterbodies, deterioration in the water quality through increased sediment load, spillage of cement, oil, lubricants or fuel negative impact on aquatic habitats and public health and other ecological problems, loss of forest area due to road construction, loss of topsoil, changes in the soil profile, potential soil erosion, increase in impervious surface therefore increased runoff.
2. Urban and commercial development	2. Sewer system outflows, industrial waste outfalls, increase in surface water flow, reduction in infiltration to groundwater, high risk of water quality degradation, increased flooding, erosion potential, habitat degradation and destruction.
3. Industrial development	3. Increase in pollution levels of waterbodies, industrial effluents, untreated sewage, different types of pollutants include metals, trace metals and radionuclides, nutrient enrichment of ground and surface water.
4. River engineering activities such as construction of large reservoirs, dams, flood embankment/levees, stream diversion, channelization and channel modification.	4. Habitat loss and fragmentation, increase in sediment loading, increase in turbidity, blockage in the migration route of aquatic organisms, inundation of wetlands, riparian areas, change in the water temperature increased concentration of phosphorus, nitrogen, BOD, changes in pH, increased algal growth, salt water ingress.

Table

**Step 5 Analysis of Impact Significance**

Depending on the types and extent of the proposed developmental project, the type of resources affected can be ascertained. The information thus obtained can be used to make informed decisions on whether to proceed with the project or not. It may also be used for the identification and evaluation of alternatives if the proposed project has a significant impact on the community.

**Step 6. Mitigation Measures**

Some general mitigation measures should be practiced/followed,

(a) Revegetation and tree plantations near the proposed construction site.

(b) Preventing the entry of construction material into surface water to prevent the adverse impacts on drinking water supplies, irrigation systems and river ecology.

(c) Prevent the entry of sediments into surface waters by implementing runoff control measures, mechanical sediment control measures, grassed filter strips, mulching and soil bioengineering practices.

(d) Increasing water infiltration into soil.

(e) Controlling excessive storm runoff.

(f) Controlling soil erosion.

(g) Using the runoff for useful purposes.

**Q54. If the soil is contaminated, what are the remediation methods that can be adopted during and after the execution of any development project.**

**Answer :**

The term soil contamination refers to mixing of solid or liquid hazardous/toxic substances with the natural soil. The toxic substances may be physically or chemically attached to soil particles or trapped in between the spaces of soil particles.

**Source of Contaminants**

- (i) Spilling or burying of hazardous substances in soil from oil spills, pipeline leaks from factories, mining, gas stations, airports, etc.,
- (ii) Release of hazardous substances from the smoke stack and its subsequent deposition on the surrounding soil
- (iii) Flow of water from an area containing hazardous substances
- (iv) Overuse of fertilizers and toxic pesticides.

**Impact of Soil Contamination**

The contaminates in soil can impact soil everywhere with potentially disastrous effects.

- (i) The chemical changes in soil do not allow proper growth of plants - the primary producers in the food chain. A decrease in soil fertility leads to decrease in soil yield
- (ii) The runoff of chemicals from soil into water bodies can contaminate the drinking water
- (iii) The contaminants in soil can cause cancers including leukaemia and neuromuscular blockage. The lead contaminants in soil lead to developmental damage to the brain in young children, mercury causes kidney damage while cyclodines cause liver toxicity.

**Control of Soil Contamination**

Several control measures for soil contamination are,

- (i) The soil may be dug up and can be either treated for contaminants or disposed
- (ii) Containment of soil to prevent the spread of contaminants by covering the soil using plastic sheet, either by direct contact or through seepage by rainwater.

**Treatment of Contaminated Soil**

Several approaches for the treatment of contaminated soil include the following,

- (i) Cleansing or washing the soil contaminants using water, chemical solvents or air. This method is effective in treatment of inorganic and organic contaminants
- (ii) Thermal remediation of contaminated soil by the use of incinerators to destroy the contaminants. The hydrocarbon contaminated soil is heated uniformly to 800°F. As a result of this, the dioxins formed are released into the atmosphere.
- (iii) Encouraging the growth of natural organisms in the soil to aid in the breakdown of soil contaminants. The process involved is called bioremediation, wherein anaerobic or aerobic bacteria are used to treat the soil. The microorganism dies after ingesting the contaminant.
- (iv) Encapsulation of soil contaminants to prevent them from spreading. The process involves mixing of lime, concrete or asphalt with contaminated soil, thus the contaminates are prevented from spreading. Vitrification too is another type of encapsulation which involves classification of heavy metals (eg. Radionuclide contamination).
- (v) Bioventing: The process involves injecting oxygen into contaminated soil to encourage the growth of microorganisms. These microorganisms breakdown the hydrocarbon into CO<sub>2</sub> and water.

**Q55. State appropriate techniques for slope protection.****Answer :**

The appropriate techniques of slope protection include the following

**(a) Excavation**

It refers to the partial removal or excavation of sufficient quantity of soil for slope stabilization.

**(b) Buttressing**

Construction of buttresses (a structure of stone or brick built against a wall to strengthen or support it) to flatten the slope, reduces the slope height and improves slope stability. These structures increase the resisting forces, provide lateral support and increase soil strength.

**(c) Installation of Surface and Subsurface Drainage**

These devices help to control surface and groundwater systems and help to stabilize the slopes.

**(d) Ground Inclusions**

Ground inclusions (such as ground anchors, soil nails, helical soil nails, grouted soil nails, driven soil nails, launched soil nails and rock bolts) are drilled into the soil or bedrock to provide vertical and horizontal support to the slopes.

**(e) Retaining Walls**

Retaining walls are vertical concrete structures meant to provide lateral support to the slopes.

**(f) Vegetation**

The vegetation includes trees, plants, shrubs and grasses, which help to stabilize slopes in various ways. The vegetation of any region serves as a good storehouse of water, prevents the disintegration of soil particles and provide support to upslope soil structure. Roots hold the soil particles together, increase the soil shear strength and thus prevent soil erosion.

**(g) Surface Slope Protection**

The surface slope protection can be accomplished by the application of shocrete, chunam plaster, masonry and rip-rap. Shocrete is a method in which wet or dry mix concrete is sent at a very high velocity through a hose and nozzle. Chunam plaster is a mixture of soil, lime and cement applied on the surface of a slope. Rip-rap is a wall of loose stones, cobbles and boulders placed across a slope, to prevent landslides and soil erosion.

**Q56. Discuss the post-project impacts of a coal-based power plant and mitigation measures.**

Model Paper-II, Q5(b)

**Answer :**

The environmental impact of coal-based power plants are:

**1. Air Pollution**

Air pollution from point source include particulates matter, gaseous emissions such as sulfur dioxide, oxides of nitrogen, carbon monoxide, hydrocarbons. Air pollution from non-point source include transportation of coal from the source to the plant site, loading/unloading of coal, coal storage yard, handling and transportation of fly ash.

**2. Water Pollution**

The main sources of water pollution include cooling tower blow down, boiler blow down, fly ash handling, effluents released from oil handling, from transformer areas, power house and turbine areas.

**3. Land Degradation**

Land degradation results from changes in land use pattern resulting in erosion, loss of biodiversity, changes in soil quality and quantity.

**4. Noise Pollution**

Usage of boilers, turbines and crushers in the power plants cause enormous noise pollution.

**5. Health Impacts**

The human health impacts caused by chemical pollutants are tabulated below.

S.No.	Chemical Pollutant	Health Impact
1.	Sulphur dioxide	Irritation in nose, throat and airways, coughing, wheezing, shortness of breath, tight feeling of chest, asthma
2.	Nitrous oxides	Dizziness, nausea, vomiting, numbness of the body, giddiness, blurred vision, loss of blood pressure, heart attack.
3.	Suspended particulate matter	Decreased lung function, increased respiratory symptoms such as irritation of airways, coughing or difficulty in breathing.
4.	Ammonia	Burning of nose, throat, respiratory tract, bronchial and alveolar edema, airway respiratory destruction, distress
5.	Hydrogen chloride, Hydrogen fluoride	Irritation to eyes, skin, respiratory tract, cough and shortness of breath, damage to eyes and blindness.
6.	Dioxins and Furans	Skin lesions, skin discoloration altered liver functions, problems with reproduction, development and immune system.
7.	Polycyclic Aromatic compounds	Redness and inflammation of skin, cataracts, kidney and liver damage, jaundice
8.	Mercury	Loss of vision, lack of coordination of movements, impairment of speech, hearing, walking, muscle weakness
9.	Lead	Anaemia, weakness, kidney and brain damage, hearing loss, seizures.
10.	Radium	Anemia, cataracts, broken teeth, reduced bone growth, lung and bone cancer.
11.	Uranium	Damage to respiratory tract, and kidneys.
12.	Antimony, Arsenic, Beryllium, Cadmium, Nickel, Selenium, Manganese	Lung diseases, heart problems, vomiting, stomach ulcers, carcinogenic to lungs, bladder, kidney, skin.

### Mitigation Measures in CBPP

#### Air Pollution Control

Use of air pollution control equipment, such as ESP/Baghouse for boiler stacks, bag filters for coal crusher and coal mill. The air-borne dust can be controlled by using a closed yard for storing coal, use of conveyor belt for transportation of coal, use of dust suction device while unloading coal.

Disposal of fly ash in ash ponds lined with RCC to prevent metal contamination.

Increase in the green cover around the ash pond.

Use of technologies like Selective Catalytic Reduction (SCR), Electrostatic Precipitators (ESPs), Fabric Filter (FF), Flue Gas Desulfurization (FGD), Wet ESP, Dry Sorbent Injection (DSI) and Mercury Control Methods (MCM).

#### Control of Water Pollution

The thermal power plants release general waste water, cleaning wastewater and sewage as effluents into the environment. A comprehensive waste water treatment facility must include oil separation, neutralization of wastewater, filtration, coagulation and sedimentation (using chemical agents). The temperature of the effluent must be reduced considerably and released using underwater drainage methods into the waterbody.

Land degradation can be controlled by land reclamation, salinization of soil, and prevent water logging.

Noise pollution caused by the usage of machines like boilers, turbines and crushers can be controlled by installing silencers, use of sound proofing walls and adopting sound attenuating design. All of these can help to minimize noise and vibration in the perimeter of the power plant.

## FREQUENTLY ASKED AND IMPORTANT QUESTIONS

**Q1. Explain the need for different methodologies for EIA.**

Important Question

**Answer :**

For answer refer Unit-II, Q4.

**Q2. State the importance of predictive methods in EIA.**

Important Question

**Answer :**

For answer refer Unit-II, Q7.

**Q3. Discuss about the criteria for the selection of EIA methodology.**

Important Question | July-21, (R16), Q2(b)

**Answer :**

For answer refer Unit-II, Q15.

**Q4. Describe the EIA methodologies.**

Important Question

**Answer :**

For answer refer Unit-II, Q17.

**Q5. Write a short note on a simple checklist and a descriptive checklist.**

Important Question

**Answer :**

For answer refer Unit-II, Q19.

**Q6. Describe matrix method in detail.**

Important Question

**Answer :**

For answer refer Unit-II, Q24.

**Q7. Explain the leopold matrix in detailed with suitable examples.**

Important Question | Sep.-20, (R16), Q1(a)

**Answer :**

For answer refer Unit-II, Q29.

**Q8. Describe the adhoc and matrix methods for EIA process.**

Important Question | July-21, (R16), Q2(a)

**Answer :**

For answer refer Unit-II, Q30.

**Q9. What are the major methodologies of EIA? Explain any two methods.**

Important Question | Sep.-20, (R16), Q1

**Answer :**

For answer refer Unit-II, Q34.

**Q10. List out the impact identification methods of EIA. Explain network method, overlay method and adhoc method.**

Important Question | Dec.-20, (R16), Q2

**Answer :**

For answer refer Unit-II, Q15, Topic: Impact Identification, Q31, Q33 and Q18.

**Q11. What is the significance of cost benefit analysis in EIA?**

**Answer :**

Important Question | Sep.-20, (R16), Q2(b)

For answer refer Unit-II, Q39.

# UNIT 3

## Environmental Management Plan



### Syllabus

**Environmental Management Plan - EPM Preparation, Monitoring Environmental Management Plan, Identification of Significant or Unacceptable Impacts Requiring Mitigation, Mitigation Plans and Relief and Rehabilitation, Stipulating the Conditions, Monitoring Methods, Pre-Appraisal and Appraisal.**

### LEARNING OBJECTIVES

In this unit, you will learn the following concepts,

- ✓ Identify the measures to be taken for environmental management
- ✓ Ways to mitigate the adverse impacts on various environmental components
- ✓ Responsibilities to be carried out during the lifetime of the project
- ✓ Identify the potential environmental impacts of a proposed project activity
- ✓ Identify the resource allocation to support the human resources
- ✓ Monitor the stipulated conditions
- ✓ Monitoring the methods for environmental parameters by the project proponents, impact assessment agency and pollution control boards.

### INTRODUCTION

This unit is designed to introduce the learners about the purpose of the environmental management plan. It discusses some of the methods that can be used to mitigate the impacts of the developmental projects. This process ensures that the project is implemented in an environmentally sustainable manner. It helps to identify the potential environmental risks developing from a proposed project and take necessary actions to minimize the risks.

**PART-A SHORT QUESTIONS WITH SOLUTIONS**

Model Paper-I, Q1(e)

**Q1. What is an environment management plan?****Answer :**

Environmental management refers to management of all components of the biophysical environment, including the living (biotic) and the non-living (abiotic) factors. Environmental Management Plan (EMP) also called an impact management plan, is a part of EIA reporting. It explains the several mitigation and monitoring measures that needs specific action to be carried out by the proponent during project construction and operation for a sustainable environment.

Model Paper-II, Q1(e)

**Q2. What is environment monitoring plan?****Answer :**

Environmental monitoring plan involves paying close attention to monitoring and supervision of local conditions to assess the effectiveness of development interventions. The process involves discussions among project managers, government officials and researchers for accurate prediction of impacts or changes in the impact trends. It can even warn the project proponents of unexpected adverse impacts and the effectiveness of implemented mitigation measures.

**Q3. What are the different types of monitoring activities?****Answer :**

The three different types of monitoring activities are,

**(a) Baseline Monitoring**

It is carried out prior to carrying out the project to establish the reference systems that are likely to undergo changes.

**(b) Effects Monitoring**

It is implemented during the project progress to determine the accuracy of predictions and effectiveness of mitigation strategies. Feedback received from experts and the general public are considered during this phase for necessary improvements.

**(c) Compliance Monitoring**

It is assessed to verify the standards and regulations framed to control untimely hazards or disasters.

**Q4. What are the ways to interpret project induced changes?****Answer :**

The anticipated project induced changes can be addressed in the following ways,

**(a) Statistical Approach**

In this method, the percentage and direction of project induced change from natural variation is calculated.

**(b) Review of Plans and Policies by Competent Authority**

The EIA related plans, policies and programs must be reviewed by agencies and organizations that include ministries of the central government, local self-government bodies in whose territory the project is proposed; traditional decision making bodies, councils, etc., private sector organization (trade association, chambers of commerce and industries); non-government organization.

**Q5. Discuss various guidelines for mitigation soil erosion.****Answer :**

Erosion of soil by various agents can be reduced by adopting the following methods,

- (i) By minimizing the amount of soil bared through reduced vegetation.
- (ii) By retaining the stubble of the crops in the soil.
- (iii) By retaining vegetation in sensitive areas.
- (iv) By construction of physical structures to stabilize the slipping away of soil.
- (v) By retaining vegetation in sensitive areas.
- (vi) By promoting the growth of macroscopic and microscopic soil organisms.
- (vii) By promoting the use of anthropogenic chemicals in the soil.
- (viii) By encouraging extensive plantation of trees.

Model Paper-I, Q1(f)

**Explain mitigation measures to control soil erosion.**

- Answer :**
- The erosion of soil by various agents can be controlled developing a strong vegetative cover by various ways :
- (i) Strip cropping.
  - (ii) Restoring soil fertility.
  - (iii) By constructing physical structures to stabilize the slipping away of soil.
  - (iv) By minimizing the amount of soil bare through reduced vegetation.
  - (v) By promoting the growth of macroscopic and microscopic soil organisms.

**Q7. How do you plan to control dust pollution in the mine site?**

- Answer :**
- The dust pollution in mine site can be controlled by the following ways,
- (i) The dust released from the point source can be controlled by using techniques such as electrostatic precipitators, cyclone scrubbers, biofiltration, adsorption, wet scrubbing adsorption, condensation and chemical treatment.
  - (ii) Watering the ground before the excavation begins.
  - (iii) Use of dust suppression techniques such as water sprays, chemical additives, local exhaust ventilation and vacuum methods.
  - (iv) Use of safety procedures and personal protective equipment to prevent adverse health effects to the miners.
  - (v) Use of enclosed conveyors to transport products from one place to another.
  - (vi) Use of physical barriers between the point source of dust and the worker, for instance use of enclosed cabins to isolate the miners.

**Q8. What are the structural and non-structural mitigation measures of flood?****Answer :**

The various mitigation measures for floods can be categorized as structural and non-structural.

**Structural Mitigation Measures Include**

- (i) Reservoirs for storing impounding monsoon flows.
- (ii) Preventing overbank spilling by constructing embankments and flood walls.
- (iii) Construction of proper flow channels.
- (iv) Improving drainage.

**Non-Structural Mitigation Measures Include**

- (i) Managing floodplains by measures such as flood plain zoning, flood proofing.
- (ii) Wetland management.
- (iii) Pre-disaster management such as relief, flood fighting, education.
- (iv) Post-disaster management measures such as relief, flood fighting, search and rescue, evacuation medical and psychiatric assistance and flood insurance.

**Q9. Describe the biological and regulatory mitigation measures for the mitigation of biological impact.****Answer :**

The significant measures for mitigation against biological impact by developmental activity are,

- (i) Restrictions to rights-of-way and limiting the cleared areas.
- (ii) Implementation of vegetative stabilization to protect the soil from erosion, waterlogging and salinization.
- (iii) Creation of alternative and accessible habitats within the proximity of the existing population of the species of interest.
- (iv) The disturbed areas must be revegetated to reduce habitat fragmentation.
- (v) The area of land that is being disturbed must be reduced.
- (vi) Collection and storage of topsoil for future use to ensure conservation of existing seed banks.
- (vii) Conducting surveys by ecologists on the different species inhabiting the project area. Clearance of vegetation should take place outside the breeding season.

**Q10. Explain about the methodology for the assessment of soil and groundwater.****Answer :****Model Paper-III, Q1(f)**

The steps involved in the study of impact assessment on soil and groundwater are:

**Step-1**

A clear delineation of the EIA study area.

**Step-2**

Identification of impact of project on soil and/or groundwater.

**Step-3**

Description of the existing environmental status of the study area.

**Step-4**

Acquisition of significant information related to quality and quantity of soil and/or groundwater.

**Step-5**

Analysis of anticipated environmental impact of developmental project and impact prediction.

**Step-6**

Interpretation of the anticipated project induced changes.

**Step-7**

Identification and incorporation of mitigation measures.

**Q11. What is the impact of construction activities and infrastructure development on land?**

**Answer :**

Impact of construction activities and infrastructure development on land is caused by consumption of natural resources, generation of pollutants and waste, all of which lead to global warming, waste disposal, discharges to water, land contamination, air and noise pollution. The different types of pollutants generated by the construction industry include toxic elements like, carbondioxide, hydrogen sulfide, asbestos, dredging material and rubble etc.

**Q12. What do you mean by rehabilitation in EIA?**

**Answer :**

Model Paper-II, Q1(f)

Rehabilitation in EIA refers to the resettlement of the relocated communities from their indigenous habitats in the event of a major development activity. Rehabilitation of people is relevant and necessary for the following reasons,

- (i) To help people to live a safe and secure life.
- (ii) To restore the economic vitality of the community.
- (iii) To help strengthen the resilience of displaced people.

**Q13. What is the difference between environmental audit and impact assessment?**

**Answer :**

<b>Environmental Audit</b>		<b>Impact Assessment</b>
(i)	It covers the environmental issues for which standards are available.	It includes all types of environmental issues to measure the performance.
(ii)	It has to be conducted regularly.	The impact assessment is conducted before the proposed policy, program or development project is initiated.
(iii)	The geographic boundaries for conducting environmental audit is well defined i.e. site specific.	The geographic boundaries for conducting impact assessment is unlimited i.e. wherever a particular product impacts the environment.

**Q14. What are the stages of environmental audit?**

**Answer :**

The different stages of environmental audit are,

**(a) Pre-Audit Activities**

The pre-audit activities incorporate all the activities involved prior to the on-site audit of the proposed project.

**(b) On-Site Activities**

The on-site activities include verification of records and relevant documents related to the proposed project, conducting confidential interviews with the members employed with the project, inspection of the proposed project site, review of the safety measures implemented and conducting a closing meeting.

**(c) Post-Audit Activities**

The post-audit activities related to a proposed project involves the translation of the collected data into meaningful information to facilitate the decision making process.

**Q15. What are the main types of environmental audit?**

**Answer :**

Model Paper-III, Q1(e)

The environmental audit is of two main types,

**1. Objective-Based Type of Environmental Auditing**

The objective-based type of environmental auditing is further classified into,

- (i) Liabilities audit
- (ii) Management audit
- (iii) Activities audit.

**Q15. Client-Driven Type of Environmental Auditing**

- The client-driven type of environmental auditing is further classified into the following types,
- (i) Regulatory external audit
  - (ii) Independent external audit
  - (iii) Internal environmental audit
  - (iv) Third party audits.

**Q16. List the post audit activities of a project.****Answer :**

Once the on-site activities are completed, the post-audit activities follow, wherein, the collected data is translated into meaningful information to enable better decisions.

The team leader of the audit team prepares a draft report of the on-site observations within 2-weeks of the on-site activity. This step is followed by the review of the report by the environmental department, law department etc. A final report is prepared by the same audit team, assisted by the respective specialists. It contains the statement of facts and proposals on how to improve environmental performance, improvements in education or awareness raising, ways to increase environmental responsibility, investments in new equipment and environmental protection technology.

The audit report is to be circulated to all the members of the audit team including the audit management committee, senior site auditors, site facilitators and audit personnel for endorsement. The environmental audit report generally includes the following items.

- (i) An executive summary
- (ii) Introduction and background information to the audit
- (iii) Scope and objectives
- (iv) Description and methodology of audit
- (v) Summary of observations, findings and recommendations
- (vi) Conclusion
- (vii) Annexes.

**Q17. Differentiate between post-audit and pre-audit.****Answer :**

	<b>Post Audit</b>	<b>Pre-Audit</b>
(i)	The information collected following the onsite work is translated into meaningful information (a draft report). The report is reviewed by the plant management to confirm the accuracy of information.	The pre-audit activities involve issues like planning the audit, selection of workforce for the audit team, preparation of audit protocol, procure background information about the organization, etc.
(ii)	Any deficiency in the audit report calls for a corrective action plan.	It involves development of audit plan and protocols.

**Q18. Bring out detailed comparision between an environmental review and an environmental audit.****Answer :**

	<b>Environmental Review</b>	<b>Environmental Audit</b>
1.	The main aim of Environmental Review is to decide on the performance standards that must be met. (Eg: A company may intend to reduce the total gaseous emissions from 50 tonnes to 10 tonnes/year).	The aim of environmental audit is to confirm if the performance standards are being met. (Eg: The company actually brings down the total emissions to 10 tonnes/year).
2.	It covers all environmental issues (such as changes in the landuse, nature reserves, vegetation, historical/cultural monuments, local biodiversity, etc.)	It covers only the standard environmental measures.
3.	Environmental review is conducted before any important change is brought about in the operation process or practices.	Environmental audit has to be conducted regularly, in a time-bound manner.
4.	Environmental review is conducted wherever the product is likely to have an environmental impact, starting from the selection of raw material, its transportation, manufacture, product use and disposal.	Environmental audit is conducted in well-defined geographic boundaries.

**Q19. Enumerate different types of liabilities audit, management audit and activities audit.**

**Answer :**

The different types of liabilities audit are,

- (i) Compliance audit
- (ii) Operational risk audit
- (iii) Acquisition audit/transactional audit
- (iv) Health and safety audit.

The different types of management audit are,

- (i) Corporate audit
- (ii) Systems audit
- (iii) Policy audit
- (iv) Issues audit.

The different types of activities audit are,

- (i) Site audit
- (ii) Waste audit
- (iii) Product audit
- (iv) Cross-boundary audit.

**Q20. Write briefly on the appraisal step of EIA for developmental projects.**

**Answer :**

The fourth step of EIA is the appraisal of EIA for developmental projects. The Impact Assessment Division of the MoEF receives the application from the project proponent for grant of appraisal and environmental clearance. The technical staff of the Impact Assessment Agency (IAA) examines the project proposal and the report. It is then sent to the Impact Appraisal Committee (IAC). The data furnished by the project proponent is assessed by the IAC. They may even visit the project site to understand the environmental aspects and the impacts of the proposed project. Depending on the impact outcome, the Committees can suggest whether to approve or reject the proposed project, then the MoEF can approve or reject the proposal.

The different types of projects that are reviewed include industry, river valley and water resources, mining, thermal power plants, and infrastructure projects.

## **PART-B ESSAY QUESTIONS WITH SOLUTIONS**

### **EMP PREPARATION, MONITORING ENVIRONMENTAL MANAGEMENT PLAN**

Discuss the components of environmental management plan.

**OR**

Define planning. Explain environmental management planning. Give two practical examples.

The term planning, in relation to the environment, can be defined as a decision - making process to analyze/assess the environmental, social, political, economic factors that may impact the environment when a developmental activity is undertaken. The aim of environmental planning is to maintain a sustainable environment for the future generations.

Environmental Management Plan (EMP), also called an impact management plan, is a part of EIA reporting. It explains the several mitigation and monitoring measures that need specific action to be carried out by the proponent during project construction and operation for a sustainable environment.

#### **Components of EMP**

Some of the main components of EMP are,

#### **List of Environmental Impacts**

A summary of the predicted adverse environmental and social impacts of the proposed project for which mitigation is necessary should be specified.

#### **Description of Mitigation Measures**

The mitigation measures about the predicted environmental impacts of proposals and recommendations must be explained. It should include the project design, operating procedures and the technical aspects of implementing the various measures.

#### **Description of Monitoring Program**

This program should explain the impacts, their measurement indicators and detection limits that will indicate the need to take corrective actions.

#### **Organized Arrangement**

The mitigation and monitoring arrangements must be well co-ordinated so that the various actors involved in the project can act responsibly.

#### **Implementation Schedules and Reporting Procedure**

This component of EMP should include the information on the progress and results of mitigation and monitoring measures.

#### **Cost Estimates and Source of Funds**

The initial investment and recurring expenses during the design stage, pre-construction stage, construction stage and operation stage of the project must be specified.

#### **Examples**

Auroville is a small township located in a rural area in a low-lying plateau on south-east coast of Tamil Nadu. It is 160 km south of Chennai in South India. The place is reputed for wasteland reclamation and reforestation work. The barren land has been transformed into a lush green area by planting more than two million different types of trees. Soil and water conservation by building small check dams, promoting biodiversity, environmental restoration and inorganic forming to create an environment friendly, sustainable urban area are the main activities pursued in Auroville. Ecologically sound agricultural methods have been developed by excluding the use of pesticides and harmful chemicals and promoting the use of biodegradable pesticides throughout the region. Renewable energy sources such as solar, wind and biomass are in use. The town has more than 1200 photovoltaic panels, 30 windmills for generating electricity and supply water. A ferro-cement biogas system has been designed to process animal and vegetable waste to produce methane gas and organic fertilizers.

China is coming up with an environmentally friendly city, Dongtan by name, on the suburbs of Shanghai. It is the world's first carbon neutral city, with the following features : energy efficient housing system, recycling and reuse of water, restriction on usage of cars and a sanctuary for migratory birds.

Answer :

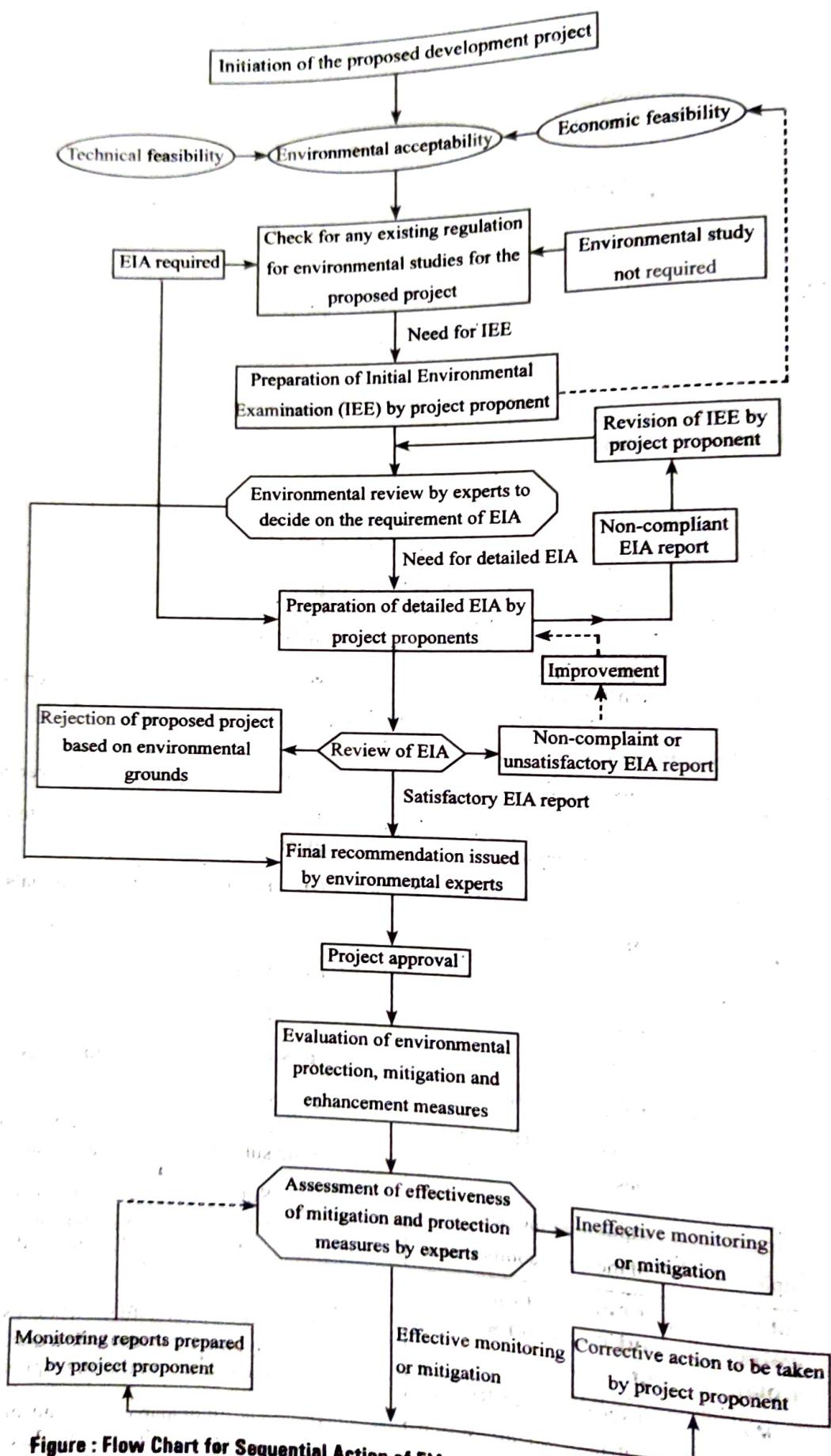


Figure : Flow Chart for Sequential Action of EIA as an Environmental Management Tool

Q23. Discuss the objectives of environmental management. Add a note on the importance of EMP in the EIA process.

**Answer :**  
Environmental management refers to management of all components of the biophysical environment, including the living (biotic) and the non-living (abiotic) factors.

The objectives of environmental management include the following.

Protection, conservation and preservation of the environment and its resources.

Proper land and water management for a sustainable environment.

Preserving the ecological heritage for our future generations.

Promoting eco-friendly technologies.

Involving men, women, children and NGOs in all environmental related activities.

Strategic measures for afforestation of denuded wastelands.

Mandatory environmental education course in all educational institutions.

Help the government at local, state and national level to frame laws for environmental conservation.

#### Importance of EMP in EIA process

1. EMP ensures that adequate measures are taken to protect, conserve and preserve the environment and its resources so that minimal damage is caused to the environment by project activities.

2. It is committed to comply with environmental protection legislation.

3. It provides awareness about the sensitive natural features of the project site.

4. EMP provides an overview of the likely emergency situations that can arise at the project site and the actions needed to manage such exigencies.

5. It includes providing adequate training to the personnel involved in the implementation of the EMP components.

Q24. Explain in detail the environment management plan for air, water and land environment for thermal power plant project.

**Answer :**

Model Paper-III, Q6(a) | Sep.-20 (R16), Q8

The environmental management plan for air, water and land environment of thermal power plant projects are as discussed below.

#### Environment Management Plan for Air

The various methods of controlling air pollution are,

1. Control of air pollution by zoning.
2. Dilution of source discharge by use of tall stacks (chimneys).
3. Control by using source correction methods (by changing raw materials, process methods, equipment etc).
4. Reduction of pollutant discharge at source by use of controlling equipment.

#### 1. Control of Air Pollution by Zoning

Air pollution can be controlled by proper zoning. The city should be planned in such a way that residential areas and heavy industries are not located too close to each other.

- ❖ Providing a green belt between the industries and the township will reduce the impact of air pollution.

#### 2. Dilution of Source Discharge by Use of Tall Stacks

In this method, the pollutants are carried away to higher altitudes to reduce the concentration by means of diffusion and dilution.

- ❖ These pollutants are taken to high altitudes by means of tall stacks or chimneys such as 250 m chimneys.

#### 3. Control by using Source Correction Methods

The various methods available to control air pollution by process changes are :

- (i) By substituting raw materials
- (ii) By modifying the process
- (iii) By modifying or replacing the equipment
- (iv) By changing the operation

#### (i) By Substituting Raw Materials

The method of substituting raw materials or fuels is generally applied for atmospheric pollution control. The basic substitutions that can be done are as follows :

- (a) Substituting low volatile coals instead of high volatile coals is preferred for reduction of smoke and soot in industrial and commercial heating processes.
- (b) Low sulphur-fuels when used in place of high sulphur fuels results in a great reduction of sulphur dioxide gas in the atmosphere.
- (c) The fluorspar used in an open hearth furnace if changed with bauxite flux, the emission of air pollutants decreases considerably.

(ii) **By Modifying the Process**

The process of control of air pollution can be modified either by eliminating (or altering) any unit operation or by adding (or substituting) any unit operation. Some examples of modifying the processes are as follows,

- The combustible refuse may be disposed without the process of incineration.
- In brass foundry, the top layer of the brass is provided with a fluxing material to reduce the emission of brass fumes in air which causes air pollution. This is an additional operational step included in this method.
- In the process of manufacture of gas, the air used is substituted by oxygen to reduce the finally achieved contaminant.

(iii) **By Modifying or Replacing the Equipment**

This method of air pollution control may be applied in the following ways,

- By modifying certain units of the equipment.
- By replacing or repairing the faulty equipment.
- By substituting one type of equipment in place of another type.

**Examples**

- ❖ For handling volatile materials, several units such as condensers, adsorbers, compressors etc., may be used. This reduces the vapour losses from such materials.
- ❖ Cupolas are interchanged with reverberatory furnaces for reducing the atmospheric pollution in cast iron foundries.

(iv) **By Changing the Operation**

In this method, the operational practice of a process is changed to reduce the pollution. For example, the high sulphur fuel in coal burning is replaced by low sulphur fuel reducing the amount of emission of sulphur dioxide in the atmosphere.

**4. Reduction of Pollutant Discharge at Source by Use of Controlling Equipment**

This method helps in reducing the pollutants at a source by use of various air pollution control equipment.

**Environment Management Plan For Water**

Water covers three-fourth of the earth's surface. Water is used by man for recreation and aesthetics, aquatic life, public water supply, agriculture and industry.

Polluting the water leads to its contamination and gives rise to various water-borne diseases. Hence, the consequences of water pollution leads to the following,

- We tend to lose the number of working days as we fall ill.
- Missed educational opportunities due to ill health.
- The expenses on healthcare increases.
- Draining of family resources.

**Preventive Measures**

In order to lead a healthy life, we must take proper precautions in disinfecting the city water. The various ways by which we can control water pollution are,

- Safe disposal of human excreta.
- Paints, hazardous wastes and motor oils should not be discarded down the drain, as they migrate to the water source thereby contaminating it.
- A non phosphate or low phosphate detergent may be used to wash clothes as the high phosphate content in lakes and streams endanger the lives of fish and wildlife.
- Plastic bags should not be dumped into water bodies, as the aquatic animals consume it, which leads to their death.
- Water supplied to cities for drinking should be disinfected properly.
- The effluent waste should be released into the water after pretreating it. The treated effluent can be used for gardening purposes.
- Usage of the root zone method helps to control water pollution. In this process, the contaminated water is run through the root zones of specially designed reed beds. The reeds function by absorbing oxygen and creates a condition for thriving of various microorganisms. These microorganisms purify the contaminated water.
- Treatment of sewage prevents water pollution.
- Avoid excess use of chemical fertilizers and pesticides as it leads to water pollution. Thus, biogas fertilizers and biopesticides should be used in agriculture.
- Recycling of waste materials helps to minimize water pollution.
- Installation of sewage treatment plants help to minimize water pollution.
- The pollution control system designed and developed at NASA's Marshall Space Flight Center (MSFC) combines both water and air pollution control into one system. This can be implemented in all the developing countries to control water pollution.

**Environment Management Plan For Land**

Several measures may be taken to minimize or control land pollution. Some of them are as follows,

- Motivate our neighbours against littering and start an anti-litter campaign.
- The domestic wastes can be dumped in areas far from the residential places.
- Follow the three 'R's of the environment i.e., reduce, reuse and recycle. Inorganic materials like glass, metals, plastic and paper can be recycled.
- Use of biopesticides like *Bacillus thuringiensis*, neem (*Azadirachta indica*) and *Trichogramma* instead of synthetic pesticides. Motivate the agriculturists for organic farming by avoiding the use of synthetic fertilizers and pesticides. The crop residue is left in the soil which gets incorporated thereby preventing soil erosion and increasing the organic matter in the soil.

**Q25. Write a detailed note on "environmental management in industries".**
**Answer :**

The leading environmental challenges across the globe are climate change, water availability, pollution, waste generation and their disposal. Industries use enormous amounts of raw material and energy, therefore, they are a major source of pollutants and waste. Despite the efforts made in this direction to save the environment from further degradation, still remains an important issue.

Many industrial organizations have begun to realize the importance of environmental management and have integrated environmental management in overall management systems of the organizations by prioritizing and implementing the environmental issues.

Industries can play a positive role in meeting these environmental challenges by adopting efficient production processes, preventive strategies, cleaner technologies and procedures throughout the lifecycle of industrial products. Such sustainable practices can help reduce the impact on resource use and the environment and thus contribute towards a more sustainable society.

Some automobile industries across the world are committed to meeting customer needs in a sustainable way with environmentally friendly technology and products. Some of their contributions are,

- (i) Active participation in the manufacture of fuel efficient and ultra low-emission hybrid vehicles.
- (ii) Supporting the research and technology involved in production of such eco-friendly vehicles.
- (iii) Encourage the use of cleaner fuels in automobiles.
- (iv) Provide vehicle renovation to extend vehicle life.
- (v) Adopting global environmental standards and encouraging its implementation amongst dealers and suppliers of various products.
- (vi) Encouraging the reduction of resource consumption, pollution and waste generation through reuse and recycling.
- (vii) Conserving and enhancing the environment by investing and participating in projects leading to improvement of natural and community environments.
- (viii) Promoting public awareness about environmental issues and concerns by providing appropriate information, training and support to its employees, and communication with all the stakeholders.
- (ix) Encouraging the employees to take actions to reduce energy use by some of the following ways.
  - ❖ Turning off the electrical gadgets when not in use and after hours as well.
  - ❖ Meetings and video-conferences may be combined in order to reduce air travel.
  - ❖ Vehicles may be auctioned online to reduce business air travel by the dealers.

- (x) Energy consumption in industries can be reduced by modernization and upgradation of plant and machinery, usage of fuel substitutes, recovery and reuse of by-products and disposing of old units.
- (xi) Water consumption for various industrial purposes (E.g. In steel industries) can be reduced considerably by emphasizing on water recirculation in all process units, close monitoring of water losses, recycling of ash, recycling of treated sewage water.
- (xii) Treatment of waste water by physio-chemical methods and its recycling.
- (xiii) The company vehicles should be monitored for emissions and checked for pollution under control certificates at various places.
- (xiv) The power plants are provided with instruments for continuous online sampling and analysis of gases, closed circuit television network for monitoring stack emissions and a continuous ambient air monitoring station.
- (xv) Investment on pollution control in thermal power plants by using coal with lower sulphur and lower ash content.

Environmental considerations have now become an important part of industries' everyday reality. Still, there is lack of seriousness about various environmental issues. The top management of various industrial organizations should take a proactive role in environmental decision making and implement them, thus contributing to the environmental performance and productivity of the industries.

### **3.2 IDENTIFICATION OF SIGNIFICANT OR UNACCEPTABLE IMPACTS REQUIRING MITIGATION**

#### **Q26. State the guidelines for mitigation of disasters.**

**Answer :**

The guidelines for mitigation of disasters are intended to increase public awareness in the face of the exigencies. Some of them are discussed below,

##### **(i) Early Warning Symptoms**

The early warning symptoms of an impending disaster have a major role in mitigating the effects of disasters. It enables the affected people to enhance the disaster response operations. The early warning symptoms include detection of signs of impending catastrophe, analysis of symptoms and disseminating information to the concerned people.

##### **(ii) Land-Use Zoning**

Hazard prone areas must be identified and marked. Its usage must be prevented through national or local legislation or prohibitions. Such areas should not be used for residential or industrial purposes. However, the hazard prone areas can be used for agricultural activities.

**(iii) Building Codes**

The building codes are meant to improve the quality of new constructions in order to resist catastrophes and thus protect life and property. The building codes are established in consultation with builders, architects and the public.

**(iv) Incentives**

Hazard mitigation can be accomplished by a wide range of incentive techniques. For example, funds may be given to firms or households in hazard prone areas to strengthen the existing buildings or to include certain modifications during the construction phase.

**(v) Provision of Assets at Subsidized Rates**

Community cyclone shelters may be provided to people residing in cyclone prone areas at subsidized rates or for free. Deep bore holes may be drilled in drought prone areas or sufficient land should be provided for water harvesting in such regions.

**(vi) Increase Public Awareness**

Awareness raising campaigns about the hazards must be conducted to educate the population about how to respond and cope when hazard events occur.

Efficient mitigation plans must be considered and implemented systematically and prevent the impact of natural hazards.

**Q27. Discuss some measures to mitigate floods and cyclones.****Answer :****Floods**

Floods occur when water overflows on the banks of rivers due to heavy rains, melting of ice and snow, thereby exceeding the limits of carrying capacity of rivers.

The mitigation measures taken to prevent floods are,

9. The public should be made aware of the floods providing warnings in advance.  
Hence, measures should be taken to prevent floods as it leads to loss of lives and property.

**Cyclones**

Cyclones are violent tropical storms or winds in which the air moves very fast in a circular direction.

The mitigation measures to prevent cyclones are,

1. Afforestation of land should be done, as forests act as buffering areas against strong winds and flash floods.
2. Trees prevent the entry of cyclones in land, thus acting as a barrier to cyclones.
3. Public should be alerted about the cyclone in advance so as to evacuate the areas prone to it.
4. The buildings constructed should be resistant to wind and water.
5. Construction of cyclone shelters helps to minimize loss of human lives.
6. Means of communication should be through underground as it could lead to communication break during cyclones.
7. Cyclonic storms lead to flooding, hence measures should be taken to prevent floods.
8. Construction of embankments helps to minimize floods.
9. Soil erosion and floods can be prevented by afforestation.
10. Coastal shelter belt plantations help to break severe winds.
11. Plantation along the coastal areas prevents the loss of soil, hence fields can be protected.
12. Public settlements should be avoided in coastal areas in the range of 5 km from the sea.
13. Experiments are being conducted to prevent cyclones using wind power.

Hence, by following the above mitigation measures the arrival of cyclones can be minimized.

**Q28. Discuss the important preventive measures to mitigate earthquakes and landslides.****Answer :**

Important preventive measures to mitigate earthquakes and landslides are,

**Earthquakes**

Earthquakes are sudden violent movement of the earth's surface and even tectonic plates of the ocean which may cause great damage (i.e., when the Richter scale reads above 6).

Some of the mitigation measures to avoid earthquakes are,

1. Avoid construction of houses in areas which are highly prone to earthquakes (like Ganga plains and western parts of Rajasthan). The ground should be stable consisting of solid rocks rather than sandy or muddy soil so as to prevent sinking or collapsing of taller buildings.

### UNIT-3 Environmental Management Plan

- 1. Buildings constructed on areas prone to earthquakes should be equipped with destruction tools so as to prevent their collapse.
  - (i) Steel used should be flexible.
  - (ii) The base of the building should contain shock absorbing rubber blocks.
  - (iii) Fire proof materials should be used while constructing buildings.
- 2. Gas pipes and electricity supplies should be automatically shut when an earthquake strikes. This prevents outbreak of fires.
- 3. The public should be alerted in advance about the striking of earthquakes as and when detected in seismograph recording.
- 4. The dumping of fluid wastes by injecting it in deep wells should be avoided. This was practised in U.S, Japan and Canada which was leading to earthquakes.

#### Example

- 5. Earthquake occurred at the Rocky Mountain Arsenal near Denver, Colorado due to injection of fluid.
- 6. Carrying off nuclear blasts for testing leads to development of tremors in the earth. This could lead to earthquakes.
- 7. Digging of excessive borewells can also lead to earthquakes as the groundwater table levels decrease.
- 8. People inhabited in earthquake prone areas should be made aware to take preventive measures in order to save themselves when an earthquake strikes.

As earthquakes are a natural climatic disaster which is not in the control of human reach, therefore measures should be taken by preventing its cause, building safe constructing for the public to reside within, and also educating the public about the safety measures to be taken when an earthquake strikes.

#### Landslides

Landslides are sudden and quick movements of rock and soil down a steep slope.

#### Cause of Landslides

Landslides are induced by,

- (a) Natural phenomenon: Such as storms, earthquakes, fires and volcanoes.
- (b) Human intervention: This includes the following factors,
  - (i) Intense deforestation
  - (ii) Soil erosion
  - (iii) Excessive development in landslide prone areas
  - (iv) Construction of roads and communication lines in mountains regions
  - (v) Construction of human settlements in mountain areas.

#### Mitigation Measures

- Landslides are induced by storms, earthquakes, fires, volcanoes and human intervention by modifying the land. The mitigation measures taken to prevent landslides are,
  1. Avoid excessive exploration of natural resources as its changes the land topography. This may lead to landslides.
  2. Drains and pipelines should be clear as surface drainage of water on the slope could lead to landslides, as the slopes become slippery.
  3. Promote afforestation as the deeply rooted plants binds the soil particles and helps to dewater the slope.
  4. Soil erosion should be avoided on cliff or steep hilly areas.
  5. Avoid digging of channels on the hilly slopes as it prevents surface drainage of water.
  6. Embankments (artificial slope made of earth or stones) and walls should be constructed when the bottom of a slope is cut.
  7. The steep slopes should be reduced by grading or by diverting the water from the slope's surface.
  8. Slopes prone to landslides should be vegetated with plants. If vegetation is not possible then use plastic sheeting, erosion mats or any other erosion control material.
  9. Robots can prevent landslides without the loss of human lives. This has been practised in Italy, where a Roboclimber weighing four tons prevented landslides and saved many human lives.
  10. Measures should be taken to prevent rock fall by installing rock anchors or rock bolts.

Landslides cannot be totally prevented but preventive measures help to decrease the loss of lives and property due to landslides.

#### Q29. Write the mitigation measures in EIA.

**OR**

**Write a note on identification of mitigation measures.**

**OR**

**What mitigation measures are taken to counteract the adverse effects of a natural calamity?**

**Answer :**

The different types of measures that can be employed for mitigation of adverse environment are,

- ✓ Loss and damage to soils from erosion, compaction and pollution can be mitigated by good practice techniques. Erosion of soil by various agents can be reduced by minimizing the amount of soil bared through reduced vegetation, by retaining the stubble of the crops in the soil, by retaining vegetation in sensitive areas, by construction of physical structures to stabilize the slipping away of soil, by promoting the growth of macroscopic and microscopic soil organisms, by promoting the use of anthropogenic chemicals in the soil, by encouraging extensive plantation of trees.

**General Mitigation Measures**

Some general mitigation measures should be pre-planned followed,

For remaining answer refer unit-III, Q29.

**Q31. What are impacts occurring in land during operation phases?**

Sep.-20. (R16)

OR

**Write a detailed note on direct land use impacts**

**Answer :**

Given below are the impacts of construction activities and infrastructure development on various aspects of land or groundwater.

**1. Landforms**

Landforms created by different natural forces include mountains, valleys, deserts, plateaus, plains, hills, loess, etc. Man-made changes in landforms include development of ports on level lands close to waterways, railway lines, highways, roads and streets on gentle terrain, agriculture and parklands on areas prone to occasional flooding; central business districts on levelled land. The construction related impacts on landforms include changes in the surface of land, uncontrolled clearing of vegetation, gross changes in hydrology, slope modification, soil erosion, increased tendency to experience subsidence, collapse, shrinkage and landslides.

**2. Soil Profile**

Soil is the loose superficial layer of the earth's crust consisting of mineral matter, soil water, soil organic matter, soil organisms and soil air. The types of soil impacts owing to construction activities include soil removal, soil profile mixing, soil compaction, soil erosion, soil contamination, vegetation clearing, reduced permeability of soil, and thus impede the infiltration of rainfall. Spills and toxic elements discharged from construction activities cause soil pollution.

The industrial and municipal water supplies rely on two major sources of drinking water, groundwater and surface water. Both these sources of water are likely to be polluted by contaminants. The groundwater, generally stored in underground aquifers, receives water from soil saturated with precipitation or through stream and river runoff. When the storing capacity of aquifers exceeds, the excess water is drained into streams or rivers. The groundwater and surface water are intimately interconnected such that the pollution of surface water can reach groundwater and vice versa.

**3. Soil Composition**

Construction activities can have significant detrimental impacts on the physical, chemical and biological properties of soil. Therefore, sustainable use and management of soil resources on construction sites should be an integral part of the environmental assessment process.

2. Restrictions on the cutting of plantation at the site.
3. Development of green belt on the surrounding periphery of the project site.
4. Watering the ground before the excavation process begins.
5. Soil contamination from oil and material spills by adopting spill control procedures.
6. Restoring the vegetation on barren lands by landscaping with fast growing grass cover, plants, flowers, bushes and trees.
7. Implementing appropriate water conservation measures to meet the increased demand for water.
8. Implementing appropriate energy conservation measures to meet the increased demand for electricity.
9. Use of safety procedures and personal protective equipment to prevent adverse human health from dust and noise.
10. Prevent the entry of construction material into surface water to prevent the adverse impacts on drinking water supplies, irrigation systems and river ecology.
11. Prevent the entry of sediment into surface waters by implementing runoff control measures, mechanical sediment control measures, grassed filter strips, mulching and soil bioengineering practices.
12. Regulation on the open burning of solid waste/garbage.
13. Use of air pollution control techniques such as electrostatic precipitators, cyclone scrubbers, mist filtration, thermal oxidation/ incineration, catalytic oxidation, biofiltration, adsorption, wet scrubbing/ absorption, irradiation, condensation, and chemical treatment for reducing pollutant levels from point sources.
14. Modifications in the project with changes in the design patterns.

**Q30. What type of mitigation measures can be implemented to reduce the impact on the soil.****Answer :**

The term mitigation refers to reduction in the effects due to a proposed developmental activity. The mitigation measures can be broadly categorized into the following types,

- (a) Measures innate to the project, such as use of environment-friendly technologies, sustainable changes in the construction/production processes.
- (b) Measures that mitigate the possible negative impacts from a development. For instance, the negative impact of sewage pollution can be minimized by installing treatment plants. The loss of habitat and habitat fragmentation can be minimized by habitat replacement or creation.
- (c) Adoption of measures that prevent the negative effects, such as use of adequate barriers against noise, dust, by the use of mufflers, silencers at the air inlet/outlet, anti-vibration pad, earmuffs and earplugs, etc.

**Slopes**

The type of construction activity depends upon the steepness of the terrain. It is difficult to develop a sloping terrain due to the serious erosion problems. The steeper the slope, the greater the threat of erosion. Residential areas, industrial belts, roads, airports, recreation facilities can be developed on gentle slopes. The rocky hillsides may experience rockfalls, the glacier regions may experience avalanches, while the valleys face the threat of flash flooding.

**Seismicity**

Anthropogenic activities such as heavy engineering and construction works, mining, oil and gas production, hydroelectric power generation, underground disposal of wastewater, injection of geothermal fluids, impoundment of large reservoirs behind dams, controlled explosion related to mining or construction, underground nuclear tests, injection and withdrawal of fluids from subsurface may induce seismicity or movement of the earth's tectonic plates.

**Land Subsidence, Collapse and Shrinkage**

Land subsidence is the sinking of the land, generally through man-driven or technologically driven circumstances, such as extraction of natural gas, subsurface mining activities.

**Flood Plains**

Flood plain areas often face drainage problems due to the periodic flooding and siltation. These areas are generally suitable for agriculture but not for urban development.

**Land Use**

Construction and land development activities involve ground clearing, soil compaction, increased traffic, noise, dust and other anthropogenic activities leading to serious environmental problems such as stormwater runoff, high rates of erosion, resulting in short and long term adverse impacts on water quality in streams, rivers, lakes, ponds, aquatic life habitats and increase in flood plains.

**Mineral or Engineering Resources**

The minerals used in the construction industry (such as road making, in concrete house construction, railway ballast) are of different types such as clay, chalk, limestone, dolomite, brick, clay, gypsum, slate, building stone, etc. The risks involved include mine subsidence, weak and compressible soils and seismicity. The mining industry has a significant role in the country's economic development. However, the extraction of mineral resources has significant impact on the stability of the seabed, air pollution with dust and gases caused by drilling, blasting, mine haulage, deforestation, changes in landforms, groundwater and surface water contamination, collapse of unfilled tunnels and visual pollution.

**Buffer Zones**

It refers to the undisturbed area around the core zone where the project activity is planned. The buffer zones should be generously provided in the vicinity of the project site in order to minimize the impact of human disturbance by construction activity.

**Q32. What is meant by land drainage?****Answer :**

Model Paper-I, Q7(b) | Sep.-20 (R16), Q6(c)

Land drainage is a process of allowing water in wet areas like irrigated land to rapidly drain away or to relieve hydrostatic pressure by a variety of land drains or water courses.

Advantages of land drainage are,

- (i) It decreases soil erosion
- (ii) It improves structure of soil and soil productivity
- (iii) Sufficient drainage leads to early ploughing and planting.
- (iv) In an area the water table is reduced by drainage.
- (v) From soil excess soil can be leached out.
- (vi) The drainage of the area extends the growing season of the crop.

Land drainage refers to mainly two types of drainage,

**Surface Drainage**

- (i) Surface drainage is the removal of excess rain water falling on the fields or the excess irrigation water applied to the fields, by constructing open ditches or drains, field drains etc.
- (ii) The land is sloped towards these ditches or drains to allow the excess water to flow into these drains
  - (a) Shallow surface drains: These drains are constructed to drain excess irrigation water collected in the depressions in the fields as well as storm water.
  - (b) Deep surface drains: These drains are actually outlet drains which carry seepage water from the underground tile drains and flood water of the catchment area from the shallow surface drains..

**Sub-surface Drainage**

- (i) It is also known as tile drainage.
- (ii) Subsurface drainage is used where the soil is permeable enough to allow economical spacing of the drains.
- (iii) These systems consist of a surface or subsurface main drains and laterals.
- (iv) Water is carried into the outlet by main drains, which receive water from the laterals.

**Q33. What is the methodology need to be adopted to study the impacts on soil quality due to any developmental activity?**

July-21, (R16), Q4(a)

**OR**

**Discuss the mitigation measures for soil and groundwater impacts.**

Model Paper-I, Q6(b)

**OR**

**Describe the existing environmental conditions/status for the EIA study.**

**Refer Only Topic: Step 3: Description of the Existing Environmental Status of the Study Area**

**OR**

**What are the ways to interpret project induced changes.**

**Refer Only Topic: Step 5: Analysis of Anticipated Environmental Impact of Developmental Project and Impact Prediction**

**Answer :**

The steps involved in the study of impact assessment on soil and groundwater are as follows,

#### **Step 1: A Clear Delineation of the EIA Study Area**

The term delineation refers to the identification of the site where a proposed developmental activity is planned.

Delineation is essential for the following reasons :

- (i) It is helpful to determine land use activities.
- (ii) It enables the identification of sensitive areas for protection.
- (iii) It helps to identify the less sensitive areas for developmental activities.
- (iv) It enables proper management of environment and natural resource.
- (v) It helps in understanding the ecology, geography, geology and cultural features of the site.

Environmental site assessment (or pre-acquisition site assessment), where a proposed action is planned is essential to define the characteristics of the area, which is likely to be significantly affected by the proposed project. This step should include the land-use map, land-use policies, zoning and details of the development project to be undertaken.

The land-use map should depict the following,

- ❖ Residential areas
- ❖ Commercial areas
- ❖ Industrial areas
- ❖ Institutional parks or recreation areas
- ❖ Infrastructure or built up land (roads, railways, airports, mining/quarrying sites, etc.)
- ❖ Dump sites
- ❖ Natural areas (forest land, agricultural land, wetlands/marshy/salt pans, grazing land, wildlife sanctuary, national parks, wastelands, wildlife corridor, waterbodies).

#### **Characteristics of the Study Area**

The different characteristics of the study area to be considered for EIA are,

1. Geology - Nature of rock, soil and geological resources.
2. Topography - Land features.
3. Soils - Type of soil in the project area, black, red or yellow.
4. Groundwater resources - Quality of groundwater from deep wells and subsurface aquifers.
5. Surface water resources - Waterbodies, water courses, drainage basins, subbasins, water quality.
6. Terrestrial botanical and zoological communities. Vegetation, wildlife, genetic resources, endangered species, threatened species.
7. Aquatic communities - Nature of aquatic habitats, fish and aquatic communities, species abundance.
8. Environmentally sensitive area - Include wetlands, flood plains, slopes, agricultural lands and mines.
9. Air quality - Existing air quality in the project site.
10. Landuse - Landuse pattern of the project site includes the area covered for residential, commercial, industrial, recreation, transportation, agriculture, waterbodies, etc.
11. Demographic profile - Total population in the study area, average sex ratio, average family size, age of the population, literacy levels, occupational profile, traditional skills, sources of livelihood.
12. Sound levels - Noise generated from construction activities, operation of construction equipment.
13. Socio-economic condition - Population, occupation status, demographics, employment pattern, social values, amenities, health conditions.
14. Infrastructural services - Schools, offices, shopping areas.
15. Transportation - Highways, roadways, railways, airports.
16. Cultural resources - Archaeological, historical, cultural areas.
17. Project economics - Economic costs and benefits from the proposed project activity.

#### **Step 2: Identification of Impact of Project on Soil and/or Groundwater.**

For answer refer Unit-III, Q31.

#### **Step 3: Description of the Existing Environmental Status of the Study Area**

The description of the following components of the environment must be included,

##### **(a) Air Environment**

Existing air quality, wind speed, wind direction, humidity, pollutants in air (TSP, PM<sub>10</sub>, PM<sub>2.5</sub>, SO<sub>2</sub>, NO<sub>x</sub>, Br<sub>2</sub>, Cl<sub>2</sub>, HBr, HCl, CO, Methane, H<sub>2</sub>S).

### Water Environment

Existing water resources such as groundwater, resources from dug wells, tube wells, hand pumps, aquifers and surface water resources such as streams, tanks, rivers, reservoirs, lakes, ponds, wetlands, estuarine and coastal waters, their quality and quantity, impact of proposed construction activity on water resources.

### Noise Environment

Noise levels of the study area, predicted noise levels during and following a construction activity, and the actions needed to reduce the noise levels.

### Meteorology and Climate Data

Temperature, air pressure, water vapour, humidity, precipitation, wind movement.

### Vegetation Found in the Study Area

The proponents of the planned construction activity should include a description of all types of vegetation - Vegetation ecotypes (Example: Forested, agricultural, wetland riparian), old growth forests, rare plants, medicinal plants, non-native species, etc.

The description of the existing environmental status of soil and groundwater with respect to the study area should include the following,

### Chemical Composition of Groundwater

The chemical composition of groundwater depends on several factors such as frequency of precipitation, the quantity of salts leached, duration of rainwater in the root zone and intermediate zone, presence of organic matter in soil which may get dissolved in the downward percolating water, the chemical reactions involved in the interaction of water with minerals.

The description should include the type of aquifer present in the study area - whether it is unconfined or confined, the levels of pollution in the groundwater resources. The pollutants in the soil are discharged/drained through the unsaturated soil to a saturated zone, where all the pores and fractures are filled with water.

The groundwater generally stored in underground aquifers receives water from soil saturated with precipitation or through stream and river runoff. When the storing capacity of aquifers exceeds, the excess water is drained into streams or rivers. The groundwater and surface water are intimately interconnected such that pollution of surface water can reach groundwater and viceversa.

Description of the underground drainage system, wherein, the rainwater infiltrates rapidly through sinkholes and fractures in the karst landscape. The karst landscapes are very fragile and vulnerable to various anthropogenic activities.

Description of the multiple aquifer systems wherein two or more aquifers are interconnected and possibly separated by the aquitards at the project site. The quality and quantity of groundwater flow vary considerably between the different aquifers.

4. Quantitative data on the extractable groundwater resources.
5. Information related to uses of groundwater within the study area for many industrial processes, agricultural and municipal use, or public water supplies.
6. A description of the connection between the surface water and groundwater should include the manner and extent of connection and understand the complex relationship between the groundwater and floodwater exchanges.
7. Understand the factors influencing the likelihood of groundwater contamination.
8. Information of the depth of usable quality groundwater, which generally varies from several metres upto several hundred metres.
9. Description of the unsaturated zone where the pore spaces are not filled with groundwater. This is meant to determine the amount and quality of groundwater that is available for human use.
10. A description of groundwater quality characteristics.
11. Emphasis on soil or groundwater problems in the study area, such as leaks and spills at factories and commercial facilities, improper hazardous waste disposal, improper use and disposal of pesticides, leachate containing increased level of bacteria, hazardous chemicals, metals and ammonia from landfill sites, saline intrusion, fertilizers, animal wastes, leakages from underground storage tanks, pipeline breaks leading to pollution from sewage, petroleum products and other chemicals, leakages from underground injection wells.

### Step 4: Acquisition of Significant Information Related to Quality and Quantity of Soil and/or Groundwater

This step includes the assessment of current state of soil and/or groundwater by in situ, satellite and airborne observation. It also includes laboratory analysis of quantity variables (groundwater levels and recharge rates), and quality variables (physical and chemical variables).

The soil at the proposed construction site should be given maximum importance for EIA because,

- ❖ Any developmental activity causes disturbance to the soil.
- ❖ The agricultural land may be disturbed or lost due to project activity.
- ❖ Contamination of land is likely to occur.

The condition of soil at the project site can be assessed by three ways,

#### (a) Desk Study

The desk study involves collecting information by literature review related to the soil characteristics and geological information at the proposed construction site.

**(b) Field Work**

The field work involves observation of the colour and texture of soil at the proposed project site.

**(c) Laboratory tests**

The laboratory tests involves the use of soil kits and penetrometers to determine the physical and chemical properties of soil such as, moisture content, texture, density, pH, cation and anion exchange capacity, presence of organic compounds, minerals, heavy metals, pollutants, soil productivity, soil hydrologic function (infiltration and permeability) and soil environmental health.

**Step 5: Analysis of Anticipated Environmental Impact of Developmental Project and Impact Prediction**

The potential environmental impacts, during the construction and operation of the project, can be broadly categorized into the following types,

**(a) Primary Impact**

- (i) release of air pollutants
- (ii) Release of heat
- (iii) Changes in ambient noise levels.

**(b) Secondary Impact**

- (i) Changes in air quality
- (ii) Impact on visibility
- (iii) Particulates deposition on water and land
- (iv) Climate change.

**(c) Tertiary Impact**

- (i) Impact on human health
- (ii) Impact on aesthetics
- (iii) Impact on agricultural productivity
- (iv) Impact on flora and fauna
- (v) Impact on economic output
- (vi) Impact on socio-cultural environment.

The anticipated impacts due to construction activity are,

- (a) Soil compaction by earth movers and other heavy equipment
- (b) Soil erosion
- (c) Overexploitation of agricultural soil
- (d) Soil salinization and soil acidification
- (e) Dust pollution by brick, silica and asbestos
- (f) Noise pollution by construction equipment, diesel generator operations
- (g) Damage to environment
- (h) Damage to the health of construction workers.

The positive impacts include creation of employment opportunities, infrastructure development, business output (or sales volume), wealth generation, revenue flow and taxes, leading to a considerable boost for the local retail economy. The additional workforce may demand for health, education, and housing services which may lead to additional construction activities.

**Step 6: Interpretation of the Anticipated Project Induced Changes**

For answer refer Unit-III, Q4.

**Step 7: Identification and Incorporation of Mitigation Measures**

The term mitigation refers to reduction in the effects due to a proposed developmental activity. The mitigation measures can be broadly categorized into the following types,

- (a) Measures innate to the project, such as use of environment-friendly technologies, sustainable changes in the construction/production processes.
- (b) Measures that mitigate the possible negative impacts from a development. For instance, the negative impact of sewage pollution can be minimized by installing treatment plants. The loss of habitat and habitat fragmentation can be minimized by habitat replacement or creation.
- (c) Adoption of measures that prevent the negative effects, such as use of adequate barriers against noise, dust, by the use of mufflers, silencers at the air inlet/outlet, anti-vibration pad, earmuffs and earplugs, etc.

**General Mitigation Measures**

Some general mitigation measures should be practiced followed,

For remaining answer refer Unit-III, Q29.

**Q34. Discuss the identification and incorporation of mitigation measures for soil.****Answer :**

Sep.-20, (R16), Q5

For answer refer Unit-III, Q33, Topic: Step 7: Identification & Incorporation of Mitigation Measures.

**Q35. Discuss the mitigation measures to control groundwater pollution.****Answer :**

The mitigation measures to control ground water pollution are:

- (i) Control of pollution at the source.
- (ii) Restrictions on over-pumping of groundwater. Excessive pumping of groundwater causes the water from contaminated aquifers to flow into uncontaminated aquifers.
- (iii) Preventing the leachates in a landfill from leaving the landfill area.
- (iv) Injecting air at the base of the aquifer to blow out the volatile materials in it.
- (v) Inserting a barrier into the ground to prevent seepage of the pollutant.

prohibition in setting up landfill sites and gasoline stations over groundwater that supplies to the wells.

prohibition of grazing livestock near the groundwater.

Neutralization of the contaminant by inducing a chemical biological reaction

**Explain in detail about impacts, significance and mitigation measures of coal-based power plants.**

The environmental impact of coal-based power plants are:

#### Air Pollution

Air pollution from point source include particulates matter, gaseous emissions such as sulfur dioxide, oxides of nitrogen, carbon monoxide, hydrocarbons. Air pollution from non-point source include transportation of coal from the source to the plant site, loading/unloading of coal, coal storage yard, handling and transportation of fly ash.

#### Water Pollution

The main sources of water pollution include cooling tower blow down, boiler blow down, fly ash handling, effluents released from oil handling, from transformer areas, power house and turbine areas.

#### Land Degradation

Land degradation results from changes in land use pattern resulting in erosion, loss of biodiversity, changes in soil quality and quantity.

#### Noise Pollution

Usage of boilers, turbines and crushers in the power plants cause enormous noise pollution.

#### Health Impacts

The human health impacts caused by chemical pollutants are tabulated below.

S.No.	Chemical Pollutant	Health Impacts
1.	Sulphur dioxide	Irritation in nose, throat and airways, coughing, wheezing, shortness of breath, tight feeling of chest and asthma.
2.	Nitrous oxide	Dizziness, nausea, vomiting, numbness of the body, giddiness, blurred vision, loss of blood pressure, heart attack.
3.	Suspended particulate matter	Decreased lung function, increased respiratory symptoms such as irritation of airways, coughing or difficulty in breathing.
4.	Ammonia	Burning of nose, throat, respiratory tract, bronchial and alveolar edema, airway respiratory destruction, distress.
5.	Hydrogen chloride, Hydrogen fluoride	Irritation to eyes, skin, respiratory tract, cough and shortness of breath, damage to eyes and blindness.
6.	Dioxins and furans	Skin lesions, skin discoloration altered liver functions, problems with reproduction, development and immune system.
7.	Polycyclic aromatic compounds	Redness and inflammation of skin, cataracts, kidney and liver damage and jaundice.
8.	Mercury	Loss of vision, lack of coordination of movements, impairment of speech, hearing, walking and muscle weakness.
9.	Lead	Anemia, weakness, kidney and brain damage, hearing loss and seizures.
10.	Radium	Anemia, cataracts, broken teeth, reduced bone growth, lung and bone cancer.
11.	Uranium	Damage to respiratory tract, and kidneys.
12.	Antimony, arsenic, beryllium, cadmium, nickel, selenium, manganese	Lung diseases, heart problems, vomiting, stomach ulcers, carcinogenic to lungs, bladder, kidney, skin.

### Mitigation Measures in Coal Based Power Plants

#### 1. Air Pollution Control

Use of air pollution control equipment, such as ESP/ Baghouse for boiler stacks, bag filters for coal crusher and coal mill.

The air-borne dust can be controlled by using a closed yard for storing coal, use of conveyor belt for transportation of coal, use of dust suction device while unloading coal.

Disposal of fly ash in ash ponds lined with RCC to prevent metal contamination.

Increase in the green cover around the ash pond.

Use of technologies like Selective Catalytic Reduction (SCR), Electrostatic Precipitators (ESPs), Fabric Filter (FF), Flue Gas Desulfurization (FGD), Wet ESP, Dry Sorbent Injection (DSI) and Mercury Control Methods (MCM).

#### 2. Control of Water Pollution

The thermal power plants release general wastewater, cleaning waste water and sewage as effluents into the environment. A comprehensive waste water treatment facility must include oil separation, neutralization of wastewater, filtration, coagulation and sedimentation (using chemical agents). The temperature of the effluent must be reduced considerably and released using underwater drainage methods into the waterbody.

3. Land degradation can be controlled by land reclamation, salinization of soil, and prevent water logging.
4. Noise pollution caused by the usage of machines like boilers, turbines and crushers can be controlled by installing silencers, use of sound proofing walls and adopting sound attenuating design. All of these can help to minimize noise and vibration in the perimeter of the power plant.

### Q37. What are the effects of developmental activities on soil and groundwater?

#### Answer :

The developmental activities have the following effects on soil and groundwater,

- (a) Disposal of liquid waste from municipal waste, water effluents, sewage sludge, industrial effluents and sludges, wastewater from home septic systems, legal or illegal dumping in watercourses.
- (b) Discharge of waste by local industries and businesses into street gutters and storm drains, street cleaning and road salting, all of which contribute to surface and groundwater pollution.
- (c) Malfunctioning of the rural sewage system leading to surface runoff and/or direct infiltration to groundwater.
- (d) Runoff from mines and mine wastes, quarries.

- (e) Waste and "grey" water from recreational boats and recreational landuses like ski-resorts, boating, marinas, campgrounds, parks, etc.
- (f) Underground disposal of hazardous waste.
- (g) Dispersion of contaminated sediments by dredging.
- (h) Leaks or spills from underground tanks storing fuels used for transport purposes.
- (i) Saltwater intrusion into groundwater caused by residential development along the seaside.
- (j) Pumping of untreated effluents contaminated with toxic organic and inorganic substances flow into rivers and polluting the groundwater for years rendering it unfit for human consumption.
- (k) Agrochemical pollution of groundwater due to extensive farming. The agrochemicals and pesticides like nitrates and DDT used in farming enter the groundwater through surface runoff or underground leaching.
- (l) The dissolved nitrogen in the form of nitrates and heavy metals like chromium, lead and nickel are the common contaminants identified in groundwater in several parts of rural and urban India.
- (m) The surface waters are reported to have elevated level of bacteria, low dissolved oxygen content, elevated concentrations of organics like malathion, polychlorinated biphenyls; dioxins, high concentration of dissolved solids like chlorides, metals, cadmium, zinc, lead, silver, aluminium, etc., high levels of pathogens (fecal coliform or other bacteria) are a concern in some waters.

### Q38. How is environmental impact assessment significant for groundwater developmental activities?

#### Answer :

The EIA of groundwater development activities provide information on the following aspects:

#### (a) Water Balance/ Water Budget

The water balance/water budget enables us to estimate the status of water resource availability. A general formula adopted by environmentalists for estimation of water balance is as follows,

$$P = Q + E (= S)$$

Where,

$P$  = Precipitation

$Q$  = Stream flow

$E$  = Evapotranspiration

$S$  = Changes in storage.

#### (b) Aquifer Characteristics

The aquifer characteristics that can be assessed by the EIA of groundwater development activities, are the hydraulic conductivity/transmissivity (both vertical and horizontal), effective porosity and specific yield/storage capacity of the well.

### Groundwater Use

The groundwater is extracted through borewells and openwells to provide for more than 70% of the irrigated area and about 80% of domestic water supply. This information has been obtained by the EIA studies.

### Land Use and Land Cover

The EIA studies of groundwater development activities provides information about the land use and land cover changes that affect the quality of groundwater. The quality of groundwater deteriorates due to residential sanitation, solid waste disposal in uncontrolled dumps, industrial and mixing development, leaching of nutrients and use of pesticides etc.

### Groundwater Quality

The EIA study depicts the various causes for degradation of the groundwater quality. The groundwater generally stored in underground aquifers receives water from soil saturated with precipitation or through stream and river runoff. The groundwater and surface water are intimately interconnected, such that pollution of surface water can reach groundwater and vice-versa.

### Geological Data

The EIA study provides information of the geological data about the study area and it includes the surface and sub-surface geology, soils, land use, vegetation, etc.

Hence, adequate measures need to be adopted, to help prevent or reduce the actual/potential effect, which includes the conservation and management of groundwater resources in a sustainable manner. It includes,

Promoting integrated watersheds for agriculture, domestic and industrial use.

Use of proper flood control methods.

Interlinking of main rivers.

Analysis of overexploited areas of freshwater resources by hydrological surveys.

Groundwater monitoring and protection by suitable rainwater harvesting and artificial recharge on a large scale.

**How does the steel industry impact the soil quality and what type of mitigation measures need to be taken up?**

July-21 (R16), Q4(b)

The major manufacturing processes in the iron and steel industry include coke making, iron making, steel making by oxygen furnace or electric arc technology, refining and finishing operations like acid pickling, painting, chrome galvanizing, tinning, plastic coating, tempering etc.

All these activities carried out in the steel industry are energy intensive and contribute to the following.

- (i) Air emissions ( $\text{CO}_2$ ,  $\text{SO}_x$ ,  $\text{NO}_x$ ,  $\text{PM}_2.5$ ).
- (ii) Wastewater contaminants
- (iii) Hazardous wastes
- (iv) Solid wastes

The operations of the steel industry tend to deteriorate the agricultural land due to discharge of large toxic metal contents like arsenic, iron, manganese, chromium, copper, nickel, titanium, zinc and lead. These heavy metals alter the soil properties, especially the soil microbiological and biochemical properties. These are considered as main threats to both plants and animals.

### Effects on Plants

The toxic effects on plants due to modified soil properties include,

1. Reduction in seed germination.
2. Reduced fruit yield.
3. Stunted growth.
4. Reduced nutrients (sugar, starch, amino acids and protein content) in plants.
5. Reduced chlorophyll content.
6. Malformation in root and shoot.
7. Reduced chlorophyll and carotenoid content.
8. Reduced number of leaves, and leaf area.
9. Reduced enzyme activity.
10. Rapid and complete death of leaves.

### Treatment of Polluted Soil

Several approaches for the treatment of polluted soil include the following,

#### (i) Physical and Chemical Methods

The various processes involved in remediating polluted soil include, encapsulation, solidification, stabilization, electrokinetics, vitrification, vapour extraction, soil washing, flushing, etc.

#### (ii) Biological Method

The biological method (bioremediation) is an environmentally friendly and economical remediation method compared with other methods.

Bioremediation is a process in which living organisms (such as bacteria, fungi and plants) are used to clean up the contaminated sites in the environment. The living organisms help to convert the hazardous materials of chemical pollutants (oil, petroleum products, solvents, pesticides) into less toxic/non-toxic harmless substances (such as water and carbon dioxide). Bioremediation is considered as an eco-friendly and cost-effective method of cleaning up of the pollutants in the environment.

### Examples of Living Organisms used in Bioremediation Process

#### Bacteria

*Pseudomonas* spp., *E.coli*, *Flavobacterium*, *Deinococcus radiodurans*, *Arthrobacter*, *Pseudomonas putida*, *Azobacter*, *Accumulibacter phosphatis*, *Alcanivorax borkumensis*, *Dehalobacter restrictus*, *Dehalococcoides ethenogenes*, *Geobacter metallireducens*

#### Algae and Fungi

*Phanerochaete chrysosporium*, *Phanerochaete sordida*, *Fusarium oxysporum*, *Mortierella hyalina*.

#### Conditions Necessary for the Bioremediation Process

The conditions necessary for the bioremediation process are ambient temperature, water, nutrients (fertilizers, nitrogen, phosphorus, and other trace elements like sulfur, potassium, magnesium, calcium, manganese, iron, cobalt, copper, nickel, zinc), pH of the polluted site, concentration of contaminants, oxygen, microbial population.

#### Types of Bioremediation

The bioremediation process can be broadly categorized into the following types,

- I. Based on the presence/ absence of oxygen, bioremediation is of two types,

##### (a) Aerobic Bioremediation

In this type the microorganisms need oxygen for degrading harmful substances into water and carbon.

##### (b) Anaerobic Bioremediation

In this type, the microbial degradation of contaminants is carried out in the absence of oxygen.

- II. Based on the type of biological organism used for degradation of contaminants the process can be broadly categorized into the following types,

##### (a) Bacterial Remediation

The method involves the use of bacteria to break down the hazardous toxic substances into non-toxic or harmless substances.

##### (b) Mycoremediation

The method involves the use of fungi to degrade the contaminants in the environment.

##### (c) Phytoremediation

The method involves the use of green plants to clean and restore the contaminated soil.

##### (d) Compost Bioremediation

The microorganisms in compost can break down contaminants in water or soil.

- III. Based on the location of degradation process, bioremediation can be categorized as,

##### (a) In-Situ Bioremediation

The microbial degradation of contaminants takes place directly at the site, without the need to transport the contaminated material.

#### (b) Ex-Situ Bioremediation

In this method, the contaminated material needs to be excavated and treated in slurry reactors, biopiles or other technologies.

Bioremediation may be categorized by yet another way,

#### (a) Intrinsic Bioremediation/ Natural Attenuation

In this method, the microorganisms are used to remove toxic substances from water and soil.

#### (b) Engineered Bioremediation

It is a man-induced process wherein, engineered systems are constructed to supply nutrients and other necessary materials to increase the rate of contaminant degradation.

#### Advantages of Bioremediation

1. The main advantage is that the contaminant is destroyed.
2. This method saves on the excavation and transport costs.
3. It is a natural and eco-friendly process to destroy the contaminants.
4. It is a cost-effective method.

#### Disadvantages

1. This method cannot be used for all contaminated areas because microbial degradation may not work for all contaminants.
2. Sometimes, the microbial degradation can occur only when some ingredients are, which may not be made available.

#### Q40. Mention different soil functions that is considered for any soil environment study.

#### Answer :

Model Paper-I, Q7(a) | Sep.-20 (R16), Q5(b)

The loose superficial layer of the earth's crust is the soil (Latin: Solum) formed by the disintegration or weathering of parent rocks by physical, chemical and/or biological agents during the course of evolution.

#### Physical Properties of Soil

Some of the physical properties of soil are mentioned below,

##### (a) Soil Density

The density of soil varies with the degree of weathering. Its average density is 2.65 gm/ml.

##### (b) Porosity

Pore spaces are present between the soil particles. Porosity refers to the percentage of the soil volume occupied by the interstitial space. It is affected by soil texture, structure, compaction and organic matter.

##### (c) Permeability of Soil

Permeability of soil refers to the rate at which water permeates through the soil. Since loose soil has a large number of macropore spaces, the permeability of soil is high. The inverse is true for compact soil with many micropore spaces.

(d) **Soil Temperature**

Solar radiation, decomposing organic matter and heat from the interior of the earth contribute to soil temperature.

(e) **Soil Water**

Soil water is the ability of micropores in soils to hold water for use by the plants. Permeability and soil water are affected by the amount, size and arrangement of pores, macropores and micropores.

(f) **Soil Atmosphere**

Oxygen, carbon dioxide and nitrogen are the main gases found in pore spaces of soil. The moisture and carbon dioxide content is more in soil air.

**Chemical Properties of Soil**

Some of the chemical properties of soil are mentioned below,

(g) **Inorganic Elements and Compounds of Soil**

Compounds of following elements Al, Si, Ca, Mg, Fe, K, Na, B, Mn, Cu, Zn, Mo, Co, I, F constitute the inorganic components of the soil. More than 80 other elements are present in smaller quantities in soil.

(h) **Organic Matter of Soil**

Amino acids, proteins, purines, pyrimidines, aromatic compounds, hexose sugars, sugar alcohols, methyl sugars, fats, oils, waxes, resins, tannins, lignins are the components of humus, the chief organic component of soil. The organic matter serves as a reservoir for essential nutrients like nitrogen, phosphorus and sulphur for use by plants.

(i) **Colloidal Properties**

Colloid particles are very small ( $< 0.0002$  mm) remain suspended in water and exhibit large surface area per unit weight.

Soil is made up of crystalloids and colloids. Therefore, it has all the properties related to them, such as absorption, electrical properties, coagulation, Tyndall phenomenon, Brownian movement, dialysis etc.

(j) **Soil pH**

Soils exhibit a variety of pH, some soils are acidic, some are basic and some are neutral. pH (the negative log of hydrogen ion activity in solution) is an inverse or negative function. Soil pH decreases as hydrogen ion or acidity increases in soil solution. With decrease in acidity soil pH increases. The pH of soil usually ranges from 4 to 8.5. Soil pH affects the quantity, activity and types of microorganisms in soil which further affects the decomposition of crop residues, manures, sludges and other organics

**Q41. What are the mitigation measures adopted in restoring the soil properties?****Answer :**

Model Paper-II, Q6(a) | Sep.-20 (R16), QS(a)

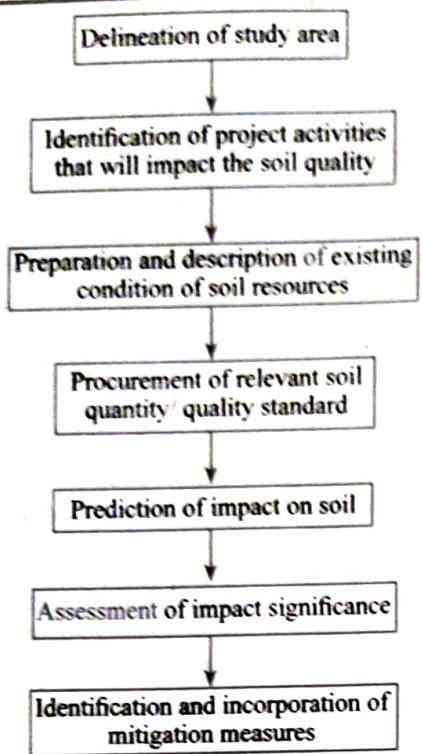
The mitigation measures that may be adopted in restoring the soil properties include the following,

- Cleansing or washing the soil contaminants using water, chemical solvents or air. This method is effective in treatment of inorganic and organic contaminates.
- Thermal remediation of contaminated soil by the use of incinerators to destroy the contaminants. The hydrocarbon contaminated soil is heated uniformly to 800°F. As a result of this, the dioxins formed are released into the atmosphere.
- Encouraging the growth of natural organisms in the soil to aid in the breakdown of soil contaminants. The process involved is called bioremediation, wherein anaerobic or aerobic bacteria are used to treat the soil. The microorganism dies after ingesting the contaminant.
- Encapsulation of soil contaminants to prevent them from spreading. The process involves mixing lime, concrete or asphalt with contaminated soil, thus the contaminates are prevented from spreading. Vitrification too is another type of encapsulation which involves classification of heavy metals (eg. Radionuclide contamination).
- Bioventing: The process involves injecting oxygen into contaminated soil to encourage the growth of microorganisms. These microorganisms break down the hydrocarbons into  $\text{CO}_2$  and water.

**Q42. Explain the methodology for prediction and assessment of impacts on soil with neat flow sheet.****Answer :**

Sep.-20 (R16), Q4

For answer refer Unit-III, Q4 and Q33, Topic: Step 4, Acquisition of Significant Information Related to Quality and Quantity of Soil and/or Groundwater.



**Figure : Flow Chart for the Prediction and Assessment of Impact on Soil**

#### **Q43. What is meant by soil liquefaction and how it is caused?**

**Answer :** Model Paper-I, Q7(b) | Sep.-20 (R16), Q6(a)

According to Allen Hazen, 1918, soil liquefaction is “ a phenomenon whereby a saturated or partially saturated soil substantially loses strength and stiffness in response to an applied stress, usually earthquake shaking or other sudden change in stress condition, causing it to behave like a liquid.”

“Soil liquefaction is the loss of strength that can occur in loose, saturated soil during or following an earthquake or other rapid loading”.

In a simpler sense, soil liquefaction can be described as a phenomenon wherein the soil loses its strength significantly, leading to ground failure. This is commonly observed in saturated sandy soil with poor drainage, or sands and gravels, and in areas where the water table is less than 20 feet deep. Saturated soil is one in which the space between the individual soil particles is filled with water.

Under normal conditions, the soil particles are packed together to form a compact structure. The individual soil particle is in contact with its neighboring soil particle. Large contact forces develop between the particles, thus giving the needed strength to the soil. The pore water pressure is low in such soils. When stress is applied externally, the load is evenly distributed among the soil particles.

During a sudden stress condition, for instance an earthquake, the compact soil structure gets disturbed and breaks down. The space between the soil grains increases and the soil flows like a liquid because the pore water pressure is high enough in such soils. Hence, dense objects sink into the liquefied soil.

Soil liquefaction has resulted in great damage to many buildings and infrastructure such as bridges, embankment dams, leading to major financial losses, etc.

Liquefaction hazards can be minimized by the following ways,

- Avoiding construction activities in liquefaction susceptible soils.
- Construction of liquefaction structures.
- Improving the characteristics of soil.

#### **Q44. Define soil fertility. How it can be gained?**

Model Paper-III, Q6(b) | Dec.-20, R(16), Q6

**Answer :**

Soil is the backbone for all types of ecosystems and its health is important for a stable food system. Soil – the loose superficial layer of the earth's crust is formed by the disintegration or weathering of parent rocks by physical, chemical and or biological agents since time immemorial. The formation of an inch of topsoil takes many centuries. Unfortunately, many bio-regions have suffered human-induced soil degradation/regression/regression. These include:

1. Intensive farming to increase the agricultural products. The fertile soil gets damaged by the excessive use of fertilizers and irrigation methods.
2. Uncontrolled construction activity by construction of houses leads to loosening of soil particles which can be easily carried away by rainwater or wind.
3. Construction of roads contributes to soil degradation. The loose soil along roadsides can be easily carried away by rainwater or wind.

The fertility of the soil can be restored by intensive ecosystem restoration efforts. Ecological land use is the ideal way to prevent the loss of soil cover by encouraging dense and crowded developments to occur on lands that are unsuitable for agriculture or forestry.

Some of the strategies to improve land use planning include,

- (a) **Shifting Cultivation**  
It refers to the phenomenon wherein pieces of land are cultivated temporarily until the soil loses fertility and then the land is abandoned, as it becomes infertile and unsuitable for crop production. The abandoned piece of land is reclaimed back by allowing growth of natural vegetation.
- (b) Use of fertilizers to enhance soil fertility. Farmers can use organic fertilizer made from plant and animal wastes or commercial inorganic fertilizer made of various minerals.
- (c) Adoption of recommended agricultural practices (RMPs) for agricultural intensification to produce the optimum sustainable yield.
- (d) The sustainable agriculture practices include,
  - (i) **Multiseed sowing** : In this method, the seeds of various legumes and grains are sown, which on germination are mulched back into the soil.

- (ii) Intercropping : This involves growing vegetables like ladies finger, brinjal, chilli, ridgegourd, pumpkin, papaya, green gram and black gram along with other agricultural crops.
- (iii) Fencing and border crops: Timber and fodder value crops are grown around the agricultural fields as fence and border crops.

Minimize burning of pastures and crop residues so that the flora and fauna are retained in the natural ecosystem to maintain biological diversity and ecological balance.

Crop rotation : The best method of crop rotation is to first grow legumes followed by grains, leafy crops, then vegetables and root crops. This practice helps to prevent soil depletion which otherwise is quite common in monoculture.

Other advantages of crop rotation include,

- (i) Increase in the fertility of soil
- (ii) Improvement of soil structure
- (iii) Reduction of weed problems
- (iv) Reduction of disease problems.

Practice of green manure : This involves growing rye around the field or on the whole field. The food crop is harvested, then the plants are ploughed in the fields to add nutrients to the soil. This practice is referred to as mulching. Further, it improves soil water infiltration, decrease in evaporation losses, as well as weed control.

Zero tillage : This refers to the practice of sowing seeds directly into the soil without tilling, thus saving on expenditure incurred in terms of fuel and equipment use for tilling the field to make it ready for the next crop.

Increase the productivity of agricultural land. This is accomplished by following ways,

- (i) Selection of quality seeds of high yielding variety.
- (ii) Ideal season for sowing seeds.
- (iii) Ideal method of sowing seeds.
- (iv) Use of proper fertilizers, their dosage, method and time of application.
- (v) Appropriate use of pesticides and weedicides.
- (vi) Provision for irrigating the agricultural lands.

Raising awareness among farmers by providing them with technically sound, economically attractive, environmentally safe, viable and widely acceptable management practices for sustainable agricultural productivity.

The different types of organic fertilizers include animal manure (dung and urine of cattle, horses, poultry, other farm animals), green manure (freshly cut green vegetation ploughed into the topsoil), compost (breakdown product of organic matter like leaves, crop residues, food wastes, paper and wood by the microorganisms). All these types of fertilizers add organic matter and humus to the soil.

Inorganic fertilizers are the inorganic compounds of nitrogen, phosphorus and potassium. The soil fertility can be restored by using both organic and inorganic fertilizers in combination.

#### **Q45. How soil is affected around the mines?**

Dec.-20 (R16), Q5(a)

##### **Answer :**

The process of extracting minerals and their ores from the earth's crust by digging is known as mining. The process of mining poses a threat to the environment and also to the workers working in mines. The impact of the mining activities on the soil are as mentioned below.

1. Mining leads to deforestation due to the diversion of forest land for mining purposes. This is because large areas of land are needed so that miners can dig into the earth.
2. Apart from large scale deforestation, the vegetation of the surrounding areas has to be cleared to lay roads and construct residential facilities for the mine workers.
3. Large scale deforestation leads to loss of biodiversity due to loss of habitat of the animal species.
4. Mining operations cause ground compaction due to the heavy machinery operations, traffic and storage activities etc.
5. The mining dust causes change in the texture of the parent soil, the soil components like soil horizons, soil structure, soil microbe population, nutrient cycles.
6. Washing toxic metals into nearby land surfaces reduces soil fertility.
7. Loss of vegetation may enhance weathering (both physical and chemical). The rain-bearing clouds formed in the mined areas pick up carbon dioxide from the atmosphere and form a weak acid. When the rain falls, the weak acid attacks the exposed rock surface and causes its weathering.
8. The immediate impact of mining activity is Acid Mine Drainage (AMD)/ Acid Rock Drainage (ARD). It is the outflow of acidic water from coal mines or abandoned mines of metals. This usually occurs when the sulphide minerals are uncovered during the process of mining. Acid Mine Drainage is hazardous to the environment as it disrupts the cycle of nature. It also forms a blanket over the water bodies, usually streams and rivers and prevents the entry of sunlight, thus photosynthesis does not occur. This leads to the death of the aquatic plants, thus disturbing the aquatic ecosystem.
9. Change in natural drainage. The groundwater recharge through the surface reduces, because reduced infiltration results in increased surface runoff, leading into sedimentation ponds which can then overflow into the nearby streams.
10. Disruption in the aesthetics of the landscape.

#### **Q46. Differentiate direct and indirect impact in vegetation and wildlife impact analysis.**

##### **Answer :**

Sep.-20 (R16), Q3(b)

The direct impact to vegetation and wildlife as a result of developmental activities include the following:

1. Direct mortalities
2. Habitat loss
3. Habitat fragmentation
4. Animal displacement

5. Loss of forage, ground cover and breeding habitats
6. Removal of vegetation
7. Reduction in wildlife population.

The indirect impact to vegetation and wildlife as a result of developmental activities include the following.

1. Increased noise pollution
2. Increase in human presence
3. Increase in vehicle-related mortalities
4. Increase in dust pollution
5. Dispersal of invasive or non-indigenous species into a new location.

#### **Q47. How to carry out the impact assessment studies on vegetation due to any developmental activity.**

Model Paper-II, Q7(b) | July-21, (R16), Q3(a)

**OR**

**What do you understand by the word vegetation? How is it impacted by the development activities.**

**Answer :**

Dec.-20 (R16), Q3

The term vegetation refers to the plants of a particular region.

The developmental activities are placing significant stress on the native population of vegetation and wildlife. Land, that was once a habitat for different types of vegetation and wildlife, is being converted into residential and commercial developments, roads and other uses. The development projects and other related activities impact both the quantity and quality of vegetation and wildlife habitat.

There are a number of ways in which the developmental activities can impact the vegetation.

#### **1. Habitat Loss**

Habitat loss is considered to be one of the greatest primary threats to species and emergent ecosystem processes to the natural world. Man is taking over the natural areas at an alarming rate to provide for home and agriculture. Increasing habitat loss eliminates the ability of the species to move and survive in the altered conditions. The other major factors contributing to habitat loss are,

- (i) Large-scale commercial deforestation
- (ii) Conversion of forests to agriculture and livestock production
- (iii) Conversion of bogs and swamps to landfills, dumps and residential areas.
- (iv) Increased urbanization, wherein, natural ecosystems and agricultural lands are converted into shopping centers, housing developments, water projects (dams, hydropower, irrigation), linear projects (such as laying roads, pipelines and waterways) and other commercial establishments. All the above mentioned factors reduce or eliminate the usefulness of wild areas as a habitat for the other species that live there.

#### **2. Habitat Fragmentation**

Habitat fragmentation refers to the breaking up of the natural habitat into progressively smaller and more isolated fragments. Such fragmented pieces of habitats are very often too small or localized at far off places to support the survival and reproductive needs of many species. This brings about a significant reduction in a species ability to reproduce. Other changes caused by habitat fragmentation are the crowding effects, changes in microclimate, changes in species composition, etc.

#### **3. Habitat Disruption**

The impact of development/human activity on vegetation and wildlife results in edge effects, wherein the interior area of a habitat is affected by disturbances from the surrounding areas.

Edges refer to the area between the two adjoining habitats. The edges of any habitat will have conditions that are different from those well within the habitat. For instance, the boundary between a forest and a field can have greater intensity of sunlight, higher wind speeds, drier and less shady conditions.

So, the edge effect results in loss of habitat, species diversity and composition, community dynamics and ecosystem functioning, introduction of invasive/exotic species into natural habitats. Species inhabiting near the edges are more vulnerable to predation and brood parasitism.

All forms of terrestrial aquatic ecosystems are suffering widespread disruptions as people discharge raw sewage, toxic chemicals and other pollutants into them.

The invasive/exotic species, introduced either purposefully/accidentally, have a negative impact on the ecosystem. The invasive species may prey upon the native species, or compete with the native species, interbreed with them, or introduce pathogens and parasites that may kill the native species.

#### **4. Changing Aquatic Habitat**

Any developmental activity affects the quality and quantity of aquatic habitat. The coastal ecosystem has degraded owing to the conversion of coastal habitats to development, highway construction, diking, dredging, filling, bulk heading, etc. Such developmental activities have many potential effects on runoff processes, streamflow patterns and as a result on the aquatic ecosystem. The developmental activities alter the hydrologic processes when the hillslopes are denuded of vegetation, changes in the landscape patterns lead to increased imperviousness in the landscape, decrease in the soil permeability. These conditions result in reduced interception and infiltration rate, decrease in the subsurface flow, evapotranspiration, stormwater storage and therefore, decreased groundwater recharge, increased flooding, streambed erosion and sedimentation.

The vegetation of any region serves as a good storehouse of water and prevents the disintegration of soil particles. The plants provide an excellent protective covering to prevent soil erosion due to the impact of the rainfall. The leaves of the trees that fall on the ground prevent water runoff, so that the water can percolate into the soil. Roots hold the soil particles together thus preventing soil erosion.

The burgeoning human population impacts the environment. Increase in population means, more vehicles (burning of fossil fuels), more construction activities, urban sprawls, more roads and infrastructure, increased use of fertilizers, pesticides, detergents, industrial and household waste, release of metal and chemical contaminants, industrial processes, all of which transform the pristine and natural ecosystem into an inhospitable habitat for animal and plant life.

The industrial water supplies rely on two major sources of water, groundwater and surface water. Both these sources of water are likely to be polluted by contaminants. The groundwater contains pesticide chemicals and nitrates while most bacteria and other microorganisms contaminate the surface waters. The groundwater and surface water are intimately interconnected such that pollution of surface water can reach groundwater and vice-versa. Over-exploitation of ground water for industrial, domestic and irrigation purposes can lead to drying up of rivers and lakes.

### 5. Daily Anthropogenic Activities

Nearly any anthropogenic activity affecting a physical or biological component of the ecosphere has an impact on the vegetation and wildlife. Human activities include agriculture, forestry, livestock grazing, unregulated off-road vehicular traffic, recreational activities such as hiking, wildlife viewing, boating, recreational uses in wilderness and other protected areas.

Various developmental activities would generally require removal of vegetation and the associated wildlife alteration. The intensity of human activity has a direct relationship to the impact on wildlife. The more intense the human activity, the greater the impact on wildlife.

Humans and their activities have caused many global problems such as climate change, ozone layer depletion and extinction of wildlife species, all of which are increasingly seen as threats to our very survival. Development is, of course, necessary to provide decent housing, good jobs and education to meet other basic needs. However, development must be pursued in a manner that does not overburden the natural environment. In a simpler sense, sustainable development must be promoted and encouraged to enable us to hand a better world for everyone now and for generations to come.

Developmental Activity	Implication	Effect on Vegetation and Wildlife
Site clearance	❖ Removal of tree stumps, bushes, undergrowth.	<ul style="list-style-type: none"> <li>❖ Lack of shelter for nesting birds, less population of birds</li> <li>❖ Loss of important insect species.</li> <li>❖ Loss of habitat</li> <li>❖ Reduced population of important species.</li> <li>❖ Habitats become vulnerable to damage by insects, diseases, acid rain, wind.</li> <li>❖ Negative impact on water cycle.</li> <li>❖ Habitat fragmentation</li> <li>❖ Ecological integrity of soil is destroyed</li> <li>❖ Loss of small-scale economic opportunities like fruit-picking, sap extraction, rubber tapping.</li> </ul>
	❖ Removal of vegetation	<ul style="list-style-type: none"> <li>❖ Loss of wildlife corridors</li> <li>❖ Habitat loss and fragmentation.</li> </ul>
	❖ Removal of soil	<ul style="list-style-type: none"> <li>❖ Leaching of sediment and nutrients into the streams.</li> <li>❖ Exacerbate flooding.</li> </ul>
	❖ Removal of waste, bricks, stones, unwanted materials, old foundations and small structures.	<ul style="list-style-type: none"> <li>❖ Loss of barn owl roost and breeding sites.</li> </ul>
	❖ Changes in the water course.	<ul style="list-style-type: none"> <li>❖ Pollution of water course as soil, waste concrete, toxins in runoff can enter the water course, impact aquatic habitat, plant life, invertebrates and all life stages of fish.</li> <li>❖ Acidification of water bodies.</li> </ul>

**ENVIRONMENTAL IMPACT ASSESSMENT**

Construction site setup	❖ Location of office accommodation	<ul style="list-style-type: none"> <li>❖ Significant negative impact on protected species.</li> <li>❖ Air pollution</li> <li>❖ Ground and surface water contamination and changes in water table.</li> </ul>
	❖ Store houses (warehouse storage)	<ul style="list-style-type: none"> <li>❖ Coastline erosion from sand mining</li> <li>❖ Loss of soil resources, vegetation cover and sedimentation</li> <li>❖ Changes in land use and topography</li> <li>❖ Noise pollution.</li> </ul>
Laying of haul roads	❖ Crude temporary road of rubble and concrete	<ul style="list-style-type: none"> <li>❖ Clearing of native vegetation Significant adverse impact on the species or ecological community that is endangered, vulnerable and protected.</li> <li>❖ Dispersal of exotic species.</li> <li>❖ Modified animal behaviour</li> <li>❖ Changes in populations due to direct kills of smaller animals from motorized vehicles.</li> <li>❖ Spread of noxious weeds, displacement of native forage.</li> <li>❖ Habitat fragmentation</li> <li>❖ Changes in the physical characteristics of the environment, such as increase in soil density, generation of "heat island" effect, decrease in the porosity of soil, dust pollution, changes in soil structure, aridity, erosion and hydrology.</li> <li>❖ Changes in the chemical environment such as addition of heavy metals, salt, organic molecules, ozone, etc.</li> <li>❖ Increase in the likelihood of additional, unplanned activities.</li> <li>❖ Displacement of larger animals.</li> </ul>
Ground works in construction activity	<ul style="list-style-type: none"> <li>❖ Excavation and earthmoving, drainage, foundations, under-ground spaces (eg., vehicle, parking, storage)</li> </ul>	<ul style="list-style-type: none"> <li>❖ Local disturbances habitat and wildlife.</li> <li>❖ Altered hydrologic flow</li> <li>❖ Noise pollution</li> <li>❖ Airborne dust</li> <li>❖ Visual pollution at the allocated development area</li> <li>❖ Contamination of land</li> <li>❖ Disruption of flow regime in flood plain wetlands</li> <li>❖ Sediment from the construction projects cause problem with stormwater infrastructure.</li> <li>❖ Negative effect on water quality, biological health of streams, wetlands and sea.</li> </ul>

<b>Construction material</b>	<ul style="list-style-type: none"> <li>❖ Cement, bricks, timber, metal sheets, stone, wattle</li> </ul>	<ul style="list-style-type: none"> <li>❖ Exploitation of natural resources.</li> </ul>
		<ul style="list-style-type: none"> <li>❖ Increased sewage pollution</li> <li>❖ Eutrophication of water bodies</li> <li>❖ Aesthetic pollution</li> <li>❖ Decrease in the productivity of ecosystems</li> <li>❖ Ecosystem destabilization</li> <li>❖ Increase in the occurrence of disasters</li> <li>❖ Loss of wildlife habitat</li> <li>❖ Erosion of soil</li> <li>❖ Shortage of water</li> <li>❖ Water and air pollution</li> <li>❖ Waste generation</li> <li>❖ Heat island effect.</li> </ul>

**Q48. Deforestation is one of the global concern of today. In this context, discuss the following.**

- (a) **Causes of deforestation**
- (b) **Sustainable forest management.**

**Answer :**

**(a) Causes of Deforestation**

Forests cover 12% of the land in India, but the estimated value is around 33%. This is due to deforestation.

**Reasons for Deforestation**

The major causes of deforestation are:

1. Rapid urbanization is leading to deforestation as the land is not available.
2. Forests are overexploited so as to develop them into agricultural lands.
3. Overgrazing of forest lands is also leading to deforestation.
4. Shifting of farmers from the production of cocoa exports to growing of cash crops is leading to falling of trees, so as to develop agricultural lands.
5. Cutting down of trees for firewood, paper, timber and other building materials.
6. Mining of minerals and their ores have also led to the destruction of forests extensively.
7. To generate hydroelectricity for irrigation, dams are built which have led to the falling of trees.
8. Projects undertaken for building of roads, laying of pipelines, constructing dams etc., have led to deforestation.
9. Mining and exploration of oil also leads to deforestation.
10. The acid rain and forest fires too contribute to deforestation.
11. Forests are being cleared for the purpose of cattle ranching.

**Remedies**

Measures taken to mitigate deforestation are as follows:

1. Prevent overgrazing of forest lands.
2. Overexploitation of timber should be prevented, which is maintained by the branch of forestry i.e., silviculture. This branch is responsible for the establishment, development and reproduction of timber trees like teak, sal, sheesham etc. Illegal logging should be prevented. The forest officials should cooperate in protecting the forests.
3. Recycling of forest products like paper should be practised.
4. Burning of forests should be strongly prevented so as to develop into pasture lands.
5. Forests should be conserved by growing plants tolerant to diseases, fire and pests.
6. Plantation of seedlings of forest trees with crop plants, enables the trees of the forest to grow better.

7. Forest departments and other communities involved in conserving forests have taken to plantation of eucalyptus trees, cassia trees, teak trees, tamarind trees etc., in the government waste lands, along roadsides, railway lines, marginal lands of the farms thereby contributing to social forestry. This has met the basic demands of wood for rural people, prevented the erosion of soil, maintained ecological balance and provided shade along the roadside.
8. We should buy foods (eg., bananas, pepper, cloves, coffee) that are grown in a sustainable way.
9. Encourage the use of environmentally friendly paper.
10. Encourage the use of recycled paper.
11. Practise of silviculture helps to replenish the forests.
12. Plant an equal amount of saplings so as to compensate for the fallen trees. Thus, equal balance should be maintained between the growth rate and falling of trees.

**(b) Sustainable Forest Management**

Sustainable forest management aims at managing our precious forest resources in a manner that does not eliminate or degrade them, or otherwise diminish their usefulness for present and future generations. Some of the various best management techniques that can be practiced by land owners, loggers and forest contractors to improve the health and productivity of forests are listed below.

**1. Harvesting**

Harvesting is an important part of the best management practices to maintain a healthy forest. Timber extraction is usually done by the forest department in our country for construction, paper pulp, industrial uses, etc. However, it is important to prevent severe damage to the forest site as excessive timber extraction can lead to depletion of wood resources as well as degrading other forest resources such as loss of consumptive uses, loss of ecological functions and loss of non-consumptive values (such as ecotourism, genetic resource, etc.). Trees may be harvested by clear cutting, shelter wood cutting, seed tree or single tree selection methods.

**2. Thinning**

The process involves removal of a portion of the trees in the forest to avoid competition of sunlight, nutrients and water. The weak, unhealthier and low quality trees are removed so that the healthier ones get sufficient sunlight, water and nutrients to grow faster and stronger. The smaller plants also get enough sunlight and grow well to provide food and shelter for wild animals.

**3. Reforestation/Afforestation**

Reforestation or afforestation refers to growing of trees in a particular area that was once cleared. This can be accomplished in two ways.

**(i) Natural Regeneration**

It involves the growth of trees from seeds dispersed by wind or animal, or dropped naturally by trees.

**(ii) Artificial Regeneration**

It involves the growth of trees by human involvement (by sowing seeds or by planting seedlings).

Large scale afforestation programs can be undertaken to reforest the denuded land. A mass voluntary tree planting drive using locally growing tree species as the main breeds may be launched to enable people to remake their natural surroundings, whether for profit, for aesthetics, for sport or recreation or for natural habitat for wildlife.

**4. Prescribed Burning**

This method involves controlled application of fire to a specific land area to reduce the litter layer consisting of leaves, branches and dead trees on the forest floor. Such fires keep the forest floor relatively clean so that the sunlight penetrates the forest and encourages the growth of shrubs and grasses which form the food for wild and domestic animals.

All the above mentioned methods help in preservation and protection of pristine forest resources.

**Q49. Explain about the environmental impact of deforestation, causes, effects and control strategies.**

**Answer :**

Sep-20 (R16), Q3

For answer refer Unit-III, Q48, Topic: Causes of Deforestation.

The term deforestation refers to denuding the green canopy or the destruction of forests and woodlands for the following purpose:

- (a) To convert forests to agricultural land for crop production to feed the increased number of people, and for cattle rearing.
- (b) Logging of commercial wood for firewood, paper and building material.
- (c) Urbanization
- (d) Mining activities and oil exploration.

The fertility of the soil is maintained by the presence of vegetation that forms a protective cover over the soil. The nutrient

cycle helps to maintain the fertility of the soil. During rains, the water aids the nutrients to penetrate the soil. Plants' roots absorb the nutrients present in the soil. When the leaves fall, the insects, worms and other decomposers decompose the leaves and return the nutrients to the soil.

Destruction of vegetation incurs loss of protective cover for the soil. The top soil becomes vulnerable to wind and water erosion. The surface water runoff increases, resulting in a higher rate of soil erosion and soil leaching. The productivity of soil decreases due to reduced soil depth, soil organic matter, soil fertility. Decrease in the water holding capacity of the land is due to decrease in soil depth. Erosion of topsoil causes lots of soil getting washed from the land, into the local creeks and rivers, leading to silting up of rivers and significant increase in the incidence of flooding. Siltation damages the fish eggs and decreases their hatch rates.

The other problem associated with deforestation is the change in the local and global climate through disturbance of the water cycle. The underground water is drawn up by the root system of the trees and released into the atmosphere by the process of transpiration. The felling of trees will render a drier climate in the region, also affecting the rainfall pattern.

#### **Q50. What are the effects of deforestation?**

July-21, (R16), Q3(b)

**OR**

**How deforestation affect the livelihood of people who depend on forest?**

**Answer :**

Model Paper-II, Q7(a) | Dec.-20 (R16), Q4

The term deforestation refers to the permanent destruction or devastation of green cover in the forest and woodlands, usually by humans and their activities. The deforested land is utilized for various purposes like cultivation of food, construction of houses, etc.

Forests cover 12% of the land in India, but the estimated value is around 33%. This is due to deforestation.

For answer refer Unit-III, Q48, Topic: (a) Causes of Deforestation.

Forests support diverse life forms as they can provide three basic ingredients for survival of the species - water, food and shelter.

Timber products are in high demand almost worldwide. This encourages harvesting, transporting, processing, buying or selling of timber against the national laws, thus making illegal logging a lucrative industry. The main cause of deforestation is illegal logging due to which half of the original forest cover has already disappeared. Several species of animals like tiger, rhinoceros, elephants are almost nearing extinction due to loss of their habitats.

Transportation of timber from the forests to the places in demand adds to the greenhouse gases in the atmosphere leading to a global warming trend, where the average temperature becomes higher. The sawing and sanding of the wood products adds dust to the atmosphere.

The term deforestation refers to destruction of forests and woodland. The tribal hunter-gatherers depend on the forests for their livelihood. They rely on the forests for water, fuelwood and other resources. The forests provide water for domestic use and hydroelectric power.

Some of the medicines derived from the forests are enlisted below:

Quinine - cure for malaria

Curare - anaesthetic and muscle relaxant used in surgery.

Rosy periwinkle - cure for Hodgkin's disease and leukemia.

Other drugs - arthritis, hepatitis, insect bites, fever, coughs and colds.

The forests are destroyed for the following purposes:

- To convert forests into agricultural land, to feed the increased number of people and for cattle rearing.
- To earn money by growing cash crops.
- Logging of commercial wood.
- Cutting down trees for firewood, paper and building material.
- Urbanization.
- Mining and oil exploration.
- The acid rain and forest fire too contribute to deforestation.

#### **Problems Associated with Exploitation of Forests**

Some of the problems associated with exploitation of forests are as under:

##### **1. Change in the Local and Global Climates through Disturbance of**

###### **(a) The Carbon Cycle**

The trees absorb carbon dioxide from the atmosphere to produce carbohydrates, fats and proteins in them. This carbon is then released as CO<sub>2</sub> when the trees are either burnt or rot, causing an increase in CO<sub>2</sub> concentration in the atmosphere. CO<sub>2</sub> contributes to the greenhouse effect.

###### **(b) The Water Cycle**

The underground water is drawn up by the root system of the trees and released into the atmosphere by the process of transpiration. The felling of trees will render a drier climate in the region.

Felling of trees also affects rainfall patterns.

###### **(c) Erosion of Soil**

The root system of the trees holds the soil particles firmly. With the removal of trees, erosion of soil takes place.

###### **(d) Owing to soil erosion, silting of rivers, lakes and dams takes place.**

**(e) Extinction of Species**

Forests are home to more than half the world's species. Cutting down of trees leads to extinction of thousands of species of birds and animals. Some of them are the orangutan, mountain gorilla, manatee, jaguar and puerto rican parrot. The orangutans feed on various plant parts like leaves, figs, fruits, bark, nuts and insects. The old trees in the forests support the growth of woody vines that serve as aerial ladders, thus enabling the animals to move around, build nests and hunt for food. Thus, loss of forests lead to endangering the lives of plants and animals.

**2. Natural Conflicts with Wildlife**

As the green cover depletes, the wild animals are forced to move out of their traditional homes into areas inhabited by humans, causing dreadful encounters with wild animals like elephants, poisonous snakes etc.

**3. Desertification**

Deforestation contributes to the desertification of the green canopy.

**4. Effect on Ecotourism**

The potential earnings from the ecotourism market suffers due to deforestation. Tourists would be unwilling to travel to see the polluted rivers, carcasses of wild animals, stumps of the trees and unused wastelands.

**5. Social Effects of Deforestation**

Case studies have documented that the indigenous people living in the forests have been rendered homeless due to invasion by cattle ranchers, loggers and land speculators.

### **3.3 MITIGATION PLANS AND RELIEF AND REHABILITATION, STIPULATING THE CONDITIONS**

**Q51. Write short notes on mitigation planning.****Answer :**

Model Paper-III, Q7(b)

Mitigation planning refers to the actions taken to identify the disaster risk areas and bring down the long term risk to life and property.

This process has four steps. They are,

**(i) Organize Resources**

This step includes motivation of the community members as well as technical experts for a successful mitigation planning process.

**(ii) Risk Assessment**

This step includes identification of risk involved and potential consequences of hazards and its impact on life and property.

**(iii) Develop Mitigation Plan**

Based on the understanding of risk assessment, the communities should put forth maximum efforts to avoid or minimize the undesired effects of a catastrophe.

**(iv) Implement Plan and Monitor Progress**  
Specific measures for mitigation of disasters are to be implemented. At the same time periodic evaluations must be conducted to monitor the progress.

For instance, tourist destinations located in islands are generally prone to sea accidents, tsunamis, landslides etc. In order to protect the island, adequate measures must be taken for disaster preparedness, prevention and mitigation.

The following strategies may be adopted to protect the tourist destination from an emergency.

- (i) Identify the disaster risk areas.
- (ii) Allocate evacuation routes to facilitate the tourists from the risk zones to reach the safety zones safely and timely.
- (iii) Recognize the safety zones.
- (iv) The hotels and lodges should be well equipped for disseminating disaster information to tourists and ensure the effective disaster emergency response.
- (v) Raising awareness to all stakeholders, government agencies, private sectors, tourism sector and tourists about the potential hazards of the area.

### **Q52. Explain the push and pull factors which lead to migration from rural areas.**

**Answer :**

It is estimated that about three billion people in the developing countries now live in urban settlements. The rapid population growth and the transformation in the world economy have contributed a lot to this. It is believed that over the next 30 years another two billion people would add to the urban areas in the developing world.

At the beginning of the twentieth century, the urban areas were concentrated in the advanced industrial countries of about 16 cities across the globe with a population of one million or more. In 1950, 733 million people lived in urban areas in 83 cities in the world. Between 1950 and 2000, the number of urban dwellers almost quadrupled from 733 million to 2.857 billion. As of now, there are about 400 cities that contain a million people in each. It is estimated that by the year 2017, the developing world is likely to have more urban cities than rural areas.

The urban population in India rose from 25.6 million in 1901 to 212.8 million in 1991 which is about 26% of the total population-urbanized. Many problems could cope up due to such socio-economic and environmental problems. If urbanization i.e., 634 million people will be in urban regions of India by 2030. If this trend is not checked and corrected, it would lead to extreme dire consequences like water shortage, electricity, transportation, education, housing, security and failure in other services, thereby causing a major drain on the economy. The public funds do not meet the demands and therefore national revenue pools are to be drained, thus imposing adjustments in national priorities.

### UNIT-3 Environmental Management Plan

Some of the reasons for large scale migration of people from rural areas are as follows,

- (a) Robust economic growth, increased economic opportunities and social development in urban areas.
- (b) Deterioration in the quality and quantity of agricultural lands.
- (c) Poor market infrastructures.
- (d) Shortage of finance supporting institutions as a source of credit for small scale farmers.
- (e) Better access to good jobs, education, innovation, clean water, sanitation, health care, electricity, telecommunications, attractive business investments and better living standards in urban areas.
- (f) Greater female labour force participation.
- (g) High general health, well-being, literacy, women's status and social mobility.

Urban areas are important social and cultural centers for museums, art galleries, industries, theatres, fashion houses and other important cultural centers.

Further, it has been observed that in recent years most of the urban growth is occurring in megacities. The reason being that smaller cities have some unaddressed problems like housing, piped water, sanitation, waste disposal and other basic services.

Attempts to control rural-urban migration have proved to be less fruitful. This is because the migrants (workers) would like to explore the opportunities the cities offer and moreover, the cities too need workers.

In some countries, the main cause for urban growth is due to natural increase i.e., the difference between the births and deaths. Thus, in the long run, the natural increase leads to urban growth.

Unmitigated urban growth hurts the environment drastically owing to increased use of energy in transportation, thereby causing air pollution. But, at the same time, we need to understand that if the human population were more dispersed, then human settlements would try to encroach upon more prime lands and natural habitats. Hence, densely populated regions are of utmost importance for the protection of the ecosystem.

#### Q53. Explain the observations on the difference between urban and rural environments.

##### Answer :

People inhabiting different parts of the world are broadly categorized into two distinct groups, those inhabiting urban areas lead an urban life while those residing in rural areas experience a rural life.

##### Urban Life

The urban areas have all the modern amenities like internet, telephone, television and satellite communication facilities. Further, urban cities are blessed with shopping complexes, theatres, malls, restaurants, large housing complexes and skyscrapers. A number of factors that attracts greater number of people to the urban areas are as follows.

- (a) Robust economic growth, increased economic opportunities and social development.
- (b) Better access to good jobs, education, clean water, sanitation, health care, electricity, telecommunications, attractive business investment and better living standards.
- (c) Greater female force participation.
- (d) High general health, well-being, literacy, women's status and social mobility.

#### Rural Living

The rural areas are deprived of the modern amenities, it is less crowded, with absence of concrete constructions. People live in close proximity with nature with ample greenery all over. However, there are certain environmental problems faced by the rural people. Some of them are discussed below,

##### 1. Pollution

Pollution of air is caused by the burning of wood, cow-dung cakes, kerosene etc. for cooking food. They produce a lot of smoke, soot and hydrocarbons which goes into the environment and pollutes it. The conventional chulhas used by the village people generates carbondioxide, which is a poisonous gas and cause health hazards. Other toxic substances in the smoke are oxides of sulphur, nitrogen, soot and ash. These pollutants cause irritation in eyes, respiratory problems, asthma and other chronic healthy problems.

##### 2. Public Hygiene

Several hygiene problems among rural people arise due to non-availability of clean drinking water, improper disposal of sewage, dust and particulate matter in the air, poor ventilation in houses, lack of education and excessive use of fertilizers and pesticides.

##### 3. Improper Agricultural Activities

Improper agricultural activities cause land degradation due to shifting cultivation without adequate fallow periods, absence of soil conservation measures, cultivation of fragile lands, unbalanced fertilizer use, faulty planning or management or irrigation.

##### 4. Soil Erosion

Soil erosion is caused by overgrazing and intensive cultivation.

##### 5. Forest Degradation

Forest degradation is caused by overgrazing and over-extraction of green fodder, over-exploitation for fuel wood and timber collection and mining activities.

Other consequent environmental impacts owing to thoughtless human intervention are water logging, salinity, nutrient depletion, lowering of the groundwater table, pollution of water resources by household waste, sewage and agricultural chemicals.

**Q54. What are the impacts of resettlement and rearrangement of people due to development activity? What are your suggestions for proper justification with reference to suitable development.**

**Answer :**

Displacement or relocation of people arises due to both natural and human made disasters. The growth of core sectors like power, mining, heavy industry and irrigation has displaced a large number of people since the independence of India. Only a small percent of people were resettled and the rest were rendered homeless and impoverished.

The possibilities of adverse effects resulting from displacement (physical or economic or both) of people are, loss of their land, means of livelihood, loss of stable patterns of social and cultural life, productive assets and income sources are lost, relocation to environment where their productive skills are less applicable and there is greater competition for resources, weak community structures and social networks, dispersal of kin groups, diminished cultural identity, traditional authority and mutual help. Even today, large scale displacement continues in this era of new economic policy of liberalization and globalization owing to increase in the demand for land. Hence, appropriate policies must be devised to avoid or minimize the possibilities of adverse effects mentioned above. The objectives of the policies must be to minimize the hardship to the affected families and enhance or restore their livelihood opportunities.

#### Case Study

##### Sardar Sarovar Project

The Narmada river is the largest westward flowing river into the Gulf of Khambar in the Arabian Sea in India. The Sardar Sarovar Dam is on this river in the state of Gujarat. The construction workers and the related bureaucrats of Sardar Sarovar Project reside in Kevadia colony, which is a few kilometers downstream from the dam.

This project is aimed at taking excess water of Narmada basin to the water starved areas of Saurashtra, Kuchchh, North Gujarat and Rajasthan. (1.8 million hectares in Gujarat and Rajasthan). This type of water transfer enables the unproductive land to convert to arable land. 320,000 people would be displaced for the reservoir, hundreds/thousands more would lose land or livelihood due to related developments. A disproportionate number are tribal peoples.

Thousands of people who have been resettled are struggling to survive on cramped plots with no arable land or source of livelihood. Faced with these future prospects, villagers have vowed to remain on their lands and face submergence behind the partly built dam rather than face a life of certain destitution.

Local protests taking the form of a movement, known as Narmada Bachao Andolan (Save Narmada Movement) have been led by Medha Patkar, a renowned social activist.

A film documentary 'Drowned out (2002)' follows one tribal family who decide to stay at home and drown rather than make way for the Narmada Dam.

Author Arundhati Roy wrote a protest of NDP in her book 'The Cost of Living'.  
**Dimensions of the Dam**  
Length = 1210 m (3970 ft)  
Reservoir with full level = 139 m above sea level.  
Main canal from reservoir to Rajasthan State = 460 km long,

Width = 250 m at the head (near the dam)  
Width of canal at Rajasthan border = 100 m.

The opponents of the project feel that more than 320,000 people would be relocated for the reservoir, many hundreds or thousands will lose land or livelihood due to allied developments.

The World Bank was funding the project to the tune of \$450 million. It formed an independent review committee, the Morse Commission chaired by an ex-head of the UN development programme, Bradford Morse to review the resettlement and environment components of the project.

The Morse Commission strongly criticized the project and the involvement of World Bank in it.

The NBA believes that more than,

- (a) A million people will be rendered homeless and landless.
- (b) Several thousands of acres of land in the states of Gujarat, Maharashtra and Madhya Pradesh will be inundated with water by the 213 km long reservoir. The tribal people (adivasis or Bhils) to be displaced by SSP live in 14 villages in Gujarat, 33 in Maharashtra and around 53 in M.P.
- (c) Several thousands of acres of land would be lost to the network of canals, if it is ever completed.
- (d) About 50,000 adivasis would be displaced by the proposed Shoolpaneshwar Wildlife Sanctuary in Gujarat in order to compensate for the forests and wildlife lost to the construction of the reservoir. So far, no arrangements have been made to resettle or compensate these people. Thousands of people would be displaced by the proposed two national parks by the Ministry for Environment in Madhya Pradesh.
- (e) The dam is meant to store and divert all the waters of Narmada to various places excepting the monsoon season. In such a case, the river would dry up downstream thereby affecting the livelihood of thousands of families of the fishing community. The water supply to all the villages and towns in the downstream would be severely affected.
- (f) The lands inhabited by the tribal people are being taken over for the purpose of afforestation to compensate for the trees lost to the reservoir.
- (g) Lack of grazing lands for the grazing animals.
- (h) Poor quality and flood prone cropland.
- (i) Splitting up of families among different resettlement sites.

The Government of India has taken significant measures in the Parliament. The bill is primarily applicable to rehabilitation and resettlement of persons affected by the acquisition of lands for projects.

### Suggestions for Proper Justification with Reference to Sustainable Development

Some of the many suggestions for proper justification with reference to sustainable development are as follows,

#### (i) Environmental Protection

Each one of us must understand that environmental protection supports sustainable development. A healthy environment of clean air, unpolluted water and healthy soil is necessary for survival of all life forms. Reuse and recycling of natural resources allows us to save it for future generations.

#### (ii) Promote Social Equity and Cohesion

Sustainable development must focus on improvement of employment and working conditions, improve social cohesion, a healthy, safe and just society without discrimination towards anyone.

#### (iii) Promote Eco-Efficient Economy

Sustainable development can be accomplished by promoting a competitive and eco-efficient economy which provides better living standards and employment opportunities.

#### (iv) Promotion of Sustainable Development Across the Globe

Traditional practices that are sustainable and environment friendly must be encouraged. If we are able to manage our resources sustainably, the conflicts about them would reduce and thus protect the global environment.

#### (v) Promotion of Fundamental Rights and its Protection

Promoting fundamental rights by resisting all forms of prejudices and contributing to reduction of poverty across the globe contributes to sustainable development.

#### (vi) Addressing the Needs of the Present Generation

Ethical relationship between humans and the natural environment enables the fulfillment of the needs of the present generation without compromising the ability of the future generation to meet their own needs.

#### (vii) Encourage Participation of Citizens

We, as responsible citizens of India, should constantly monitor the developmental activities taking place around us. Any developmental activity that has a potential to harm the natural environment must be brought to the notice of authorities such as the local administration, the forest department or the pollution control board to look into the issue, so that the environment is not degraded further.

#### (viii) Observe Precautionary Approach Towards Environment

Implementation of policies that protect human health and the environment in the face of uncertain risks must be encouraged. Other suggestions for sustainable development include easy access to information, encouraging participation of businesses and social partners, promotion of coherence and integration of environmental policies and making the polluters pay for damaging the environment.

### 3.4 MONITORING METHODS, PRE-APPRAISAL AND APPRAISAL

#### Q55. What is an environmental audit?

##### Answer :

The International Chamber of Commerce (ICC) has defined environmental audit as, "a management tool comprising a systematic, documented, periodic and objective evaluation of how well the environmental organization, management and equipment are performing with an aim of helping to safeguard the environment by,

- (i) Facilitating management and control of environmental practices
- (ii) Assessing compliance with company policies, which include meeting regulatory requirements".

The United States Environmental Protection Agency has defined environmental audit as a systematic, documented, periodic and objective review by regulated entities of facility operations and practices related to meeting environmental requirements.

Thus, the environmental audit can be defined as an assessment tool to manage the activities of an organization to evaluate its environmental performance. The environmental audit in India began as early as in the 1970s. The procedure for environmental audit was introduced under the Environment Protection Act, 1986 by the Ministry of Environment and Forests. Any organization needing the consent under section 25 of the Water (Prevention and Control of Pollution) Act, 1974 or under section 21 of the Air (Prevention and Control of Pollution) Act, 1981 or under the Hazardous Waste (Management and Handling) Rule of 1989 issued under the Hazardous (Protection) Act, 1986, needs to submit an environment audit report every year by the 30th September. The Environment Audit Report was given a new name as Environment Statement in 1993. It is mandatory that every industrial organization should prepare an annual report on environmental matters and submit the same to the Pollution Control Board, though it is practiced by only a very limited number of companies.

**Q56. What are the steps involved in pre-audit activities?**

Sep.-20, (R16), Q7(c)

*Refer Only Topic: Pre-Audit Activities*

**OR**

**Explain the on-site audit and post audit activities.**

Model Paper-III, Q7(a) | Sep-20, (R16), Q7

*Refer Only Topic: On-site Activities and Post Audit Activities*

**OR**

**Discuss the stages of environmental audit.**

**Answer :**

An environmental audit can be structured in three activity steps. They are discussed as under.

### 1. Pre-Audit Activities

Pre-audit activities incorporate all the activities involved prior to the on-site audit of the proposed project. The following requirements must be fulfilled before taking up an environmental audit.

- Preparation for organizing and scheduling the audit procedure.
- Organize/appoint an audit team or an Audit Management Committee (AMC) to conduct field assessment, collect and analyze the information, make judgement about the proposed projects and its environmental compliance status. The audit team generally comprises of about eight people who are subject specialists with technical expertise, qualified external consultants or full time auditors, or representatives of business units/company. The members appointed in the audit team should be familiar with the principles of the environmental auditing process. The AMC appoints an Audit Team Leader for the auditing process. The audit team needs to be given travel and lodging arrangements, once they confirm their availability.
- Analysis of the project.
- Preparation for the site visit to collect background information such as site layout, site history, blueprints, organizational structure etc.
- Preparation of questionnaire to collect necessary information of the audit site before commencing on on-site audit activities.

The questionnaire should cover all aspects of the environment, which has to be completed by the internal auditor. A sample of the questions that are generally included in the pre-audit questionnaire are,

- Is the site owned/leased?
- What is the date of purchase of the site?
- What is the area of the site?
- What are the remedial measures/corrective actions taken for environmental management?

(v) Is an inventory maintained for the office supplies, computer-related supplies, refreshment supplies etc..

(vi) Records of the energy use for the site

(vii) What are the sources of water supply to the project site?

(viii) Specify the water treatment systems

(ix) Specify the sources of wastewater, type of discharge and volume of discharge on a daily basis

(x) Specify the wastewater pretreatment prior to discharge

(xi) What are the sources of indoor air pollutants?

The several questions asked vary from topics like waste management, air quality monitoring and control, wastewater management, water supply management, material management, energy management, hazardous material management, noise monitoring and control, transportation and travel, emergency response procedures, staff awareness and training, overall environmental management and general departmental information.

(f) Obtain commitment from the head of the company/organization/project about the pre-audit activities and communicate the same to all the employees in the form of an open memo during the internal management meetings. The memo should specify the audit site, audit objectives and areas of audit.

The areas of audit includes the following,

- Conformance to the regulations
- Pollution management, control and minimization
- Treatment of pollutants at source and their discharge
- Resource management- materials, energy, water etc
- Prevention measures from environmental emergencies and preparedness.

### On-Site Activities

On-site auditing includes the following activities,

- Verification of records and relevant documents related to the proposed project. It also includes management policies, records of the inventory, monitoring, calibration, transportation, previous audit reports, minutes of the meeting, record of the suggestions given etc.
- Confidential interviews with the members employed with the project from all levels of the organization i.e., from the senior management to the support personnel. These interviews must be conducted at the interviewee work station without interfering with the job performance. The interviewer should assure the interviewee of confidentiality and anonymity of information.

### UNIT-3 Environmental Management Plan

- (c) Inspection of the proposed project site, the operation processes and equipment. In-depth field survey for essential information to assess the pollution control measures undertaken, wastewater sampling, ambient noise and stack monitoring, sampling and analysis of the same, for compliance with legislature and regulatory requirements, internal policies, guidelines etc
- (d) Review of the safety measures to be implemented
- (e) Identification of various aspects on how to improve the environmental performance
- (f) Before the conclusion of the site audit, the audit evidence must be reviewed for the adequacy of collected information, address the issues that need immediate attention, mark the issues that need follow-up, and finally prepare a report for the closing meeting
- (g) The closing meeting is the conclusion of the onsite audit activities. The main purpose of the closing meeting is,
  - (i) To discuss the findings and observations of the audit with the project personnel
  - (ii) Analyze the issues that need immediate attention
  - (iii) Mitigation measures/corrective actions recommended for environmental improvement
  - (iv) To agree on contentious issues and reporting schedules.
- (h) The findings and observations during the audit process are documented in the formal audit report.

#### Post-Audit Activities

Once the on-site activities are completed, the post-audit activities follow, wherein, the collected data is translated into meaningful information to enable better decisions.

The team leader of the audit team prepares a draft report of the on-site observations within 2 - weeks of the on-site activity. This step is followed by the review of the report by the environmental department, law department etc. A final report is prepared by the same audit team, assisted by the respective specialists. It contains the statement of facts and proposals on how to improve environmental performance, improvements in education or awareness raising, ways to increase environmental responsibility, investments in new equipment and environmental protection technology.

The audit report is to be circulated to all the members of the audit team including the audit management committee, senior site auditors, site facilitators, audit personnel for endorsement. The environmental audit report generally includes the following items,

- (i) An executive summary
- (ii) Introduction and background information to the audit
- (iii) Scope and objectives
- (iv) Description and methodology of audit
- (v) Summary of observations, findings and recommendations
- (vi) Conclusion
- (vii) Annexes.

**Q57. What are the objectives of environmental audit?**

Dec.-20 (R16), Q7(b)

OR

**What are the main objectives of environmental audit? Explain.**

Sep.-20 (R16), Q6

OR

**What is the purpose of post audit and environmental audit.**

#### Answer :

##### Objectives of Environmental Audit

Some of the objectives of the environmental audit are as mentioned below,

- (a) To minimize the resource consumption in order to conserve the resources as these are the valuable assets of any nation.
- (b) To minimize waste generation by abatement and reduction in waste.
- (c) To promote the use of green technologies to reduce the damaging impacts on the environment in an efficient and cost-effective manner.
- (d) To promote good pollution control practices to help in pollution control.
- (e) To achieve sustainable development for protection and preservation of the environment.
- (f) To improve the health and safety of individuals during the production process in industrial units.
- (g) To evaluate if the organization abides by the regulatory requirements.
- (h) To ensure that the natural resources are used for the nation's progress.
- (i) To identify the deficiencies and problems with the operations and processes to lessen the risk of future problems.
- (j) To improve the image of the organization by putting up the environmental information of the organization in the public domain.

**Q58. Describe advantages and disadvantages for the existence of audit protocols.**

**Answer :**

#### Advantages

Effective environmental audit programmes have the following advantages,

- (a) The amount of waste production is considerably reduced.
- (b) Environmental audit helps conserve resources and thus the input costs are significantly reduced leading to financial benefits.
- (c) It helps to prevent and control pollution of the environment.
- (d) It helps the project proponents to take corrective actions wherever necessary.
- (e) It helps to improve the image of the organization in public view, which in turn, can cause a hike in the share prices.
- (f) It helps to provide warning about the possible future problems the project may face.
- (g) Risks from environmental hazards are reduced.
- (h) Environmental audit facilitates the recycling and reuse of resources, thus leading to cutting down expenditure.
- (i) Increase in environmental awareness among customers, workers, staff and consumers.
- (j) Improvement in the quality of life of people.

#### Disadvantages

The disadvantages of environmental audit protocols are as mentioned below :

- (i) High capital investment for conducting audits.
- (ii) The information provided may be disruptive.
- (iii) The audit may serve as a guide and not a law. The environmental audit policies and laws may include exceptions.
- (iv) Any violations by the organization becomes public.
- (v) Any violations by developmental activity need to be fixed. Hence, it would be unwise to perform an audit in case of fund crunch.

**Q59. Explain in detail the ecological monitoring and audit programme.**

**Answer :**

Sep.-20 (R16), Q3(a)

Ecological monitoring involves paying close attention to monitoring and supervision of local conditions to assess the effectiveness of development interventions. The process involves discussion among project managers, government officials and researchers for accurate prediction of impacts or changes in the impact trends. It can even warn the project proponents of adverse impacts and the effectiveness of implemented mitigation measures.

An environmental audit can be structured in three activity steps. They are discussed as under,

For answer refer Unit-III, Q56.

**Q60. How often environment audit are conducted in an organization?**

Sep.-20, (R16), Q7(a)

**Answer :**

The environment audit must be conducted regularly.

The government of India has made it mandatory for all industries to provide annual environment audit reports of their operations.

**Q61. What are the principle areas of environmental auditing?**

Sep.-20, (R16), Q7(b)

**Answer :**

The principle areas of environmental auditing are,

1. Material audit
2. Vitality audit
3. Water audit
4. Well being and safety audit
5. Natural quality audit
6. Waste audit
7. Designing audit
8. Consistence audit

**Q62. What is environmental audit (EA)? What are the advantages of environmental audit?**

**Answer :**

Model Paper-II, Q6(b) | Dec.-20 (R16), Q7(a)

For answer refer Unit-III, Q55 and Q58, Topic: Advantages.

**Q63. What is environmental audit and explain about types of environmental audit.**

**Answer :**

July-21 (R16), Q5(a)

For answer refer Unit-III, Q55, Q15 and Q14.

## FREQUENTLY ASKED AND IMPORTANT QUESTIONS

**Q1.** How to carry out the impact assessment studies on vegetation due to any developmental activity.

July-21, (R16), Q3(a)



**Q2.** What do you understand by the word vegetation? How is it impacted by the development activities.

Dec.-20 (R16), Q3

Answer :  
For answer refer Unit-III, Q47.

**Q3.** What are the effects of deforestation?

July-21, (R16), Q3(b)



**Q4.** How deforestation affect the livelihood of people who depend on forest?

Dec.-20 (R16), Q4

Answer :  
For answer refer Unit-III, Q50.

**Q5.** What are the steps involved in pre-audit activities.

Sep.-20, (R16), Q7(c)



**Q6.** Explain the on-site audit and post audit activities.

Sep-20, (R16), Q7

OR

**Q7.** Discuss the stages of environmental audit.

Answer :  
For answer refer Unit-III, Q56.

**Q8.** What are the objectives of environmental audit?

Dec.-20 (R16), Q7(b)



**Q9.** What are the main objectives of environmental audit? Explain.

Sep.-20 (R16), Q6

OR

**Q10.** What is the purpose of post audit and environmental audit.

Answer :  
For answer refer Unit-III, Q57.

**Q11.** Explain the sequential action of EIA as an environmental management tool with neat flow sheet.

Important Question | Sep.-20 (R16), Q2

Answer :

For answer refer Unit-III, Q22.

**Q12.** Explain in detail the environment management plan for air, water and land environment for thermal power plant project.

Important Question | Sep.-20 (R16), Q8

Answer :

For answer refer Unit-III, Q24.

**Q13.** What are impacts occurring in land during operation phases?

OR

**Q14.** Write a detailed note on direct land use impacts.

Important Question | Sep.-20, (R16), Q6(b)

Answer :

For answer refer Unit-III, Q31.

**Q8. What is meant by land drainage?**

**Answer :** Important Question | Sep.-20 (R16), Q6(c)  
For answer refer Unit-III, Q32.

**Q9. What is the methodology need to be adopted to study the impacts on soil quality due to any developmental activity?**

**Answer :** Important Question | July-21, (R16), Q4(a)  
For answer refer Unit-III, Q33.

**Q10. Discuss the identification and incorporation of mitigation measures for soil.**

**Answer :** Important Question | Sep.-20, (R16), Q5  
For answer refer Unit-III, Q34.

**Q11. How does the steel industry impact the soil quality and what type of mitigation measures need to be taken up?**

**Answer :** Important Question | July-21 (R16), Q4(b)  
For answer refer Unit-III, Q39.

**Q12. Mention different soil functions that is considered for any soil environment study.**

**Answer :** Important Question | Sep.-20 (R16), Q50(b)  
For answer refer Unit-III, Q40.

**Q13. What are the mitigation measures adopted in restoring the soil properties?**

**Answer :** Important Question | Sep.-20 (R16), Q5(a)  
For answer refer Unit-III, Q41.

**Q14. Explain the methodology for prediction and assessment of impacts on soil with neat flow sheet.**

**Answer :** Important Question | Sep.-20 (R16), Q4  
For answer refer Unit-III, Q42.

**Q15. What is meant by soil liquefaction and how it is caused?**

**Answer :** Important Question | Sep.-20 (R16), Q6(a)  
For answer refer Unit-III, Q43.

**Q16. Define soil fertility. How it can be gained?**

**Answer :** Important Question | Dec.-20 (R16), Q6  
For answer refer Unit-III, Q44.

**Q17. How soil is affected around the mines?**

**Answer :** Important Question | Dec.-20 (R16), Q5(b)  
For answer refer Unit-III, Q45.

**Q18. Differentiate direct and indirect impact in vegetation and wildlife impact analysis.**

**Answer :** Important Question | Sep.-20 (R16), Q3(b)  
For answer refer Unit-III, Q46.

**Q19. Explain about the environmental impact of deforestation, causes, effects and control strategies.**

**Answer :** Important Question | Sep.-20 (R16), Q3  
For answer refer Unit-III, Q49.

**Q20. Explain in detail the ecological monitoring and audit programme.**

**Answer :** Important Question | Sep.-20 (R16), Q3(b)  
For answer refer Unit-III, Q59.

**Q21. How often environment audit are conducted in an organization?**

**Answer :** Important Question | Sep.-20, (R16), Q7(b)  
For answer refer Unit-III, Q60.

**Q22. What are the principle areas of environmental auditing?**

**Answer :** Important Question | Sep.-20, (R16), Q7(b)  
For answer refer Unit-III, Q61.

**Q23. What is environmental audit (EA)? What are the advantages of environmental audit?**

**Answer :** Important Question | Dec.-20 (R16), Q7(b)  
For answer refer Unit-III, Q62.

**Q24. What is environmental audit and explain about types of environmental audit.**

**Answer :** Important Question | July-21 (R16), Q5(b)  
For answer refer Unit-III, Q63.

# Environmental Legislation and Life Cycle Assessment



## Syllabus

**Environmental Legislation and Life Cycle Assessment** - Environmental Laws and Protection Acts, Constitutional Provisions-Powers and Functions of Central and State Government, The Environment (Protection) Act 1986, The Water Act 1974, The Air Act 1981, Wild Life Act 1972, Guidelines for Control of Noise, Loss of Biodiversity, Solid and Hazardous Waste Management Rules.  
**Life Cycle Assessment:** Life Cycle Analysis, Methodology, Management, Flow of Materials-Cost Criteria  
- Case Studies.

### LEARNING OBJECTIVES

In this unit, you will learn the following concepts,

- ✓ Understand the legislative framework of environmental regulation
- ✓ Familiarize with the dominant issues of the environmental law
- ✓ Knowledge of the administrative process involved with environmental law
- ✓ Understand the powers and functions of central and state government related to environmental legislation
- ✓ Identify the core environmental issues along with legal and institutional responses to them
- ✓ Analyze the specialized legislative measures dealing with pollution of water, air, noise, solid and hazardous waste
- ✓ Importance of biodiversity
- ✓ Describe the methodology for assessing the environmental impact associated with all the stages of the life cycle of a product.

### INTRODUCTION

This unit provides an overview of several legislations that directly or indirectly deal with the environment. The major acts for environmental protection in India are : The Environment Protection Act 1986, The Water Act 1974, The Air Act 1981, Wildlife Act 1972, Solid and Hazardous Waste Management Rules.

All these laws are of utmost importance because without adequate regulations and laws, environmental conservation cannot be achieved. This unit further deals with the life cycle assessment as a technique for assessing the environmental aspects associated with any given product or service.

**PART-A SHORT QUESTIONS WITH SOLUTIONS**

Model Paper-I, Q1(h)

**Q1. List out any four environment protection acts.****Answer :**

The four Environment Protection Acts are,

- The Air (Prevention and Control of Pollution) Act, 1981
- The Water (Prevention and Control of Pollution) Act, 1974
- The Forest Conservation Act, 1980
- The Wildlife Protection Act, 1972.

**Q2. State the purpose of the environment protection act.****Answer :**

The purpose of the Environment Protection Act is as mentioned below.

- To regulate the interaction between humans and the environment.
- To minimize the impacts on the environment in a comprehensive manner to ensure ecological equilibrium.
- Sustainable development of the environment.
- Ensure better livelihoods to those people dependent on particular resources by conservation rather than degradation of resources.

**Q3. What is environment protection act?****Answer :**

The Environmental Protection Act, 1986 is one of the most important Acts laid down by the Constitution of India. It consists of 26 sections distributed in four chapters. The Act empowers the central government to take suitable measures to protect and improve the environment.

**Q4. What is the water act?****Answer :**

The Water (Prevention and Control of Pollution) Act, 1974 was enacted by the parliament under Article 48-A of the Indian Constitution. The Act is a comprehensive legislation, dealing with the preservation of water quality and control of water pollution. It consists of 64 sections distributed in 8 chapters.

**Q5. What are the objectives of water act?****Answer :**

The main objectives of Water Act are,

- To prevent and control water pollution
- To empower the State and Central Pollution Control Boards to take necessary legal action against anyone responsible for pollution of water bodies.

**Q6. List various clean air act amendments.**

Model Paper-II, Q1(g)

**Answer :**

The amendments to the Clean Air Act administered by the United States Environmental Protection Agency (EPA) are,

- Curb the three major environmental threats – acid rain, urban air pollution, toxic air emissions
- Use of alternative clean fuels
- Use of low sulphur coal and natural gas
- Reduce dependency on oil imports
- Encourage energy conservation.

**Q7. What is the wildlife act?****Answer :**

The Wildlife Protection Act, 1972 is a comprehensive legislation enacted by the Government of India with the sole aim to control poaching and illegal trade of wildlife (animals, birds and plants) as well as its derivatives and to generate environmental consciousness among the people. The Act extends to all the states in the country, with the exception of Jammu and Kashmir (which has its own Act). The Act comprises six schedules, which give varying degrees of protection to plants and animal species of India.

**Q8. State the limitations of the wildlife act.****Answer :**

The drawbacks or limitations of the Wildlife Act are, Adequate and immediate compensation is not provided for the victims of wildlife attacks.

(a) Lack of encouragement to those people who have been protecting wildlife on their own.

(b) The present bill does not encourage community/private initiatives.

(c) Prohibits the involvement of forest inhabitants in wildlife conservation.

(d) Imposes restriction of chemical farming in and around protected areas.

**Q9. Discuss the objectives of environmental legislation.****Answer :****Model Paper-I, Q1(g)**

The main objectives of environmental legislation are:

Protect and improve the environment

Prevent the occurrence of hazards to life on earth.

Ensure co-ordination between regulatory agencies for environmental protection.

Ensure sustainable utilization of the natural resources.

Regulate environmental pollution of all types - be it air, water, soil, noise, radiation, etc.

Promote conservation of the natural environment.

Safeguard the endangered species.

Promote biological diversity.

Protection of human health from the pollutants of the environment.

Preserve the forests and encourage environment friendly agriculture.

**Q10. Mention the noise standards for residential/silence/industrial areas.****Answer :****Model Paper-III, Q1(g)**

The control of noise is important in order to protect the hearing abilities and other health concerns of each one of us. The noise pollution control committee has recommended ambient air quality standards in respect of noise, which is as mentioned below,

	Limit in dBA ( $L_{eq}$ )	
	Day time 6am-10pm	Night time 10pm-6am
Industrial area	75	70
Commercial area	65	55
Residential area	55	45
Silence zone	50	40

dBA( $L_{eq}$ ) = time weighted average of the level of sound decibels on scale A which is relatable to human hearing.

**Q11. Discuss the effects of noise on people.****Model Paper-II, Q1(h)****Answer :**

The adverse effects on mental health caused due to the excessive noise exposure are as mentioned below.

Anxiety, stress, nervousness, nausea, headache, emotional instability, argumentativeness, mood swings, increase in social conflicts, neurosis, hysteria, as well as psychosis.

Noise pollution causes impaired cognitive task performance at work, leading to errors and accidents with consequent health and economic impacts. A wide range of negative reactions that can develop are anger, disappointment, dissatisfaction, withdrawal, helplessness, depression, anxiety, distraction, agitation, exhaustion, unfriendliness, non-participation, drug addiction, disruption in peace of mind.

From the above explanation, it may be concluded that the physical condition of the people, their health and environmental hazard can be alleviated by adopting sustainable measures and restricting the noise emissions through international, national and local measures.

**Q12. What is meant by biodiversity?****OR****Explain biodiversity.****Answer :**

The term biodiversity is a contraction of biological diversity. It can be defined as the variability among living organisms in its different forms and relationships, inhabiting the different ecosystems and surviving in every earthly environment. In general terms, the word biodiversity can be described as the concentration of various entities such as genera, ecosystem, different species and organisms confined to a particular region.

**Q13. Differentiate between endangered and vulnerable species.****OR****Endangered species.****Answer :****Model Paper-III, Q1(h)****Endangered Species**

The endangered species of flora and fauna represents the population that could be extinct very soon due to the damage of their areas, poaching, low rate of productivity, etc.

E.g.s: Green turtle, hawksbill and black buck.

**Vulnerable Species**

The vulnerable species include those species of flora and fauna which are soon to become endangered due to overexploitation, destruction of their natural habitat and environmental calamities.

E.g.s: Blue sheep, Asiatic elephant and Gangetic dolphin.

**4. I ENVIRONMENTAL LAWS AND PROTECTION ACTS**

**Q14.** Write a short note on environmental legislation.

**Answer :**

**Environmental Legislation**

The term environmental legislation refers to the management of the environment under a strong legal framework to help or protect the environment. An international conference on human environment was organized in Stockholm from 5th June to 16th June, 1972 as U.N. Conference on Human Environment to bring awareness to people to exert efforts for preservation of the environment for the wellbeing and prosperity of all. Since then, 5th June is celebrated every year as World Environment Day across the world. In India, the Department of Environment was set up in 1980, which later became the Ministry of Environment and Forests in 1985. The MoEF served as the nodal agency at the centre for planning, encouraging and organizing the environmental programmes. Along with the MoEF, the Central Pollution Control Board and the State Pollution Control Board form the regulatory and administrative core.

**Constitutional Provisions for Environmental Protection**

In the Constitution of India, Article 48-A states, "The state shall endeavour to protect and improve the environment and to safeguard forests and wildlife of the country". Protection of the environment has been made a fundamental duty of every citizen of India under Article 51 A (g). According to it, "It shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures".

The Government of India has formulated about 30 Acts and rules related to the environment. The environmental legislations passed by the Government of India are enlisted below,

- (i) The River Boards Act, 1956.
- (ii) The Merchant Shipping Act, 1970.
- (iii) The Wildlife Protection Act, 1972, Rules 1973 and Amendment 1991.
- (iv) The Water (Prevention and Control of Pollution) Act, 1974.
- (v) The Water (Prevention and Control of Pollution) Cess Act, 1977.
- (vi) The Water (Prevention and Control of Pollution) Rules, 1978.
- (vii) The Forest (Conservation) Act 1980 and Rules 1981.
- (viii) The Air (Prevention and Control of Pollution) Act, 1981.
- (ix) The Air (Prevention and Control of Pollution) Rules, 1982.
- (x) The Atomic Energy Act, 1982.
- (xi) The Environmental (Protection) Act, 1986.
- (xii) The Environmental (Protection) Rules, 1986.
- (xiii) The Air (Pollution and Control of Pollution) Amendment Act, 1987.
- (xiv) The Motor Vehicles Act, 1988.
- (xv) The Hazardous Waste (Management and Handling) Rules, 1989.
- (xvi) The Manufacture, Storage and Import of Hazardous Rules, 1989.
- (xvii) The Manufacture, Use, Import, Export and Storage of Hazardous Microorganisms/Genetically Engineered Organisms or Cells Rules, 1989.
- (xviii) The Coastal Regulation Zone Notification, 1991.
- (xix) The Public Liability Insurance Act and Rules and Amendment, 1991.
- (xx) The National Environment Tribunal Act, 1995.
- (xxi) The National Environment Appellate Authority Act, 1997.

## UNIT-4 Environmental Legislation and Life Cycle Assessment

(viii) The Biomedical Waste Management and Handling Rules, 1998.

(ix) The Environment (Siting for Industrial Projects) Rules, 1999.

(x) The Municipal Solid Waste (Management and Handling) Rules, 2000.

(xi) The Ozone Depleting Substances (Regulation and Control) Rules, 2000.

(xii) The Batteries (Management and Handling) Rules, 2001.

The Ministries and departments that deal with environmental issues are the Ministry of New and Renewable Energy Sources, Ministry of Power, Ministry of Rural Development, Ministry of Urban Development and Poverty Alleviation, Ministry of Petroleum etc.

### Enforcement of Environmental Legislation

Effective implementation of environmental legislation needs the involvement of an agency that collects relevant data, assess it and pass it onto the law enforcement agency.

In order to protect and conserve the pristine environment, a number of laws have been enacted by the Indian government which include laws to curb all sorts of pollution – environment, water, noise and air, forest conservation, coastal regulation, biological diversity, wildlife protection and many more.

It has been observed that despite of the existence of a legal framework for protection of the environment, environmental degradation still continues, perhaps due to lapses in enforcement of environmental legislation.

## 2 CONSTITUTIONAL PROVISIONS - POWERS AND FUNCTIONS OF CENTRAL AND STATE GOVERNMENT

### 5. What are the constitutional provisions relating to environmental protection in India?

Answer : Model Paper-I, Q8(a)

The different constitutional provisions relating to environmental protection in India are as mentioned below.

#### Article 48 A

Article 48 A is enshrined under the Directive Principles of State Policies. According to this article, "the state shall endeavour to protect and improve the environment and to safeguard the forests and wildlife of the country".

#### Article 51 A(g)

It says that, "it shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures".

It may be observed that both the articles, Article 48 A and Article 51 A(g) are almost similar, except for the fact that the Article 51 A(g) emphasizes on the fundamental duty of the citizens, whereas Article 48A is the duty of the state to protect the environment.

#### (iii) Article 253

Article 253 deals with provisions related to legislation for giving effect to international agreements. It also states that notwithstanding anything in the foregoing provisions of this chapter, Parliament has power to make any law for the whole or any part of the territory of India for implementing any treaty, agreement or convention with any other country or countries or any decision made at any international conference, association or other body. The Parliament has used Article 253 to enact various laws for the protection of the environment like Wildlife Act 1972, Water Act 1974, Air Act 1981, the Environmental Protection Act 1984.

#### (iv) Article 246

This Article divides the subjects of legislation between the Union, the State and the Concurrent list. It emphasizes that both State and Union have the power to make laws for protecting the environment. The concurrent list includes subjects like education, population control, and family planning, criminal law, prevention of cruelty to animals, protection of wildlife and animals, forests and many more.

#### (v) Article 47

According to this Article, it is the duty of the State to improve the standard of living of citizens by providing health facilities, sanitation, proper nutrition and protecting the environment to live safely. It lays emphasis on being more conscious of the environment.

#### (vi) Article 21

It states that "No person shall be deprived of his life or personal liberty except according to the procedure established by law".

#### (vii) Article 19 (1)(g)

It states that it is the fundamental right of the citizens to practice any profession or to carry out any occupation, trade, business in any part of the country with some reasonable restrictions. Those business activities or trade that are hazardous to public health must not be carried out.

#### Article 32 and 226

Article 32 enables an individual to approach the Supreme Court directly for infringement of a fundamental right. Article 226 empowers a High Court to issue a written command for violation of a fundamental right or any other legal right.

The Indian Constitution has laid down various provisions and Acts for the protection of the environment. Our activities have caused many global problems such as pollution of the environment, climate change, ozone layer depletion, extinction of species, water scarcity, overextraction of natural resources, all of which are increasingly seen as threats to the environment as a whole. Development is, of course, necessary to provide decent housing, good job and education to meet the basic needs. However, development must be pursued in a manner that does not overburden the natural environment. In a simpler sense, sustainable development must be promoted and encouraged to enable us to hand a better world for everyone now and for generations to come.

### 4.3 THE ENVIRONMENT PROTECTION ACT 1986

#### Q16. Explain the environment protection act, 1986.

**Answer :**

Model Paper-I, Q8(b)

The Environment Protection Act, 1986 is one of the most important Acts laid down by the constitution of India. It consists of 26 sections distributed in four chapters. The salient features of the Environment Protection Act, 1986 are discussed below.

#### 1. Objectives

The main aim of the Act is to,

- (i) Protect and improve the environment.
- (ii) Prevent the occurrence of hazards to life on earth.
- (iii) Execute the resolution passed at the United Nations Conference on Human Environment held at Stockholm, Sweden in June 1972.
- (iv) Ensure co-ordination between regulatory agencies for environmental protection.
- (v) Ensure sustainable utilization of the natural resources.

#### 2. Important Definitions used in the Act

##### (a) Environment

According to Section 2(a) of EPA 1986, 'environment includes water, air and land and the interrelationship which exists among and between water, air, land and human beings, other living creatures such as plants, micro-organisms and property'.

##### (b) Environmental Pollutant

According to Section 2(b) of the Act, 'environmental pollutant means any solid, liquid or gaseous substance present in such concentrations, as may be or tend to be, injurious to the environment'.

#### (c) Environmental Pollution

According to the Section 2(c) of the Act, 'environmental pollution means the presence in the environment of any environmental pollutant'.

#### (d) Hazardous Substance

According to Section 2(e) of the Act, 'hazardous substance means any substance or preparation which, by reason of its chemical or physiochemical properties or handling, is likely to cause harm to human beings, other living creatures, plants, micro-organisms, property or the environment'.

#### (e) Occupier

According to Section 2(f) of the Act, 'occupier in relation to any factory or premises means a person who has control over the affairs of the factory or premises and includes, in relation to any substance, the person in possession of the substance'.

#### 3. General Powers of the Central Government

- (a) Formulate rules to regulate environmental pollution.
- (b) Preparation of standards for various environmental pollutants.
- (c) Restricting the areas for industrial establishment.
- (d) Ranking the hazardous substances.
- (e) Establishment of laboratories for carrying out research on issues regarding environmental pollution, provide training and information dissemination.
- (f) Testing of samples collected from the factory premises to check if they are abiding to the required standards.
- (g) Co-ordinating with the various state government officers under this act or under any law.
- (h) Design a course of action for a nation-wide programme on prevention, control or abatement of any kind of pollution.
- (i) The central government can introduce new environment-related standards, restrictions and prohibitions.
- (j) The enforcement of the above Act in a stringent manner is an important prerequisite for its success apart from safeguarding the environment and sustaining its inherent quality.

**Penalties**

Those not complying with the standard conditions or found violating the Act are penalized with imprisonment for a term which may extend up to five years or a fine of one lakh rupees. Serious violations can lead to stiffer penalties with imprisonment for a term, which may extend to seven years or fine of ₹5000/- per day.

Some of the important rules made under the Act are enlisted below,

- (i) The Environment (Protection) Rules, 1986.
- (ii) The Hazardous Wastes (Management and Handling) Rules, 1989.
- (iii) The Manufacture, Storage and Import of Hazardous Chemical Rules, 1989.
- (iv) The Hazardous Microorganism Rules, 1989.
- (v) The Chemical Accident (Emergency Planning, Preparedness and Response) Rules, 1996.
- (vi) The Bio-medical Waste (Management and Handling) Rules, 1998.
- (vii) The Recycled Plastics Manufacture and Usage Rules, 1999.
- (viii) The Municipal Solid Waste (Management and Handling) Rules, 2000.
- (ix) The Noise Pollution (Regulation and Control) Rules, 2000.
- (x) The Ozone Depleting Substances (Regulation and Control) Rules, 2000.

Public concern and support is essential to accomplish the Environment Protection Act. It needs the encouragement by environmentalists, social activists, policy-makers, environmental philosophers, politicians, bureaucrats, industrialists for the effective implementation of environmental laws for conservation and protection of the environment.

**Role of Stakeholders in Implementation of Environment Protection Act**

The stakeholders include individuals, communities, recreational interest groups, expert groups, business affiliations, academic organizations, government agencies, private organizations, non-governmental organizations, and others having interest in the protection of the environment. They can involve themselves in the decision-making, planning and management of our environment. All of them can focus their attention on concerns relating to a sustainable environment, such as use of renewable resources, global climate change, deforestation, biodiversity loss, etc.

**4.4 THE WATER ACT, 1974**

**Q17. Discuss about water act.**

July-21, (R16), Q8(a)

**OR**

**Explain water (prevention and control of pollution) Act, 1974.**

Sep.-20, (R16), Q8

**OR**

**Discuss briefly the provision of the water (prevention and control of pollution) act, 1974.**

Model Paper-II, Q8(b)

**Answer :**

The Water (Prevention and Control of Pollution) Act, 1974 was enacted by the Parliament under Article 48-A of the Indian constitution. The Act is a comprehensive legislation, dealing with the preservation of water quality and control of water pollution. It consists of 64 sections distributed in 8 chapters.

**Important Provisions of the Water Act**

According to the Section 2 of the Water Act, water pollution is described as "such contamination of water or such alteration of the physical, chemical or biological properties of water or such discharge of any sewage or trade effluent or of any other liquid, gaseous or solid substance into water (whether directly or indirectly) as may or is likely to, create a nuisance or render such water harmful or injurious to public health or safety or to domestic, commercial, industrial, agricultural or legitimate uses or to the life and health of animals or plants or of aquatic organisms".

The main objective of the Act is to establish State and Central Pollution Control Boards and empower them to take necessary legal action against anybody/person responsible for pollution of water bodies like lakes, streams, inland waters, underground waters, sea water, sewers etc.

**Powers of the Boards**

The Central Pollution Control Board is committed to follow the guidelines laid down by the Central Government in writing. The functions and powers of the Central Board listed out in the Water Act are,

- (i) Appraise the central government on issues regarding the prevention and control of pollution.
- (ii) Organize the activities of the State Boards and deal with/ work out on the controversies among them.
- (iii) The Central Board acts as State Board and exercises the powers and performs the functions for the Union Territories. The central government may direct the Central Board to appoint a person or body of persons to exercise its powers or perform its functions for a particular Union Territory.
- (iv) The Central Board arranges for technical support and guides the State Boards, encourages and sponsors research related activities regarding prevention, control or abatement of water pollution.
- (v) Provide training to persons involved in activities related to prevention, control or abatement of water pollution.

- (vi) Co-ordinate a comprehensive programme related to the prevention and control of water pollution via mass media.
- (vii) If the State Board fails to perform its duties as per the guidelines laid down by the central government, the Central Board may be directed to perform the functions of the State Board.
- (viii) Collect information on technical and statistical data regarding water pollution, measures to prevent and control water pollution and circulate the information by preparing manuals, provide guidance regarding treatment and disposal of sewage and effluents.
- (ix) Design a course of action for a nation-wide programme on prevention, control or abatement of water pollution.
- (x) Perform other functions as laid down by the central government.

#### **Functions of State Board Under Water Act**

The functions of the State Board under the Water Act 1974 are to,

1. Organize a detailed proposal for the prohibition, control or lessening of pollution of water bodies in the state.
2. Counsel the state government on matters relating to prevention, control or abatement of pollution.
3. Gather and communicate the information regarding prohibition, control or abatement of water pollution.
4. Motivate research activities pertaining to the problems of water pollution, prevention, control of pollutants in water bodies.
5. Work with the Central Board in arranging training programmes to individuals participating in pollution control activities.
6. Organize large-scale education programmes on control of water pollution.
7. Investigate the effluents discharged into water bodies, set-up sewage treatment plants and water-purification plants.
8. Make changes in the effluent standards for the effluents and sewage discharged into the water.
9. Develop economical and reliable methods of sewage treatment with due considerations to the conditions of soils, climate and water resources of different regions.
10. Develop ways and means of utilization of sewage and effluents in agriculture.
11. Implement efficient methods to discard sewage and effluents on land due to the scant stream flows that cannot be used for dumping the sewage.
12. Impose certain standards for the treatment of sewage according to the type of receiving water to ensure that the receiving water into which the effluent is ultimately discharged is not significantly polluted.
13. Advise the state government on all matters concerning prevention and control of water pollution.

#### **Penalties for Violation of Provisions of the Act**

The board is authorized to collect samples of effluents and get them analyzed for different constituents in the Central or State laboratories. It can instruct the polluting establishment to shut down for causing environmental pollution. Those not complying with the standard conditions or found violating the Act are penalized with imprisonment upto three months or with fine of ₹10,000/- or with both. Serious violations of law can lead to stiffer penalties of seven years of imprisonment or fine of ₹5000/- per day.

### **4.5 THE AIR ACT, 1981**

#### **Q18. Discuss briefly the provision of the air (prevention and control of pollution) act, 1981.**

**Answer :**

Model Paper-III, Q8(a)

The Air (Prevention and Control of Pollution) Act was enacted by the Parliament in the 32<sup>nd</sup> year of the Republic of India under Article 253 of the constitution.

The main provisions of the Act are,

- (a) Prevent, control and mitigate air pollution.
- (b) Setting up of Central and State Pollution Control Boards.
- (c) Authorize the boards to effectively implement the Act.

The different types of air pollutants such as carbondioxide, carbonmonoxide, sulphurdioxide, nitrogen oxides, lead, smoke, volatile organic compounds generated from different sources such as industries, power plants and automobiles are considered under this Act. Any industrial plant can be put to operate only with the prior consent of the State Pollution Control Board. The State Board can lay down standards for emission of air pollutants into the atmosphere after consultation with the Central Pollution Control Board.

#### **Important Definitions used in the Act**

##### **(a) Air Pollution**

According to the Act "air pollution is the presence in the atmosphere of any air pollutant".

##### **(b) Air Pollutant**

According to the Act "air pollutant is any solid, liquid or gaseous substance (including noise) present in the atmosphere in such concentrations as may be or tend to be injurious to human beings or other living creatures or property or environment".

##### **(c) Control Equipment**

According to the Act "control equipment is an apparatus, device, equipment or system to control the quality and manner of emission of any air pollutant and includes any device used for securing the efficient operation of any industrial plant".

**Central Pollution Control Board**

The Central Pollution Control Board was established in 1981 by the Government of India. It has an important role in abatement and control of pollution in the country.

Some of the functions of the Central Pollution Control Board includes the following:

To improve the air quality of the surrounding environment and prevent, control or lessen the air pollution in the country.

Advise the central Government regarding pollution prevention and control and in the improvement of air quality.

Raising awareness nationwide for prevention, control or abatement of environmental pollution.

To coordinate the activities of various State Boards and settle their disputes, if any.

Provide technical support and advise the State Pollution Control Boards, conduct and sponsor research programmes relating to pollution problems, their prevention and control.

Provide training to personnel involved in pollution prevention, control and abatement programmes.

Organize mass awareness programmes through mass media to disseminate and educate the public regarding pollution prevention, control and abatement.

Collect, compile and publish technical and statistical data regarding environmental pollutants and work out various activities for prevention, control and abatement of pollutants.

Prepare manuals, codes and guidelines regarding treatment and disposal of sewage.

Lay down standards for quality of air or water in consultation with the respective State Government.

Set up research laboratories.

The CPCB is empowered to issue consent to industry, local bodies and other authority for violation of rules regarding general emission, effluent standards, hazardous chemicals and waste, bio-medical waste, industrial solid waste, municipal solid waste under the Environment Protection Act, 1986.

**Functions of the State Board**

The functions of the State Board under the Air Act are, Organize a detailed proposal for the prevention, control or abatement of air pollution.

Counsel the state government on matters relating to prevention, control or abatement of pollution.

Gather and communicate the information regarding prohibition, control or abatement of air pollution.

Motivate research activities pertaining to the problems of water pollution, prevention and control of pollutants discharged into the atmosphere.

Work with the Central Board in arranging training programmes to individuals participating in pollution control activities.

6. Organize large-scale education programmes on control of air pollution.
7. To test the control equipment used in industrial plants or manufacturing processes and give instructions to take necessary steps for the prevention, control or abatement of air pollution.
8. To put down the standards for emission of air pollutants, its quantity and composition, discharged into the atmosphere from the industrial plants and automobiles, with the exception of ships and aircrafts.
9. To advise the State Government regarding suitable locations for setting up of any industry.
10. Perform other functions as laid down by the Central Board or the State Government.

**Penalties for Violation of Provisions of the Act**

The companies, government departments or individuals not complying with the standard conditions or found violating the Act are penalized with imprisonment upto three months or with a fine of ₹10,000/- or both. Serious violations of law can lead to stiffer penalties of seven years of imprisonment or fine of ₹5000/- per day.

**Drawbacks of the Air Act**

- Some of the major drawbacks of the Act are,
- (a) The offenders or defaulters of the Act are given a 60 days notice period before taking them to the court. The time given is sufficient enough to destroy the evidence of the offence.
  - (b) An industry can be set up outside the Air Pollution Control area without prior permission of the State Pollution Control Board.
  - (c) The air pollutants discharged by the aircraft or ship are excluded from the Act.

**4.6 WILD LIFE ACT, 1972**

**Q19. Explain the wildlife act.**

**OR**

**Discuss briefly the provision of the wildlife protection act.**

**Answer :**

The Wildlife Protection Act, 1972 is a comprehensive legislation enacted by the Government of India with the sole aim to control poaching and illegal trade of wildlife (animals, birds, and plants), as well as its derivatives and to generate environmental consciousness among the people.

The Act extends to all the states in the Country, with the exception of Jammu and Kashmir (which has its own Act). The Act comprises six schedules which give varying degrees of protection to plants and animal species of India.

The main aim of the Act,

- (a) Impose a ban on hunting of wild animals and birds, especially the rare and endangered species.
- (b) Establish sanctuaries and national parks.
- (c) Regulate the commercial exploitation of wildlife and its derivatives (parts or products).
- (d) Counsel the government regarding wildlife affairs.

### Important Definitions used in the Act

#### (a) Wildlife

According to the Act, "wildlife includes any animal, bees, butterflies, crustacea, fish, moths and aquatic and land vegetation which forms part of any habitat".

#### (b) Habitat

According to the Act, "habitat includes land, water or vegetation which is the natural home of any wild animal".

#### (c) Hunting

According to the Act "hunting means,

- To capture, kill, poison, share and trap any wild animal or trying to do so.
- To injure, destroy or take away any part of the body of such an animal and damage or disturb the eggs or nests of wild birds and reptiles".

The main provision of the Wildlife Protection Act, 1972 is the constitution of a Wildlife Advisory Board, with the Prime Minister as the Chairperson of the Board. The Wildlife Advisory Board is constituted in each state or Union Territory to advise the State Government. The Board consists of the following members.

- Minister incharge of forests in the state or Union Territory or Chief Secretary to the Government as Chairman.
- Two members of the state legislature.
- Secretary incharge of forests to the State Government.
- The forest officer incharge.
- Chief Wildlife warden.
- Other officers and employees.

Under Section 7 of the Wildlife Act, the Board should convene meetings atleast twice a year.

### Functions of the Wildlife Advisory Board

According to Section 8 of the Act, the Wildlife Advisory Board shall advise the State Government regarding-

- Declaration of certain areas as a sanctuary, national park, game reserves and closed areas for the purpose of protection, conservation and developing wildlife.
- To laydown guidelines for granting licence and permits.
- To bring about amendments to any schedule.
- Other matters related to protection of wildlife.

### Declaration of Sanctuary

According to Section 18 of the Act, if the State Government believes that a particular area is of ecological, floral, faunal, geomorphological or zoological importance, then that particular region may be declared as a sanctuary for preserving the wildlife. According to Section 27, no one is allowed to enter or reside in the sanctuary, without prior permission by the Chief wildlife warden or the authorized officer.

### Declaration of National Parks and Closed Areas

According to Section 35, if the State Government finds that a particular area is of ecological, floral, faunal, geomorphological or zoological importance, then that particular region may be declared as a National Park for preserving the Wildlife.

According to Section 37, the State Government can stop the hunting activities in the closed areas for a specific period.

### Prohibition of Hunting

According to Section 9 of the Wildlife (Protection) Act, hunting of wild animals is prohibited, with the exception as provided under Sections 11 and 12 of the Act.

Under Section 11 of the Act, the Chief Wildlife Warden has to give a written permission for hunting, if the animal has become dangerous to human life, or the animal is suffering from incurable disease.

Under Section 12 of the Act, the Chief Wildlife Warden can give permission to hunt wildlife for the purpose of education, scientific research and their scientific management in zoological gardens or museums etc.

### Penalties for Violation of Provisions of the Act

Hunting of endangered species and altering the boundaries of a Wildlife Sanctuary or National Park is considered as serious offence. Of the six schedules in the Wildlife (Protection) Act, 1972, Schedule I and Part II of Schedule II provide complete protection. The offences committed under these schedules are liable to the highest penalties. The offences committed under Schedule III and Schedule IV are less. The species included in Schedule V can be hunted freely.

Violation of the Wildlife (Protection) Act incurs imprisonment of 3 years to 7 years and a fine of ₹10,000. Subsequent offences of this kind incurs imprisonment upto seven years and a fine of ₹25,000. \*

### Limitations of the Wildlife Act

The drawbacks or limitations of the Wildlife Act are-

- Adequate and immediate compensation is not provided for the victims of wildlife attacks.
- Lack of encouragement to those people who have been protecting wildlife on their own.
- The present bill does not encourage community/private initiatives.
- Prohibits the involvement of forest inhabitants in wildlife conservation.
- Impose restriction of chemical farming in and around protected areas.

## UNIT-4 Environmental Legislation and Life Cycle Assessment

### 7.7 GUIDELINES FOR CONTROL OF NOISE

**Q20.** Discuss the importance of environmental awareness in controlling noise pollution. State comfortable noise levels as per WHO standards.

**Model Paper-I, Q9(a)**

**Answer :** Environmental awareness is a process of learning that gives an overall perspective about the knowledge and develops sensitivity towards the environment.

The destructive health effects of excessive noise exposure considered as an important public health problem. Some of effects are,

Noise affects the hearing abilities of humans. The human ears are injured owing to the damage to the anatomical structures of the ear. Therefore, the quality and clarity of auditory perception is affected.

Excess noise causes earaches, drum punctures, infection of middle ear and bone overgrowth.

It causes stress, fright and labored breathing.

Increase in the level of cholesterol in blood.

Damage to heart (cardiovascular constriction).

Increase in blood pressure leads to smooth muscle hypertrophy, narrow lumen in small vessels, increased resistance to blood flow, the end result is hypertension.

The blood vessels of the brain enlarge causing headache and nausea.

Stomach disorders leading to malfunctioning digestive systems.

Alteration in secretion of hormones.

Alteration in functioning of kidneys.

Mental disorders caused by changes in brain chemistry.

Noise has harmful effects on unborn babies. Excessive noise affects the neurological development leading to delay in the development of auditory and linguistic skills, thereby affecting the learning ability.

The quality of work performance is hampered due to argumentativeness, mood swings and anxiety.

Sleep disorders.

Increased susceptibility to minor accidents.

Increased dependence on sedatives and sleeping pills.

General fatigue.

The control of noise is important in order to protect the living abilities and other health concerns of each one of us. The Noise Pollution Control Committee has recommended ambient quality standards in respect of noise, which is as mentioned below,

Area	Limit in dBA ( $L_{eq}$ )	
	Day time 6am-10pm	Night time 10pm-6am
Industrial area	75	70
Commercial area	65	55
Residential area	55	45
Silence zone	50	40

$dBA(L_{eq})$  = time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.

**Q21.** Discuss various ways to control noise from industrial activity.

**Model Paper-II, Q9(a)**

**Answer :**

#### Measures to Mitigate/Control Noise Pollution

Some measures may be taken to mitigate or control noise pollution. They are,

- Strict legislation essential to curb noise pollution.
- Ban on the use of loudspeakers at night and silent zones should be followed.
- The automobile users should minimize the use of honking horns.
- Use of ear plugs in noisy areas should be encouraged.
- The industrial plants should follow standard noise control measures.

Efforts must be made to restrict the noise emissions from traffic through international, national and local measures. Certain measures for the reduction of noise emission from the traffic may be followed.

1. Restrictions to the growth of the traffic.
2. Protection of houses by using sound insulators.
3. Adjustments in the composition and timing of traffic flows.
4. Noise pollution may be reduced by means of speed limits and imposing traffic restrictions.

We may hope that some effective regulations are imposed to at least quieting our noisy world.

The techniques/methods used for Noise control measures can be broadly classified as,

- (a) Noise control at the source of generation.
- (b) Control in the transmission path of noise.
- (c) Use of protective equipment.

#### (a) Noise Control at the Source of Generation

Some of the following techniques may be employed in order to contain the noise pollution.

- (i) Minimizing the noise levels from the domestic sector. The noise pollution caused by domestic appliances like dishwashers, vacuum cleaners, food mixers, washing machines, radio, tape recorders, television sets, can be reduced by operating them discreetly. The noise produced at home can be minimized by using absorbing materials such as drapes, carpets, acoustical tiles on walls, floors and ceiling.

- (ii) Regular maintenance of automobiles and machines. Proper servicing and tuning of machines and vehicles must be done to minimize the noise levels and improve the life of machines. Proper silencers must be fitted to automobiles and two wheelers to reduce the noise levels.
- (iii) Control over vibration of materials. The noise produced due to vibration of materials can be reduced by providing rubber padding to vibrating materials.
- (iv) Restriction on the usage of loudspeakers. The usage of loudspeakers must be prohibited except for important meetings/ functions.
- (v) Selection of machinery/ equipment of superior technology that minimizes noise generation.
- (b) Control in the Transmission Path of Noise**  
The transmission path of noise can be changed by the following techniques.
- Placing barriers between noise source and receiver. The noise levels can be reduced by placing barriers between the noise source and receiver so that the sound waves get absorbed/ refracted/ radiated in the surrounding environment. However, in this method, the barrier can reflect the sound waves towards the source.
  - The building design should incorporate the use of noise absorbing material for wall door/window/ ceiling to reduce the noise levels.
  - Green belt development:** Green belt development refers to the regeneration of green canopy by afforestation activities. Trees absorb sound and help to reduce the intensity of sound waves considerably, thus reducing noise pollution. Plants with dense foliage, evergreen trees, and a combination of taller plants and shorter shrubs must be planted close to the noise source. The shrubs and trees that help to attenuate the sound levels, include cottonwoods, poplar, aspen trees, garlic pear tree, nagchampa and beach hibiscus.
- (c) Use of Protective Equipment**
- Ear muffs and earplugs are commonly used as a protective equipment for noise attenuation.
  - Use of white noise machine  
The latest technology for reducing the effects of unpleasant sound is by creating the sound of white noise. A white noise machine is used for this purpose, which is placed between the noise source and the receptor. It produces pleasant sounds like that of a waterfall, soft music, etc.
  - Use of active noise control method  
The method involves use of a nullifying antinoise, that has the same amplitude but of opposite polarity to the noise that is being controlled, by using computers. In a simpler sense, two sound waves of equal amplitude and opposite phase result in cancellation of the sounds.

The measures for controlling noise pollution mentioned above can save a lot of people from long term health complications from the onslaught of noise. We can look forward to rescue the noisy world to silence back again.

## 4.8 LOSS OF BIODIVERSITY

### Q22. Discuss the reasons for loss of biodiversity on earth.

**Answer :**

Model Paper-III, Q22(b)

In general terms, the word "biodiversity" can be defined as the concentration of various entities such as genera, ecosystem, different species and organisms confined to a particular region.

There are numerous reasons which led to the loss of biodiversity on earth. Few of these reasons are effectively discussed below,

#### 1. Urbanization or Industrialization

Urban areas refers to those regions of the society where the local residents have extremely high standard of life in all respects. Hence, urbanization is a process by which the standard of a given area can be enhanced. This generally happens when a given region is promoted to many developmental activities in which industrialization is said to be the prime motive. As many societies of a given country turnouts to be urbanized, people belonging to these areas do not care about various other notions such as nature and other elements.

Hence, with the increase in population in these areas various drastic effects such as sharing of limited supply of goods and services, vacating many forest areas, not caring for the values of flora and faunas etc., are seen which is leading to the loss of biodiversity.

Rapid industrialization and urbanization is also destroying the natural habitats of flora and fauna, hence, they are becoming endangered species. Example, destruction of grasslands in India had led the black buck (*Antelope cervicapra*) to become an endangered species.

#### 2. Deforestation or Reduced Green Cover Throughout the World

Man's selfishness and greed to acquire greater land was one of the major causes which led to deforestation. Deforestation refers to cutting down the forests and utilizing these lands for various other purposes like converting into agricultural lands, constructing houses etc. This may resort to loss in biodiversity since the trees which were destroyed supported many species of the animal kingdom as the trees are the major source of livelihood and shelter to these animals. These depletion can lead to huge increase in pollution as trees intake harmful carbon dioxide and release the oxygen during the photosynthesis process.

It also accounts for decrease in rainfall as the trees help to bring about the rainladen clouds. Loss of soil erosion also occurs as the roots are not present to bind the soil particles, which leads to loss of highly organic humus soil content. It also leads to decrease in the ground water table as surface-run off of water occurs, thereby the ground water resources are not replenished.

#### **Soil Degradation/Erosion, Loss of Fertility of Land**

These generally occur due to deforestation, overgrazing, large streams of running water, droughts, famines, improper tilling and levelling of lands, jhoom cultivation etc.

#### **Drilling, Excavations, Constructions of Roads and Projects**

This also causes loss of biodiversity since, drilling of land causes usage of heavy machinery which consumes gallons of fuels and at the same time releasing poisonous or harmful gases, hence polluting the earth. At certain times improper drilling of lands (during laying of roads or excavating ores) can lead to severe earthquakes causing huge loss to life and property. While implementing river valley projects, if the outcomes of projects are not analyzed scientifically, this may also cause huge loss to life and property.

Example, The Hydel project which was used for irrigating cultivated lands and also for producing electricity created a serious impact on the ecosystems of the environment.

#### **Illegal Business and Smuggling Activities**

The smuggling activities include illegal trade of highly valuable items such as animal skins, all types of drugs, sandal woods etc. These items can earn extremely large profits in foreign markets. These smuggling activities include killing of wild animals illegally and destruction of useful trees, hence causing huge loss of biodiversity on earth.

#### **Unequal Developmental Activities**

When we analyze the current scenario of this world, only few countries have established themselves as developed nations, whereas the other nations where poverty has its deep roots are referred to as underdeveloped nations. Hence, this unequal globalization also accounts for loss in biodiversity since the greed of developed nations may fascinate them to exploit several natural resources of underdeveloped nations by means of power.

#### **Exploitation of Natural Resources**

As the population is increasing terribly, the governments of most of the countries started exploiting the available natural resources without analyzing the various outcomes of it in the near future. This is not restricted to only crude oil supplies but it extends itself even to other natural resources such as metals, coal, diamonds and natural gases etc.

All the above factors contribute to loss of biodiversity, imposing a major threat to the environment as the biotic and abiotic components of nature are interrelated and dependent on each other.

#### **Q23. How does soil erosion cause biodiversity loss?**

##### **Answer :**

Model Paper-III, Q9(a)

Soil erosion is a serious problem in most parts of the world. Several factors that contribute to the erosion of soil are,

- Natural soil and landscape characteristics (steepness of hills, types of soil, amount of precipitation, etc).
- Human activities, such as unsustainable agricultural land use, large scale farming, overgrazing, inappropriate irrigation and water management, habitat alteration (e.g. urban expansion).

Loss of vegetation on the ground, such as trees in the forests and grasses in grassland expose the soil to agents of erosion i.e., wind and water.

Soil erosion leads to the following,

- Decline in soil fertility.
- Loss of soil organic matter content.

The soil organisms (generally referred as the biological engines of the earth), though low in biomass, are very important for a functioning soil with a significant role in the following aspects,

- Fundamental nutrient cycling processes.
- Soil structure dynamics
- Decomposition of organic matter
- Degradation of pollutants / toxic residues
- Regulation of plant communities.
- Reduced availability of potable water and surface water.
- Depletion of aquifers due to lack of water recharge.
- Reduced water retention capacity, hence higher flood risk.
- Water pollution of nearby water bodies.
- Scarcity of water and food insecurity affecting livestock and agriculture.
- Loss of animals and plants due to dehydration and reduced crop yields.
- Formation of sediment by the eroded topsoil in the water bodies leading to mortality of aquatic life, clogging of irrigation ditches, boat channels, reservoirs and lakes.
- Alteration in the fundamental nutrient cycling processes, particularly the carbon, nitrogen and phosphorus cycles. All of us should put forth our best efforts to reduce the area and percentage of land affected by erosion and reduce the severity of erosion.

## 4.9 SOLID AND HAZARDOUS WASTE MANAGEMENT RULES

**Q24.** Write about municipal solid waste management and handling rules.

**Answer :**

Model Paper-I, Q9(b)

The provisions of Municipal Solid Waste (Management and Handling) Rules 2000 are relevant to every municipal authority responsible for collection, segregation, storage, transportation, processing and disposal of municipal solid waste. The draft of Municipal Solid Waste Management and Handling Rules were published under the notification of Government of India in the Ministry of Environment and Forests.

The rules consists of 4 schedules. They are as given below,

### I. Schedule I

This is concerned with the implementation schedule. It includes setting up of provision for processing and disposal of waste, keeping track of the functioning of waste processing and disposal facilities, upgradation of existing landfill sites, identification of landfill sites for waste disposal for future use.

### II. Schedule II

The schedule II of Municipal Solid Waste Management and Handling Rules is concerned with collection, segregation, storage, transportation, processing and disposal of municipal solid wastes.

#### (a) Collection of Municipal Solid Waste

The municipal authorities are responsible for,

- Organizing door-to-door collection of municipal solid wastes.
- Collection of waste from slum areas, hotels, restaurants, office complexes and commercial areas.
- Utilization of biodegradable waste from slaughter houses, meat and fish markets, fruits and vegetable markets.
- Collection and proper disposal of horticulture, and construction or demolition wastes or debris.
- Prohibition of movement of strong animals around waste storage facilities.

#### (b) Segregation of Municipal Solid Waste

This includes organization of awareness programmes by the municipal authorities for proper segregation of wastes and at the same time promote recycling or reuse of segregated materials.

#### (c) Storage of Municipal Solid Waste

The municipal authorities are responsible for maintenance of storage facilities in a hygienic manner.

- (d) **Transportation of Municipal Solid Waste**  
The municipal authorities are responsible for clearing of wastes by transporting them in a suitable manner.

(e) **Processing of Municipal Solid Waste**

The processing of municipal solid waste includes composting, vermicomposting, anaerobic digestion of biodegradable wastes. The reusable waste is recycled.

(f) **Disposal of Municipal Solid Waste**

The non-biodegradable and inert waste are sent to landfill sites for landfilling.

### III. Schedule III

The Schedule III of Municipal Solid Waste Management and Handling Rules is concerned with selection of landfill sites, provision of facilities at the landfill site, specifications for waste disposal at the landfill site, provisions for prevention of pollution problem, ambient water quality and air quality monitoring, the vegetative cover at the landfill site and the post closure care of the landfill site.

### IV. Schedule IV

It includes the standards for composting treated leachates, incineration, pelletisation, energy recovery, etc.

### Authorities and Responsibilities

The municipal authorities are responsible for the following,

- Handling of municipal solid waste as per the rules.
- Setting up of waste processing and disposal facilities with the consent of the State Pollution Control Board.

### Q25. Write a note on the management of biomedical waste.

**Answer :**

Model Paper-II, Q9(b)

#### Biomedical Waste

Biomedical waste refers to all the wastes generated in hospitals, research institutions, healthcare teaching organizations, clinics, laboratories, blood banks, animal houses and veterinary institutes. The waste thus generated is discarded and not intended for further use.

According to the Biomedical Waste (Management and Handling) Rules, 1998, every organization must segregate, disinfect and dispose of their waste in an eco-friendly manner.

#### Aspects

The biomedical waste management system must include the following aspects,

#### 1. Assessment of Waste

The waste generated should be assessed for the quantity, the point of generation and the type of waste to determine a safe method of disposal.

**Segregation of Waste**

The waste must be segregated in different containers or coded bags to prevent the spread of infection to health care workers.

**Accumulation of Waste**

The waste gets piled up between the point of waste generation and disposal. The storage areas for holding the wastes should be properly maintained by disinfecting the walls and floors regularly. The storage area should be impervious to putrifiable and other wastes.

**Transportation**

The untreated biomedical waste must be transported properly from the generation site to the site for treatment and disposal.

**Treatment**

The waste must be treated properly by disinfecting or decontaminating it to kill the pathogenic organisms. Following this treatment, the waste can be handled safely.

The syringes and needles are fragmented to bits in needle destroyers and syringe cutters. The glassware including culture plates should be disinfected, cleaned, sterilized and autoclaved before reuse. Gloves and other disposable items must be shredded and destroyed. Scalpel blades and glass should be kept disinfected and transported to incubators. Liquid waste containing pathogens or chemicals should be disinfected for contamination and then neutralized with reagents.

**Disposal**

The wastes are disposed of by various methods including incineration, autoclaving, chemical methods, thermal methods, ionizing radiation process, deep burial in sanitary landfills and microwaving.

Special importance must be given for proper collection and segregation of biomedical waste generated in various health care facilities to contain the hazards associated with improper waste disposal to health care workers, patients and the local community. Therefore, safe and effective waste management should be made mandatory in healthcare facilities.

**Q26. Write a brief note on biomedical waste management and handling rules.****Answer :**

Biomedical Waste Management and Handling Rules is a legal binding issued by the Ministry of Environment and Forests, Government of India, under the Environment Protection Act, to control the indiscriminate disposal of hospital waste or biomedical waste by hospitals, nursing homes, veterinary hospitals, animal houses, pathological labs and blood banks. The wastes include human anatomical wastes, ampoules, blood, body fluids, disposable plastics and syringes, used bandages, surgical gloves, blood bags, placenta, intravenous tubes, etc.

Safe management and disposal of wastes generated by the health care establishments is very important because of its infectious and hazardous characteristics in order to avoid any adverse effect to human health and the environment. Therefore, proper treatment of biomedical waste is done by technologies like incineration, autoclave, hydroclave or microwave.

**Q27. Define hazardous wastes. State the characteristics of hazardous wastes.****Answer :**

Model Paper-III, Q9(b)

**Hazardous Waste**

Hazardous waste may be defined as the solid, liquid, and semi-solid waste materials discarded from various sources such as, households, manufacturing units, mining and agricultural industries. They are toxic chemicals that are harmful to humans, plants and animals. The hazardous waste are characterized by ignitability, corrosivity, reactivity and toxicity.

**Characteristics**

Hazardous waste consists of materials that have the following characteristics,

**(a) Inflammable**

This category includes hazardous liquids that can burn at less than 60°C.

**Example:** Unwanted gasoline.

**(b) Toxic**

This category of hazardous waste includes substances that are injurious to human health and the environment. Examples include arsenic, barium, benzene, cadmium, carbontetrachloride, chlordane, chlorobenzene, chloroform, chromium, cresol, dichlorobenzene, dichloroethane, dichloroethylene, hexachlorobenzene, hexachlorethane, lead, lindane, mercury, silver tetrachloroethylene, vinyl chloride.

**(c) Reactive**

The materials included in this category are unstable at normal temperatures and pressures. They can cause an explosion or release poisonous fumes.

**Example:** Ethers, sodium and cyanide wastes.

**(d) Corrosive**

This category includes aqueous solutions with pH less than 2 or greater than 12.5. They have the ability to burn and destroy the skin, cause irritation in the eyes and corrode steel, rubber and plastic at a rate greater than 65 mm per year. The examples of corrosive materials are strong acids, alkaline degreasers and chemicals used in wastewater treatment.

- Q28. How are the hazardous chemicals stored and transported? Give a brief account of safety measures.**

**Answer :**

Hazardous materials have the potential of producing harmful physical or health effects, therefore, they should be handled and stored in an appropriate manner.

#### Storing Hazardous Materials

1. The hazardous materials must be stored in their original containers with proper product labels, containing their exact contents, hazardous properties, date of receipt and the date of expiry.
2. The pressurized containers should neither be stored in the sun nor in wet/damp areas.
3. A bag of sand/sawdust must be kept handy to soak up the spilled chemicals from leaking containers.
4. Flammable items like gasoline, kerosine, propane gas, paint thinner should be stored in a well-ventilated garage.
5. Paints contain hazardous metals and solvents and must be stored in a well-ventilated area, away from children, pets and rain.
6. Hazardous material should not be disposed off in the sewer, on the ground or in the trash.
7. Waste hazardous materials must be stored in non-leaking, safe containers with label pasted including the names of the contents.
8. Only the required amount of hazardous materials may be bought, which can be used before the expiration date of the material.

#### Transportation of Hazardous Substances

1. Transportation of hazardous material must be done with care. The carriers that carry hazardous goods should be appropriately registered and display the type of dangerous and hazardous goods.
2. The goods carriers containing hazardous goods should be fitted with a spark arrester and a technograph, an instrument to record the lapse of running time of the vehicle, the time speed maintained, acceleration, deceleration etc.
3. In the case of goods carrier containing more than one type of hazardous material, such carriers should display the types of materials in labels.
4. The consignor is responsible for safe transport of hazardous materials. The goods carrier should have the following,
  - (a) A valid registration.
  - (b) Equipped with first aid, safety equipment, tool box, in case of any accident.
  - (c) Knowledge about the type of hazardous goods.
  - (d) The driver should be well-trained to handle dangerous goods during transportation.

5. In case of an accident, if any, the driver should report to the nearest police station.
6. The transport carrier should have a Transport Emergency Card (TREMCARD) inside the vehicle, the TREMCARD should contain the following information,
  - (a) The details of the substance being carried
  - (b) Contact name
  - (c) Telephone number
  - (d) Action to be taken in case of an emergency.
7. Transport of hazardous substances overseas needs awareness of the international agreements and legal requirements of the respective countries.

- Q29. Describe the basic principles and practice of nuclear waste management of India.**

**Answer :**

#### Classification

The nuclear waste can be broadly categorized into the following types,

1. **Exempt Waste and Very Low Level Waste (VLLW)**  
This types of waste is produced in manufacturing processes in food processing, chemical and steel industries as well as the renovation/dismantling operations at nuclear industrial sites.
2. **Low-Level Waste (LLW)**  
This group includes paper, rags, tools, clothes, filters, etc., containing short-lived radioactivity generated from hospitals and industry. This type of waste can be buried in shallow land.
3. **Intermediate Level Waste (ILW)**  
This type of waste includes resins, chemical sludges that have higher amount of radioactivity. This type of waste needs shielding during handling and transport.
4. **High-Level Waste (HLW)**  
This type of waste is generated during the burning of uranium fuel in a nuclear reactor to generate electricity. Since uranium is highly radioactive, it needs proper cooling and shielding.

#### Methods

Some of the methods involved in nuclear waste management includes the following,

- (a) **Geologic Disposal**  
The radioactive waste is immobilized in an insoluble matrix (Example, borosilicate glass or synthetic rock) and sealed in a corrosion - resistant stainless steel container. The containers are then layered with bentonite clay. The entire set-up is then buried deep underground.
- (b) **Ocean Dumping**  
This is considered as the least expensive method of nuclear waste disposal. Russia has about 60% of the world's nuclear reactors and disposes off its waste into the oceans.

### **Sub-Seabed Disposal**

In this method, the floor of the deep oceans containing sedimentary soft clays are drilled/dug to depths of the order of hundreds of metres. The radioactive material stored in canisters are placed in these holes vertically, one above the other. It has been suggested that it would take a few thousand years for the radioactive material to mix with the ocean waters.

### **Subductive Waste Disposal Method**

This is considered as one of the most environment friendly and economical way of nuclear waste disposal. The process involves the sliding of one tectonic plate over the other which is ultimately absorbed into the mantle. The radioactive material in a subducting plate can be carried through the earth's crust and into the mantle.

### **Transmutation of Nuclear Waste**

The term transmutation refers to transformation of one chemical element into another. Machines like cyclotrons are used for this purpose, wherein, the elements are bombarded with high-speed particles. In the case of radioactive material, the spent fuel (hazardous and long-lived isotope) is converted into a less radioactive and short-lived isotope, in order to eliminate the radiological hazards and waste disposal problems.

### **Disposal of Radwaste into the Sun**

This is a very expensive means of nuclear waste disposal and involves vast technical development. This option involves placing the radwaste in the Earth's orbit and then accelerated so that the waste would drop into the sun.

### **Q30. Discuss in brief the hazardous waste management and handling rules.**

**Answer :**

Some of the important provisions under the Hazardous Management and Handling Rules are,

The operator of a hazardous waste facility is responsible for collection, storage and disposal of hazardous waste. The hazardous waste must be handled carefully without affecting the environment.

The hazardous waste must be properly packaged depending upon its composition with suitable handling, storage and transport, labeling and packaging.

Transportation of hazardous material should comply with the provisions of the rules made by the Central Government under the Motor Vehicles Act, 1988.

The hazardous waste must be disposed off at an appropriate site.

The respective State Government should identify the hazardous waste disposal site and conduct environmental impact assessment.

Processing of hazardous waste to be done by a combination of methods namely solidification, incineration, pyrolysis, chemical oxidation, or disposed at a landfill site.

The export and import of hazardous waste from India to any country should be done as per the Basal Convention.

### **Q31. Describe the solid and hazardous waste rules.**

July-21, (R16), Q6(b)

**Answer :**

For answer refer Unit-IV, Q24 and Q30.

### **4.10 LIFE CYCLE ASSESSMENT: LIFE CYCLE ANALYSIS, METHODOLOGY, MANAGEMENT, FLOW OF MATERIALS - COST CRITERIA - CASE STUDIES**

### **Q32. Write a note on the life cycle assessment (LCA).**

**Answer :**

According to the ISO 14040, "Life Cycle Assessment (LCA) is a technique for assessing the environmental aspects and potential impacts associated with a product."

- ❖ Compiling an inventory of relevant inputs and outputs of a product system.
- ❖ Evaluating the potential environmental impacts associated with those inputs and outputs.
- ❖ Interpreting the results of the inventory analysis and impact assessment phases in relation to objectives of the study".

Life Cycle Assessment (LCA) can be considered as a holistic and systematic environmental management tool to assess the environmental aspects of a product (physical goods and services) from the cradle to the grave, i.e., its entire life cycle. Thus, it includes the extraction of raw materials, manufacture of the product, its use for a specified purpose, reuse or recycling, final disposal of the product and identifying the environmental impact at each stage.

Life Cycle Assessment is also known by other names - 'Life cycle analysis', 'ecobalance' and 'cradle to grave analysis'.

#### **Aim of Life Cycle Assessment**

1. It gives an insight into the product related environmental impact.
2. It provides an understanding of the interdependent nature of the state of environment resulting from anthropogenic activities.
3. It enables the decision-makers to take appropriate measures for improving the environment by using sustainable materials for the manufacture of products.
4. It helps to analyze the origin of problems related to the product.
5. It helps to design new products that are ecofriendly and greener.

#### **Phases of Life Cycle Assessment**

The methodology for Life Cycle Assessment involves four interrelated phases namely,

##### **1. Goal and Scope Definition**

In this phase, the purpose of study, the reasons for conducting the study, the spatial and temporal scope, the decisions taken in support of LCA, and the conclusions drawn are specified.

## 2. Inventory Analysis

This stage involves the identification and quantification of the inputs and output of materials, energy, water and pollutants released into the environment.

## 3. Impact Assessment

It involves assessment of impacts on resource depletion, human health, ecological impacts, etc.

## 4. Interpretation

The inventory analysis and impact assessment results are interpreted by the decision makers to reduce the impact of the products on the environment.

Let us consider an example wherein fruit juices are packed in two possible alternatives: a carton and a glass bottle. A glass bottle may be reused many times whereas a carton can be used only once. Additionally, the glass bottle needs washing and transportation whereas the carton can be disposed off after single use. Thus, we can conclude that carton would be the environmentally best choice for packaging processed juices.

### Q33. Discuss life cycle assessment with the help of a case study.

#### Answer :

A comparison of disposable/ single-use cups with washable/reusable/multi-use cups to carry out Life Cycle Assessment (LCA) from the environmental perspective.

#### Objective

The main objective of this study is to understand the environmental impacts of disposable cups (made of paper, lined with polyethylene (PE), and polystyrene (PS)) and reusable cups (made of polycarbonate (PC) or polypropylene) used in sports stadiums during entertainment and cultural events.

#### Processes Involved

The processes involved in the study of LCA of single use cups includes the following:

1. Manufacturing of cups.
2. Transportation of cups from the manufacturing site to the sports stadium where the events happen.
3. Use of air blowers to clean the stadium to collect the used cups littered by the spectators, participants, etc.
4. Elimination of the used cups by incineration.

The processes involved in the study of LCA of reusable cups include,

- ❖ Manufacturing of cups.
- ❖ Transportation of cups from the manufacturing site to the sports stadium.
- ❖ Collection of used cups, and their transportation to the washing facility.

However, the manufacture and use of detergent for washing the cups are not included.

The main aspects of this study are,

- (i) Transportation variable: It includes the distance travelled, mode of transportation used, size of the load.
- (ii) Frequency of cups usage: It refers to the number of times the cups have been reused. For instance, the polycarbonate/ polypropylene cups may be used 150 times.

#### Inventory Analysis

The inventory analysis of the case study reveals the following aspects.

- (i) Quantification of discharge of pollutants to water, air and soil.
- (ii) Extraction of raw material from the environment and its processing.

A comparison of the two types of cups used in the case study depicts that the reusable/multiuse cup releases more carbonmonoxide and nitrogen oxide to the environment, when the losses and transportation to the washing facility are considered.

However, the reusable cups have,

- (i) Lowest emissions and extractions per functional unit.
- (ii) Considering 5% loss of cups at every event and the distance to be travelled for washing.

The single use cups

- (i) Discharge high amounts of cadmium in air.
- (ii) Discharge hexavalent chromium in water.
- (iii) Need large amounts of crude oil for the extraction process.

#### Impact Assessment of the Case Study

The impact assessment phase gives an overview of the impact of emissions and extractions on human health, ecosystem quality and natural resources, etc.

Based on some impact assessment methods, it has been concluded that the single use cups cause immense damage to human health, ecosystem and natural resources, whereas the reusable cups have the least impact.

However, a comparison between the two types of cups depicts the following:

- (a) The loss of cups due to breakage/theft reduces the number of times the cups are reused.
- (b) Due to the loss, the impact of manufacturing the item on the environment increases manifold.
- (c) The transportation of the used cups to the washing facility has considerable impacts.

For instance, the cups carried by a smaller or partially loaded vehicle to the cleaning facility has larger impact when compared to a fully loaded large vehicle.

<b>Cup Type</b>	<b>Category of Environmental Impact</b>				
	<b>Human Health</b>	<b>Quality of Ecosystems</b>	<b>Climate Change</b>	<b>Resource Depletion</b>	<b>Water Consumption</b>
Washable cups	***	***	***	***	***
Disposable cups	*	**	*	*	*

\*\*\* = Best

\*\* = Average

\* = Worse

### Conclusion

The environmental impacts caused by the usage of disposable and reusable cups have been analyzed. In practice, it is better to take appropriate measures where the impact on the environment are the highest. Considering the large entertainment events, the environmental impact of the cup is small when compared to transportation of people to the place of the event. For instance, the effect of one disposable cup is nearly similar to the impact of transporting a person by car to a distance of 100 m.

On a broader perspective, travelling a distance of 10 km to the event is 100 times more harmful than using a disposable cup. Hence, all efforts must be focussed at reducing the impact of the event by actively encouraging the use of public transport. The material and waste management should be given secondary preference.

### Q34. Suggest some alternatives to LCA studies on single use plastic products.

#### Answer :

Some of the recommendations to LCA studies on the use of plastics include the following,

#### (a) Opt for Reusable Product

Use of reusable products is not only important for environmental health, but also cost-effective. The customers should be encouraged to bring their own grocery bags, cups or containers to minimize the use of single use plastic products.

#### (b) Change from 'Single-Use' to 'Multi-Use'

Studies have documented that the reusable products have less impact on the environment. The environmental impact of single use plastic products can be mitigated by reusing them to the maximum extent possible instead of disposing them off. For instance, the durable items made from plastic such as bags, bottles, cups can be reused or repurposed.

#### (c) Designing of Sustainable Products

All efforts must be focussed by the product designers to ensure reusable, repairable and upgradable materials that are safer.

The products should possess the following features,

- (i) Sustainability
- (ii) Durability
- (iii) Prepared by using renewable energy
- (iv) Made from recycled material
- (v) Made/sourced locally to avoid expenses on air freight
- (vi) Disposal in an environmentally friendly manner.

#### (d) Analysis of Geographical and Social Context Matters

The product designers and policy makers must take into account the geographical and social contexts when contemplating product alternatives. Various parameters must be taken into consideration such as production requirements, expected use, reusability, infrastructure related waste management.

Eventually, the single use plastic products must be done away with, to reduce damage to the environment.

Claudia Giacovelli, Programme Management Officer of the United Nations Environment Programme of International Environmental Technology Centre (IETC) is of the view that, "it is the single-use nature of products that is the most problematic for the planet, more so than the material that they're made of. The best solution may not be the same in all societies but taking a life cycle approach can help in setting the base towards the right decision".

## FREQUENTLY ASKED AND IMPORTANT QUESTIONS

**Q1. Discuss about water act.**

**Answer :**

For answer refer Unit-IV, Q17.

July-21, (R16), Q6(a) | Sep.-20, (R16), Q8

**Q2. Discuss the objectives of environmental legislation.**

**Answer :**

For answer refer Unit-IV, Q9.

Important Question

**Q3. What is meant by biodiversity?**

**Answer :**

For answer refer Unit-IV, Q12.

Important Question

**Q4. Write a short note on environmental legislation.**

**Answer :**

For answer refer Unit-IV, Q14.

Important Question

**Q5. What are the constitutional provisions relating to environmental protection in India?**

**Answer :**

For answer refer Unit-IV, Q15.

Important Question

**Q6. Explain the environment protection act, 1986.**

**Answer :**

For answer refer Unit-IV, Q16.

Important Question

**Q7. Discuss briefly the provision of the air (prevention and control of pollution) act, 1981.**

**Answer :**

For answer refer Unit-IV, Q18.

Important Question

**Q8. Explain the wildlife act.**

**Answer :**

For answer refer Unit-IV, Q19.

Important Question

**Q9. Write about municipal solid waste management and handling rules.**

**Answer :**

For answer refer Unit-IV, Q24.

Important Question

**Q10. Describe the solid and hazardous waste rules.**

**Answer :**

For answer refer Unit-IV, Q31.

Important Question | July-21, (R16), Q6(b)

**Q11. Write a note on the life cycle assessment (LCA).**

**Answer :**

For answer refer Unit-IV, Q32.

Important Question

# UNIT 5

## Case Studies



### Syllabus

**Case Studies - Preparation of EIA for Developmental Projects**-Factors to be Considered in Making Assessment Decisions, Water Resources Project, Pharmaceutical Industry, Thermal Plant, Nuclear Fuel Complex, Highway Project, Sewage Treatment Plant, Municipal Solid Waste Processing Plant, Air Ports.

### LEARNING OBJECTIVES

In this unit, you will learn the following concepts,

- ✓ Understand the manner in which EIA is prepared for developmental projects
- ✓ Ensure sustainable development with minimal environmental degradation
- ✓ Predict the effect of a proposed activity
- ✓ Outline the nature of the decision-making process and the important factors to be considered
- ✓ Stimulate interest and actively acquire information on environmental management through several case studies.

### INTRODUCTION

This unit enlightens the readers about the importance of EIA for development projects in order to promote a safe environment, and sound sustainable development through identification of proper alternatives and mitigation measures. It helps to predict the environmental consequences of any developmental activity.

Several case studies have been included in this unit to exemplify how the EIA process is implemented and illustrate various aspects of EIA in practice.

**PART-A SHORT QUESTIONS WITH SOLUTIONS**

**Q1. What are the factors to be considered for taking decisions on assessment of impact significance?**

**Answer :**

Model Paper-I, Q1(l)

The factors to be considered for taking decisions on assessment of impact significance are,

1. Meteorology and air quality
2. Topography
3. Hydrology
4. Demographics
5. Land use
6. Soil conditions
7. Mineral resources
8. Ecological studies
9. Extent of the developmental activity
10. Relocation/displacement of inhabitants of the area
11. Resource availability
12. Environmental sustainability.

**Q2. Suggest some of the factors that should be considered for siting an industry.**

**Answer :**

Model Paper-II, Q1(l)

The important factors to be considered for siting of industries include,

- (i) According to the Forest Conservation Act, 1980, no developmental projects should be set up in the vicinity of the forests.
- (ii) The agricultural land should not be used for setting up industries.
- (iii) The land chosen for setting up industry should have the facility for waste water treatment plant as well as store and recycle the effluents. The reclaimed wastewater may be used for green belt development. Thus the green canopy can be regenerated by afforestation activities. The green canopy should ideally be 500 m wide around the industry.
- (iv) Sufficient greenery of nearly 1 km should be maintained between the adjacent large-scale industries.
- (v) Enough land should be set aside for the storage of waste generated at different stages of the industrial operations.
- (vi) The layout of the industrial set-up should be attractive.
- (vii) The township associated with the industry should be located at an appropriate distance.
- (viii) The industrial establishments should be equipped with ambient air quality measuring stations.

**Q3. What are the areas to be avoided for the siting of Industries?**

**Answer :**

Model Paper-I, Q1(l)

The areas to be avoided for setting up of industries are as mentioned below,

1. Industrial development is allowed at a distance of 25 km away from the ecologically sensitive areas.
2. In the coastal region, the industries should be 500 m away from the high tides.
3. About 500 m away from the flood prone regions.
4. Nearly 500 m away from the highway and railway.
5. Nearly 30 to 50 km away from the residential areas.

**UNIT-5 Case Study**  
**What are the positive environmental impacts of the metro rail project activity?**

Model Paper-III, Q1(i)

**Answer :**

**Positive Impacts**

The positive impacts of metro rail project activity are,

Reduced travel time for commuting from one place to the other.

Safe and comfortable mode of transportation.

Increased accessibility at workplace.

Decrease in congestion on roads.

Reduced fuel consumption as it uses renewable sources of energy.

Reduced vehicular emissions as people prefer to use metro rail.

Reduction in road accidents due to less congestion of roads.

Increase in employability or job/employment opportunities.

**25. What are the negative environmental impacts of the metro rail project activity?**

**Answer :**

**Negative Impacts**

The negative impacts of metro rail project activity include,

Changes in the land use.

Encroachment into nature reserves.

Loss of vegetation, as trees are chopped down to make way for laying railway lines.

Negative effect on the historical/cultural moments.

Complications due to resettlement and rehabilitation of people.

Diversion of traffic on the main arterial roads.

Health risks due to use of a large number of excavators and dumper trucks to transport the excavate (rock, sandy silt, mica, etc.) to specific disposal sites.

Water pollution arising from improper disposal of construction waste.

Soil contamination from accidental leakage and spillage of oil or fuel.

Noise pollution from various equipment.

**26. List the factors to be considered for layout of sewage treatment plant.**

**Answer :**

In order to treat wastewater from industries, treatment plants are laid in the vicinity of recycling units. Before final discharge onto land, a separate control unit for assessing wastewater quality is considered.

The water flow rates are optimized by use of proper length of pipes connecting the units.

The units can be controlled manually or automatically depending on the size of the treatment plant.

If the final effluent discharge is suitable for agricultural use, then the layout is preferred closer to agricultural land.

Sufficient backup of power resources should be made available to control automated units.

Storage space for additional volume of unexpected water flow is necessary.

Model Paper-III, Q1(j)

**PART-B ESSAY QUESTIONS WITH SOLUTIONS****5.1 PREPARATION OF EIA FOR DEVELOPMENTAL PROJECTS - FACTORS TO BE CONSIDERED IN MAKING ASSESSMENT DECISIONS**

**Q7.** Enumerate the factors to be considered in making an assessment decision.

**Answer :**

For answer refer Unit-V, Q1.

**Q8.** Explain the importance of EIA for developmental projects.

Model Paper-III, Q10(a)

**Answer :**

Environmental Impact Assessment has a significant role in the developmental projects.

- (i) It contains the details of the developmental project, including the details of the physical features, the landuse requirements, the nature, type and quantity of materials used for construction and operation, the type, nature and quantity of discharges (air, water, soil, noise pollution etc.) during the developmental phases. Thus, the predicted adverse environmental and social impacts of the proposed project is specified.
- (ii) It looks into the possibilities of improving the environment, for instance, improving wetland areas and increasing the economic opportunities on the site as part of the project.
- (iii) The loop holes in the baseline data can be determined.
- (iv) The negative impacts of the proposed developmental project can be ascertained.
- (v) The ways to minimize the negative impacts of the project can be identified.
- (vi) Improve environmental sustainability.

**5.2 WATER RESOURCES PROJECT, PHARMACEUTICAL INDUSTRY, THERMAL PLANT, NUCLEAR FUEL COMPLEX, HIGHWAY RPOJECT**

**Q9.** Explain in detail about a case study related to a water resources project.

**Answer :**

Model Paper-I, Q10(a)

A brief description about a case study of dams is given below.

Dams are concrete structural barriers constructed across rivers and streams to block or control the flow of water in them. The dams serve two major functions,

1. To store water to compensate for the fluctuations in the discharge by rivers.
2. To increase the hydraulic head (difference in the heights of water levels in the upstream of the dam and the downstream river).

Dams serve many purposes. Some of them are,

- (a) Generation of electricity.
- (b) Supply water for irrigation, industrial and household activities.
- (c) Control the effect of flood waters.
- (d) Encourage river navigation and recreational activities like swimming, fishing and boating. The dams are usually categorized into four major classes: Embankment, Graving, Arch and Buttress.

**Problems by Construction of Dams :** Construction of dams in the forest areas may cause flooding, thereby it may lead to total destruction of the entire forests. The environmental effects associated with the construction of dams include both the physical and social aspects.

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## UNIT-5 Case Studies

### Physical Environmental Effects

- The physical environmental effects are as follows,
- Deforestation for dam construction leads to complete loss of forest lands.
- Endangerment of both wildlife and aquatic life.
- Effects on the natural vegetation including rare species of trees.
- The reservoirs may increase the incidence of water borne diseases.
- Changes in water quantity and quality.
- Soil erosion and sedimentation or siltation causes blockage of the sluice gates.
- Restriction to the movement and migration of resident fish species.
- Flooding of dams can submerge the plants and trees. With passage of time, they begin to rot, reducing the oxygen content in water and eventually killing the plants and fish inhabiting the water.
- Dams can affect the geology of a particular area.

### Social Environmental Effects

- The social environmental effects are as follows,
- Relocation and resettlement of people result in disruption of their lifestyle.
- Disruption of the productive system of people.
- Change in the biodiversity in the upstream and downstream regions.
- Impact of relocation on the populations inhabiting new areas.

### Environmental Problems

The environmental problems associated with the construction of dams across the rivers are many. Some of them are discussed as under,

1. Sedimentation or siltation: The silt gets deposited and trapped at the dam, allowing clear water to flow downstream. The heavy layers of sediments may even block the sluice gates. Desilting of the reservoirs may be carried out as part of the maintenance program, but this adds to the already enormous costs of maintaining the dams.
2. The area under irrigation decreases due to the very high rate of sedimentation or siltation of many dams. People living in upstream areas tend to grow highly water intensive crops, so that those living in the downstream do not get water at all. In certain regions, a lot of water is getting diverted from irrigation to urban and industrial use. In other areas, water logging, weed growth and salination have led to the destruction of productive farmland.

Siltation of the reservoirs also causes shut down of power stations leading to power shortages. The irrigation sector is of the view that siltation in dams is a common problem all over the world, desilting of dams anywhere across the globe has not been reported so far.

At times, the sediment gets contaminated with heavy metals, for example mercury. Mercury gets dissolved into water and then into the fish in the water. All the living organisms that eat this fish suffer from mercury poisoning. Mercury poisoning causes brain damage, birth defects, liver disorders and other ailments.

2. The rapid pace of industrialization, mining and dumping of wastes cause serious pollution problems. When the level of water upstream is lowered to accommodate the flood waters, the silt and other waste rubbish remains and form a breeding ground for disease-causing organisms like flies, mosquitoes, bacteria and parasites, thus threatening the health of the surrounding population.
3. Dams act as physical barriers for the movement and migration of resident fish species. The aquatic habitats downstream are also affected. The fluvial species are transformed to lacustrine species. For example, in the Pacific Northwest, the dams check the migration of coho, chinook and sockeye salmon from the ocean to their upstream spawning grounds. When the young fish swim down from the river to the ocean, they may be chewed up by the turbines of the dam.
4. Reservoirs may increase the incidence of waterborne diseases. The waste dumps, silt, rubbish and the effluents and industrial pollutants decompose and form a breeding ground for mosquitoes, flies, parasites, bacteria and other disease causing organisms, thereby threatening the health of the surrounding population.
5. The reservoirs formed by the construction of dams may trigger earthquakes. The enormous height of dams and reservoirs distort the geomagnetic field of the area, which results in drastic long term climatic and seismological changes, including the possibility of earth tremors.
6. The rotting vegetation in and around the reservoir release greenhouse gases, thus contributing to global warming.
7. The aging structure of dams is a potential safety hazard. Breaching of dams, either partially or catastrophically, causes enormous loss of life and property.
8. The contamination in the impounded sediment reduces the water quality (temperature, dissolved oxygen and nutrients), thus making the ecosystem uninhabitable.

9. When the area behind the dam is flooded, the plants and trees are submerged which begin to rot, thus reducing the oxygen content in water and eventually killing the plants and fish in the water. The rotting plants emit large amounts of methane, a powerful heat trapping gas.
10. The biodiversity in the upstream and downstream region is reduced. The proposed Three Gorges Dam across the Yangtze River in the People's Republic of China cause extinction of the Chinese alligator, the Ganges river dolphins, the Siberian white crane, the Yangtze River finless porpoise, the Indus River dolphins, the migratory fish and migratory birds.

- (vi) People participating in a protest march for challenging the construction have been charged with treason.
- (vii) Villagers protesting against the construction have been threatened with suspension of their ration cards, termination of power supply to the villages and demolition of roads.
- (viii) Relocation of villagers from scheduled areas deprives them of constitutional rights, traditional strength and culture. As they become migrant labourers and urban slum dwellers, they are unable to maintain their adequate living standards.

In order to avoid all kinds of disputes and problems, suitable agricultural land must be provided to affected families and encourage them to carry out the normal agricultural activities, comfortable resettlement and rehabilitation must be ensured by providing them facilities for housing, health education, water supply, market, sanitary, communication, community park, panchayat ghar and tourist resorts.

We are now aware of the fact that the fragile ecosystemic equilibrium is destroyed by the damming of the rivers. Hence, several important considerations must be taken into account while designing and constructing dams. This requires proper input from engineers, geologists, hydrologists, ecologists, financiers and other professionals.

#### **Q10. Describe the environmental impact assessment of an inland waterways project.**

**Answer :**

**Model Paper-II, Q10(a)**

A brief description of the Ganga – Bhagirathi – Hooghly river system between Haldia (Sagar) and Allahabad National Waterway – 1 (NW – 1) named as “Jal Marg Vikas Project” is given below.

The length of the waterway is about 1620 km, and is being extensively used for various cargo movements (includes cement, flyash, iron ore, coal, steel shed, tyres, iron, sheets of galvanized steel, stone chips, boulders, grains, sand, chips, cooking and non-coking coal, etc) as well as tourists in four states namely Jharkhand, Bihar, Uttar Pradesh and West Bengal.

#### **Need of EIA for the Project**

The main goal of EIA is to identify, predict and to quantify the changes in the environmental parameters like air pollution, water pollution, noise pollution or the biodiversity, during the construction of terminal sites at Sahibganj, Varanasi, Haldia, Ghazipur and Kalughat, maintenance dredging, vessel management system, shore protection works.

#### **Possible Impacts of the Project**

The possible impacts of the inland waterways on the environment are,

### Impacts due to Dredging Activities

Dredging activity involves the removal of rock, sand, gravel, mud and clay from the bottom of the waterbodies for safe commercial navigation of ferry boats, ships and barges. The dredging activities can have a significant impact on water quality, land, aquatic ecology, avifauna and the ecological environment.

The data collected at the project site show sandy clay to clayey loam type soil texture, with pH in the alkaline range of 6.5 to 8.0. The concentration of heavy metal and pesticides were found to be within acceptable limits. The concentration of cadmium was found to be moderately high due to the effluents discharged directly from the industries into the river. The total hardness, ferric, zinc, arsenic and chloride levels were above the desirable limits.

### Impacts due to Barge Operations

The barge operations can have a significant impact on the water quality of the river. The garbage, oil waste, sewage, bilge water, and ballast water produced by the barges affect the water quality. Use of antifouling paints to coat the bottom of the ships can cause harm to the aquatic environment.

The main component of the antifouling paint is the biocide which prevents the undesirable organic and inorganic deposits at the base of the barge. The biocide may leach out into the water and cause harm to aquatic life.

Collision of barges by accidents may cause oil spill, leading to oil pollution. The oil spills can cause contamination of fish, amphibians, reptiles, birds and mammals, leading to their mass mortality.

The ambient air quality monitoring and noise quality conducted in National Waterway showed the levels of  $PM_{2.5}$ ,  $PM_{10}$ ,  $SO_2$ ,  $NO_2$ , CO and noise within the prescribed standard limits.

### Impact on Socio-economic and Cultural Activities

The National Waterway pass through four states of Uttar Pradesh, Bihar, Jharkhand and West Bengal having densely populated areas, cross several archaeological, social, culturally sensitive and important places with minimal impact caused by the project.

The barge operations and dredging activities may interfere with the celebrations take Kumbh Mela at Allahabad (January - February), Ganga Mahotsav at Varanasi (October-November), Dhrupad Mela at Tulsi Ghat of Varanasi (February to March), Chatt at Bihar and Jharkhand (October-November), and Ganga Sagar Mela at Sagar (January). Mitigation measures are being undertaken to minimize the impacts.

### Mitigation Measures

The mitigation measures that need to be adopted to help, prevent or reduce the actual/potential effect include the following:

(i) Selection of appropriate dredging equipment must be considered to avoid contamination of the aquatic environment. These include the oozier pump suction dredger and closed clamshell bucket dredger.

- (ii) Implementation of vegetative stabilization to protect the soil from erosion, waterlogging and salinization.
- (iii) Protection of natural drains by embankments.
- (iv) Prevent the entry of construction material into surface water to prevent the adverse impacts on drinking water supplies, irrigation systems, river ecology, etc.
- (v) Prevent the entry of sediments into surface waters by implementing runoff control measures, mechanical sediment control measures, grassed filter strips, mulching and soil bioengineering practices.

As the main aim of the EIA is to identify, predict and to quantify or qualify the changes in the environmental parameters, the survey of the inland waterways project gives an idea of the harm to the environment caused by developmental activities and adopt suitable mitigation measures. Therefore, EIA enables minimization of the adverse effects on humans, plants, animals and the environment as a whole.

### Q11. Explain in detail about a case study related to the pharmaceutical industry.

#### Answer :

Model Paper-I, Q10(b)

#### Introduction

The report is an Environmental Impact Assessment (EIA) report for the expansion of the Quality Assurance Department of M/s. ABCD Pharmaceuticals Ltd. The aim of EIA study is to assess the impacts of the proposed expansion of the department on environment, to devise suitable measures for mitigation of harm to the environment and take advantage of the beneficial impacts of the proposed project.

#### Identification of Project

M/s ABCD pharmaceuticals Ltd. is a large pharmaceutical industry located at Survey No. 420/Z/A, village chitkul, Zanskar Road, Taluka Karad in Khojwan district of Meghalaya State for the manufacturing of various bulk drugs and intermediates.

#### Promoters of the Company

The promoters of the company have a rich experience in manufacturing drugs and other synthetic organic chemicals.

#### Features of Project Location

Approximate geographical position: Latitude  $32^{\circ} 34'34.98''$

Longitude  $83^{\circ} 05'29.16''$

Nearest city: Cherrapunji (About 10 km)

• Nearest highway: NH – 102 kms

#### Need of the Project

In the pharmaceutical industry, quality assurance is involved in various activities, such as purchasing, dispatching, warehousing, operational protocols, manufacturing, training, quality control, validation and packaging.

The need for expansion is to

- (i) Ensure that the pharmaceutical products are produced continuously
- (ii) The products are according to the quality standards of intended use.
- (iii) The products are safe, efficient and of best quality to meet the end user's needs.

### Description of the Existing Environment the Baseline

A description of the existing environment of the proposed project includes the following,

#### Ambient Air Environment

The air quality of the proposed project can be assessed with the help of air quality monitoring stations to evaluate the various pollutants, namely total particulate matter, respirable particulate matter, oxides of nitrogen, sulfur dioxide, ammonium, carbon monoxide, hydrocarbons. The construction activities would generate pollutants like suspended particulate matter ( $PM_{2.5}$ ) and particulate matter ( $PM_{10}$ ).

Other air pollutants that can be generated include sulphur dioxide ( $SO_2$ ), oxides of nitrogen ( $NO_x$ ) and carbon monoxide ( $CO$ ), smoke and unburned hydrocarbons.

#### Noise Environment

Noise pollution from construction activities, such as loading and unloading of construction material, operation of generators, concrete mixing plants, can affect the areas close to the site. Appropriate noise muffling devices would be used to minimize the noise level during the construction phase of the project.

#### Water Environment

The proposed developmental activity does not have the potential of affecting the surface and ground water quality and quantity during the operation of the project.

The project proponents intend to implement the rainwater harvesting techniques to recharge the groundwater.

Recycle and reuse of waste water is an alternative option in waste water management in order to conserve the resources. Thus, implementation of rainwater harvesting would have a positive effect on the quality and quantity of groundwater resources.

#### Land Environment

The proposed project lies in the vacant land of the M/s ABCD pharmaceuticals Ltd, The construction activities may not affect the land use activities in the project area.

Revegetation and tree plantations around the proposed construction site would improve the visual aesthetics of the area.

#### Biological Environment

The description of the biological environment would include the flora, fauna, natural resources and habitats, along with community types and their geographical distribution.

The description of the floral environment involves a five level classification of vegetation. The different levels are vegetation structure, dominant plant types, size and density, size and habitat, special plant species.

The description of the faunal environment should include different species of animals of various groups, such as amphibians, reptiles, fish, birds, mammals, rare faunal species, etc.

#### Socio-Economic Environment

- The developmental projects may impact the socio-economic environment by the following ways.
- Increase in the living standards due to increase in the access to employment opportunities.
  - Increase in the earnings of the people.
  - Increase in business in the region.
  - Increase in the inflow of funds to improve the social infrastructure.

#### Prediction of Impacts and Evaluation of Significant Environment Effects

The role of impact prediction of a project activity is to understand the consequences of the proposed development, the extent of changes that can affect the environment, so that the decision-makers can identify the most important issues.

- Impact on air quality.
- Impact on noise levels
- Effect on water quality
- Impact on landuse
- Socioeconomic environment.

#### Mitigation Including the Environment Management Plan (EMP) and Monitoring

The measures to be taken for mitigation of adverse environmental impacts during the operational phases of an engineering project are,

- Use of environment -friendly technologies, sustainable changes in the construction/ production processes.
- Adoption of measures that prevent the negative effects, such as use of adequate barriers against noise, dust, by the use of mufflers, silencers at the air inlet/outlet, anti-vibration pad, ear muffs, and ear plugs, etc.
- Prevent the entry of sediments into surface waters by implementing runoff control measures, mechanical sediment control measures, grassed filter strips, mulching and soil-bioengineering practices.
- Increasing water infiltration into soil.
- Controlling excessive storm runoff.
- Controlling soil erosion.
- Using the runoff for useful purposes.

Environment management refers to management of all components of the biophysical environment, including the living (biotic) and the non-living (abiotic) factors. It explains the several mitigation and monitoring measures that need specific action to be carried out by the proponent during project construction and operation for a sustainable development.

Environmental monitoring plan involves laying emphasis to the monitoring and supervision of local conditions to assess the effectiveness of development interventions. The process involves discussions among project managers, government officials and researchers for accurate prediction of impacts or changes in the impact trends. It can even warn the project proponents of unexpected adverse impacts and the effectiveness of implemented mitigation measures.

**Conclusion**

As the main aim of the EIA is to identify, predict and to qualify or quantify the changes in the environmental parameters, the survey of the expansion of the Quality Assurance Department gives an idea of the impact of construction activities on the surrounding environment and adopts suitable mitigation measures. Therefore, EIA enables minimization of the adverse effects on humans, plants, animals and the environment as a whole.

**Q12. Considering thermal power project as an example, explain the appropriated mitigation measures to control environmental impact of the power plant.**

**OR**

**Explain in detail about a case study related to EIA of thermal power plants.**

**Answer :****Model Paper-II, Q10(b)**

The different types of thermal power plants used for electricity generation are coal-fired plants, nuclear power plants, hydroelectric power plants, geothermal power plants, renewable energy plants and solar thermal electric plants.

The sequence of processes involved in power generation are,

1. Burning of fuel in the boiler to boil water at a constant temperature to convert into steam.
2. Further heating of the steam in a superheater to produce superheated steam.
3. The high pressure steam is made to pass through a small nozzle, which thus acquired kinetic energy and exerts force on the turbine blades. The turbines produce the electrical energy from the mechanical energy.
4. The steam leaving the turbine is condensed to water. The heat from the steam is transferred to a cooling medium i.e water.
5. The condensate is reintroduced into the boiler.

**Environmental Issues related with Thermal Power Plant****1. Changes in Land Use Pattern**

The potential impacts on the environment due to changes in the land use pattern due to the thermal power plants are,

- (i) Habitat loss and fragmentation
- (ii) Increase in sediment loading
- (iii) Loss of biodiversity
- (iv) Increase in turbidity
- (v) Blockage in the migration route of aquatic organisms
- (vi) Inundation of wetlands and riparian areas
- (vii) Change in water temperature
- (viii) Increased concentration of phosphorus, nitrogen, BOD
- (ix) Changes in PH
- (x) Increased algal growth
- (xi) Salt water ingress.

- 2. Construction of Civil Structures**
- (i) Significant negative impact on protected species
  - (ii) Air pollution
  - (iii) Ground and surface water contamination and changes in water table
  - (iv) Loss of soil resources vegetation cover and sedimentation
  - (v) Changes in land use and topography
  - (vi) Noise pollution
  - (vii) Clearing of native vegetation
  - (viii) Dispersal of exotic species
  - (ix) Airborne dust
  - (x) Visual pollution at the allocated development area.

**Environmental Impact During Operational Stage**

The impact of the thermal power plant on the environment during the operational stage include,

- (i) Water pollution
- (ii) Air pollution due to increase in the dust and  $\text{NO}_x$  levels, sulphur dioxide, carbon monoxide, carbon dioxide, hydrocarbon
- (iii) Noise pollution resulting from boilers, compressors, turbines, etc.,
- (iv) Reduction in the quality of water from the industrial processes released into the body of water has harmful effects on aquatic life. The stress on certain aquatic life forms can cause death, resulting in a negative effects on the food chain and causing an entire ecosystem to fail.
- (v) With increase in temperature of water, the solubility of oxygen in water decreases. This might cause stress for many cold water fish.
- (vi) Devegetation causes the soil to be eroded into streams, rivers and lakes. The muddy water thus formed absorbs more sunlight, which raises the temperature of water. The eroded soil settles in stream bed, thus causing the channel to widen. The soil particles suspended in water bodies act like a sandpaper. This can cause damage to the gills of fish and cause difficulty breathing muddy water restrict the vision of fish to feed.
- (vii) Aquatic plants (eg. algae) thrive well in warmer water temperatures resulting in growth of large amounts of algae and plants. The process of decomposition of these plant materials by bacteria uses a lot of oxygen. Thus can add to the stress on fish and other aquatic organisms, which might get killed.

**Socio-Cultural Aspects**

The social environmental aspects are as follows,

- (i) Resettlement of people
- (ii) Disruption of productive system of people
- (iii) Disruption of the lifestyle of people
- (iv) Impact of relocation on the populations inhabiting new areas.

(v) Relocation of villagers from scheduled areas deprives them of constitutional rights, traditional strength and culture. As they become migrant labourers and urban slum dwellers, they are unable to maintain their adequate living standards.

In order to avoid all kinds of disputes and problems, suitable agricultural land must be provided to affected families and encourage them to carry out the normal agricultural activities. Comfortable resettlement and rehabilitation must be ensured by providing facilities for housing, health, education, water supply, market, sanitary, communication, community park, panchayat ghar and tourist resorts.

**Q13. Considering nuclear power reactors as a case study, describe the positive and negative environmental impacts and suggest an EMP to mitigate the negative impacts.**

**Answer :**

The Kudankulam Nuclear Power Plant, developed by the Nuclear Power Corporation of India (NPCIL), is situated in the Tirunelveli district of Tamil Nadu, nearly 650 km South of Chennai. It is intended to use Russian technology of pressurized water reactors (PWR) supplied by the Atomstroy export. Its construction began in the year 2001, and aimed at making it operational by 2023.

#### Positive Environmental Impact of Nuclear Power Plant

The positive environmental impact of nuclear power plant includes the following :

- (i) The nuclear power plants do not produce smoke or carbondioxide, therefore they do not pollute the environment.
- (ii) It requires a small amount of fuel to produce a huge amount of energy.
- (iii) Generation of job opportunities for local residents.
- (iv) Increase in the living standards due to increase in the access to employment opportunities.
- (v) Increase in the earnings of people.
- (vi) Increase in business in the region.
- (vii) Increase in inflow of funds to improve the social infrastructure.
- (viii) Improvement in the health of the local economy.
- (ix) The wastes produced are small.

#### Negative Environmental Impacts of Nuclear Power Plant

The negative environmental impact of nuclear power plant includes the following :

- (i) Clearing forests to set up the nuclear power plant disturbs the natural habitat of flora and fauna.
- (ii) The discharge or runoff of heated water from the nuclear power plants into the waterbodies like streams, rivers, lakes or coastal ocean water result in killing or injuring the aquatic organisms.
- (iii) Release of greenhouse gases (such as carbondioxide, carbonmonoxide, nitrous oxides and sulphurdioxides) by the diesel generators used as a means for back-up electric power.

(iv) Threat of exposure to nuclear radiation in the vicinity of the power plant.

(v) Exposure to nuclear radiation can have a negative impact on human health.

#### Suggestions for EMP to Mitigate the Negative Impacts

Some of the suggestions to mitigate the negative impacts of power plants are as mentioned below :

1. Nuclear power plants should be designed in such a manner that there is no leakage of radioactive material.
2. The radioactive wastes should be stored in deep underground facilities or underground caverns called as nuclear waste repositories.
3. Setting up nuclear power plant far from wilderness areas to prevent air pollution of the environment.
4. High amounts of CO<sub>2</sub> released by the power plants may be captured at the exhaust pipe and deposited it in underground geologic formations.
5. Planting of trees to take up CO<sub>2</sub> released into the atmosphere.
6. Generation of electricity using renewable resources such as wind power, solar power, biomass power plant systems.
7. The process water discharged by the power plants must be cleaned and filtered and then discharged into the waterbodies.
8. Soil erosion from the construction site can be prevented by the use of erosion control best management practices.
9. The damage to the wetlands near the construction site by use of heavy machinery can be avoided by siting of power plants far away from the wetlands.
10. Sedimentation and soil erosion problems caused by earth-moving and digging activities during the construction phase of the plant should be properly managed by adopting soil erosion control plans.
11. Avoid construction activities near the historic buildings, burial grounds, archeological sites, cultural areas, aircraft approach paths and runway alignments.
12. Noise pollution caused by power plant operation by the steam generators, steam turbine generators, fuel handling equipment, air compressors, air separators, cooling towers, ventilation fans, delivery trains and trucks. The noise levels can be reduced by placing barriers between the noise source and receiver, so that the sound waves get absorbed/refracted/radiated in the surrounding environment.

Plants with dense foliage, evergreen trees and a combination of taller plants and shorter shrubs must be planted close to the noise source to attenuate the sound levels.

## Q14. Discuss a case study of EIA for a highway road project.

**Answer :**

### Model Paper-III, Q10(b)

A brief description of the Ujjain-Jaora highway project is given below. The location of the project follows a definite route Ujjain-Unhel-Nagda-Jaora of Madhya Pradesh. The length of the project is about 95 km along the rivers of Shipra, Ambhir and Malini. Some hills, drains, wells and lakes are found along the project location. The different types of soil along the highway are the black cotton soil, sandy soil and the rocky strata.

#### Need of EIA for the Project

The main goal of EIA is to identify, predict and to quantify or qualify the changes in the environmental parameters like air, water pollution, noise pollution or the biodiversity, owing to construction activity related to the project.

#### Possible Impacts of the Project

The possible impacts of highway construction are,

Changes in the land use

Encroachments into nature reserves

Loss of vegetation

Noise and air pollution

Potential loss of living quality, wildlife and plants

Habitat destruction, fragmentation of ecosystem

Draining or contamination of wetlands.

#### Collected

Research studies indicate that the pollutants released at the project site are, sulphur dioxide ( $SO_2$ ) – 106 mg/m<sup>3</sup>, Oxides of nitrogen ( $NO_x$ ) – 113 mg/m<sup>3</sup>, Carbon monoxide (CO) – 37000 mg/m<sup>3</sup>, Lead (Pb) – 0.1 mg/m<sup>3</sup>, Suspended Particulate Matter (SPM) – 557 mg/m<sup>3</sup>.

Exposure to dust pollution can lead to a variety of health effects, including increased respiratory symptoms, irregular heart beats, non-fatal heart attacks, heart or lung disease, bacterial and fungal infections, fibrosis, cancer, etc.

Damage to vegetation due to land clearing

Compaction of soil caused by construction vehicles can impact both plants and animal species.

Clearing of vegetation exposes top soil to erosion.

Exposure to noise gives rise to general annoyance, irritability, increased susceptibility to heart disease and high blood pressure, impaired hearing, nervousness, digestive tract symptoms, etc.

#### Mitigation Measures

The mitigation measures that need to be adopted to help, prevent or reduce the actual/potential effect include the following,

- (a) Implementation of vegetative stabilization to protect the soil from erosion, waterlogging and salinization.
- (b) Limiting the cleared areas.
- (c) Protection of natural drains by embankments.
- (d) Vegetation enhancement programs in potentially sensitive and unstable areas.
- (e) Water spraying on the soil to prevent traffic, dust affecting the residents nearby.
- (f) Highway roads should be made to pass through less sensitive areas.
- (g) Putting up fences or obstacles to prevent wildlife from crossing the highway.
- (h) The explosion activities for road laying may be carried out in summer and during daytime to prevent animals trespassing the area.
- (i) The top soil should be collected and stored for future use.
- (j) Soil compaction caused by the weight of vehicles and machinery can be prevented by restricting the vehicular movement to defined tracts and avoiding its use outside the construction zone.
- (k) The disturbed areas must be revegetated.
- (l) Prevent the entry of construction material into surface water to prevent the adverse impacts on drinking water supplies, irrigation systems, river ecology, etc.
- (m) Prevent the entry of sediments into surface waters by implementing runoff control measures, mechanical sediment control measures, grassed filter strips, mulching and soil bioengineering practices.
- (n) Underpasses may be constructed to avoid disturbance to wildlife trails.
- (o) Noise pollution can be controlled by adopting noise dampening measures such as limitations on vehicular speed, antinoise road paving by using asphalt mixtures, noise abatement walls or embankments or hedges, improvement in traffic flows/traffic diversions/detours, improvement of public transportation, soundproofing of rooms with triple glazing and installation of acoustic panels on the walls and ceilings.

As the main aim of the EIA is to identify, predict and to quantify or qualify the changes in the environmental parameters, the survey of the highway construction project gives an idea of the pollutants emanating due to the construction activities and adopt suitable mitigation measures. Therefore, EIA enables minimization of the adverse effects on humans, plants, animals and the environment as a whole.

**Q15. What are the impacts of highways on environment?**

Refer Only Topic: Highway Project-Expressway

OR

Considering the two developmental projects given below, explain how vegetation is affected and what are the subsequent impacts.

- (a) Water resources development project – major dam.
- (b) Highway project – Expressway.

**Answer :**

**(a) Water Resources Development Project – Major Dam**

Several research findings suggest that imposing changes in the flow of rivers result in significant changes in the hydromorphological characteristics, biodiversity, the types of vegetation, the animal and plant life, i.e. the web of life it supports.

The major effect of dams in the ecosystem is the inundation of habitats. In the upstream region of the dam, the freeflowing stream habitat converts to a steady water reservoir ecosystem. Such change in the ecosystem brings about changes in the temperature, chemical composition, dissolved oxygen levels and physical characteristics, as stated by the International River Annual Report, 2016.

During flooding, some plant species may submerge completely and cease to grow and die. The others may adapt themselves structurally and biochemically to revive growth.

Some of the adaptations in plants include :

- (i) Development of enlarged air spaces called aerenchyma.
- (ii) Development of large pores on the bark of trees called lenticels.
- (iii) Switching to anaerobic respiration.

The death of plants due to flooding followed by its decomposition may lead to several environmental problems.

Some of them are,

- (i) Release of carbondioxide.
- (ii) Release of methane gas.
- (iii) Release of methylmercury into the surrounding environment.

**(b) Highway Project - Expressway**

**Effect of Expressway on Vegetation**

The rapid increase in infrastructure development owing to industrialization, urbanization and modernization has led to several environmental repercussions. The development of highways leads to the following impacts,

- (i) Changes in the landuse.
- (ii) Encroachments into nature reserves.
- (iii) Loss of vegetation.
- (iv) Noise and air pollution.
- (v) Potential loss of living quality, wildlife and plants.
- (vi) Habitat destruction, fragmentation of the ecosystem.
- (vii) Draining or contamination of wetlands.
- (viii) Decline in the species richness of the plants.
- (ix) Decline in the endemic, rare and endangered species.
- (x) Alteration in the composition of plant communities.
- (xi) Instability of plant communities during the construction phase of the expressway.
- (xii) Changes in the drainage pattern impact the plant communities.
- (xiii) Changes in the microclimate (for instance, solar radiation, wind pattern and intensity, water flux and nutrient availability).
- (xiv) Barrier to dispersal of plant communities between different ecosystems.
- (xv) Introduction of alien or exotic species and invasive plants into the ecosystem.
- (xvi) Alteration in the soil nutrient status.
- (xvii) Loss of medicinal plants by the local communities.
- (xviii) Loss of forest communities.

Thus, a comprehensive impact of highway construction should be made mandatory.

## 6. Write a model EIA statement for a multipurpose dam.

**Answer :**

This report is an Environmental Impact Assessment (EIA) for the proposed Jamrani Dam. Multipurpose project to be sited near Jamrani Village, Nainital District in the state of Uttarakhand, India. The proposed dam would create an additional irrigation potential of about 60,600 hectares, which would increase the irrigation from 52% to nearly 93%. The Jamrani Dam project would supply drinking water to the nearby cities, generate 30 MW power, increase potential for scale pisciculture, generate employment opportunities and improve the living standards of the local people.

Model Paper-I, Q11(a) | Dec.-20, (R16), Q8

### Description of the Project

Project	
Type of dam	Gravity dam
Location	Near Jamrani village
Crest level	750 m
Crest length	480 m
Height of dam above ground level	131 m
Thickness of dam at deepest foundation	167 m
Number of spillway openings	4
Capacity of reservoir	210 Mm <sup>3</sup>
Total cost of project	86,000 lacs

### Characteristics of the Study Area

The different characteristics of the study area to be considered for EIA are,

#### Geology

The information on geology of the project area gives us knowledge of the site's soil, rocks and engineering risks. The region has phyllites, schists, gneisses, quartzite, purple and green slates, pink siliceous limestone, sandstones, claystones, siltstones, pseudoconglomerates.

#### Topography

The topography of the project area is characterized by steep terrain, with ridges and depressions, along with larger flatland areas.

#### Soils

The project site has wide variations in soil characteristics, especially in texture, depth, stoniness, colour, drainage, moisture content and organic matter content.

#### Surface Water Resources

The Gola River (or the Gaula River) originates in the lesser Himalayas near the Paharpani village of Uttarakhand state, and finally merges with the Ramganga River near Bareilly in Uttar Pradesh. Ramganga River is a tributary of River Ganges.

#### Terrestrial, Botanical and Zoological Communities.

The project area is habitat for different kinds of animals such as the chital (spotted deer), barking deer, sambar, goral, wild pig, the Asian elephant, the Royal Bengal tiger, Leopard, jungle cat, Indian civet, Himalayan yellow-throated Marten, Sloth bear, Asiatic black bear, Indian pangolin, monitor lizard, and more than 230 birds species including ducks, cormorants, egrets, plovers and herons.

The floristic composition of the project area is classified into tropical, Himalayan sub-tropical, subalpine and alpine vegetation. The vegetation consists of pine, oak, walnut, rhododendron, larch, spruce, fir, cypress, juniper, birch, blue poppies, mosses and lichens.

#### Aquatic Communities

The commonly occurring aquatic communities are the fishes, such as *Barilius* sp and *Garra* sp. The golden mahseer *Tor putitora* and *Schizothorax richardsonii* are rarely found.

#### Environmentally Sensitive Areas

The environmentally sensitive areas include the notified protected areas (archaeological sites, defence installations), forests, wildlife corridors, and wildlife sanctuaries.

#### Demographic Profile

According to the latest reports, nearly 462 families from 15 districts of Nainital would be affected by the proposed Jamrani Dam Project.

### **Environmental Impacts of the Project**

The possible impacts of the project on the environment include,

- (i) Displacement of people to new areas.
- (ii) Loss of precious agricultural land, historical and cultural sites.
- (iii) Loss of forested areas, wildlife, habitat, flora and fauna.
- (iv) Erosion of topsoil with loss of protective cover.
- (v) Transfer of knowledge and skill to local people.
- (vi) Increase in pollution due to usage of pesticides and fertilizers.
- (vii) Deterioration in water quality.
- (viii) Invasion by alien aquatic weeds.
- (ix) Changes in the quality and quantity of water downstream.
- (x) Damage to vegetation due to land clearing.
- (xi) Exposure to dust pollution can lead to a variety of health effects, including increased respiratory symptoms, irregular heart beats, non-fatal heart attacks, heart or lung diseases, bacterial and fungal infections, fibrosis, cancer, etc.
- (xii) Loss of wildlife habitat, indigenous flora and fauna.
- (xiii) Reservoir sedimentation.
- (xiv) Pollution of water and soil from the oil spills of the machinery and equipment.
- (xv) Increase in groundwater level due to percolation of water.
- (xvi) Deterioration in groundwater quality due to seepage of agrochemicals used to maintain the water quality in the reservoir.
- (xvii) Increase in local population and economic activities.

### **Mitigation Measures**

- The mitigation measures include the following aspects,
- (i) The clearance of vegetation may be restricted to critical areas.
  - (ii) Awareness campaigns may be conducted to the staff and people living nearby about the need to conserve nature.
  - (iii) Adopt strict measures in conservation of the environment.
  - (iv) The movement of heavy vehicles and machinery may be restricted to the designated routes only.
  - (v) Implementation of vegetative stabilization to protect the soil from erosion, waterlogging and salinization.
  - (vi) Soil compaction caused by the weight of vehicles and machinery can be prevented by restricting the vehicular movement to defined tracts and avoid its use outside the construction zone.
  - (vii) The disturbed areas must be revegetated.
  - (viii) Reforestation of disturbed areas.
  - (ix) Provide job training and encourage job on training to aspirants.
  - (x) Adopt good practices of dam operation rules.
  - (xi) Set up a buffer zone between the waterfront and residential area.
  - (xii) Avoid discharge of waste effluents into the dam.
  - (xiii) Avoid dust pollution by watering the area around the construction site.

### **Environmental Monitoring and Management Plan**

Environmental monitoring plan involves paying close attention to monitoring and supervision of local conditions to assess the effectiveness of development interventions. The process involves discussions among project managers, government officials and researchers for accurate prediction of impacts or changes in the impact trends. It can even warn the project proponents of unexpected adverse impacts and the effectiveness of implemented mitigation measures.

The following parameters are monitored:

1. Compensation of land to the residents displaced from the project area.
2. Implementation of social welfare measures, such as income generation, providing education facilities, infrastructure development, setting up healthcare facilities, etc.
3. Surveillance of water quality and ensure supply of safe water for the consumers.
4. Monitoring of sediment load to analyze the effectiveness of soil conservation measures.
5. Monitoring of air quality and noise levels for control of air and noise pollution in the project area.

### **Conclusion**

Any developmental project of this magnitude such as the Jamrani Dam Multipurpose project has both positive and negative impacts on the environment. However, it is of utmost importance to identify the impacts and implement measures at increasing the positive impacts and minimizing the negative impacts through an elaborate environmental management plan.

### **Q17. Describe the environmental impact assessment of a greenfield expressway project.**

**Answer :**

**Model Paper-II, Q11(a)**

The Delhi – Mumbai Expressway is a greenfield expressway project that connects India's national capital with the financial capital (Mumbai). It is considered as the longest expressway in the country.

#### **1. Route**

The route followed by this expressway includes Delhi - Gurugram - Mewat - Kota - Ratlam - Godhra - Vadodara - Surat - Dahisar - Mumbai, covering a distance of 1380 kms.

The expressway is expected to cut the travel time between two cities by half. The eight-lane expressway meanders through five states (namely Haryana, Rajasthan, Madhya Pradesh, Gujarat and Maharashtra).

#### **2. Need of the Project**

The expressway is needed for the following reasons.

- (a) Upgrade the quality of the current roads that are in use.
- (b) Building new roads for better connectivity of two cities.
- (c) Improved access to ports, coastal regions, etc.

- (d) Better management of traffic and cargo/freight.  
 To enhance tourism.
- (e) Better access to the villages in close proximity to the road.
- (f) To provide economic opportunities to the local residents.
- (g) To provide basic amenities to the residents living nearby the proposed project.
- (h) To improve the traffic facilities in the project road.
- (i) To increase the economic prosperity in the fields of agriculture, commerce, education, health, social welfare and public safety.

#### **Project Area**

The project covers a distance of 1380 km, connecting Delhi to Mumbai.

#### **Project Proponent**

The project proponent is National Authority of India (NHAI), a nodal agency of the Ministry of Road Transport and Highways (MoRTH), Government of India.

#### **Environmental Impact Assessment (EIA) Study**

The methodology involved in the study deals with the identification of baseline data which can be used to predict and quantify the impacts and suggest remedial measures to mitigate the possible impacts.

#### **Policy, Legal and Administrative Framework**

The National Highway Authority of India (NHAI) has to provide the following clearances before the project execution.

- Environmental Clearance from the Ministry of Environment and Forests
- Permission from the Forest Department for tree cutting
- Relocation of the residents living in proximity to the proposed project under Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013.
- No Objection Certificates from the Central Pollution Control Board and State Pollution Control Board, Transport Department, Irrigation Department, etc.

#### **Baseline Environmental**

##### **(a) Physical Environment**

The climate of the project area has both hot and cold seasons. The hot season extends from March to May, monsoon season from June to October, and the cold season from November to February.

#### **Topography**

The project aligns on the northern Indian plain, hills, undulating ground surface and forest areas.

#### **Geology**

The geology of the project area comprises metamorphosed quartzite, slates and limestones.

#### **Soil**

The entire project area has black, alluvial and brown soils.

#### **Ambient Air Quality**

The project intends to cut down the air pollution, reduce traffic congestion and cost of transportation.

#### **Ambient Noise Level**

The noise level went up at certain locations due to the industrial and commercial activities.

#### **Surface Water**

Few waterbodies shall be impacted due to the proposed activity, resulting in the degradation of water quality.

#### **Groundwater**

The groundwater quality would be impacted during the construction activities and operation phase of the proposed project.

#### **(b) Biological Environment**

The proposed project passes through the wildlife sanctuary (Mukundra Hills Tiger Reserve of Rajasthan), hence wildlife clearance is required under the Wildlife (Protection) Act, 1972. The project area comprises agriculture lands, fallow lands with plantations of paddy, sugarcane, maize, legumes, onions, cotton, tobacco, red-chillies, brinjal and other vegetables. The non cultivable wastelands are covered with tree species such as banyan, eucalyptus, sacred figs, tamarind, lantana, milkweeds, mature tea trees.

8.

#### **Potential Environmental Impacts**

The potential environmental impacts during the construction and operational stages on the environmental components have to be analyzed and suitable mitigation measures to be adopted to reduce its environmental footprint to the lowest possible.

9.

The level of particulate matter, carbon monoxide, noise levels, contamination of waterbodies, may increase during the construction phase. However, their level would remain within prescribed standards.

#### **Mitigators Avoidance and Enhancement Measures**

The mitigation measures that need to be adopted to help prevent or reduce the actual potential effect include the following,

- (i) Implementation of vegetative stabilization to protect the soil from erosion, waterlogging and salinization
- (ii) Limiting the cleared areas
- (iii) Protection of natural drains by embankments
- (iv) Vegetation enhancement programs in potentially sensitive and unstable areas
- (v) The railway tracks should be made to pass through less sensitive areas
- (vi) Putting up fences or obstacles to prevent wildlife from crossing the railway tracks
- (vii) Revegetation of disturbed areas
- (viii) Encourage scientists and engineers to carry out research on new zero emission technologies.

#### Sustainable Infrastructure

The major highlights of the project are

##### (a) Wildlife Crossings

The greenfield expressway has the first-ever animal overpass (animal bridge) as seen in European nations.

##### (b) Environment - Friendly Features

The solar-powered street lights, vegetative cover of two million trees, drip irrigation system to water the plants, rainwater harvesting system at every half kilometer are some of the environment friendly features of the project.

##### (c) E-highway

Four lanes of the eight-lane expressway have been proposed to be dedicated to e-vehicles only. Walls are being constructed on either side of the road for security purposes. The toll plazas are located on slip lanes.

As the main aim of the EIA is to identify, predict and to quantify or qualify the changes in the environmental parameters, the survey of the greenfield expressway project gives an idea of the impact on the environment due to the construction activities and adopts suitable mitigation measures. Therefore, EIA enables minimization of the adverse effects on humans, plants, animals and the environment as a whole.

#### **Q18. Explain the environmental impacts of railways with suitable case studies.**

**Answer :**

Model Paper-III, Q11(a)

A brief description of Konkan Railway Corporation Limited (KRCL) is given below,

The location of the project follows a definite route on the western coast of India. The Konkan Railway line is meant to connect Maharashtra, Goa, coastal Karnataka and Kerala. The geography of the project site i.e. the Konkan region is an extremely rugged terrain. It is surrounded by the foothills of the Sahyadri Hills towards the east, and Arabian Sea on the westwards. The region is rich in mineral resources, agricultural land and dense forestry.

Some of the important details of the project are as given below.	Some of the important details of the project are as given below.
No. of major bridges - 179	No. of major bridges - 179
No. of minor bridges - 1819	No. of minor bridges - 1819
No. of tunnels - 92	No. of tunnels - 92
No. of cuttings /drillings - >1000	No. of cuttings /drillings - >1000
Length of the longest tunnel - 6.5 km	Length of the longest tunnel - 6.5 km
Length of the longest bridge - 2 km	Length of the longest bridge - 2 km
Total length of the project = 760 km	Total length of the project = 760 km

#### Environmental Impacts of the Railway Project

The possible impacts of the railway projects are,

##### 1. Loss of Precious Agricultural Land

The intense utilization of farmland for laying down railway tracks is leading to its degradation, loss of crops and disturbance to livestock.

##### 2. Loss of Forested Areas

The disappearance of the forest ecosystem for railways have the following impacts,

- (i) Alteration or disruption of carbon cycle and water cycle.
- (ii) Erosion of soil with the loss of protective cover.
- (iii) Extinction of species.
- (iv) Desertification
- (v) Increase in the temperature extremes.

The loss of agricultural land and forested areas cause disruption of the natural ecosystem.

##### 3. Pollution of the Environment

The exhaust gas emissions discharged from diesel engines are carbondioxide, hydrocarbons, nitrogen oxide, sulphur dioxide, particle emissions (soot), all of which are poured into the environment. These pollutants can kill plants and trees, destroy their leaves and kill the animals, thus destroying the natural ecosystem.

##### 4. Contamination of soil, groundwater and surface water by discharge of lubricating oil and disposal of waste oil.

##### 5. Noise pollution from rail traffic, infrastructure involved in railway operations such as marshalling yards, transfer stations and workshops. Such exposure of noise gives rise to general annoyance, irritability, increased susceptibility to heart disease and high blood pressure, impaired hearing, nervousness, digestive tract symptoms, etc.

**Mitigation Measures**

- The mitigation measures that need to be adopted to prevent or reduce the actual/potential effect include the following,
- i) Implementation of vegetative stabilization to protect the soil from erosion, waterlogging and salinization.
  - ii) Limiting the cleared areas.
  - iii) Protection of natural drains by embankments.
  - iv) Vegetation enhancement programs in potentially sensitive and unstable areas.
  - v) The railway tracks should be made to pass through less sensitive areas.
  - vi) Putting up fences or obstacles to prevent wildlife from crossing the railway tracks.
  - vii) The disturbed areas must be revegetated.
  - viii) Prevent the entry of lubricating oil and waste oil into the surface water and groundwater supplies to prevent the adverse impacts on drinking water supplies, irrigation systems, river ecology etc.
  - ix) The railway bogies may be fitted with noise-reducing technologies.
  - x) Implementation of the GREEN project (GREEN heavy duty ENgine) as proposed in European nations.
  - xi) Use of diesel hybrid railcars as it emits less amount of hazardous NOx and graphite, and they are less noisy too.
  - xii) Encourage scientists and engineers to carry out research on new near zero emission technologies.

**Q9. What are the environmental impacts of coal mining.****Answer :**

The process of extracting minerals and their ores from earth's crust by digging is known as mining. The process mining poses a threat to the environment and also to the workers working in mines. The impact of the mining activities on the soil are as mentioned below,

Mining leads to deforestation due to the diversion of forest land for mining purposes. This is because large areas of land are needed so that miners can dig into the earth.

Apart from large scale deforestation, the vegetation of the surrounding areas has to be cleared to lay roads and construct residential facilities for the mine workers.

Large scale deforestation leads to loss of biodiversity due to loss of habitat of the animal species.

Mining operations cause ground compaction due to the heavy machinery operations, traffic and storage activities etc.

The mining dust causes change in the texture of the parent soil, the soil components like soil horizons, soil structure, soil microbe population, nutrient cycles.

6. Wash off toxic metals into nearby land surfaces reduces soil fertility.
7. Loss of vegetation may enhance weathering (both physical and chemical). The rain-bearing clouds formed in the mined areas pick up carbondioxide from the atmosphere and form a weak acid. When the rain falls, the weak acid attacks the exposed rock surface and causes its weathering.
8. The immediate impact of mining activity is Acid Mine Drainage (AMD)/ Acid Rock Drainage (ARD). It is the outflow of acidic water from coal mines or abandoned mines of metals. This usually occurs when the sulphide minerals are uncovered during the process of mining. Acid Mine Drainage is hazardous to the environment as it disrupts the cycle of nature. It also forms a blanket over the water bodies usually streams and rivers and prevents the entry of sunlight, thus photosynthesis does not occur. This leads to the death of the aquatic plants, thus disturbing the aquatic ecosystem.
9. Change in natural drainage. The groundwater recharge through the surface reduces, because reduced infiltration results in increased surface runoff, leading into sedimentation ponds which can then overflow into the nearby streams.
10. Disruption in the aesthetics of the landscape.

**Q20. Describe the environmental impact assessment of a cement plant.****Answer :**

A hypothetical case study of EIA for the cement industry has been presented below.

**Introduction**

Anjani Portland Cement Ltd., has been set up at Chintalapalem, Suryapet Dist., of Telangana.

**Case Study on EIA of a Cement Industry**

The manufacture of cement is an energy intensive process with serious impact on the landscape and ecology. The different types of emissions at various stages of the cement manufacturing process are indicated below,

**1. Extraction of Raw Materials (Limestone, Shale, Clay, Iron, Ore, Sand)**

The dust emissions and PM<sub>10</sub> are released in this stage.

**2. Clinker production**

The air pollutants released during the clinker production include NO<sub>x</sub>, SO<sub>x</sub>, particulates, dioxin, CO<sub>2</sub> from stockpiles, conveyors and material handling facilities.

**3. Cement grinding and distribution**

In this stage the combustion of fossil and other fuels release greenhouse gases.

Therefore, the environmental audit for cement industry gives an overview of the improvements in energy efficiency, reduction in emissions, reduction in noise pollution, reduction in usage of non-renewable raw materials, all of which help in improved environmental performance.

### Goals and Objectives of the Project

- The main objective of the project is,
- Cement manufacturing.
  - Limestone mining for construction sector.
  - Provide employment to a million people.
  - Assess the environmental impact of the industry during the operation phase.

### Methodology

Standard methods were followed for the measurement of the following parameters.

- Physico-chemical characteristics of water.
- Ambient air quality levels.
- Noise levels.

### 1. Physico-chemical Characteristics of Water

The water quality monitoring stations analyze the water samples (surface water and groundwater) for various physical, chemical and biological parameters.

The water quality parameters for analysis include pH, temperature, Total Suspended Solids (TSS), Total Dissolved Solids (TDS), oil and grease, salinity, nitrate, phosphate, silicate, dissolved oxygen, biochemical oxygen demand, cadmium, lead, mercury, total organic carbon, fecal coliform, total heterotrophic bacteria.

It was observed that the water quality parameters at different locations around the cement factory were within the Indian Standard Limits.

#### (i) Ambient Air Quality Levels

Air quality monitoring stations are located at different places around the project area to assess the various pollutants such as total particulate matter, respirable particulate matter, oxides of nitrogen, sulfur dioxide, ammonium, carbon monoxide, hydrocarbons. The average concentration of all the parameters mentioned above may vary in different seasons.

It was observed that the particulate matter, gaseous pollutants in the air were found to be within the permissible limits as prescribed by the CPCB of India.

#### (ii) Noise Levels

The noise levels around the cement plant were assessed with the help of a sound level meter. It was observed that the noise levels were within the permissible limits as prescribed by the CPCB of India. The workers have been provided with personal protective equipment such as ear plugs/ear muffs etc.

#### iii) Health and Safety Measures

Adequate measures have been undertaken for the safety of the workers. These include fire extinguishers, emergency kits, ladder, fire helmet, gloves, mask, first aid box and smoke detectors etc.

### Mitigation Measures

- The mitigation measures to reduce the impact on air quality caused by the cement industry are as mentioned below:
- Collection of kiln dust and its recycling can reduce its release into the atmosphere.
  - Use of mechanical equipment for controlling cement dust include the dust collector, cyclone and electrostatic precipitators.
  - The raw material may be covered using suitable material during its transportation from one place to another.
  - Use of water sprinklers on the raw material and dusty roads to reduce dust generation.
  - Green belt development around the site acts as a dust barrier.

## 5.3 SEWAGE TREATMENT PLANT

**Q21. Write about sewage treatment plant with the help of a case study.**

Model Paper-I, Q11(b)

### Answer :

Raw sewage consists of residential, commercial and industrial liquid water discharges. Such waste waters are processed in wastewater treatment plants to produce an effluent of higher quality and then discharged back to the environment.

The waste waters are disposed off by one of the several ways mentioned below.

- Untreated effluents may be discharged to land or water bodies.
- The effluents may be dumped at a landfill site.
- Effluents may undergo the process of incineration i.e., burning of wastes in large furnaces. The ash formed during the process may be used as a landfill.
- The effluents may be partially treated before discharge.
- The effluents may undergo thorough treatment before discharge by municipal authorities and water treatment companies.

### Objectives of Treating Sewage

- The main objectives of treating sewage are as follows:
- To prevent the discharge of raw or untreated sewage into water bodies and prevent harm to aquatic life.
  - Prevention of water-borne diseases.
  - To dispose of the effluents safely and effectively.
  - To remove the organic solids from the sewage.
  - To safeguard the water sources from pollution.
  - To avoid causing any nuisance or odour problems to the environment.

### Case Study

The city of Hyderabad has 25 Sewage Treatment Plants with the capacity to treat 772 million litres per day of sewage water. 17 new sewage treatment plants will be built alongside Musi River and its catchment areas.

The total sewage generated each day is nearly 1781 million litres, of which 772 million litres are treated in various sewage treatment plants. The rest of it is discharged untreated either into the Musi River or the Hussain Sagar Lake.

The effluents may be treated by one of the following processes.

### Physical Treatment

The suspended solids in effluents may be separated by centrifugation, filtration (e.g., ultrafiltration), decantation, filter press, rotary vacuum filter, belt press, microstrainers, slow sand filters, upflow sand filters, rapid gravity sand filters, surface skimmers, Archimedian screws, grit chambers, mixers, aerators and diffusers.

In some cases, screens are used for removal of large suspended matter. Comminutors are used to reduce the particle size of suspended solid matter. Constant velocity channels are used in effluent treatment plants to remove grit from suspended matter to prevent damage to sewage treatment plants. Sedimentation tanks are large tanks used to remove fine suspended matter. The sewage is passed into sedimentation tanks where the sludge settles to the bottom of the tank. The floating materials (or scum) like oil and grease are skimmed off while the sludge settled at the bottom of the tank is continuously removed.

The floating material and suspended matter present in the sewage such as dead animals, papers, wood pieces, metallic or non-metallic containers etc., are removed with the help of screenings. Screens are the rectangular or circular shaped elements which consists of parallel bars, wire mesh or perforated plates. They may be of large, medium or small size depending upon the required treatment and nature of sewage.

The other non-solid suspended materials such as oil and grease are removed by using skimming tanks, floatation units, flow measuring units etc., while heavy materials like sand and grits are removed with the help of grit chambers or detritus tank.

The various preliminary processes involved in the removal of floating and suspended materials are as follows,

**Screening** for removing the light particles like papers, rags, metallic or plastic containers etc.

**Removal of sand and grit particles** by using grit chambers or detritus tanks.

**Chopping** or cutting of suspended matter of bigger size.

**Removal of oil and grease** which floats over the surface using skimming tanks and floatation units.

The other preliminary processes such as pumping and re-aeration are also used for the removal of heavy suspended particles. The process of flocculation is also applied for better removal of floating or suspended matter (if required).

This process is applied generally on high strength municipal wastes to reduce the amount of waste to be treated by secondary processes.

### Chemical Treatment

Chemical treatment includes coagulation and/or flocculation processes. The chemical coagulants used in the chemical process are ferrous or ferric sulphate, aluminium sulphate (alum), calcium hydroxide (lime) and polyelectrolytes. Addition of a suitable chemical coagulant to the effluent results in the formation of a precipitate or floc that settles to form a

Further treatment of effluent is accomplished by flocculation process which is mediated by addition of polyelectrolytes to the effluents. This is followed by passing the effluents through sinuous flocculation channels, hydrodynamic flocculators or mechanically mixed flocculators.

### (b) Biological Treatment

The biological treatment of effluents is achieved by either of the two ways,

- (i) Aerobic processes
- (ii) Anaerobic processes.

#### (i) Aerobic Processes

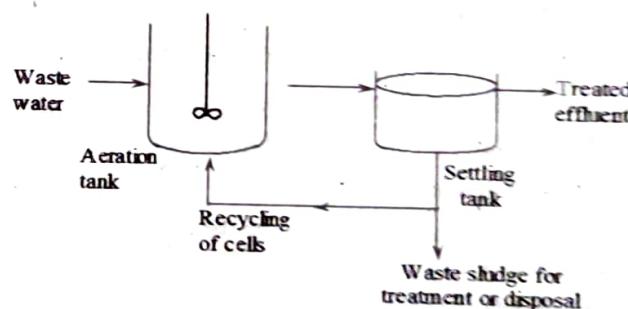
In the aerobic process of effluent treatment, the microbial population requires both oxygen and a substrate to live. These microbes consume biodegradable soluble organic contaminants such as sugars, fats, organic short chain carbon molecules and bind the less soluble fractions into floc. The organic content provides energy to the microorganisms for growth. In the aerobic system, the microbes used are members of the genera *Pseudomonas*, *Nocardia*, *Flavobacterium*, *Achromobacter*, *Zooglea*, *Beggioata* and *Sphaerotilus*.

Trickling filters, towers, Biologically Aerated Filters (BAFs), rotating biological contactors (rotating disc contactors), rotating drums, fluidized bed systems and activated sludge processes are used in aerobic treatment.

Some of the aerobic processes used in the treatment of wastewater are,

#### (a) Activated Sludge Systems

The figure below is a generalized schematic representation of an activated sludge system.

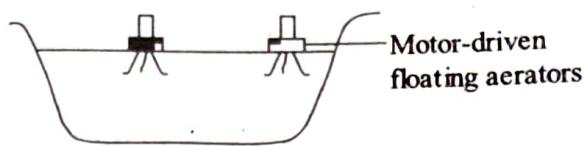


**Figure: Diagrammatic Representation of an Activated Sludge System**

The waste water, after the primary treatment operations, is sent to an aeration tank containing active microbial population. The tank must be continuously aerated. The mixture is passed to a settling tank. The settled cells are recycled back to the aeration tank in order to maintain sufficient biomass (i.e., to have a high concentration of cells) for the degradation of the organic material in the aeration tank. Other forms of activated sludge system includes extended aeration, contact stabilization, step aeration and pure oxygen processes.

**(b) Aerated Lagoons**

The aerated lagoons are the surface-aerated basins dug out in earth to carry out biological oxidation processes for treating industrial waste waters.



Aerated lagoons are generally categorized into two types,

- The completely mixed lagoon/completely suspended lagoon.

In this type of lagoon, the concentration of solids and dissolved oxygen is almost the same.

- The facultative lagoon/aerobic-anaerobic lagoon/partially suspended lagoon.

In this type of lagoon, the solids accumulate at the bottom of the basin, which undergoes anaerobic decomposition while the upper portion is open to the atmosphere, therefore, aerobic. Motor-driven floating aerators are placed on the upper surface of the lagoons. They serve two purposes,

- ❖ transfer of air into the basin
- ❖ for mixing the air with wastewater and microbes.

The solids that accumulate at the bottom of the aeration basins need to be removed periodically to avoid build up of a permanent deposit.

**(c) Aeration**

The aeration process needs a continuous supply of oxygen by either of the various methods mentioned below,

- Diffused aeration by turbine agitation or static aerators
- Surface coarse or large bubble diffuser.

The diffused aeration system is generally placed close to the bottom of the aeration tanks. It is further categorized into,

1. Fine Bubble Diffuser

These are made up of porous materials (eg. grains of pure silica) that give rise to fine bubbles of high surface area. These bubbles aid in transfer of oxygen from air to wastewater.

2. Medium Size Bubble Diffuser

These are perforated tubes with plastic mesh or woven fabric wrapping.

3. Coarse or Large Bubble Diffuser

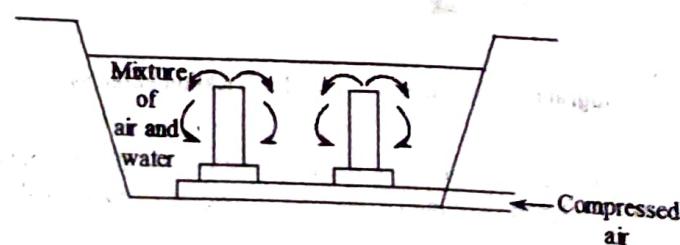
They provide large bubbles to the aeration tanks.

**Types of Aeration Systems**

The different types of aeration systems are as discussed below,

1. Static Aeration System

The static aeration system consists of a vertical tube connected to a horizontal tube and placed at the bottom of the aeration tanks. Compressed air is sent through the horizontal tube, thus transferring oxygen to the waste water. Given below is a schematic representation of static aeration system.

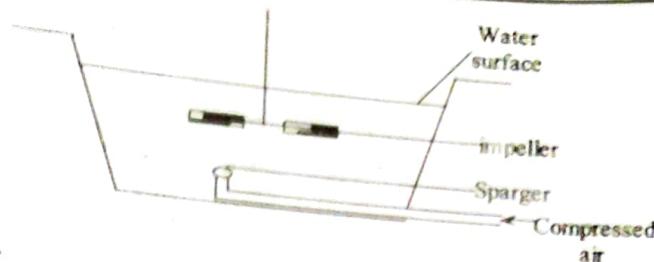


2. Turbine Aeration System

The turbine aeration system has the following components,

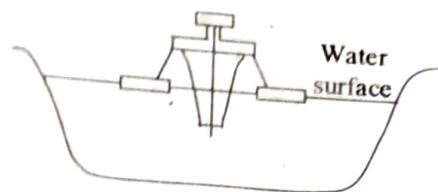
- A pipe or sparger for providing compressed air.

- Impeller : The impeller is driven by an electric motor which rotates at high speed for dispersal of air bubbles.



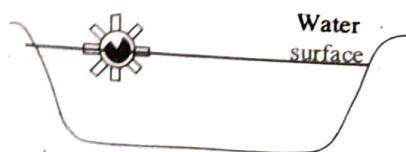
### 3. Floating Surface Aerator

It consists of a propeller driven by a motor and mounted on a float. This aeration unit floats on the water surface. The propeller pumps the liquid from under the aeration unit and sprays it above the surface of the tank. This causes transfer of oxygen from the air to the sprayed droplets.



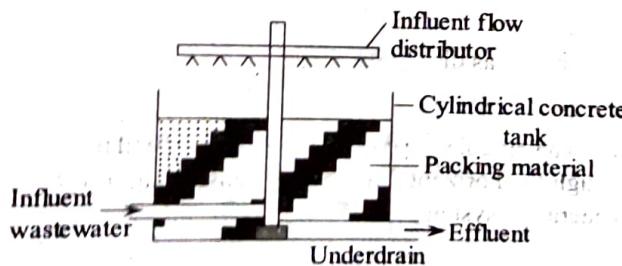
### 4. Surface Brush Aerators

It consists of blades mounted on a cylinder which rotates continuously on the surface of water.



### (d) Trickling Filter System

The trickling filter system consists of a cylindrical concrete tank (diameter = 10 – 15 mts, depth ~ 3 mts). The bottom of the tank is underlaid with a drain pipe. The tank is packed with support media made up of coke (carbonized coal), limestone or specially fabricated plastic media. The biomass is attached to the support media on which they grow. The waste water (influent) is distributed across the biomass film using perforated rotating arms that radiate from a central pivot. As the liquid trickles through the bed, oxygen in the air diffuses through the wastewater film and enters the biomass. The organic matter is absorbed and degraded by the biomass while the liquid is collected in drains at the base. With the growth of organic matter, the biomass layer thickens and in due course, some inner portion of the biomass gets detached from the support media due to lack of oxygen and nutrients, resulting in the growth of a new layer. The separated biomass now settles as flocs.

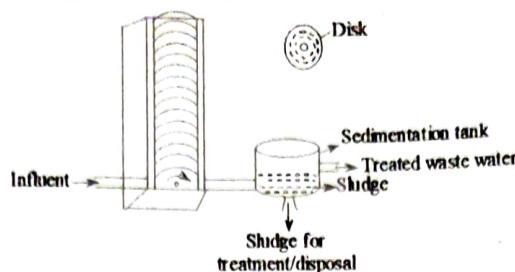


**Figure: Diagrammatic Representation of a Trickling Filter System**

### Rotating Biological Contactors

Rotating Biological Contactors (RBCs) consist of disks made up of corrugated, light plastic material (polystyrene, PVC). The biomass is attached to disks (2.5 - 3.5 m in diameter with 2 cm spacing between disks) which rotates on a central drive shaft at 10 to 15 rpm through the effluent. Up to 40% of the disks are immersed in wastewater. Upon exposure to air, the biofilm on the disks absorbs air and when submerged in wastewater, the microbes absorb the organic matter. The biofilm of 4 mm thickness grows on the surface of the disks and the excess is torn off the disks by the shear forces produced as the disks rotate through the liquid.

A sedimentation tank collects the effluents from the RBC, where the biomass in suspension settles as a sludge. The sludge is withdrawn from the sedimentation tank for further treatment or disposal.



**(f) Fluidized Bed Systems**

In these reactors, the supporting media is made up of sand, anthracite and reticulated foam with a large surface area for the attachment of biomass. In this system, the effluent is passed upward through the reactor at a high velocity. However, the velocity must not be so high that the biomass is removed/swept away from the support media. The treated effluent is then decanted off without the need of a sedimentation tank.

**(g) Biologically Aerated Filters (BAFs)**

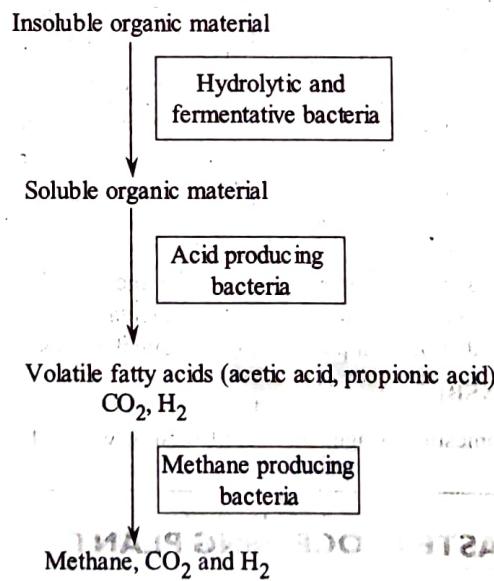
This system combines aeration and filtration along with ammonia removal. The reactor consists of packing media made up of pumice or polyethylene, to support the active biomass and filter the suspended solids. The packing media may be suspended or a fixed structure. The effluent may be passed upwards or downwards depending on the design specified by the manufacturer. The filtered solids and excess growth of biofilm is removed by regular back washing.

**(h) Membrane Bioreactors**

Membrane bioreactors consist of microfiltration or ultrafiltration membranes immersed in an aeration tank. The system effectively removes both soluble and particulate biodegradable materials from untreated effluents without the need for clarification in sedimentation tanks.

**(ii) Anaerobic Process**

The anaerobic treatment of effluents involves the degradation of organic matter to gaseous products (mainly methane and carbondioxide). The insoluble organic matter present in the wastewater is converted to soluble organic matter by the action of hydrolytic and fermentative bacteria. The acid producing bacteria consume the soluble organic matter to produce volatile fatty acids (acetic acid, propionic acid), carbondioxide and hydrogen, which in turn, is consumed by methane producing bacteria to give methane and carbondioxide.

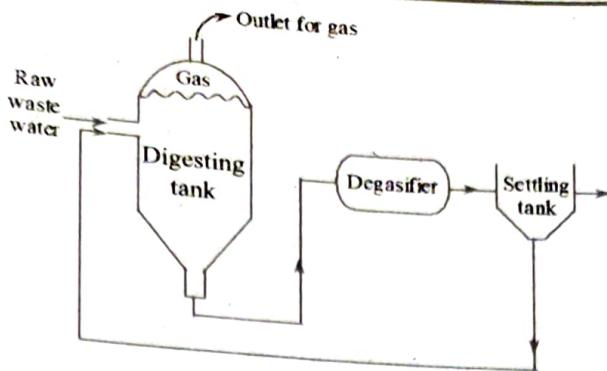


**Summary of Reactions During Anaerobic Treatment**

Some of the anaerobic processes developed are anaerobic digesters (completely mixed reactors), anaerobic filters, up-flow anaerobic sludge blankets and Imhoff tanks.

**Anaerobic Digesters**

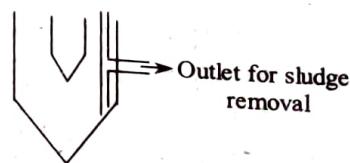
Anaerobic digesters consist of digester tanks for anaerobic digestion of effluents to occur. The tanks are sealed properly to provide anaerobic conditions as oxygen kills some of the anaerobic bacteria present in the digesting tank and disrupts the process. The effluents are sent to a degasifier and to a settling tank. The treated effluents are discharged while the solids are recycled for reuse.



**Figure: Diagrammatic Representation of Anaerobic Digester**

The gaseous by products formed are methane, carbondioxide and small amounts of nitrogen and hydrogen. Some digesters are equipped with heating coils for maintaining ambient temperatures of 30°C-35°C.  
Imhoff Tanks

Imhoff tanks consist of a rectangular tank with two chambers – an upper compartment and a lower compartment [Figure]. Such tanks are built partially underground. The untreated wastewater proceeds to the upper compartment that acts as a setting to the basin while anaerobic digestion of settled solids occurs in the lower compartment. The sludge thus formed at the bottom of the compartment is removed at an interval of six months.



**Figure: Diagrammatic Representation of an Imhoff Tank**

Sometimes, the tanks are provided with inlets and outlets at both ends and the flow of effluents into the tank is reversed periodically for even accumulation of sludge at the bottom. Imhoff tanks can be installed easily. However, it has certain drawbacks like foaming odour and scum formation due to imbalance in the digestion process. When the temperature within the tank drops to 18°C or below, the volatile acid producing bacteria increase in biomass. As a result of this, the production of methane is reduced. The gases produced during anaerobic digestion are unable to escape as they are trapped by the solids leading to the formation of scum. Such drawbacks are overcome by increasing the depth of the lower chamber of the tank. The bubbles formed at lower depths expand as they rise and escape from the solids.

#### Anaerobic Filters

Anaerobic filters consist of microbial biomass on an inert support which may be natural or synthetic material or both. Such filters are used for treating antibiotic fermentation wastes, citric acid fermentation wastes, yeast production wastewater, brewery wastewater, winery wastewater, molasses distillery slops and pharmaceutical wastes.

#### Upflow Anaerobic Sludge Blankets (UASB)

These are used in treatment of domestic sewage, sugar-beet wastes, wastes from slaughter houses, agricultural wastes, brewery, winery and distillery wastes.

### 5.4 MUNICIPAL SOLID WASTE PROCESSING PLANT

Q22. Write about the municipal solid waste processing plant with the help of a case study.

Answer :

Municipal solid waste management refers to application of suitable techniques, technologies and management programs at the following objectives,

Reduction in waste

Effective management of waste with least impact on environment and economically sustainable.

The garbage or waste generated from every household, industry or hospital is referred to as the solid waste.

Model Paper-II, Q11(b)

### Functional Components

The municipal solid waste collection involves the following components.

#### (a) Municipal Solid Waste Collection from Non-Point Sources

The waste generated from various households are collected by garbage collectors who are employed under contract by the firms or local governing bodies. The waste is collected generally in a three-wheeled cart and dumped in the community bins/communal containers.

This stage also involves the garbage clearance operations including sweeping of roads, removal of road silts, rubbles, debris, shrubs and all types of solid wastes on the roads on all days of the week.

#### (b) Municipal Solid Waste Collection from Point Sources

The waste deposited in the community bins/communal containers now form the point source for municipal solid waste. The community bins are placed at specified street corners, near markets, apartment complexes, shopping malls, hotels, gardens and religious places.

The frequency of lifting garbage from the community bins should be increased to prevent garbage pile up and create other health problems.

#### (c) Transfer of Garbage to Disposal Sites

Large dumper placer vehicles collect waste from the community bins and dump the waste at garbage dumping yards, located several kilometers away from the main city. At certain places, small collection vehicles are used to carry the garbage to transfer stations where the wastes are loaded into large vehicles (such as, trailers or Bulk Refuse Carriers) for transportation to the disposal or processing sites or a specified landfill site.

Ramky Enviro Engineers Ltd (REEL) is considered to be the leader in providing comprehensive environment management services to the city of Hyderabad.

The different kinds of environmental services taken up by this groups include,

- (i) Waste management – Hazardous, municipal, biomedical, construction waste, e-waste.
- (ii) Transformation of waste to energy.
- (iii) Recycling of waste – Water, paper, plastic etc.
- (iv) Effluent treatment plant, remediation.
- (v) Wastewater treatment.

- The significant features of the largest environmental services company are,
- (i) The hazardous waste is collected by the hazardous waste disposal experts. It is transported safely, disposed off scientifically, in compliance with the hazardous waste rules.
  - (ii) The biomedical waste is handled by the biomedical waste experts. They arrange to collect the waste from healthcare facilities, transport carefully and disposed off appropriately.
  - (iii) The municipal solid waste is disposed off appropriately.
  - (iv) The industrial and domestic waste comprising paper, plastic, e-waste, used oil, metals, construction waste and demolition waste are recycled effectively.
  - (v) The integrated environmental science include the multidisciplinary activities, such as
    - ❖ Deactivation and decontamination of waste
    - ❖ Effluent treatment plant
    - ❖ Seawater desalination
    - ❖ Sludge utilization, etc.
  - (vi) The experienced team at REEL provide expert advise at par with the scientific methodology.
  - (vii) The waste generated from construction, demolition, excavation, road building, is processed by crushing, washing, and segregation according to desired sizes and reused for the manufacture of tiles, and landfilling of low lying areas.

## 5.5 AIR PORTS

### Q23. Discuss a case study of EIA for airport construction.

#### Answer :

Model Paper-III, Q11(b)

A hypothetical case study of EIA for airport construction has been presented below,

#### Introduction

A new airport has to be set up at XYZ site to cater to the requirements of the people.

#### Goals and Objectives of the Proposed Project

The main objective of the proposed project is to build an environmentally-friendly airport with special emphasis on cost-efficiency and to provide the best service for the passengers. It is proposed to be built with the following features,

- ❖ Modern architecture,
- ❖ Efficient operation and maintenance standards.
- ❖ Additional revenue generation.
- ❖ Providing additional employment opportunities.
- ❖ Improvement in the quality of life of the local people.

The facilities intended for air traffic operations are runway, taxiway, passenger and cargo terminal buildings, control tower, hangar, maintenance areas, fencing and security, vehicle parking etc. Additional infrastructure development in the form of hotel/motel/lodging facilities/restaurants/malls/shopping centres etc.

The study area should cover a 10 kilometers radius around the proposed project site.

#### **Project Description**

The proposed project requires clearance from the Ministry of Environment and Forests (MoEF). This section should include the location of the project, with longitude and latitude, revenue village, tehsil, district and state. The details of the sponsors, the estimated cost, the existing domestic and international traffic, a map of the project site including 10 km around the site must be included. Information on the villages and human habitations, rehabilitation and resettlement of villagers/communities in the proposed project area must be provided.

#### **Baseline Environmental Data**

This section should contain information on land use/land cover, physiography, geology, minerals, soils, seismicity, area under settlement, vacant lands, roads, waterbodies, forest cover and environmentally sensitive places. Thematic maps of the study area are prepared using satellite imageries. The land use classification can be accomplished by digital image processing technique.

#### **Land Environment**

The soil quality monitoring stations located at different places around the project area, record the various soil parameters like pH, electrical conductivity, cation exchange capacity, texture, sodium, calcium, magnesium, potassium, sodium adsorption ratio, water permeability, water holding capacity, porosity and soil texture.

#### **Hydrometeorology**

The description given below is for a hypothetical example.

The area experiences high relative humidity, generally in the range of 45% to 75% throughout the year. The monsoon period sets in mid June and ends by late September. The hydrometeorological stations located at various places around the project site record the rainfall received during the year.

#### **Physiography**

The proposed project site is located in the coastal region.

#### **Geology**

The area has basaltic rocks, dykes and lava flows.

#### **Drainage**

The study area is drained by many rivers. The names of the rivers are to be included in this section.

#### **Land Environment**

The soil quality monitoring stations located at different places around the project area, record the various soil parameters like pH, electrical conductivity, cation exchange capacity, texture, sodium, calcium, magnesium, potassium, sodium adsorption ratio, water permeability, water holding capacity, porosity and soil texture.

#### **Water Environment**

The water quality monitoring stations analyze the water samples (surface water and groundwater) for various physical, chemical and biological parameters.

The water quality parameters for analysis include pH, temperature, Total Suspended Solids (TSS), Total Dissolved Solids (TDS), oil and grease, salinity, nitrate, phosphate, silicate, dissolved oxygen, biochemical oxygen demand, cadmium, lead, mercury, total organic carbon, fecal coliform, total heterotrophic bacteria.

#### **Air Environment**

Air quality monitoring stations located at different places around the project area to assess the various pollutants such as total particulate matter, respirable particulate matter, oxides of nitrogen, sulfur dioxide, ammonium carbon monoxide, hydrocarbons. The average concentration of all the parameters mentioned above may vary in different seasons.

The Traffic Noise Index (TNI) and the Noise Pollution Index (NPI) is calculated for the industrial area, commercial area and sensitive area around the proposed project site.

Assessment of the different habitat types, general status of vegetation, wildlife, rare-endangered species and the impact of the project on the environment by the monitoring stations located in the project area for ecological studies. The biotic communities in the terrestrial habitats are assessed. The different types of animals encountered in the study area are to be enlisted.

The different types of habitats in the project area are to be specified, namely open-land, salt marshes, mangrove forests, agricultural lands and man-made groves. The flora of terrestrial habitats in the project area to be mentioned include trees, shrubs, herbs, climbers, grasses, their frequency and dominance.

#### **Impact Analysis and Mitigation Measures**

The impact of the project activities on the environment are the aircraft noise caused by takeoffs, landings, taxiing, engine testing, etc. The air quality around the project area is affected as the air pollutants emitted at the airports include nitrogen dioxide ( $\text{NO}_2$ ) fine particles ( $\text{PM}_{10}$  and  $\text{PM}_{2.5}$ ), smoke and unburned hydrocarbons.

- Mitigation measures includes the following aspects,
- Improving air quality assessments at the airports
  - Emphasizing on airlines to cut emissions from aircrafts
  - Influencing the ground vehicles to reduce emissions
  - Decrease in the height at which the construction material is loaded or unloaded.
  - Use of silencers on construction equipment for noise abatement.
  - Use of noise barriers to prevent the noise emanating from the construction equipment from the sensitive receivers. Energy management systems to monitor and reduce overall energy use includes.
  - Use of renewable energy sources such as solar photovoltaic panels or wind turbines.
  - The municipal solid waste is burnt to produce electricity.
  - Use of alternative fueled airport vehicles.
  - Encourage the use of low-emission rental cars, taxis, shuttles.
  - Implement water conservation measures such as installation of automatic shutoff and low-flow plumbing fixtures, water-reuse programs.

## FREQUENTLY ASKED AND IMPORTANT QUESTIONS

**Q1. What are the factors to be considered for taking decisions on assessment of impact significance?**

Important Question

**Answer :**

For answer refer Unit-V, Q1.

**Q2. Describe the environmental impact assessment of an inland waterways project.**

Important Question

**Answer :**

For answer refer Unit-V, Q10.

**Q3. Explain in detail about a case study related to pharmaceutical industry.**

Important Question

**Answer :**

For answer refer Unit-V, Q11.

**Q4. Considering thermal power project as an example, explain the appropriated mitigation measures to control environmental impact of the power plants.**

Important Question

**Answer :**

For answer refer Unit-V, Q12.

**Q5. Considering nuclear power reactors as a case study, describe the positive and negative environmental impacts and suggest an EMP to mitigate the negative impacts.**

Important Question

**Answer :**

For answer refer Unit-V, Q13.

**Q6. What are the impacts of highways on environment?**

OR

Considering the two developmental projects given below, explain how vegetation is affected and what are the subsequent impacts.

- (a) Water resources development project – major dam.
- (b) Highway project – Expressway.

Important Question | July-21, (R16), Q7(b)

**Answer :**

For answer refer Unit-V, Q15.

**Q7. Write a model EIA statement for a multipurpose dam.**

Important Question | Dec.-20, (R16), Q8

**Answer :**

For answer refer Unit-V, Q16.

**Q8. What are the environmental impacts of coal mining.**

Important Question

**Answer :**

For answer refer Unit-V, Q19.

**Q9. Describe the environmental impact assessment of a cement plant.**

Important Question

**Answer :**

For answer refer Unit-V, Q20.

**Q10. Write about sewage treatment plant with the help of a case study.**

Important Question

**Answer :**

For answer refer Unit-V, Q21.