

# SUSTAINABLE MINING AND GEOINFORMATION

**Prof. Basanta Kumar Prusty**

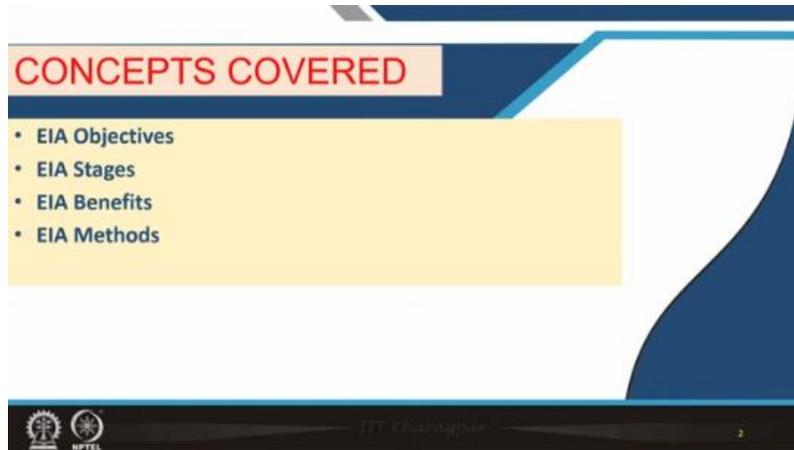
**Department of Mining Engineering**

**Indian Institute of Technology Kharagpur**

**Week – 05**

## **Lecture 25: Environmental Impact Assessment for Mining Projects-I**

Welcome, students, to Lecture 25 of the NPTEL online certification course on sustainable mining and geo-information. Today's lecture will discuss the environmental impact assessment for mining projects. In the last two classes, we discussed the environmental impacts of different mining projects. Now, for sustainable development, it is very important that we assess the likely environmental impacts of mining projects, how we can predict the impacts, how we can evaluate them, and then take mitigation measures and remedial measures so that the environmental impact is minimized. With this background, we will take two classes.



Today's class, Lecture 25, and the next class, Lecture 26, will cover environmental impact assessment in general. EIA, as an exercise and a document, is applicable not only to mining projects but also to other developmental projects. So, the general concepts of environmental impact assessment will be discussed today. In the next class, we will take a case study of mining projects, discussing the environmental impact assessment study of a particular mining project. So, the topics or concepts covered in today's class are: What is an EIA? What are the objectives of an EIA study? Then, what are the different phases

or stages of an environmental impact assessment study? What are the benefits of the EIA study? Then, we will talk about the different methods of conducting an environmental impact assessment study.

**EIA OBJECTIVES**

- New mining projects and expansion projects have to carry out EIA study prior to its opening and expansion based on the stipulated guidelines of **Environment Impact Assessment (EIA) Notification, 2006** and subsequent amendments.
- EIA is an exercise to identify and predict the impact of a project on environment and health so as to recommend **programs and operational procedures** to minimize the impact.
- EIA study to be carried out before **a project** is undertaken to ensure that it will not in any way harm the environment on a **short term and long term basis**.
- Recommendations of the EIA study may lead to redesign of specific project components, require additional studies, and suggest mitigation measures that may alter the project implementation.
- EIA's main objective is to identify significant impacts early in the project cycle so that recommendations can be incorporated into the design of the project.
- EIA will suggest appropriate environmental monitoring and management practices during project implementation.

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Environmental impact assessment, or EIA in short—what is the objective of this EIA study? First, we must understand what an EIA study is. Now, regarding mining, when a new mining project is started or there is an expansion project for an existing mine—for example, let's say we have a coal mine producing 20 million tons of coal per year, and we want to expand it to produce 30 million tons per year. This is a significant expansion. In both cases—whether opening a new mining project or expanding an existing mine to an enhanced capacity—we must carry out an environmental impact assessment study. The study is conducted based on the stipulated guidelines of the EIA notification of 2006. The Ministry of Environment, Forest and Climate Change (earlier known as the Ministry of Environment and Forest) notified guidelines in September 2006 on how to conduct an EIA. Since September 2006, there have been many amendments. So, we must follow the original notification of September 2006 as well as subsequent amendments from the Ministry of Environment and Forest, and following these guidelines, we must carry out the EIA study. EIA is an exercise to identify and predict the impact of a project on the environment and health, to recommend programs, operational procedures, and mitigation measures to minimize adverse impacts. This EIA study must be carried out before a project is undertaken to ensure it does not harm the environment, either in the short term or the long term. When we carry out the EIA study, we will discuss the different stages of the study and ultimately produce an EIA report with recommendations.

The recommendations of the EIA study may lead to a redesign of a specific project component, and it may suggest mitigation measures that will alter the project

implementation itself. The EIA's main objective is to identify the significant impact early in the project cycle so that its recommendations can be incorporated into the design of this new project and the impact can be minimized. The EIA study will also suggest an appropriate environmental monitoring scheme as well as environmental management practices during the implementation of the project so that the impact can be minimized.

**SALIENT FEATURES OF EIA**

- EIA identifies the possible **positive and negative impacts** to the environment resulting from a proposed project;
- EIA identifies **short term** and **long term** impacts;
- EIA proposes a plan which when implemented will **reduce or offset the negative impacts** of the project resulting in a minimum level of environmental degradation;
- EIA measures the level of **management plan implementation** and **degree of effectiveness** of the environmental mitigation provisions and provides for monitoring program.

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Now, coming to the salient features of the EIA, the EIA identifies the impact of the project, both positive and negative. It will also identify short-term and long-term impacts. The EIA will propose a plan that, when implemented, will reduce or offset the negative impacts. When we implement the EIA, there will be a minimum level of environmental degradation because of the project.

**EIA BENEFITS**

- Potentially screens out environmentally-unsound projects
- Proposes modified designs to reduce environmental impacts
- Identifies feasible alternatives
- Predicts significant adverse impacts
- Identifies mitigation measures to reduce, offset, or eliminate major impacts
- Engages with potentially affected communities and stakeholders.
- Influences decision-making and the development of terms and condition

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Coming to the benefits of the EIA study, the EIA potentially screens out environmentally unsound projects. So, when you do an EIA study, you will evaluate the project from the environmental point of view, studying the different impacts. So, whether the project will be environmentally acceptable or not, whether the impacts are much more compared to

the benefits of the project. That way, we can identify the environmentally unsound projects and take suitable measures to reduce the environmental impact. It proposes modified designs to reduce the environmental impact. It identifies feasible alternatives, so when we do a study, we can see that for the same project, there can be several pathways. So, it will suggest different alternatives and suggest implementing the best possible one. As it is obvious that it predicts significant adverse impacts, it identifies mitigation measures to reduce, offset, or eliminate major impacts. It engages with potentially affected communities and stakeholders. So, there is a mechanism where we are communicating with all the stakeholders—government, civil society, the community—and taking their opinions. It influences decision-making and the development of terms and conditions under which the project will be implemented. So, this is a brief about the EIA study. Now, coming to how to conduct an EIA study?

**EIA STAGES**

- Scoping
- Base Line Study
- Impact Prediction
- Impact Mitigation Plan
- Draft Environmental Impact Statement (**DEIS**)
- Public Hearing
- Review And Decision Making
- Final Environmental Impact Statement (**FEIS**)
- Post Project Monitoring

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There are different stages of the EIA study. The stages are scoping, baseline study, impact prediction, impact mitigation plan. Then, we produce the draft environmental impact statement (DEIS), public hearing, then review and decision-making, then the final environmental impact statement, and then post-project monitoring. So, these are the different stages of the EIA.

## SCOPING

- Scoping/ Terms of Reference identifies the concerns and issues for a particular project.
- There may be a set of guidelines and review checklists for different project types with general questionnaires for different sectors.
- Important to define the scope of EIA at the early stage of EIA.

Components of scoping study are:

- a. Define the proposed action
- b. Identify what is important and what is not important
- c. Set time limit of studies
- d. Determine the requirement of the study team
- e. Collect background information
- f. Identify other regulatory requirement

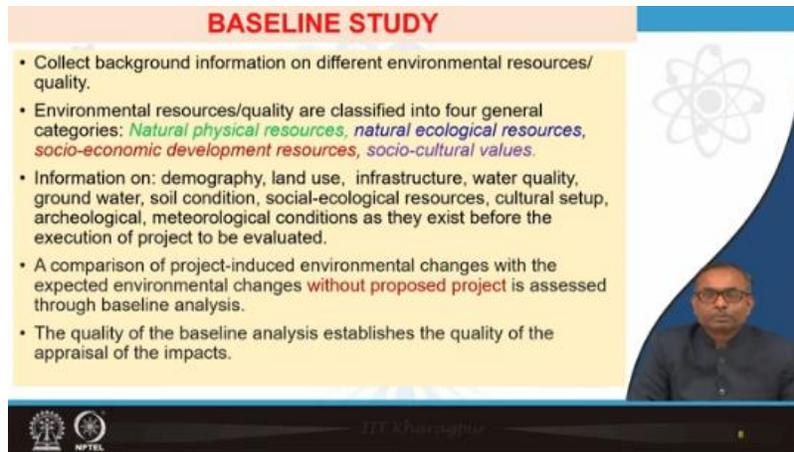
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Now, coming to scoping. Scoping, or we can also say terms of reference, identifies the main important issues and concerns for a particular project. All projects are not the same. A mining project is different from an irrigation project. An irrigation project is different from a hydroelectric dam project. So, their adverse impacts on the environment are different. Thus, the issues and concerns are also different. When we start an EIA study, we have to first identify which issues we want to concentrate on. That is the scoping or terms of reference. Now, the ministry may have a set of guidelines and review checklists for different types of projects. For a mining project, they may have a different checklist; for an airport project, they may have a different checklist; for a road project, they may have a different checklist. They may have checklists as well as questionnaires for the different sectors.

Using the scoping, we identify what are the issues, what are the boundary conditions, what is the scope of the EIA. So, components of scoping studies are: define the proposed action plan; identify what is important and what is not important. Set the time limit of the studies. It could be 6 months, or it could be 12 months, or it could be 18 months. Determine the requirement of the study team depending on the issues; depending on the relevant pollution, our team will be different. Let's say you may have air pollution, water pollution, soil degradation as the important issues. So, we have to take experts from those domains to conduct the study. Then, collect background information for the relevant environmental aspect. Then identify other regulatory requirements.

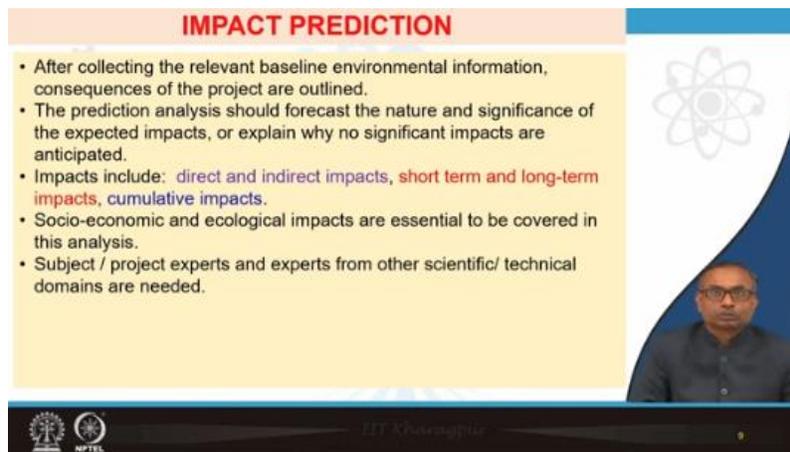
## BASELINE STUDY

- Collect background information on different environmental resources/ quality.
- Environmental resources/quality are classified into four general categories: *Natural physical resources, natural ecological resources, socio-economic development resources, socio-cultural values.*
- Information on: demography, land use, infrastructure, water quality, ground water, soil condition, social-ecological resources, cultural setup, archeological, meteorological conditions as they exist before the execution of project to be evaluated.
- A comparison of project-induced environmental changes with the expected environmental changes **without proposed project** is assessed through baseline analysis.
- The quality of the baseline analysis establishes the quality of the appraisal of the impacts.



After scoping is identified, then we go to baseline because we have to carry the baseline environmental information to know what is the pre-project environmental quality or pre-mining environmental condition. Collect background information on different environmental resources. Environmental resources can be classified to four general categories. One is the natural physical resources like air, water, soil, groundwater like that. Then natural ecological resources like vegetation, forest, flora, fauna like that. Then socio-economic development resource, what is the condition of the society, economic status of the society, the income level, the education level, social infrastructure, economic infrastructure—all these things are socio-economic resources. Then socio-cultural values, the cultural values, the heritage, historical resources—these are also very very important. We have to collect background information on all these four categories of environmental resources, particularly to give a idea we have to collect information on demography, land use, infrastructure available, water quality, ground water, soil condition, socio ecological resources, cultural setup, archaeological resources available, meteorological conditions and what is the information about all these things as they exist before the execution of the project to be evaluated? Once you collect the information on these baseline environmental status, then a comparison of project induced environmental changes with the expected environmental changes without the proposed project. Now, even when there is no project, some changes will be taking place because change is the rule of the nature. So, you have to also first ascertain what will be changes taking place without the project and what changes might take place because of the project. So, these two scenarios also we have to see. The quality of the baseline data is very very important because from the baseline data only it will help us to predict what will be the impact because of the project. So, if the baseline data quality is good, if the data is extensive will have a better ability to

predict the impact. If the baseline data is very meagre, very less, it may not be reliable and thus, our impact prediction may also be lacking in reliability.



**IMPACT PREDICTION**

- After collecting the relevant baseline environmental information, consequences of the project are outlined.
- The prediction analysis should forecast the nature and significance of the expected impacts, or explain why no significant impacts are anticipated.
- Impacts include: **direct and indirect impacts, short term and long-term impacts, cumulative impacts.**
- Socio-economic and ecological impacts are essential to be covered in this analysis.
- Subject / project experts and experts from other scientific/ technical domains are needed.

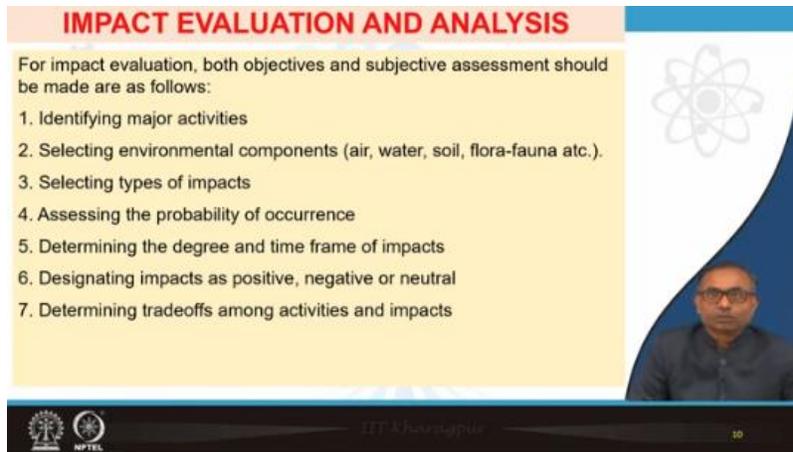
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Next is impact prediction. So, after collecting the relevant baseline environmental information now what are the likely consequence of the project, what are the likely impact: adverse impact as well as both positive impact that we have to ascertain. Who will ascertain? It will be done by the experts: subject experts, project experts, different domain specific experts. Now the impact prediction analysis should forecast the nature and significance of the expected impact. Whether it will be an adverse impact, whether it will be positive impact, whether the impact will be very extensive, severe or it will be less severe or medium. The expert team have to apply their mind and they have to predict what will be the impact. The impact will include direct and indirect impact, short term impact and long term impact. Then cumulative impact. You know for example regarding pollution, you have primary pollution and the primary pollutants interact among themselves to produce a secondary pollution. So that is a cumulative impact, that is not the primary impact. Similarly, in the socio economic sector also, what will be the impact in the ecological sector like on the flora and fauna? We have to identify and we have to predict. So, subject experts, project experts and experts from different technical domains like social science, like economics, like air pollution, water pollution, soil etc. if it is a mining project, experts from mining, they all are required to carry out this impact prediction.

## IMPACT EVALUATION AND ANALYSIS

For impact evaluation, both objectives and subjective assessment should be made as follows:

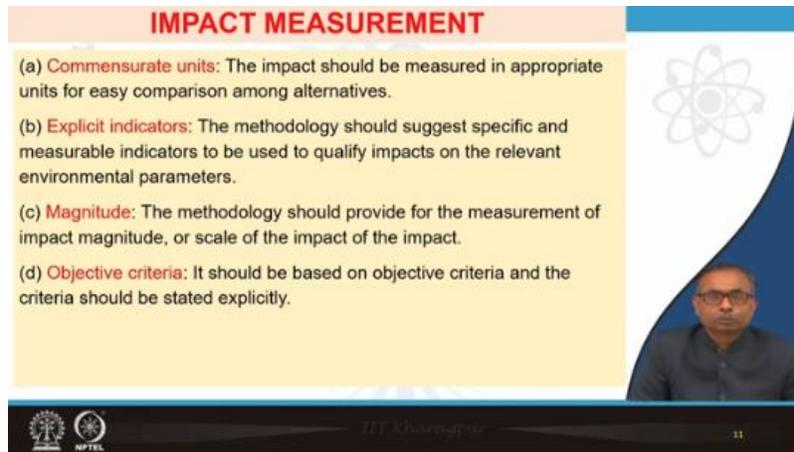
1. Identifying major activities
2. Selecting environmental components (air, water, soil, flora-fauna etc.).
3. Selecting types of impacts
4. Assessing the probability of occurrence
5. Determining the degree and time frame of impacts
6. Designating impacts as positive, negative or neutral
7. Determining tradeoffs among activities and impacts



Once the experts have predicted the impact, we have to evaluate the impact and make an analysis to derive what the mitigation measures will be. So, impact evaluation includes both subjective and objective evaluation because there are some impacts. Some impacts can be easily quantified and measured, so objective evaluation is possible. There are some parameters which are subjective and not easily measurable, so their subjective evaluation will be done. Now, for impact evaluation, what are the steps? Identifying major activities, selecting suitable environmental components or parameters like air quality, water quality, soil quality, flora, fauna—all these components of the environment we have to identify and determine what impact will occur among these attributes of the environment. Selecting types of impact—short-term impact, long-term impact, and so on. Assessing the probability of occurrence: some impacts have a lower chance of occurrence, some have a higher chance, some will have a more severe impact, and some will be less severe. Determine the degree and time frame of the impacts. Some will occur immediately in the short term, but some impacts will take more time—you will see the effect in the long term. So, the time frame is also very important. Designate the impact as positive, negative, or neutral, and determine trade-offs among activities and impacts. When you do the analysis, we have to see which impacts we can accommodate and which impacts require remedial measures so that those impacts are not at all desirable or tolerable.

## IMPACT MEASUREMENT

- (a) **Commensurate units:** The impact should be measured in appropriate units for easy comparison among alternatives.
- (b) **Explicit indicators:** The methodology should suggest specific and measurable indicators to be used to qualify impacts on the relevant environmental parameters.
- (c) **Magnitude:** The methodology should provide for the measurement of impact magnitude, or scale of the impact of the impact.
- (d) **Objective criteria:** It should be based on objective criteria and the criteria should be stated explicitly.

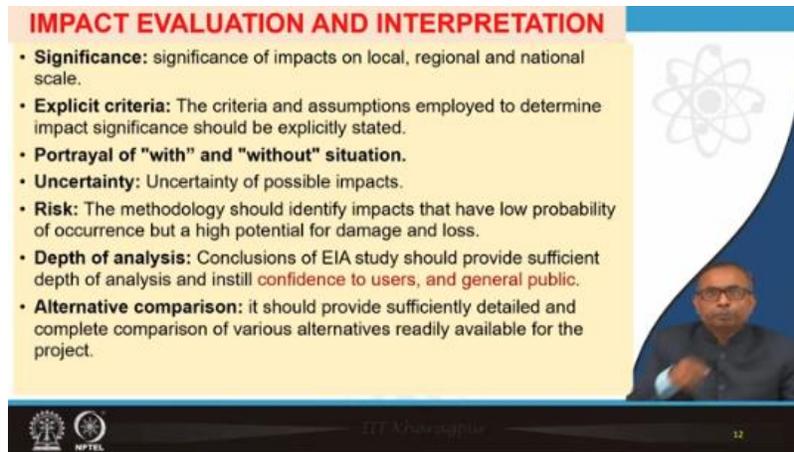


Impact measurement: For impact measurement, they should be measured in appropriate units for easy comparison among alternatives. Explicit indicators—the EIA methodology we are using should suggest specific and measurable indicators. Using these measurable indicators, we can quantify the impact, and in some cases, we can qualify the impact. For example, water quality—let’s say pH. It is an explicit parameter. So, I can measure the pH of the water, say, from mine drainage. If it is acidic, I can say it is acidic water. If it is alkaline, I can say it is alkaline water. These are very explicitly measurable parameters. But there are some parameters, like aesthetic impact or visual impact, which are not easily quantifiable or measurable. So, their subjective evaluation has to be done by subject experts. Magnitude: The methodology should provide a measurement of impact magnitude. So, we can assign a scale to the impact. For example, for air pollution or water pollution, I can assign 100 marks. If the impact is 90 or more than 80, I can say it is a very severe impact. If the impact is, say, 30, I can say it is a lesser impact. Magnitude, in some cases, must be given based on objective criteria. The criteria should be explicitly stated.

Particularly where the parameter is easily measurable, we can easily provide objective criteria. But there are some parameters which are not quantifiable—some subjectivity exists—and there, we have to use subject expert opinions. The quantification or scaling will be done by the experts, who can use a rating or classification system.

## IMPACT EVALUATION AND INTERPRETATION

- **Significance:** significance of impacts on local, regional and national scale.
- **Explicit criteria:** The criteria and assumptions employed to determine impact significance should be explicitly stated.
- **Portrayal of "with" and "without" situation.**
- **Uncertainty:** Uncertainty of possible impacts.
- **Risk:** The methodology should identify impacts that have low probability of occurrence but a high potential for damage and loss.
- **Depth of analysis:** Conclusions of EIA study should provide sufficient depth of analysis and instill **confidence to users, and general public.**
- **Alternative comparison:** it should provide sufficiently detailed and complete comparison of various alternatives readily available for the project.



Impact evaluation and interpretation: Now, the significance of the impact—when we identify the impact, what is its significance on a local, regional, or national scale? For example, air pollution from an industry—this impact may be local, or in many cases, it may extend to a regional level. For example, particulate matter can travel tens of kilometers. So, the impact may be local and regional. But if there is water pollution—for instance, a river getting polluted due to mining—the impact will be felt. Not only on a local or regional scale but also on a national scale. Let's say you have mines in a hilly region discharging into the Ganga. The Ganga is a river originating in the Himalayas and flowing all the way to West Bengal. Any pollution in the Ganga will have a national-level impact. So, you have to identify the impact and its significance. Explicit criteria: When measuring the impact, we must use very specific criteria, and it should be explicitly stated how we are measuring the impact. Portrayal of with-and-without situations—we have to compare with the project. What will be the impact without the project? What will be the impact on certainty? Some impacts we predict, but there is a chance also. Like you know, I can say there is a 50 percent chance that the air pollution will be very severe. Or I can say there is a 30 percent chance that the water quality will be severe and there will be severe adverse effect. This uncertainty also we have to quantify. Now, risk: if some pollution takes place, What will be the potential for damage and loss to the physical resources? So, uncertainty and coupled with what is the risk? If there is some pollution takes place, how much damage may take place to the physical resources, to the ecological resources? So, both are to be quantified, uncertainty as well as the risk. Now, conclusions of the EIA study should provide sufficient depth of analysis and instill confidence to the users, stakeholder and general public. Alternative comparison: EIA should provide sufficiently detailed and complete comparison of various alternatives. Because for any project, there may be several alternatives, and we will study the impact of different

alternatives and we will choose that alternative which will have less impact on the physical, biological, ecological resources. So, now coming to the impact, different type of impact. So, different project will have different impact. A mining project will have different impact. An airport project will have a different impact. A roadway project will have a different project. So, all the impact categories are not same for mining, for highway, for irrigation project.

**CHECKLIST METHODOLOGY**

Checklists is a common **impact identification** method. It is capable of bringing attention of stakeholders to most common impacts.

Checklists are of **four broad categories**. They are:

- (a) **Simple Checklists**: that are a list of parameters without guidelines provided on how to interpret and measure an environmental parameter.
- (b) **Descriptive Checklists**: that includes an identification of environmental parameters and guidelines on how parameter data are to be measured.
- (c) **Scaling Checklists**: that are similar to descriptive checklist with the addition of information basis to subjective scaling or parameter values.
- (d) **Scaling Weighting Checklists**: are capable of quantifying impacts

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The easiest method to cover all the impact category is given by a checklist. Normally the ministry of environment and forest may have a checklist for different types of projects. For mining project, they will have one checklist, For a irrigation project they will have another checklist. For an airport project, they will have another checklist. Because the impact categories are different. This is the most simplest impact identification method. There are four broad categories of checklist. One is the simple checklist, where only it gives a list of parameter without giving any additional information about how it will be used, how the impact data will be interpreted? It only gives whether this impact will be present or it will not be present. So, second is descriptive checklist. Descriptive checklist identify the environmental parameter and it gives guideline of how the parameter will be measured and how the data will be interpreted. Scaling checklist, so in the scaling checklist, the impact categories are mentioned and also it will give a scale, a numerical value scale for each impact category and scaling and weighting checklist. In this, not only a scale will be given—let us say air pollution will be given 200 marks, but then weighting will be given, air pollution has a 20 percent weightage. and water pollution has a 40% weightage. So, scaling, weighting checklist, it will have both scale as well as it will have a weight.

### Battelle Environment Evaluation System (BEES)

- BEES was developed by Battelle Laboratories of Columbus, for US Bureau of Land Reclamation. It is a **weighting scaling checklist** methodology for water-resources projects, which deals with 78 environmental factors.
- Each of the elements will be assigned an importance weight using the ranked pairwise-comparison technique. The higher the number, the greater the relative importance. Impact scaling in the Battelle EES is accomplished through the use of functional relationships for each of the 78 factors.
- Environmental impact units (EIUs) can be developed for each alternative and baseline environmental conditions. The mathematical formulation of this index is as follows:

$$EIU_i = \sum_{j=1}^n EQ_{ij} PIU_i$$

EIU<sub>j</sub> = environmental impact units for j<sup>th</sup> alternative  
 EQ<sub>ij</sub> = environmental-quality-scale value for i<sup>th</sup> factor and j<sup>th</sup> alternative  
 PIU<sub>i</sub> = parameter importance units for i<sup>th</sup> factor



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Now, the common checklist method with a scaling as well as a weighting is the Battelle Environmental Evaluation System, BEES. The BEES was developed by Battelle Laboratory in the Columbus University USA for a water resource project. It has 78 environmental parameter and so scaling is given to each of these parameter and weightage is given to each parameter. Using the scaling and weighting an environment impact unit is calculated for each parameter and then environmental impact unit for all the parameters are added to determine what is the total environmental impact unit. Once you have the total environmental impact unit, you can categorize whether the impact is less, whether the impact is moderate, whether the impact is severe. So, like that you can make a classification of the impact and this system was developed for a water resource project. Now, this system we can modify for our concerned project. For example, in the for mining, I can develop my BEES type of system to determine what will be the environment impact. of a mining project. Once the impact prediction is done, you have to suggest the impact mitigation measures.

### IMPACT MITIGATION

- Impact mitigation measures are proposed to reduce environmental and social impacts.
- Environmental Management Plan (EMP),
- Risk assessment report and disaster management plan (if hazardous substances are involved in the project),
- Rehabilitation plan (if displacement of people is anticipated) are prepared to suggest remedial measures.



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Impact mitigation measures are proposed to reduce the environmental impact, social environmental impact and the physical, biological, environmental impact and You have to propose an environment management plan which will suggest not only the remedial measure but also it will suggest a monitoring mechanism. When the project is executed, how the impacts are happening and whether our mitigation measures are working properly or not? If they are not working properly, then you can take midway correction also. Now, in case if hazardous substances are involved, you have to propose a risk assessment report, a disaster management plan. If there are some displacement of people are involved, then you have to propose a resettlement and rehabilitation plan.

**DRAFT ENVIRONMENTAL IMPACT STATEMENT**

- A draft EIA is prepared in accordance with the Terms of Reference including the range of issues identified during the scoping process.
- DEIS can be submitted to SPCB who may arrange public hearing.
- The review and decision-making starts as the proponent files an application accompanied by the documents.
- Documents are:
  - EIA and EMP report,
  - NOC,
  - Risk assessment and emergency preparedness plan,
  - Rehabilitation plan,

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Once you have identified the impacts, you have quantified the impacts, then you have to produce a document which is known as a draft environmental impact statement, DEIS. The draft EIS, the result of your baseline study, your impact assessment study, impact evaluation and interpretation study, you produce a draft environmental impact assessment statement and taking this draft environment impact statement, you submit that DEIS to the ministry. The ministry may ask the state pollution control board to organize a public hearing, In the public hearing, the draft EIS statement will be presented so that the local community, the stakeholders will give their objection and their opinion. Also, the draft EIS will be produced before the environment appraisal committee and they will give their comment or suggestions or any changes that needs to be done.

## FINAL ENVIRONMENTAL IMPACT STATEMENT

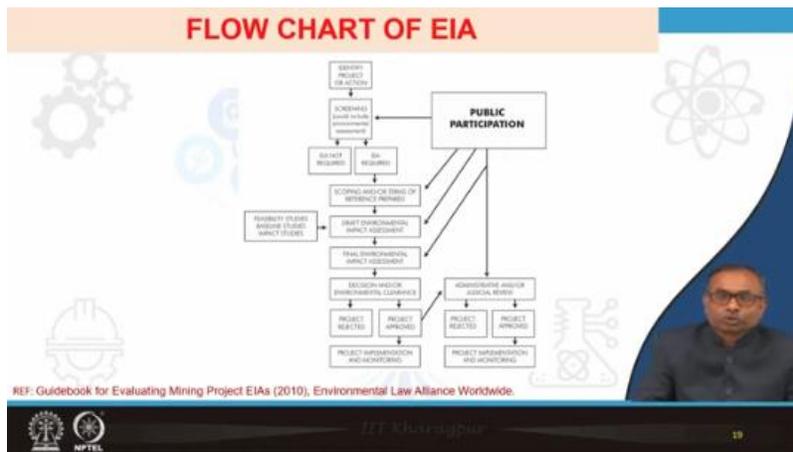
- Proponent applies for EC with DEIS to Environment Ministry.
- SPCB organizes public hearing to hear feedback from affected community
- EAC also gives their feedback.
- The feedbacks may be incorporated to prepare FEIS.
- The FEIS is submitted for final approval of the project.



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So, once the feedback comes from the environment appraisal committee, as well as the from the public hearing, the local people and the stakeholders, then you make changes, incorporate suitable changes and you produce the final environment impact statement. The final environment impact statement, you again present/submit to the Ministry and the Environment Appraisal Committee will take a decision whether to approve the project or whether to reject the project.



So, the final you can see this layout or the diagram that it shows the flowchart of the EIA. So, identify project or action, then screening or then scoping or terms of reference of the EIA study. Then you prepare the draft environmental impact statement by carrying out a baseline study, by doing the impact prediction and impact analysis. Then, you come with the public participation for the public hearing and get the feedback from the appraisal committee. Then, you produce a final environmental impact assessment report. You submit to the ministry and then the ministry will take a decision whether the ministry will give the approval or the clearance or it will reject the project. So, this is the overall format how the environment impact assessment study is carried out.

So, today's class we have discussed what is EIA, what are EIA objectives and what are the benefit of the EIA, what are the EIA stages and then what is the EIA methodology and along with the EIA, how do you evaluate the EIA, how you produce the environment management plan, this public hearing and the clearance process that we have discussed.



**SUMMARY**

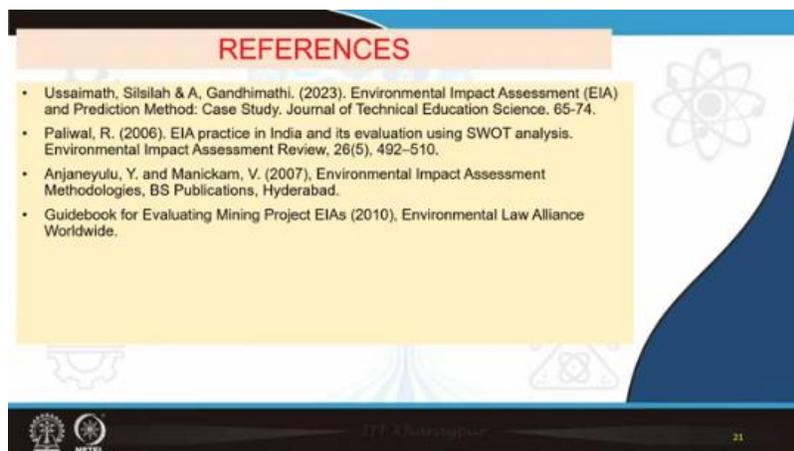
This lecture session has covered the following:

- What is EIA ?
- EIA stages
- EIA methodology
- EMP

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So, these are the references from which we have prepared the slides. You can go to these references to get more detail. This was the first class of the EIA study for mining project and the next lecture we will be discussing the EIA for a mining project. Particularly, we will discuss a case study. So, next class, the mining case study will be discussing and it will be more clear about how this EIA study is done and how it is utilized as a decision-making tool by the ministry to give the clearance, how it is used as a document so that we can improvise our project. Because, you know, it also proposes different alternatives, more suitable alternatives. So, I think this lecture was informative for you and I thank you for giving a patient hearing. Thank you very much.



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