CHAPTER ONE

1. Environment

What is environment?

- Environment simply means surroundings or it is everything that is not me.
- It is everything that surrounds us, including the air, the land, the ocean, water, and human beings, other living creatures, plants, micro-organism and property.
- It includes anything and everything.

For convenience, environment is classified in to the ***natural and human environment***. The natural environment can be classified in to two divisions:

1. Natural Environment

The natural environment can be classified in to two. These are:

a. The physical environment: This includes non-living things such as land, air and water or three physical spheres are called the lithosphere ("lithos"= rock), hydrosphere ("hydro" = water), and atmosphere ("atmos" = vapor).

b. The biological environment (biosphere ("bios"=life))**:** This includes all life forms including the plants, animals and other living organisms.

2. Human Environment

The human environment includes

- social environment
- legal environment
- political environment
- economic environment
- cultural environment

1.1. Dimensions of the environment

The environment can be structured in several ways, including ***components, scale/space and time***. The environmental components include all media susceptible to pollution, including air, water and soil; flora, fauna and human beings; landscape, urban and rural conservation and the built heritage.

The environment has also ***economic and socio-cultural dimensions. It also includes economic structure, labour markets, demography, housing and services.*** In terms of scale it is global, regional and local.

1.2. The nature of environmental impacts

Environmental impact is any alteration of environmental conditions, adverse or beneficial caused or induced by an action or set of actions. The environmental impacts of a project are that resultant changes/alteration in environmental parameters, in space and time, compared with what would have happened had the project not been undertaken. The alteration may be caused in:

1. physical environment: temperature, humidity, noise level etc
2. chemical environment: acidity of water, composition of air etc
3. biological environment: depletion in species
4. social environment: creation of sense of well being, or social tensions
5. economic environment: change in per capita income or loss of jobs etc
6. political environment: change in voter preference due to impacts of project

New developments may ***produce harmful wastes*** but also ***produce much needed jobs in areas of high unemployment***. However, the correlation does not always apply.

A project may bring physical benefits when, for example, previously polluted and derelict land is brought back in to productive use; similarly the socio-economic impacts of a major project on a community could include pressure on local health services and on the local housing market, and increases in community conflict and crime.

Projects may also have ***immediate and direct impacts*** that give rise to ***secondary and indirect impacts*** later. A reservoir based on a river system not only takes land for the immediate body of water but also may have severe downstream implications for flora and fauna and for human activities such as fishing and sailing.

1.3. Environmental inventory

Environmental inventory is a complete description of the environment as it exists in an area where a particular proposed action is being considered. The inventory is compiled from a check of descriptors for:

- the physical-chemical environment
- biological environment
- cultural environment, and
- socio-economic environment

a**.** The major areas of the **physical-chemical** environment are:

- soil, geology, topography/landscape
- surface and ground water resources
- water quality
- air quality and
- climate (temperature, precipitation, wind direction, etc)

b. Biological environment: - This refers to the flora and fauna of the area including species of trees, grasses, fish, birds etc. In the biological environment specific reference must be made to threatened and endangered plant and animal species.

c. Cultural environment: - It includes historic and archaeological sites and aesthetic resources such as visual quality.

d. Socio-economic environment: - It is about issues which are related to human environment. It is also about population growth rate, population distribution, and economic indicator of human welfare such as educational system, transportation networks, water supply, waste disposal, waste management, medical facilities, etc.

Therefore environmental inventory

- serves as a basis for evaluating the potential impacts of a proposed action on the environment
- include in EIS in the section referred to as "description of the existing environment"
- represents an initial step in the EIA processes

1.4. Environmental Impact Assessment (EIA) and its historical origin

Environmental impact assessment is the methodology or instrument of identifying, analyzing and evaluating and forecasting in advance any impact, be it positive or negative, which results from the implementation of a proposed project or public instruments.

It is also defined as a formal process for identifying the likely effects of particular activities or projects on the bio geographical environment, and on human health and well-being, along with interpreting and communicating information about these likely impacts.

EIA is a management tool, like economic analysis and engineering feasibility studies for official and managers who must make important decisions about major development projects.

From this definition we can understand that EIA is for projects. To include other things we need Strategic Environmental Assessment (SEA) that expands EIA from projects to policies, programmes, and plans. SEA is a systematic and comprehensive process of evaluating the environmental impacts of a policy, program, and plan prior to their implementation. In short, EIA is for projects and SEA for policies, plans and programs (public instruments).

The definition of the EIA, though includes the impact assessment of all types of programmes, policies, and projects, but it is more certainly applied to the developmental projects, such as the installation of a new industry, large scale animal farming projects, or a power plant, or a major airport, or a major township, etc.

Most of the countries of the world, nowadays, almost mandatorily require preparations of environmental impact assessment and to get clearance from the environmental authorities before they are granted permissions to proceed with the designated classes of the work.

The EIA of major developments have been undertaken in developed countries, particularly in USA, Europe, and Japan, etc; since 1950s or so. The main objective, however, ***was to ensure that public safety and health were adequately protected.*** Separate documents, however, were used to be submitted to each of the regulatory agencies involved, such as the water authority, air pollution control authority, etc; and no attempt was made in those earlier years to prepare a comprehensive overview. The prepared analyses were used to be reviewed by the various regulatory bodies, although not by the public.

In the 1960s and 1970s, the environmental movement resulted in environmental groups becoming more active in many countries. Responding to the demands of these pressure groups, the governments accepted the principle that ***citizens organizations should get an opportunity to participate in the decision making process of those major developments that could have significant environmental impacts.*** As a consequence, the USA enacted the first comprehensives environment legislation- the National Environmental Policy Act (NEPA) on January 1, 1970. This US action was followed by Canada, when the Canadian Federal government established an environmental assessment and review process in 1973. Many other countries then followed suit, particularly after the creation of the UN Environment Programme (UNEP).

The EIA process has, thus, evolved since the early 1970s. In the initial years, however, the emphasis was on ***assessing the impacts on measurable factors, particularly those for which some prescribed standards are available (such as the air quality, water quality, solid waste disposal, etc).*** After a few years, the EIAs began to include ***biological and ecological factors.*** More recently, the EIAs have been broadened even further to include socio-economic factors (such as employment opportunities, cultural impacts, recreational factors, etc.), so that the trade-offs among socio-economic and environmental factors could be evaluated.

It is pertinent to note that NEPA predated the 1972 UN conference in Stockholm where global concerns about the state of the environment emerged, an indicator in its own right of the mould as having the greatest international impact of any American legislation. Thus, the initiation of EIA indicates that it was environmental crisis in the industrialized countries. So for developing countries, like ours, it is the right time to apply EIA proactively than after crisis learning from others.

1.4.1. The purposes of EIA

a. An aid to decision-making

The primary purpose of EIA is to ensure that

- ***impacts of projects, plans, policies and programs, etc are adequately and appropriately considered and***

- ***mitigation measures for adverse significant impacts incorporated when decisions are taken***

  For the decision maker, for example a local authority, it provides a systematic examination of the environmental implications of a proposed action, and sometimes alternatives, before a decision is taken.

b. An aid to the formulation of development actions

Many developers no doubt see EIA as another set of hurdles to jump before they can proceed with their various activities; the process can be seen as yet another costly and time consuming activity in the permission process. However, EIA can be of great benefit to them, since it can provide a framework for ***considering location*** and ***design issues*** and ***environmental issues*** in parallel. It can be an aid to the formulation of development actions, indicating areas where a project can be modified to minimize or eliminate altogether its adverse impacts on the environment.

The consideration of environmental impacts early in the planning life of a development can lead to

- environmentally sensitive development;
- improved relations between the developer, the planning authority and the local communities;
- a smother planning permission process.

c. An instrument for sustainable development

The central and ultimate purpose of EIA is to achieve sustainable development: Development that does not cost the Earth! Existing environmentally harmful development have to be managed as best as they can. In extreme cases, they may be closed down.

Sustainable development is defined as that development, which is free from environmental degradation, poverty, and depletion of natural resource base.

It is also defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

The concept of sustainable development has challenged the society to change from its destructive and exploitative philosophy to the one that fosters long-term protection of the environment and its inhabitants. This concept has forced the scientists and other expertise to not only developed technologies which are ***efficient, productive and profitable***; but also ***to keep into consideration their impacts on health and environment, resource and energy conservation, waste management, and the social impacts*** such as the public inconveniences, unemployment, crime, etc.

Over-fertilizing the land resources, converting forests in to crop and urban land, and over harvesting forests to meet the needs of the growing population, are the short term solutions that cannot continue any more. Ultimate global of sustainable development will, in fact, require a ***stabilize population living in a secure social and physical environment***.

In the past the environment failed to feature in holistic manner in the development endeavors of the world, since project evaluation and decision making mechanisms were focused on short term technical feasibility and economic benefits. For this reason, past development practices failed short of anticipating, eliminating or mitigating potential environmental problems early in the planning process.

In recent years, major projects have encountered serious difficulties because insufficient account has been taken of their relationship with the surrounding environment. Some projects have been unsustainable because of

- resources depletion
- public opposition
- financially encumbered by unforeseen costs
- liable for damages to natural resources

Sometimes the activities which have the potential to cause harm exceeding their benefits

Example:

- Irrigation---waterborne disease, soil salination, people relocation, sedimentation
- Health service medical wastes
- Rural infrastructures (roads) ---opening forests to exploitation, soil erosion, etc.

Therefore, in order to ensure sustainable development it is essential to integrate environmental concerns in to development activities, programs, policies, etc. So, EIA as one of environmental management tools facilitates the inclusion of principles of sustainable development operation well in advance at project planning stage.

1.4.2. EIA objectives

EIA objectives can be categorized in to long term and short term.

The long term objectives include the following:

- Conservation and sustainable use of natural resources
- Protection and enhancement of the quality of all life forms
- Integration of environmental considerations in development planning processes

The short term objectives include the following:

- To assess the nature, intensity and duration of impact of proposed development projects
- To promote local community and public participation in the EIA processes of a project
- To promote social and cultural considerations in project design
- To provide a methodology for prevention and mitigation of expected impacts due to the presence of a project

1.5. Legal framework of EIA

EIA needs:

- policy/policy making body
- legislation/legislation body
- directives
- enforcement
- coordination of the different authorities/ ministries/ bodies involved

It is also imperative to know/define:

- Who conducts EIA?
- Who reviews EIA?
- Which projects need EIA?
- What /which are the guidelines, norms etc. to prepare EIA?

All the above mentioned points require a well-established legal system pertaining to environmental impacts of development activities in a country or region.

1.5.1. Legal framework in Ethiopia

The concept of sustainable development and environmental rights are enshrined in articles 44 and 92 of the constitution of Federal Democratic Republic of Ethiopia.

Article, 44: Environment rights

1. All persons have the rights to live in clean and healthy environment.
2. All persons who have been displaced or whose livelihoods have been adversely affected as a result of state programmes have the right to commensurate monetary or alternative means of compensation, including relocation with adequate state assistance.

Article, 92: Environmental objective

1. Government shall endeavor to ensure that all Ethiopians live in a clean and healthy environment
2. The design and implementation of programmes and projects of development shall not damage or destroy the environment.
3. People have the right to full consultation and the expression of views in the planning and implementation of environmental policies and projects that affects them directly.
4. Government and citizens shall have the due to protect the environment.

The Environmental Impact Assessment Proclamation (Federal Proc. No. 299/2002):- has made it mandatory that development projects are required to be subjected to EIA scrutiny. It means that EIA is a legal requirement.

1.6. Guiding principles of EIA

EIA should be:

- ***Purposive*** - the process should ***inform decision making*** and result in appropriate levels of ***environmental protection and community well-being***.
- ***Rigorous-*** the process should apply **"best practicable**" science, employing methodologies ***and techniques appropriate to address the problems being investigated.***
- ***Practical*** - the process should result in ***information and outputs which assist with problem solving*** and are acceptable to and able to be implemented by proponents.
- ***Relevant*** - the process should provide ***sufficient, reliable and usable information*** for development planning and decision making.
- ***Cost-effective*** - the process should ***achieve the objectives of EIA within the limits*** of available information, time, resources and methodology.

- ***Efficient*** - the process should impose the minimum cost burdens in terms of time and finance on proponents and participants consistent with meeting accepted requirements and objectives of EIA.
- ***Focused*** - the process should ***concentrate on significant environmental effects and key issues***; i.e., the matters that need to be taken into account in making decisions.
- ***Adaptive*** - the process should be ***adjusted to the realities***, issues and circumstances of the proposals under review without compromising the integrity of the process, and be iterative, incorporating lessons learned throughout the proposal's life cycle.
- ***Participative*** - the process should provide appropriate opportunities to inform and involve the interested and affected publics, and their inputs and concerns should be addressed explicitly in the documentation and decision making.
- ***Interdisciplinary*** - the process should ensure that the appropriate techniques and experts in the relevant bio-physical and socio-economic disciplines are employed, including use of traditional knowledge as relevant.
- ***Credible*** - the process should be carried out with ***professionalism, rigor, fairness, objectivity***, impartiality and balance, and be subject to independent checks and verification.
- ***Integrated*** - the process should address the interrelationships of social, economic and biophysical aspects.
- ***Transparent* -** all assessment, decisions, and their basis, should be open and accessible to the public.
- ***Systematic*** - the process should result in full consideration of all relevant information on the affected environment, of proposed alternatives and their impacts, and of the measures necessary to monitor and investigate residual effects.

1.7. Benefits of EIA

The potential benefits of EIA are

- saving in capital and operating costs
- environmentally sound and sustainable design
- increase project acceptance
- facilitate better decisions
- better compliance with standards
- better protection of the environment and human health

CHAPTER TWO

2. Basic EIA procedures

EIA is a systematic process that examines the environmental consequences of development actions, in advance. The emphasis, compared with many other mechanisms for environmental protection, is on ***prevention***. Therefore, the process involves a number of steps, as we can see below.

2.1. Early information collection

In best practice, EIA proponents should begin research early in the life of the project. This can include the collection of baseline data ***on local environment (both primary and secondary data)***. Early identification of a potential problem can help the proponent ***to minimize the impact by taking it into account in planning, in materials handling, and in site layout***.

2.2. Prescreening consultation

Prescreening is not normally taken as a part of a stage in the EIA process. However, its application is recommended in recognition of its importance to enhance the over all effectiveness of the EIA system.

Prescreening is a stage where the proponent and the respective environmental (Competent Agency) and other sectoral agencies established contact and hold consultation on how best to precede with EIA.

The consultation may take the form of formal ***meeting***,
a telephonic conversation or
by means of ***electronic mail.***

Undertaking of prescreening consultation is advisable because

- ***it saves time*** by avoiding delays caused by requests from the authority requiring additional information occurring at a later stage, and
- ***fosters*** a mutual understanding.
- It also allows the authority to register the application

2.3. Screening- Is an EIA needed?

Before starting the screening phase of the EIA, it is recommended that the proponent must appoint an independent consultant to assist in the process.

Screening is a process of determining whether or not a proposal should be subject to EIA and, if so, at what level of detail.

The screening phase of the EIA should decide the following:

- the need for and level of assessment
- level of government to be responsible for the project
- other necessary permits or approval process
- acceptability of the consultant to assist the proponent
- the public participation process; and
- the total life cycle of the project

In the screening process the proponent should submit to the Competent Agency a screening report that contains the following:

- the title of the proposed activities;
- the name of the proponent and the consultant(s);
- the address of the proponent and the consultant(s);
- location of the proposed development;
- the extent of the proposed activity; and
- any potential environmental issues identified by the proponent (which may include a short description of the affected environment)

2.3.1. Screening criteria

Different countries and donors use different criteria for screening project. Let us see the following example.

European Union

Screening list A = projects requiring no environmental analysis

Screening list B = projects requiring further environmental analysis

Screening list C = projects requiring a full environmental assessment

World Bank

Category A = environmental analysis is normally required as the project may have adverse and significant environmental impact

Category B = limited environmental analysis is appropriate, as the project may have specific environmental impact

Category C = environmental analysis is normally unnecessary

Category D = environmental projects, for which separate EIAs may not be required as environment would be a major focus of project preparation

EPA schedules

Schedule 1: projects which may have adverse and significant environmental impacts, and may therefore, require full EIA

Schedule 2: projects whose type, scale or other relevant characteristics have potential to cause some significant environmental impacts but not likely to warrant an environmental impact study

Schedule 3: projects which would have no impact and does not require environmental impacts

Schedule 4: all projects in environmentally sensitive areas should be treated as equivalent to schedule 1 activity of the nature of the project.

However, projects should be "screened in" by ***the decision maker*** based on

- ***the project scale***
- ***the project sectors***
- ***the sensitivity of the project location and***
- ***the expectation of adverse environmental impacts.***
- ***The attitude of the society*** i.e. degree of public interest
- ***Initial Environmental Examination (IEE) as it provides:***
    - information about the proposal
    - describes the proposal and examine alternatives
    - identifies and addresses the concerns of the community
    - mitigates adverse effects and enhances potential benefits

What are the outcomes of screening reports?

1. ***No EIA required***
2. ***preliminary assessment*** – preliminary assessment is applied to
   - projects with limited impacts which are not included in the project design
   - project proposals with inadequate information

3. Full EIA

For proposals which require EIA the next step in the process is to agree on the issues that need to be analyzed in the EIA. This process is called **scoping**.

2.4. Scoping – which impacts and issues to consider?

Scoping is the process of identifying and narrowing down the potential environmental impacts associated with the intended development project. The level of scoping will depend on

- the nature and scale of the development proposal and its complexity; and
- the sensitivity of the environment

The objectives of scoping are to:

- identify key environmental concerns and set priorities
- identify significant effects and factors to be considered
- consider reasonable and practical alternatives
- inform potential affected people
- identify the necessary information for decision making
- establish terms of reference (TOR)

The process of scoping is that of deciding, from all of a project's possible impacts and from all the alternatives that could be addressed, which are the significant ones. An initial scoping of possible impacts may identify those impacts thought to be potentially significant, those thought to be not significant and those whose significance is unclear. Further study should examine impacts in the various categories. Those confirmed by such a study to be not significant are eliminated; those in the uncertain category are added to the initial category of other potentially significant impacts. This refining of focus on to the most significant impacts continues throughout the EIA process. Good scoping has been shown to be a key factor in good environmental impact statement.

2.4.1. Who should be involved in scoping?

- the proponent
- the consultant
- the competent agency(EPA)
- affected and interested parties
- the wider community

Various techniques may be employed through the participation exercise, including:

- Public meeting
- telephone survey
- written information
- interview
- working with established groups (eg.NGOs)
- workshops, seminars etc.

Scoping is generally carried out in discussions between the developer, the competent authority, other relevant agencies and, ideally, the public. It is often the first stage of negotiations and consultations between a developer and other interested parties. It is an important step in EIA because it enables the limited resources of the team carrying issues that should later be monitored. Scoping should be begin with the identification of individuals, communities, local authorities and statutory consultants likely to be affected by the project; good practice would be to bring them together in a working group and/ or meeting with the developer.

2.5. Impact assessment study

Screening determines whether or not an EIA is required. Scoping identifies the issues that are most important to investigate in details. The assessment phase of EIA is the time when most of the work involved in impact assessment is carried out. It includes:

- Identifying impacts more specifically
- Analyzing impacts
- Determining impact significance or acceptability.

The outcome of assessment is ***EIA document***.

2.6. Identification of mitigation measures and alternatives

Mitigative measures should be clearly spelt out in the EIA. Mitigative measures aim to minimize or eliminate negative impacts and enhance the benefits. The mitigative measures should be prepared as an operational management plan and could include a combination of the following mitigation options.

- alternative ways of meeting the needs
- changes in planning and design
- improving monitoring and management
- compensation in different forms (e.g. monetary)
- replacing, relocating, rehabilitating, etc.

Alternatives are generated and examined to determine the best method of achieving project objectives, while minimizing environmental impacts. They can be grouped as follows:

- Demand alternatives e.g. using energy more efficiently versus building more generating capacity
- Activity alternative e.g. providing public transport rather than increasing road capacity
- Location alternatives either for the entire proposal or for components e.g. the location of the processing plant for a mine
- Process alternative e.g. the reuse of processed water in an industrial plant, waste minimizing or energy efficiency technology
- Input alternative e.g. raw materials, energy sources

2.7. Reporting

Once impacts have been interpreted and mitigative measures have been set, it is essential that the ***information be presented in a form that enables non-experts to comprehend.*** It is important that the information in this report is ***as comprehensive as possible since a decision regarding whether the project should go ahead or not, and whether an EIA is required to further investigate issues and alternatives, will be made on the basis of this report***. In many cases where there are no major issues identified, the scoping report will be sufficient for a decision to be made and no further studies will be required.

The report should basically be a concise presentation of the major issues identified and the public participation process. As a minimum, the report should reflect the following:

- a brief description of the project;
- all the alternatives identified during the scoping process;
- all issues raised by interested and affected parties and how these will be addressed; and
- a description of the public participation process including a list of interested and affected parts , and minutes of meeting

2.8. Reviewing

The scoping report should be submitted to the Competent Agency for review. The Competent Agency should review the document to determine whether ***the process followed in preparing the report has been adequate and that there has been sufficient consultation with interested and affected parties.***

Impacts identified in the document should be reviewed in terms of:

- socio-economic context and potential benefit
- effect on public health or risk to life
- scale, geographic extent such as regional, national or international importance
- duration and frequency
- reversibility or irreversibility
- ecological context
- degree of uncertainty

The review should also contain an analysis of the information provided to determine whether due attention has been paid to possible project alternatives and whether the issues identified have been afforded appropriate attention. The authority should complete the review within two weeks of receipt of the scoping report. Sometimes more time is required to revise depending on the nature of the project. When the review has been completed, the competent agency should decide whether to accept the application as it stands, reject the application or request that the document be amended.

2.9. Record of decision and appeal

An application may be accepted or refused by the competent agency after the screening, scoping or EIA phases. Competent agency must provide a record of decision report which should be provided to the proponent be made available to any interested and affected party on request. The record of decision report may form the basis of an environmental clearance certificate if the project is approved and may contain the details of the conditions of approval.

A proponent or other interested party who is dissatisfied may object to actions, opinions or decision made no later than four weeks after receipt of such a decision. Appeal should be submitted in writing, clearly specifying the grounds for the appeal to the general manager of the EPA depending on the competent agency for the EIA. The head of the competent agency should make his decision with in two weeks following the receipt of the appeal.

2.10. Condition of approval

The conditions of approval may be included into the record of decision but are typically prepared as a separate document. The authority, in approving a proposal may wish to make implementation of mitigation measures on condition of approval. The proponent may then require submitting a detailed Environmental Management Plan (EMP). The EMP would describe in detail how each mitigation measure should be undertaken. Monitoring criteria should also be supplied and responsibilities clearly defined. Regular independent monitoring would be undertaken at the cost of the proponent.

2.11. Internal monitoring and auditing

It is the responsibility of the proponent to conduct regular internal monitoring and auditing of the environmental performance of the operation. The audits should be a systematic evaluation of the activities of the operation in relation to the specified criteria of the condition of approval. The auditing and monitoring results may be prepared in the form of an environmental performance report, which should be submitted to the competent agency. The auditing of the competent agency would be in the form of verification of internal reports.

EIA process

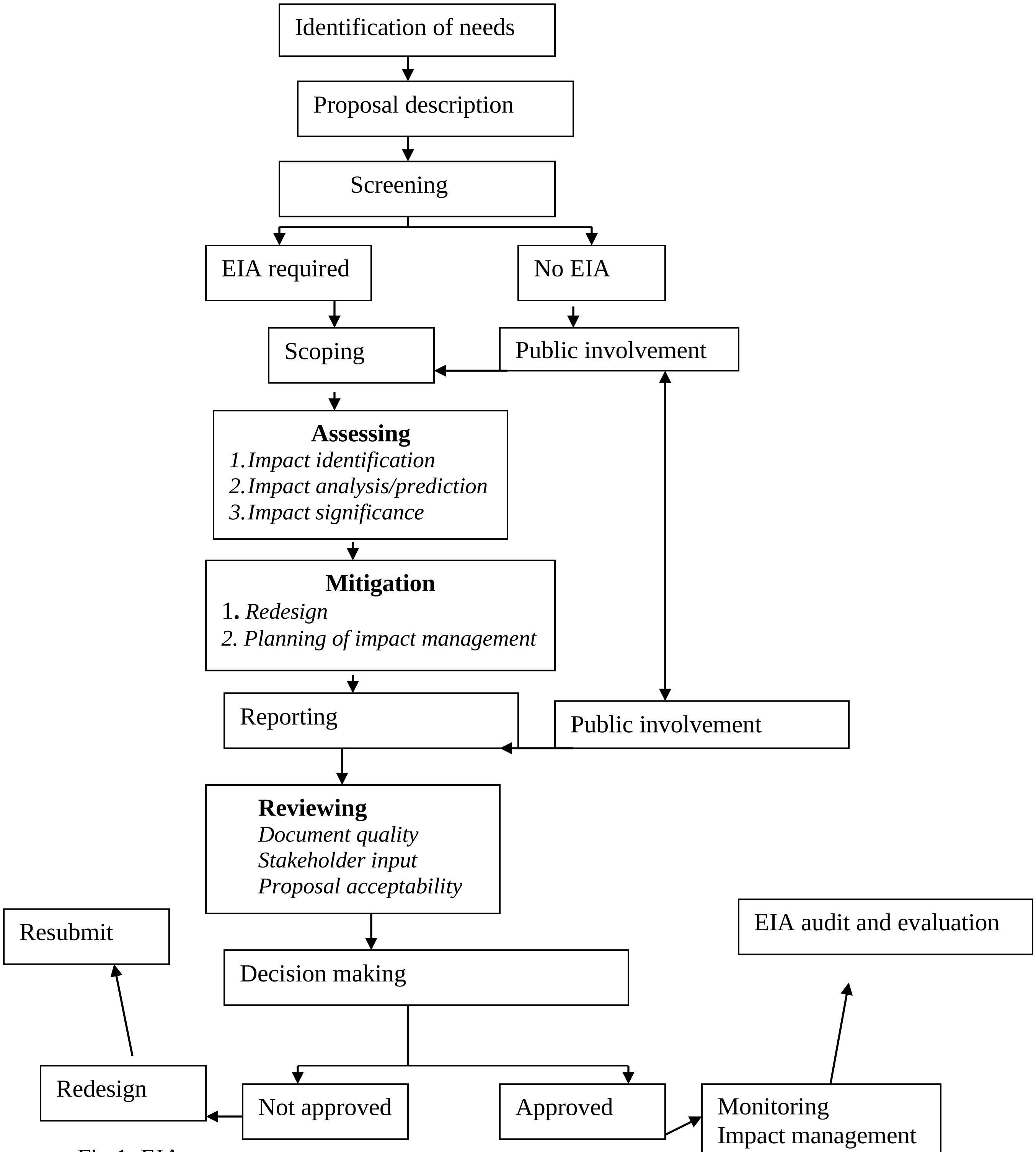

Fig.1. EIA process

Environmental Impact Statement and Environmental Auditing

CHAPTER 3-7

3. Responsible bodies and their roles
4. Impact Identification
5. Impact Prediction, Assessment and Evaluation
6. Environmental Monitoring, Auditing and Report Writing
7. Possible Environmental Impacts and their Mitigation Measures

CHAPTER THREE

3. Responsible bodies and their roles

This chapter begins with an outline of the principal actors involved in EIA and in the associated planning and development process. Any proposed major development has an underlying configuration of interests, strategies and perspectives. But whatever the development, be it a motorway, large animal farm project, a reservoir or a forest, it is possible to divide those involved in the planning and development process broadly in to five main groups. These are:

1. the developers/proponent
2. those directly or indirectly affected by or having an interest in the development
3. the competent agency
4. the consultant
5. licensing Agency

3.1. Proponent

The proponent

- is the project applicant (i.e. the developer)
    - is responsible for complying with the requirements of the EIA and for all associated costs incurred when following the EIA process.
    - is responsible to appoint an independent consultant who will act on the proponent's behalf in the EIA process
    - must ensure that adequate participation of the competent agency and interested and affected parties and the public in general has been carried out.

- is responsible to ensure that the conditions of approval are carried out (including monitoring and auditing).

3.2. Consultant

Statutory consulters are an important group in the EIA process. The planning authorities must consult such bodies before making a decision on a major project requiring an EIA. The independent consultant acts on behalf of the proponent in complying with the EIA process and is responsible for showing that he/she has:

- expertise in environmental assessment and management;
- the ability to manage the required participation process;
- the ability to produce reports that are readable;
- a good working knowledge of environmental impact assessment

3.3. Licensing Agency

Licensing Agency is any organ of government empowered by law to issue an investment permit, trade or operating license or work permit or register business organization as a case may be. The licensing agencies have a legal duty to ask that ***environmental performance criteria are included in the incentive structure to get environmental clearance certificate from the environmental (competent) agencies.*** These are required to ensure that renewal or additional permits issuance should also consider environmental performance of the applicant, thus required to seek advice or opinion from the appropriate environmental agency, etc.

3.4. Interested and affected parties

One of the key aims of the EIA process is ***to provide information about a proposal's likely environmental impacts to the developer, public and decision-makers***, so that a better decision may be made.

Interested and affected parties are important to a successful EIA and are responsible for providing input and comments at various stages in the EIA process. Some local amenity groups may also have a continuing role and an accumulation of valuable knowledge about the local environment. Generally, consultation with the public in the EIA process can help to ensure that the various groups' views are adequately taken in to consideration in the decions–making process.

3.4.1. Public participations/ public hearing

What is a public?

A public is any person, or group of people, that has a distinctive interest or stake in an issue. Thus, the identification of public which would potentially be involved in the various stages of an EIA is a basic element in the development of a public participation program.

Types of publics

There are several ways of categorizing various publics that might be involved in a public participation program for an EIA study. However, the broad based system for grouping publics consists of using four separate categories. These are:

1. Persons who are immediately affected by the project and live in the vicinity of the project.
2. Environmentalist and ecologists ranging from preservationists to those who want to ensure that development are as effectively integrated in to the needs of the environment as possible.
3. Business and commercial developers who would benefit from initiation of the proposed action.
4. The part of the general public comprising those who enjoy a high standard of living and who do not want to sacrifice this standard in order to preserve wilderness or scenic areas or to have pollution free air and water.

What is public participation?

Public participation /public hearing can be defined as a continuous, two–way communication process which involves promoting full public understanding of the processes and mechanisms through which environmental problems and needs are investigated and solved by the responsible agency. The basic purpose of including public participation programs or activities in the environmental decision making process is ***to enable productive use of inputs and perceptions from governmental agencies, private citizens and public interest groups in order to improve the quality of environmental decision making.***

In essence, public participation involves both information ***feed –forward*** and ***feed-back***. *Feed forward* is the process whereby information is communicated from public officials to citizens concerning public policy, whereas *feedback* is the communication of information from citizens to public officials regarding public policy. Feedback information is useful to decision makers in reaching time and content decisions.

Consultation and participation can be useful at most stages of the EIA process:

- In determining the scope of EIA;
- In providing specialist knowledge about the site

- In evaluating the relative significance of the likely impacts
- In proposing mitigation measures
- In ensuring that the EIS is objective, truthful and complete
- In monitoring any conditions of the development agreement.

At such, how the information is presented, how the various interested parties use that information, and how the final decision incorporates the results of the EIA and the views of the various parties, are essential components in the EIA process.

Levels of public participation

The EIA process can be considered to consist of the following stages:-

1. identification of issues and impacts (scoping)
2. conduction of base line studies of environment
3. prediction and evaluation of impacts
4. mitigation planning
5. comparison of alternatives
6. decision making relative to the proposed action, and
7. study documentation through the preparation of an environmental assessment or EIS

Public participation should be associated with all stages of EIA including plans, programs and policies. However, levels of citizen participation can range from situations in which the citizens

- Do not participate at all, to situations
- Involving taken citizen participation, to situations where
- Citizens share equally in planning, to situations where
- Citizens actually control the planning process.

Delineation of public participation objectives

The basic reasons for identifying and classifying public participation objectives are:

- To prepare a public participation plan
- Objectives change over the various stages of a study and
- Some public participation techniques are better than others for achieving particular objectives.

There are six types of objectives which should be considered in the design of a public participation programs. These are:

1. information dissemination, education and liaisons
2. identification of problems, needs and important values
3. idea generation and problems solving
4. reaction and feed back on proposals
5. evaluation of alternatives
6. conflict resolution by consensus

These objectives are tied to the various stages of EIA study. The relationships of these six objectives to the different stages of EIA study are shown in Table 3.

Table 3: Public involvement objectives at various EIA process stages

Stages of EIA / Objectives	Impact identification (scoping)	Baseline study	Impact evaluation	Mitigation planning	Comparison of alternative	Decision making	Documentation
Information dissemination	X	X	x	X	X	x	x
Identify problems ,needs , values	X	X	x	X			
Identifying problems solving approaches			x	X	X		
Obtain feed back		X	x	X	X	x	x
Evaluate alternative			x	X	X		
Resolve conflicts					X	x	

Advantages and disadvantages of public participation

The major advantages of public participation are:

1. Benefits occur when affected person, likely to be unrepresented in EIA processes, are provided an opportunity to present their views.

2. An added accountability is placed on political and administrative decision makers, since the process is open to public view.
3. Openness exerts pressure on administrators to adhere to the required procedures in decision making.
4. Finally, through public participation, the agency is forced to be responsive to issues beyond these immediately related to the project.

The disadvantages of public participation are:

1. Potential for confusion of the issue, since many new perspectives may be introduced
2. It is possible to receive erroneous information that results from lack of knowledge on the part of the participants.
3. Uncertainty of the results of process, as well as project delay and increased project costs if the public participation program is not properly planned.

Public participation can perform three vital functions. These are:

1. it can serve as a mechanism for exchange of information
2. it may provide a source of information on local values
3. It can aid in establishing the credibility of the planning and assessment process.

3.5. Competent Agency

The government, at various levels, will normally have a significant role in regulating and managing the relationship between the groups previously outlined. In Ethiopia, the principal authority/ competent agency involved currently is the Environmental Protection Authority (EPA) at Federal level and Environmental Protection Land Administration and Use authority (EPLAUA) at regional level.

The competent agency is responsible to

- Ensure that the proponent/consultant comply with the requirements of the EIA process
- Provide general guidance on procedure and information required by the consultant and the proponent
- Ensure that the evaluation/review and decisions provided are done efficiently and within reasonable time
- Ensure that the proponent is informed of any shortfalls in the process as identified through the reviews.

CHAPTER FOUR

4. Impact identification

4.1. Aims and methods

Impact identification brings together project characteristics and baseline environmental characteristics with the aim of ***ensuring that all potentially significant environmental impacts (adverse or favorable) are identified and taken into account in the EIA process.*** When choosing amongst the existing wide range of impact identification methods, the analyst needs to consider more specific aims, some of which conflict:

- to ensure compliance with regulations;
- to provide a comprehensive coverage of a full range of impacts, including social, economic and physical;
- to distinguish between positive and negative, large and small, long-term and short term, reversible and irreversible impacts;
- to identify secondary, indirect and cumulative impacts as well as direct impacts;
- to distinguish between significant and insignificant impacts;
- to allow a comparison of alternative development proposals;
- to consider impacts within the constraints of an area's carrying capacity;
- to incorporate qualitative as well as quantitative information;

- to be easy and economical to use;
- to be unbiased and to give consistent results;
- to be use in summarizing and presenting impacts in the EIS;

4.2. Types of impacts

Distinguishing impact based on their type is important:

- To manage the environmental impacts
- To assess the significance of impacts
- To minimize adverse impacts
- For consideration of the alternatives

The following are the major types of impacts.

1) Primary and secondary impacts

Primary impacts	Secondary impacts
Project inputs cause primary impacts	project out puts cause secondary impacts
Easier to analyze and measure	difficult to analyze and measure
Less significant	more significant than primary
Eg. Change in vegetation composition	Eg. landuse changes at the site

2) Short –term and long -term impacts

Identifying impacts as short –term and long-term is important ***as it enable the assessment of the cumulative impacts of the proposed project which either significantly reduce or enhance the state of the environment for future generation.***

Short term impacts denote immediate impacts of short duration such as those during construction and initial use. Long term impacts denote impacts lasting beyond the period of construction and initial use. Impacts might be short term (0-5 years), medium term (5-15 years), long terms and permanent (more than 15 years).

Eg. Noise from continuous operating equipment is permanent.

Noise from construction could be short-lived.

Eg. i) Damaging of river: - permanently change river hydrology and seriously limit future options of use of that river stretch.

ii) proposed highway through constructions: - may fore close future choice of use of those wetlands and permanently impair the eco-balance of the area.

iii) application of pesticides/herbicides: - may remove undesirable species but long-lasting/cumulative effects permanently damage other vegetative or results in long term disruption of entire ecology

iv) construction of sewage treatment plants:- it causes undesirable impacts as noise, dust etc but over long time, may be beneficial impacts such as enhanced water quality in the receiving streams, reduction in water borne diseases, cleaner air etc.

3) Reversible and irreversible impacts

Assessment of reversible and irreversible impacts involves consideration of all reversible and irreversible commitments of resources which would be involved in the proposed action. When we say resources we dose not mean only the labour and material devoted to the action, but also we mean the full range of natural and cultural resources likely to be lost or destructed by the action.

Irreversible impacts apply primarily to non-renewable resources such as fossil fuels, minerals, etc. Reversible impacts are those effects that can be restored once the project/activity is stopped. Eg. plant / animal species

4.3. Impact significance

In orders to determine the significance of environmental impacts it must be described according to the following criteria:

- **Nature of the impact:** describe effects that a proposed activity will have on the environment. Example positive, negative, direct, indirect, cumulative, etc.
- **Extent:** - showing the impacts may be realized local (e.g. dusts), regional (e.g. acid rain), global (e.g. greenhouse gas).
- **Timing**: - timing of the impacts could be immediate (during construction, operation, decommissioning) or the effect may take place much latter.
- **Duration**:-the duration of impacts range from short-lived to continuous impact.
- **Intensity**:- here it should be established whether the impact is destructive or innocuous and should be described as low, medium or high

- **Probability: -** consider the likelihood of an impact occurring.
- ***Type :-*** biophysical, social, economic etc

Impact can be predicted by;

- Professional judgment
- Mathematical models
- Experiments and case studies

4.4. Techniques for impact identification

The aim of this section is to present a range of methods from the simplest checklists needed for compliance with regulations to complex approaches (the use of interactive computer programmes, networks) that developers, consultants and academics who aim to further “best practice” may wish to investigate further. Many of the more complex methods were developed for government agencies that deal with large numbers of fairly similar project types. The methods are divided in to the following categories:

1. Ad-hoc approaches
2. Checklists
3. Delphi
4. Matrices
5. Quantitative methods
6. Networks or impact trees
7. Map overlay techniques

1. Ad hoc methods

This is the most common approach to impact assessment. Basically, ad hoc methods indicate broad areas of likely impacts by listing composite environmental parameters (for example, flora and fauna) likely to be affected by a development. It involves assembling a team of specialist to identify impacts in their area expertise.

In this method, each environmental area e.g. air, water etc, are taken separately and the nature of the impacts such as no effect, short or long term, etc, are considered. It is for rough assessment of total impacts giving the broad areas of possible impacts and the general nature of these possible impacts. For example, to explain the impact of a project on plants and animals it uses the term minimal but adverse and to express impacts on regional economy it uses the term significant or extremely significant. These statements are generally qualitative and could be based on ***subjective assessment or qualitative interpretation of quantitative data***.

Ad hoc method is a simple approach to evaluate the total impacts of a project and would ***consider each environmental area and states the nature of impacts up on it***, as perceived by the expert such as:

- No effect
- Problematic
- Short time /long time
- Reversible /irreversible

In the adhoch method, to identify the impact we should use expert opinion. Expert opinion on the impact of any activity can be sought by

- Meeting with (panel discussion), or
- Writing to the experts and asking their answers to specific questions.
- Compiling, analyzing and reporting the already published or otherwise known opinion of experts. This form of collection and collection of expert opinion is also termed as content analysis or literature survey or plain survey.

When the expert opinion is sought to be taken by calling a meeting /***panel discussions*** of the experts there can be the following additional pitfalls.

a. Halo effect
b. Decibel effect
c. Vanity effect

a) Halo effects:-those experts who are relatively more senior or eminent may cast a ‘ halo effect’ on their junior or less eminent counter parts causing the later to adopt the views of the former as ‘consensus’ even if, otherwise, there would have been dissent.

b) Decibel effect: **-** among a set of experts there are always some who exceptionally vociferous and assertive as also some who are exceptionally soft-spoken and quite. In a meeting the clamorous one tend to air their views forcefully and repeatedly, getting them adopted as ‘consensus’ even if the views of the milder members may be different or more valuable.

c) Vanity effects: - often experts tend to cling to the views they might have expressed before, or at the start, of the meeting even after realizing their flaws. They are either too vain to admit that they were wrong or fear a loss of face.

The advantage of expert opinion data gathering techniques is ***its speed and inexpensive***. For these reasons expert opinion has been, and continues to be, very extensively used in EIA. The limitation is that it is inherent subjectivity and biasness.

These limitations may not come only in the form of the opinion of the expert but also in the choice of expert by the convener (of a meeting) or the compiler (of published opinion). A convener of an expert meeting may pick and choose experts known to be leaning towards view point desired by the convener. A compiler can similarly pick and choose opinions that confirm to his/ herown bias. Paradox different compilers, by choosing the opinions of different experts and quoting them selectively, can arrive at two diametrically opposite sets of conclusion on the EIA of an activity.

2. Checklists

Checklists are methodologies used in environmental impact assessment which are developed from list of environmental features or activities that should be investigated for possible /potential impacts. Checklists are an advance on ad hoc methods in that they list biophysical, social and economic components, which are likely to be affected by a development, in more detail. Also, they serve as guide to the identification and consideration of a wide range of impacts. EPA (Environmental Protection Authorities) may provide such checklist for different projects that all items deemed important by the authority are given due consideration.

Checklists provide a method of combining a list of potential impact areas that need to be considered in the EIA processes with an assessment of often qualitative of the individual impacts. This approach has been followed by a number of public agencies since it ensures that the entire list of areas prescribed by the agency is considered in the assessment processes. For example, there may be specific checklists for specific projects.

There are four types of checklists. These are:

a. Simple checklists
b. Descriptive checklists

c. Scaling checklists
d. Scaling-weighting checklist

a. Simple checklists

Simple checklists are a list of parameters; however, no guidelines are provided on how environmental parameter data to be measured and interpreted. The *simple checklist* can help only to identify impacts and ensure that impacts are not overlooked (Table 4).

Table 4: An illustrative check list

Items	**Nature of likely impact(tick what is applicable)**									
	Adverse						**Beneficial**			
	Immediate	**much later**	**Reversible**	**irreversible**	**local**	**Wide**	**Short term**	**Long-term**	**Significant**	**nominal**
Water River lake ocean underground water quality										
Atmosphere air pollution climate temperature rainfall										
Land use Wilderness and open space forestry grazing residential agricultural commercial industrial mining & grazing wet land										
Other items										

b. Descriptive checklists

Descriptive checklists include an identification of environmental parameters and guidelines on how parameter data are to be measured.

c. Scaling checklists/ *Questionnaire checklists*

Scaling checklists are similar to descriptive checklist, with the addition of information basic to subjective scaling of parameter values. It is based on a set of questions to be answered. Some of the questions may concern indirect impacts and possible mitigation measures. They may also provide a scale for classifying estimated impacts; from highly adverse to highly beneficial (see Table5). Shows part of the questionnaire checklist.

Table 5: Part of the questionnaire checklist (for animal fattening project).

Questions to be considered in scoping	Yes/ no	Which characteristics of the project environment could be affected and how?	Is likely to be significant? Why?
Will the project lead to risks of contamination of land water from releases of pollutants onto the ground or into sewers, surface water, ground water, coastal waters or the sea			
From handling, storage, use or spillage of hazardous or toxic materials?			
From discharge of sewage or other effluent (whether treated or untreated) to water or the land?			
By deposition of pollutants emitted to air, on to the land or in to water?			
From any other sources			
Is there a risk of long-term build up of pollutants in the environment from these sources? etc.			

d. Scaling weighting checklist

Scaling weighting checklist represent scaling checklists with information provided as to subjective evaluation of each parameter with respect to every other parameter. It is one of the most commonly used methods for EIA. This system consists of a description of the environmental factors included in that checklist as well as instructions for scaling the values of each parameter and assigning importance units. The major feature of this system is that environmental impact is expressed in commensurate units.

In impact analysis there is need for development of common units of comparison, since various environmental factors are measured in differing units. The steps involved in the development of commensurate units include transformation of parameter estimates into an environmental quality scale, assignment of importance weights to the individual parameters, and the multiplication of scale values by importance values to obtain environmental impact units.

Transformation of parameter estimates into an environmental quality scale is based on the fact that there is a certain range of anticipated values for a given parameter, with the range dependent upon the units of measurements of the parameter. For example, dissolved oxygen in water will typically range between 0 and 10mg/liter, while total suspended particulates in the atmosphere may range from 20 to several thousand g/m^3. To help transform these parameter estimates into an environmental quality scale, value function graphs are important. Parameter values are shown on the abscissa, while the environmental quality scale is shown on the ordinate. Environmental quality can range from 0 to 1.0, with 0 representing poor quality and 1.0 very good quality.

There is an extension of checklist method, ranking method, which includes rating method and expected value method. This class of method is called numerical methods and obviously involves assigning number values to each of the different factors considered in impact assessment.

The numbers may be chosen from pre set scales of say 0-10 or 0-100. Ranking method is an extension of checklist method with different that plain ‘yes’ or ‘no’ statements of a check list are replaced with numerical figures with which an attempt is made to convey the extent of impact.

Threshold-of-concern **checklists** consist of a list of environmental components and, for each component, a threshold at which those assessing a proposal should become concerned with an impact. The implications of alternative proposals can be seen by examining the number of times that an alternative exceeds the threshold of concern. For example, for the component of economic efficiency, a benefit: cost ratio of 1:1 is the threshold of concern.

Advantage

- It promotes thinking about the array of impacts in a systematic way and allows concise summarization of effects.
  - It is the simplest assessment methodologies

Limitations

  - Checklists do not usually include direct cause-effect links to project activities.
  - Checklist may be too general or incomplete
  - They do not illustrate interactions between effects
- The same effect may be registered in several places under heading that overlap in content (double counting)
- The number of categories to be reviewed can be immense thus destructing attention from the more significant impacts.
  - The identification of effects is qualitative/subjective

3. Delphi

Delphi is a method of collecting opinions, from different expertise by building different methods to minimize the various negative attribute of other opinion gathering methods (mentioned earlier). This method can:

- side step ‘halo effects’
- handle large number of opinion givers than panels or brainstorming session can.
- also enables collecting opinions and using the information in developing dynamic models

Special characteristic

- Anonymity among participants
- Scope for statistical treatment of responses
- Interactive feedback

Procedure

1. A structured, formal and detailed questionnaire is given to the participants by mail or in person.

2. The organizer of the Delphi then collects, analyses, combines and averages the responses and represents them medians.
3. Questionnaire for second round are given with modification if necessary.
4. The averaged response of 1st questionnaire is provided to the participants (where the participants may be asked to respond to scaled objective item.)
5. After scrutinizing 2nd round, respondents may be asked to justify the response
6. Further interactions are continued, if necessary
7. Convergence of opinion emerges (NOT BY FORCE)

Limitations

- There is pressure towards convergence and this may suppress other valid perspectives.
- The role of the Delphi coordinator is crucial and subjective biases may be introduced through this route.
- Lack of item clarity or the common interpretation of scales and feedback may lead to invalid results.
- Delphi is time consuming and if the questionnaires are long, one may tend to fill them in a casual manner.

4. Matrices

Matrices are grid like tables used to identify the interaction between project activities and environmental characteristics. While checklists are "one dimensional" lists of potential impacts which tell whether an impact will occur or not, matrices are 'two dimensional' lists which also give an indication of the 'magnitude' of likely impacts. Matrices are thus checklists of a higher dimension and contain more information than the latter.

There are different types of matrices. These are:

a. simple matrix
b. magnitude matrix
c. Leopold matrix
d. Weighted matrices

a. Simple matrices methods are basically generalized checklists where usually one dimension of a matrix is a list of environmental, social, and economic factors likely to be affected by a project. The other dimension is a list of actions associated with development activities (e.g. construction, operation, decommissioning, buildings, access road, etc.). Impacts are identified by placing a cross in the appropriate cell or marking cells representing a likely impact resulting from the interaction of a facet of the development with environmental features. Table 6 shows an example of a *simple matrix*.

Table 6: part of a simple matrix

Environmental component	Project action				
	Construction		Operation		
	Utilities	Residential and commercial building	Residential building	commercial building	Parks and open space
Soil and geology	X	X			
Flora	X	X			x
Fauna	X	X			x
Air quality				X	
Water quality	X	X	x		
Population density			x	X	
Employment		X		X	
Traffic	X	X	x	X	
Housing			x		
Community structure		X	x		x

*b. Magnitude matrices is d*efined as the degree, or expensiveness or scale of impact (How large an area, how severely affected) – normative and evaluative. *Magnitude matrices* go beyond the mere identification of impacts by describing them according to their magnitude, importance and/or time frame (e.g. short-, medium- or long-term). Table 7 is an example of a magnitude matrix.

Table 7: Part of a magnitude matrix

Environmental component	Project action				
	Construction		Operation		
	Utilities	Residential and commercial building	Residential building	commercial building	Parks and open space

Soil and geology	•				
Flora		•		O	
Fauna		O			O
Air quality	O				•
Water quality	.	.	O	•	O
Population density	O				
Employment	•		O		.
Traffic	•	O	O		
Housing				O	
Community structure					

• = large negative impact O=large positive impact

. = small negative impact o= small positive impact

c. Leopold matrix. Although there are many variants of the matrix approach, the best known interaction matrix methods is the Leopold et al., developed in 1971. It is based on a horizontal list of 100 project actions and a vertical list of 88 environmental components. In each appropriate cell, two numbers are recorded**.** Table 8 shows sample matrix. The number in the top left-hand corner represents the impact's magnitude, from ten to one, with 10 representing a large magnitude and one, a small magnitude. That in the bottom right-hand corner represents the impact's significance, from 10 (very significant) to 1 (insignificant); there is no negative significance. This distinction between magnitude and significance is important: an impact could be large but insignificant, or small but significant.

Table 8: sample matrix.

Proposed action		Deforestation	Land use change	Mining
Environmental component	Soil	5 / 2	6 / 3	9 / 3
	Water	1 / 7	5 / 3	6 / 1
	Land	5 / 2	6 / 3	2 / 1
	vegetation	6 / 3	7 / 4	6 / 4

The Leopold matrix is easily understood, can be applied to a wide range of developments, and is reasonably comprehensive for first-order, direct impacts. However, it has disadvantages. The fact that it was designed for use on many different types of project makes it unwieldy for use on any one project. It cannot reveal indirect effects of developments. It gives no indication whether the data on which these values are based are qualitative or quantitative; it does not specify the probability of an impact occurring; it excludes details of the techniques used to predict impacts; and the scoring system is inherently subjective and open to bias. People may also attempt to add the numerical values to produce a composite value for the development's impacts and compare this with that for other developments; this should not be done because the matrix does not assign weightings to different impacts to reflect their relative importance.

d. Weighted matrices were developed in an attempt to respond to some of the above problems. Importance weightings are assigned to environmental components, and sometimes to project components. The impact of the project (component) on the environmental component is then assessed and multiplied by the appropriate weighting(s), to obtain a total for the project. Table 9 shows a small weighted matrix that compares three alternative project sites. Each environmental component is assigned an importance weighting (a), relative to other environmental components. The magnitude (c) of the impact of each project on each environmental component is then assessed on a scale 0-10, and multiplied by (a) to obtain a weighted impact (a×c): for instance, site A has an impact of 3 out of 10 on air quality, which is multiplied by 21 to give the weighted impact, 63. For each site, the weighted impacts can then be added up to give a project total. The site with the lowest total, in this site B, is the least environmentally harmful. However, the evaluation procedure depends heavily on the weightings and impact scales assigned.

Table 9: a weighted matrix: alternative project site

Environmental component	(a)	Alternative sites					
		Site A		Site B		Site C	
		(c)	(axc)	(c)	(axc)	(c)	(axc)
Air quality	21	3	63	5	105	3	63
Water quality	42	6	252	2	84	5	210
Noise	9	5	45	7	63	9	81
Ecosystem	28	5	140	4	112	3	84
Total	100		500		364		438

a = relative weighting of environmental component (100)

c= impact of project at particular site on environmental component (0-10)

Distributional impact matrices: represent another possible development of the matrix approach. Such matrices can broadly identify who might lose and who might gain from the potential impacts of a development. This is useful information, which is rarely included in the matrix approach, and indeed is often missing from EISs. Impacts can have varying spatial impacts – varying, for example, between urban and rural areas. A project can also have different impacts on different groups in society (for example the impacts of a proposed new settlement on old people, retired with their own houses, and young people, perhaps with children, seeking affordable housing and a way into the housing market).

5. Quantitative or Index methods

These methods are based on a list of factors thought to be relevant to a particular proposal and which are differentially weighted for importance. Likely impacts are identified and assessed. Impact results are transformed into a scale of environmental quality.

The scores and the factors weighting are multiplied and the resulting scores added to provide an aggregate impact score. By this means beneficial and harmful impacts can be summed and total scores compared. The alternative giving the best score is the preferred option.

Quantitative methods attempt to compare the relative importance of all impacts by weighting, standardizing and aggregating them to produce a composite index. The best known of these methods is the environmental evaluation system (EES). It consists of a checklist of environmental, social and economic parameters that may be affected by a proposal. It assumes that these parameters can be expressed numerically and that they represent an aspect of environmental quality. For instance, the concentration of dissolved oxygen is a parameter that represents an aspect of the quality of an aquatic environment. For each parameter, functions are designed by experts to express environmental quality on a scale 0-1 (degraded-high quality).

The attraction of these quantitative methods lies in their ability to ‘‘substantiate’’ numerically that a particular course of action is better than others. This may save decision-makers considerable work, and it ensures consistency in assessment and results. However, these methods also have some fundamental weaknesses. They effectively take decisions away from decision-makers. The methods are difficult for lay people to understand, and their acceptability. Quantitative methods also treat the environment as if it consisted of discrete units. Impacts are related only to particular parameters, and much information is lost when impacts are reduced to numbers.

6. Network /impact tree methods

Network methods illustrate the multiple links between project activities and environmental characteristics. It also recognizes the interactive nature of environment components and takes an ecological approach for identifying the secondary, tertiary and higher order impacts. Environmental sub systems are interconnected and any impact on one of the subsystems effects several other subsystems. That is why a 'primary' impact may lead to 'secondary', 'tertiary' and higher order impacts.

Impact identification using networks involves following the effects of development through changes in the environmental parameters in the model. The *Sorensen network* was the first network method to be developed. Figure 2. shows a section of the network dealing with impacts on construction of dam. Water is one of the six environmental components, the others being climate, geophysical conditions, biota, access conditions and aesthetics.

The Sorensen method begins by identifying potential causes of environmental change associated with a proposed development action, using a matrix format; for herbicides and fertilizers. These environmental changes in turn result in specific environmental impacts; in the example, the clearing of vegetation could result in an increased flow of fresh water, which in turn could imperil cliff structures. The analyst stops following the network when an initial cause of change has been traced through all subsequent impacts and changes in environmental conditions, to its final impacts. Environmental impacts can result either directly from a development action or indirectly through induced changes in environmental conditions. A change in environmental conditions may result in several different types of impact. This method should lead to the identification of remedial measures and monitoring schemes.

Procedure

- Start with a project activity and identify the types of impacts which would initially occur.
- Select each impact and identify the impacts which may be induced as a result. This process is repeated until all possible impacts have been identified. Sketching results in 'impact tree' (see Fig.2).

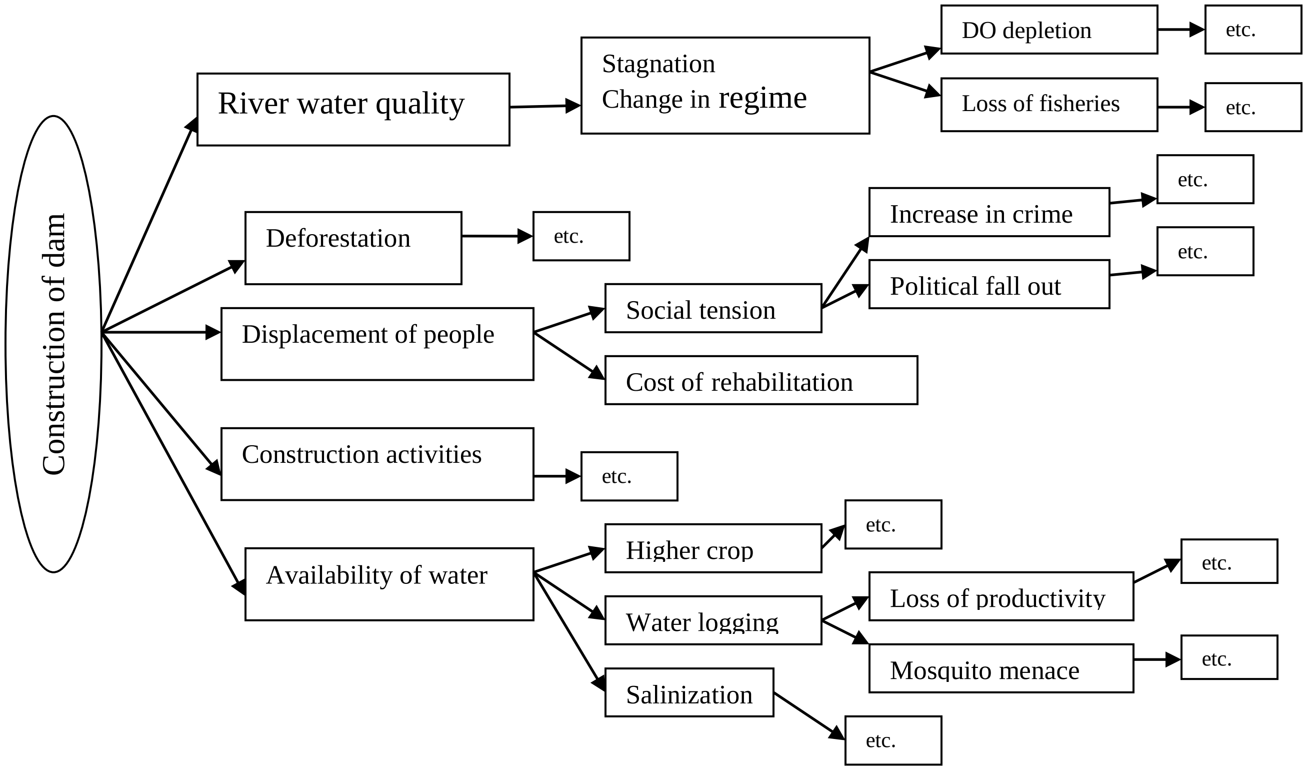

Fig.2: Typical example of impact tree– some branches

Network methods do not establish the magnitude or significance of interrelationships between environmental components, or the extent of change. They can require considerable knowledge of the environment. Their main advantage is their ability to trace the higher-order impacts of proposed developments.

7. Map Overlay Techniques

Overlay maps have been used in environmental planning since the 1960s, before the NEPA was enacted. A series of transparencies is used to identify, predict, assign relative significance to and communicate impacts. A base map is prepared, showing the general area within which the project may be located. Successive transparent overlay maps are then prepared for the environmental components that, in the opinion of experts, are likely to be affected by the project (e.g. agriculture, woodland, noise, animal farm project etc.). The project's degree of impact on the environmental feature is shown by the intensity of shading, slight-shading and unshading. Unshaded areas are those where a development project would not have a significant impact. Alternatively, the same process can be carried out using GIS and assigning different importance weightings to the impacts: this enables a sensitivity analysis to be carried out. The overlay maps method is particularly useful for identifying optimum corridors for developments such as electricity lines, roads, and grazing land, for comparisons between alternatives, and for assessing large regional developments. However, the method is limited in that it does not consider factors such as the likelihood of an impact, secondary impacts or the difference between reversible and irreversible impacts. It requires the clear classification of often indeterminate boundaries (such as between forest and field), and so is not a true representation of conditions on the ground. It relies on the user to identify likely impacts before it can be used.

However, the choice of impact methodology depends on

- Type and choice of proposal
- Type of alternatives being assessed
- Nature of the likely impacts
- Experience of EIA team with the impact identification methods
- The resource available –cost, information, time, personnel.

CHAPTER FIVE

5. Impact Prediction, Assessment and Evaluation

5.1. Impact prediction

EIA deals not only with the assessment of already occurred impacts of a past or presently on going activities but also with the forecasting of further impacts if the ***'as –it- is' situation continues or changes (as in terms of capacity expansion of an industry or commissioning of new industries in an area).***

Impact forecasting is the heart of the EIA process, although the process is not linear. Indeed the whole EIA exercise is about prediction. Prediction is often not treated as an explicit stage in the process.

Once the range of impacts has been identified the potential size of each one must be ***predicted.*** Prediction can be done on

- ***physical***
- ***biological*** and
- ***socioeconomic data***

Prediction ***should not be used sophisticated prediction method i.e.*** should be kept in proportion to the scope of the EIA and the importance of the particular impact. ***If possible, impact should be predicted quantitatively.***

To predict the impact we should know the following.

A. what to predict
B. how to predict (the methods and models used in prediction) and
C. living with uncertainty (the limitations implicit in such exercises)

A. Dimensions of prediction (what to predict)

The objective of prediction is ***to identify the magnitude and other dimensions of identified change in the environment with a project or action, in comparison with the situation without that project or action.*** Predictions also provide the basis for the assessment of significance.

The impacts of the project should be predicted:

1.on human beings, buildings and man-made features

- Change in population arising from the development, and consequential environment effects.
- Visual effects of the development on the surrounding area and landscape.

- Levels and effects of emissions from the development during normal operation.
- Levels and effects of noise from the development.
- Effects of the development on local roads and transport.
- Effects of the development on buildings, the architectural and historic heritage, archaeological features, and other human artifacts, e.g. through pollutants, visual intrusion, vibration.

2. on flora, fauna and geology

- Loss of, and damage to, habitats and plant and animal species.
- Loss of, and damage to, geological, palaeotological and physiographic features.
- Other ecological consequences.

3.on land

- Physical effects of the development e.g. change in local topography, effect of earth-moving on stability, soil erosion, etc.
- Effects of chemical emissions and deposits on soil of site and surrounding land.
- Land-use/resource effects:
    a. quality and quantity of agricultural land to be taken;
    b. sterilization of mineral *resources*;
    c. other alternative uses of the site, including the ‘‘do-nothing’’ option;
    d. effect on surrounding land uses including agriculture;
    e. waste disposal.

4. on water

- Effects of development on drainage pattern in the area.
- Changes to other hydrographic characteristics, e.g. groundwater level, watercourses, flow of underground water.
- Effects on coastal or estuarine hydrology.
- Effects of pollutants, waste, etc. on water quality.

5. On air and climate

- Level and concentration of chemical emissions and their environmental effects.
- Particulate matter.
- Offensive odours.

- Any other climatic effects.

6. Other indirect and secondary effects associated with the project

- Effects from traffic (road, rail, air, water) related to the development.
- Effects arising from the extraction and consumption of material, water, energy or other, resources by the development.
- Effects of other development associated with the project, e.g. new roads, sewers, housing power lines, pipelines, telecommunications, etc.
- Effects of association of the development with other existing or proposed development.
- Secondary effects resulting from the interaction of separate direct effects listed above.

Impact prediction should also identify

- *direct* and *indirect* impacts (simple cause-effect diagrams may be useful here),
- the *geographical extent* of impacts (e.g. local, regional, and national), whether the impacts are *beneficial* or *adverse,* and
- the *duration* of the impacts.

Another dimension is the unit of measurement, and the distinction between *quantitative* and *qualitative* impacts. Some indicators are more readily quantifiable than others (e.g. a change in the quality of drinking water, in comparison, for example, with changes in community stress associated with a project). Predictions should also include estimates of the probability that an impact will occur, which raises the important issue of uncertainty.

B. Methods and models for prediction (how to predict)

- There are many possible methods to predict impacts.
- For example, a study undertaken by Environmental Resources Ltd for the Dutch government in the early 1980s identified 150 different prediction methods used in just 140 EIA studies from The Netherlands and North America.
- None provides a magic solution to the prediction problem.

All predictions are based on conceptual models of how the universe functions; they range in complexity from those that are totally intuitive to those based on explicit assumptions concerning the nature of environmental processes…the environment is never as well behaved as assumed in models, and the assessor is to be discouraged from accepting off-the-shelf formulae.

Predictive methods can be classified in many ways; they are not mutually exclusive. In terms *of scope*, all methods are ***partial*** in their coverage of impacts, but some seek to be more ***holistic*** than others.

Partial methods may be classified according to ***type of project*** (e.g. retail impact assessment) and ***type of impact*** (e.g. wider economic impacts).

Some may be ***extrapolative***, others may be more ***normative***.

For **extrapolative methods,** predictions are made that are consistent with past and present data. Extrapolative methods include:

- ***trend analysis (extrapolating present trends, modified to take account of changes caused by the project)***
- ***scenarios*** (common-sense forecasts of future state based on a variety of assumptions),
- ***analogies*** (transferring experience from elsewhere to the study in hand) and
- ***intuitive forecasting*** (e.g. the use of the Delphi technique to achieve group consensus on the impacts of a project).

Normative approaches work backwards from desired outcomes to assess whether a project, in its environmental context, is adequate to achieve of a major project may be 50 per cent local employment. The achievement of this outcome may necessitate modifications to the project and/or to associated employment policies (e.g. on training). Various scenarios may be tested to determine the one most likely to achieve the desired outcomes.

Methods can also be classified according ***to their form***, as the following types of model illustrate.

1. Mathematical and computer-based models

Mathematical models seek to represent the behavior of aspects of the environment through the use of mathematical functions. They are usually based upon scientific laws, statistical analysis or some combination of the two, and are often computer based.

The underpinning functions can range from simple direct input-output relationships to more complex dynamic mathematical models with a wide array of interrelationships.

Mathematical models can be divided into ***deterministic and stochastic models.*** Deterministic models, like the gravity model, depend on fixed relationships. In contrast, a stochastic model is probabilistic, and indicates the degree of probability of the occurrence of a certain event by specifying the statistical probability that a certain number of events will take place in a given area and/or time interval.

An example of a deterministic mathematical model often used in ***socio-economic impact predictions.*** The injection of money into an economy – local, regional or national-will increase income in the economy by some multiple of the original injection. Modification of the basic model allows it to be used to predict income and employment impacts for various groups over the stages of the life of a project**.**

2. Physical/architectural models and experimental methods

Physical, image or architectural models are illustrative or scale models that replicate some element of the project-environment interaction. For example, a scale model (or computer graphics) could be used to predict the impacts of a development on the landscape or built environment.

Field and laboratory experimental methods use existing data inventories, often supplemented by special surveys, to predict impacts on receptors. Field tests are carried out in unconfined conditions, usually at approximately the same scale as the predicted impact; an example would be the testing of a pesticide in an outdoor pond.

Laboratory tests, such as the testing of a pollutant on seedlings raised in a hydroponic solution, are usually cheaper to run but may not extrapolate well to conditions in natural systems.

3. Expert judgments and analogue models

All predictive methods in EIA make some use of expert judgment. Such judgment can make use of some of the other predictive methods, such as mathematical models and cause-effect networks or flow charts.

4. Other methods for prediction

The Leopold matrix also includes magnitude predictions, although the objectivity of a system where each analyst is allowed to develop a ranking system on a scale of 1-10 is some what doubtful. Overlays can be used to predict spatial impacts, and the Sorensen network is useful on tracing through indirect impacts.

C. Living with uncertainty

Environmental impact statements often appear more certain in their predictions than they should. All predictions have an element of uncertainty. There are three sources of uncertainty relevant to the EIA process as a whole. These are:

a. uncertainties about the physical, social and economic environment;

b. uncertainties about guiding values such as policy guidance; and

c. Uncertainties about related decisions such as planning, negotiation, etc.

All three classed of uncertainty may affect the accuracy of predictions, but the focus in an EIA study is usually on ***uncertainty about the environment.*** This may include the use of inaccurate and/or partial information on the project and on baseline environmental conditions, unanticipated changes in the project during one or more of the stages of the life cycle, and oversimplification and errors in the application of methods and models.

5.2. Prediction and assessment of impacts on the environment

5.2.1. Prediction and assessment of impacts on the air environment

In this section we will try to addresses the basic concepts of and a methodological approach for conducting a scientifically based analysis of the potential air quality impacts of proposed projects and activities.

The most important projects that exhibit air quality impacts are construction and operation of

- Fossil fuel-fired power plants
- Petroleum refineries
- Petrochemical operations
- Iron and still miles
- Hazardous waste incinerators
- Major highways or freeways and air ports
- Dams
- Waterways
- Industrial parks
- Highway, etc

These activities cause emission of particulate and gaseous air pollutants.

Basic steps for prediction and assessment

To systematically address the air quality impacts of potential projects or activities, it is necessary to be familiar with basic information regarding air pollution. ***Air pollution*** is defined as the presence of any contaminants (pollutants) such as solid, liquid, or gaseous substance (including noise) present in the atmosphere in such concentrations that may or tend to be injurious to human beings, or other living creatures, or plants, or property, or enjoyment.

The sources of air pollution can be categorized according to type, that is, whether natural or artificial, by number and spatial distribution, or by type of emissions such as gases and particulates. The number and spatial distribution category includes single or point sources, area or non-point sources, and line sources.

The two major classes of gaseous air pollutants are inorganic gases and organic vapors. Examples of widely occurring inorganic gases includeSO_2, NOx, CO, hydrogen sulfide; and organic vapors include hydrocarbons, alcholes, ketones, and esters. Secondary air pollutants resulting from photochemical reactions include oxidants, with the primary component being ozone, sulphur, nitrogen, and carbon containing inorganic gases.

Particulate air pollutants are any dispersed matter, solid or liquid, in which the individual aggregates are larger than single small molecules (about 0.0002 mm in diameter) but smaller than about 500mm.

The basic steps associated with prediction of changes in air quality and assessments of the impact of these changes are as follows:

Step 1: Identification of air pollutants

Step 2: Description of existing AIR quality level

Step 3: Determination of air pollution dispersion potentials

Step 4: Assemblage of basic meteorological data

Step 5: Presentation of air quality standards

Step 6: Emission inventory

Step 7: Impact prediction

5.2.2. Prediction and assessment of impacts on biological environment

Many Projects (and activates) can cause undesirable impacts on terrestrial or aquatic ecosystem. Examples of such impacts include:

- habitat degradation through overgrazing practices
- wetland drainage for agricultural, industrial or urban development practices;
- habitat loss, with attendant consequences on fish and wildlife because of excessive deforestation practices;

- changes in habitat and associated fish and wildlife species due to the construction and operation of hydropower projects;
- loss of critical habitat for endangered or threatened species as result or timber harvesting, recreational developments, and or military training activities;
- multiple aquatic and terrestrial ecosystem effects from acid rain formed as a consequence of SO_2 emissions from coal-fired power plants; and
- potential toxic effects to plants and or animals as a result of air-or water pollutant discharges or of waste disposal activities of industries and municipalities.

Basic steps for prediction and assessment

Step 1: Description of biological setting

Step 2: Identification of rare and endangered species

Step 3. Procurement of relevant laws, regulation, or criteria related to biological resources and protection of habitat or species.

Step 4. Impact predication activities: *using* analogies (case studies), physical modeling and mathematical modeling and based on professional judgment.

Several options are available for impact prediction-approaches including:

- qualitative description of impacts
- the use of habitat based methods or ecosystem models
- biodiversity and sustainable development consideration

Step 5:- Assessment of impact significance

Step 6:- Identification and incorporation of mitigation measures

Mitigation measures for biological impacts can include:-

- avoidance
- minimization
- rectification
- preservation and
- compensation

5.3. Evaluations

5.3.1. Evaluation in the EIA process

Once impacts have been predicted, there is a need to assess their relative significance to inform decision makers whether the impacts may be considered acceptable. Evaluation follows from prediction and involves an assessment of the relative significance of the impacts. Methods range from the simple to the complex, from the intuitive to the analytical, from qualitative to quantitative, from formal to informal. Cost benefit analysis (CBA), monetary valuation techniques and multi-criteria/multi-attribute methods, with their scoring and weighting systems, provide a number of ways into the evaluation issue.

The most formal evaluation method is the comparison of likely impacts against legal requirements and standards (e.g. air quality standards, building regulations etc). Of course, for some type of impacts including socio-economics, there are no clear –cut standard. Socio-economic impacts provide a good example of fuzziness in assessment, where the line between being significant or not significant extends over a range of values which build on perceptions as much as facts. Socio-economics impacts can raise in particular the distributional dimensions to evaluation, ***who wins and who loses.*** Beyond the use of standards and legal requirements, all assessments of significance either implicitly or explicitly apply weights to the various impacts (i.e. some are assessed as more important than others). The social effects of resource allocation decisions are too expensive to allow the decision to emerge from some opaque procedure free of over political.

5.3.2. Monetary benefit- cost analysis and input-output methods

Cost benefit analysis itself lies in a range of project and plan appraisal methods that seek to apply monetary values to costs and benefit. At one extreme are *partial approaches*, such as financial appraisal, cost minimization and cost effectiveness methods, which consider only a subsection of the relevant population or only a subsection of the full range of consequences of a plan or project. *Financial appraisal* is limited to a narrow concern, usually of the developer, with the stream of financial costs and returns associated with an investment. *Cost effectiveness* involves selecting an option that achieves a goal at least cost (for example, devising a least-cost approach to produce coastal bathing waters that meet the criteria). The cost effectiveness approach is more problematic where there are a number of goals and where some actions achieve certain goals more fully than others.

CHAPTER SIX

6. Environmental monitoring, auditing and report writing

6.1. Environmental monitoring

Environmental monitoring is can be defined as the continuous assessment of environmental or socio-economic variables by the systematic collection of specific data in space and time. Environmental monitoring can be used to:

Document the baseline conditions at the start of the EIA

- Assess performance and monitor compliance with agreed conditions specified in construction permits and operating licenses and modify activities or mitigation measures if there are unpredicted harmful effects on the environment.

Identify trends in impacts.

- Verify the accuracy of past prediction of impacts and the effectiveness of mitigation measures in order to transfer this experience to future activities of the same type.

6.1.1. Types of environmental monitoring and issues to be considered

No.	Types	Definitions	Issues to be considered	Systems of approach
1	**Baseline monitoring**	It is the measurement of environmental parameters during a pre-project period	Identifying the resource base before the implementation of the proposed activities	Baseline data collection
2	**Impact monitoring**	It is the measurement of environmental parameters during project construction and implementation	Identify/detect changes in the parameters	▪ Visual observation ▪ Interview ▪ Document review
3	**Compliance monitoring**	Unlike the previous monitoring activities, takes the form of periodic sampling or process emissions to ensure that regulatory requirements are	Check against regulatory requirements and standards e.g. in relation to emission of pollutants.	▪ Document review ▪ Interview ▪ Visual observation

		observed and standards are met.		▪ Sample testing

There are several types of environmental monitoring. The following are the most common ones with common issues.

6.2. Environmental auditing

Environmental auditing is part of the overall environmental management system. It is used to check systems and procedures against legal requirement, standards, best practices and professional judgment.

6.2.1. Types of and issues to be considered

The following are few of major environmental auditing and the most common issues to be considered.

Types of Audit	Definition of	Issues to be considered	Systems of approach
Compliance audit	It is the verification process where by the company established the extent to which it is complying with environmental legislation with environmental legislation, discharge and emission consent limits, building permit (standards).	Check against that all relevant environmental legislation and standards are being considered	▪ Interview (check list) ▪ Document review ▪ Visual observation
Environmental risk audit	It is the process of conducing an assessment to identify potential risk points in the chain from receipt of raw material through the production processes to storage and distribution	▪ Assess conditions & working procedures ▪ Assess the likelihood of an environmentally damaging occurrence and the consequences	▪ Interview ▪ Visual observation ▪ Document review

		of the event.	
Reacquisition audit	This is commonly undertaken before the transfer of ownership from one individual to another.	▪ Assess contaminated land buildings ▪ Undertake historical survey through identifying past and current activities ▪ Undertake site assessment ▪ Undertake sample test	▪ Interview ▪ Document review ▪ Visual observation ▪ Laboratory testing
Management systems audit	It is the process of checking the system or procedures against the existing policy and standard and relevance of those standards and procedures for ensuring continual improvement in environmental performance.	▪ Check operations against written procedures ▪ Check their continual improvement program	▪ Interview ▪ Visual observation ▪ Document review

6.3. Environmental impact assessment report writing

6.3.1. Background

Report writing is an important part of any EIA study that enable to communicate the findings of the study to a wide range of professionals, decision makers, administrators and the public. Each individual EIA report should ideally be tailored to fit the circumstances of the project. However, it is useful to follow certain general guidelines to fit together the essential components of the study so as to generate a coherent advisory report helpful to the decision makers as well as the general public. A brief description of the typical contents of each section of an EIA report is given below.

6.3.2. Contents of EIA report

I) Executive summary

The summary has to be concise and present the highlight of the main issues pertinent to decision makers on the project. It should be developed in non-technical terms such that decision makers and other stakeholders may readily understand it.

II) Details of the report

1. Introduction

This part would be introductory in nature and should provide a background of the project. It presents a review of the existing situation and demonstrates the need for the proposed project. Details regarding the composition of the EIA study team, the budget adequacy (in professional person), work plan and the report organization should also form a part of this category.

2. The site and surroundings

The site and surrounding area should be described in this part. This part should include the following information.

- A description of the location and layout, including a vicinity map.
- Existing land use patterns should be described.
- Existing water body and water use in the area.
- Demographic profile which includes population density, sex, age, etc
- Soil profiles, including identification of soil types, erosion, geology etc
- Hydrology and water quality, resources.
- Meteorological data and air quality etc.
- Ecological data would be included.

3) About the project

This part should describe the relevant systems of the proposed project. This should include the plant layout, inclusive of the drainage system, description of materials utilized and produced (mass balance), design criteria adopted and the access ways to be used. Project information should be described in terms of the following activities, such as site preparation, operation on site, transportation, welfare and closure.

4) Environmental effects of project operation

The anticipated impacts of the project operation on the environment should be described in this part. EIA methods such as matrix and network, together with tools such as predication models, may be useful at this stage. All direct and indirect impacts should be speculated at this stage.

5) Evaluation and analysis of impact

The type of evaluation method or tool, for example, matrix, network, GIS, cost-benefit analysis, etc used to quantitatively evaluate the impact due to the proposed action, should be highlighted in this part of the report.

6) Design of mitigation measures

In this part of the report, mitigative measures, which are established to prevent, reduce or compensate for impacts mentioned under part 5 are detailed. Finding better ways of doing things, minimize or eliminate negative impacts, enhance benefits and protect public and individual rights to compensation are common mitigative measures.

7) Environmental Management Plan (EMP)

This part should describe in detail the implementation plan to be adopted by the proponent during implementation for mitigation, protection or enhancement measures which are recommended in part 6. This part is the most crucial and significant part of the entire EIA report. It is therefore essential that this part should be presented with precision and clarity. The outline may be structured as follows:

- Objective;
- Work plan/Implementation schedule;
- Resources requirements;
- ➢ Manpower
- ➢ Material provision/availability
- ➢ Budgetary provision for EMP.

8) Environmental monitoring programs

The proposed monitoring programs to be implemented to monitor environmental impacts due to the operation of the project should be described in this part. The programs should be initiated prior to the commencement of the construction activities.

CHAPTER SEVEN

7. Possible Environmental Impacts and their Mitigation Measures

7.1. INTRODUCTION

Environmental Impact is the change in an environmental parameter, over a specific period and within a defined area resulting form a particular activity compared with the situation, which would have occurred, had the activity not been initiated. Environmental impacts (negative or positive) resulted from different interventions, can vary in their nature being direct, indirect, etc. Impacts can range from insignificant to highly significant. Their extent could be local, regional or global; some impacts may felt immediately or may not be evident for some time. The others may have short terms or long term; temporary or permanent impacts. Some impacts can be random or predictable; they may be reversible or irreversible upon the decommissioning of a project.

The potential environmental impact resulted from the intervention should be identified, analyzed and described. The impacts can be on biophysical (soil, water, air, flora and fauna), social, economic, cultural or health.

In this module only major impacts are discussed although it is believed that, a lot of impacts may occur depending on the type and nature of projects. The checklists of impacts listed here in this module are examples and not complete list of impacts occurred because of implementation of different interventions. Similarly, mitigation measures are not complete list of what can be done in order to mitigate negative impacts. Mitigative measures can be done in order to mitigate negative impacts. Mitigative measures can be taken before or after the occurrences of the impacts to rehabilitate or compensate the negative impact already occurred. Under this section, expected impacts of different interventions on biophysical, socioeconomic etc, environmental and their mitigation measures are listed.

7.2. Possible impacts on soil and their mitigative measures

Possible impacts		Some mitigative measures
1.	Soil erosion as a result of different activities	▪ replanting right species of trees, shrubs and grasses in a right time on disturbed areas. ▪ minimize the area of ground clearance. ▪ careful design/plan of projects ▪ carry out soil conservation and or agro-forestry measures.
2.	Loss of nutrients because of different activities	▪ the same as above. ▪ reducing harvest removal.
3.	Because of use of mechanization, pesticides and machineries may result in soil compaction.	▪ using appropriate machineries/mechanization in appropriate time. ▪ planting leguminous plants improve soil structure. ▪ improve soil structure by planting species that improve soil structure or by adding organic matter
4.	Occurrence of salinization because of different activities like irrigation with saline water.	▪ adding organic matter/neutralizing ▪ planting salt tolerant species
5.	Soil Acidity	▪ reduce the addition of artificial/organic chemical ▪ adding alkaline substance like lime ▪ appropriate use/disposal of chemicals
6.	Alkilinization of arable land	▪ avoiding the use of alkaline water for irrigation purposes ▪ adding organic matter (compost)
7.	Imbalance of biological activities as a result of contamination of soil with toxic chemicals and loss of organic nutrients due to soil erosion.	▪ appropriate use of wastes/toxic chemicals ▪ take any measures that are used to minimize loss of nutrients. ▪ adding organic mater (green maturing, compost). ▪ promote cleaner production (preventing/minimizing waste)

8.	Productive topsoil covered by proposed activities or removal of productive top soil for temporary or permanent purposes	▪ collect and reuse the excavated top soil to form a superficial layer. ▪ conversions of borrow pits and spoil dumpsites in to scenic lookouts. ▪ use vertical space than horizontal.

7.3. Possible impacts on water and mitigative measures

Possible Impacts		Some mitigative measures
1.	Flooding, channel modification, river canal siltation	▪ leaving sufficient enough buffer zones of undisturbed vegetation between the site of the project and water bodies ▪ use water flow speed reduction measures e.g. soil conservation measures ▪ plan carefully to avoid the change/modification of the previous channel flow/natural flow of water.
2.	Reduction/lowering of surface or ground water table.	▪ locate those water-consuming projects, if possible, in areas where availability of ground or surface water is not a problem ▪ choose the most appropriate techniques to minimize the amount of water consumed ▪ ensure that the utilization of ground water is within the capacity of natural system to replenish itself ▪ re-use the recycled wastewater
3.	Excess increment of nutrients in water bodies (eutrophication).	▪ sitting projects far away from susceptible areas to erosion in order to reduce chemical pollution of water bodies ▪ carry out soil conservation measures ▪ leaving sufficient enough buffer zones of undisturbed vegetation between the site of the projects and water bodies ▪ avoid direct waste disposal into or near water bodies

		▪ reduce the amount of inlet of both chemical and biological fertilizers to water bodies
4.	Pollution of surface and ground water through direct or indirect addition of toxic chemicals or water or organic chemicals.	▪ sitting projects far away form susceptible areas to erosion in order to reduce chemical pollution of water bodies ▪ leaving sufficient buffer zones of undisturbed vegetation between the site of the project and water bodies ▪ install silting basins to reduce silt, pollutants and debris from runoff before it is discharged to adjacent water bodies ▪ monitoring pipeline systems and impoundments for leaks to reduce contamination of ground water. E.g. Preparing waterproof waste water collectors ▪ monitor sites even after the project has been closed (as necessary) and train local communities to conduct water quality tests to reduce ground water pollution ▪ reclaiming landscapes where devastating activities have been taken place to reduce water pollution ▪ recycling or wastes to reduce water pollution ▪ use treatment techniques especially in industrial activities ▪ choice of the most appropriate technique, replacing processing equipment ▪ dispose safely/properly expired toxic chemicals

5.	Increment of suspended solids (turbidity) in water bodies through soil erosion or direct release of waste from different activities.	▪ sitting projects far away from susceptible areas to erosion in order to reduce siltation, turbidity and chemical pollution of water bodies ▪ carry out soil conservation measures ▪ leaving sufficient enough buffer zones of undisturbed vegetation between the site of the project and water bodes. ▪ installing silting basins to reduce silt, pollutants and debris from runoff before it is discharged to adjacent water bodies
6.	Increment of the amount of silt/sediment in downstream area including agricultural land, reservoirs, etc.	▪ Minimize the area of ground clearance; provide good vegetative cover or; control the volume and speed of water flows ▪ careful design/plan of projects can avoid soil erosion; ▪ carry out soil conservation measures. ▪ leaving sufficient enough buffer zones of undisturbed vegetation between the site of the project and water bodies.

7.4. Possible impacts on air quality and their mitigative measures

Possible Impacts		Some mitigative measures
1.	Depletion of ozone layer and climatic change due to emission of some gases (SO_2, CO_2, NO_2, fluoride, CO, CFCS etc.) to the atmosphere.	▪ control the emission of SO_x, NO_x, Co and other applicable chemicals by scrubbing with water or alkaline solutions, incineration or absorption by other catalytic processes. ▪ recycle wastes to reduce the amount of pollutants released to the atmosphere ▪ choose environmentally friendly processes, technologies or raw materials. ▪ treat effluent gases to reduce the amount of pollutants. ▪ establish treatment plant
2.	Reduction of air quality due to dust	▪ control particular matters by scrubbers, fabric filter collectors or electrostatic precipitators. ▪ choice of environmentally friendly processes, technologies or raw materials reduce the amount and significance of pollutants ▪ watering of the area form which dust is generated;

7.5. Possible impacts on flora, fauna and ecosystem and mitigative measures

	Possible Impacts	Some mitigative measures
1	Loss of flora and fauna when projects are established at the spot or in vicinity	▪ locate projects far away from sensitive areas; ▪ carry out necessary rehabilitation measures when phasing out a project
2	Stability and health of an ecosystem may be affected when habitat is fragmented.	▪ plant with native species in vicinity of a project and adjacent areas to wildlife to provide additional habitats and migration routes/corridors for local animals; ▪ fence wildlife areas to avoid people interference if possible also establish a legal protection system/framework;
3	Direct killing of animals like collisions with vehicles	▪ at important areas use of tunnels/bridges reduces interference and collision rates ▪ fencing or plant barriers can reduce the interference of human beings and traffics to wildlife ; ▪ take measures, like speed break on roads, to reduce the speed of vehicles where road crosses protected areas.
4	Disturbance of ecosystem because of extraction of sand, gravel or rock	▪ avoid, if possible, the extraction of sand, gravel etc from river bottom/water bodies. ▪ use alternative site to exploit the resources ▪ avoid the use of dynamite/explosive in water bodies ▪ avoid construction materials during breeding seasons in both water and terrestrial ecosystems
5	Exploitation of natural resources (flora and fauna) because of immigrants to project area	▪ before the establishment of projects planting appropriate tree species, which can be used for different purposes, to minimize burden on the sitting natural resources ▪ use alternative energy resources and construction materials ▪ use proper waste management technology ▪ make clear demarcation between the resource and project area.
6	Flora and fauna in wetlands	▪ avoid the excessive clearance of vegetation from stream

	are affected	banks ▪ locate projects as much as far as possible from wetlands ▪ avoid the releaser or minimize the use of hazardous chemicals in the catchments of vulnerable wetlands; ▪ if possible, the project should not modify water flow/course ▪ use soil and water conservation measures in the catchments to reduce siltation.
7	Introduction of new species or change of cultivation may cause for development of pests, diseases or weeds.	▪ if needed research on invasive exotic species should be carried out in enclosed areas ▪ avoid the use of invasive exotic species for landscaping, reforestation or for other purposes ▪ control the importation of uncertified seed or germ plasm to the region to avoid import of plant pests/disease;
8	Direct or indirect killing of aquatic and terrestrial animals spreading of pesticide/insecticide for different purposes.	▪ use integrated pest management to avoid mass killing of animals ▪ the concentration and length of time to chemicals should be to the level of the standard. ▪ use appropriate and trained man power for application of chemicals ▪ avoid the use of very poisonous pesticides in particular, on fields sloping down to watercourses during rain seasons with heavy precipitation ▪ apply pesticide, when a number of fauna are at the side. E.g. timing.
9	Contamination or use of polluted water may affect wild life and nearby communities to the project area.	▪ use of chemicals or disposal of wastes in a proper way reduce the impact; ▪ handling of unused/used poisonous chemicals until they are treated and disposed properly ▪ be sure that effluents are treated to the standard before joining water bodies. ▪ avoid the use of very poisonous pesticides in particular on

		fields sloping down to water courses during seasons with heavy precipitation. ▪ proper disposal of expired chemicals prevents the potential impacts on flora and fauna. ▪ proper disposal of wastes reduces siltation and pollution of water
10	Improper use of modern biotechnology or introduction of genetically modified varieties to the region may lead to genetic erosion	▪ regulate/control importation of varieties to avoid genetic erosion; ▪ regulate import of species to avoid the spoiling of the natural means of existence of existing fauna. ▪ avoid the use of invasive exotic species for landscaping, reforestation, research or for other purposes; ▪ care has to be taken in activities related to modern biotechnology to reduce/avoid the impacts on indigenous species or genetic erosion;
11	Change of the living condition of fish when its migration route is blocked by constructions e.g. dams/reservoirs	▪ design carefully diversion wears, dams/reservoirs etc. to allow aquatic species to swim against the current; ▪ use filters not to get away fishes to irrigation canals ▪ construct ladders so that the fishes jump and migrate against the flow of the water.
12	Water logging may affect the flora (especially deep rooted plants) and fauna of the area.	▪ digging of canals to lower the water table ▪ planting high water consuming species ▪ minimizing over irrigation
13	Depletion of resources beyond their	▪ restrict or limit the optimum amount to be exploited/harvested according to the management plan done for the specific resource ▪ use recycling methods

7.6. Possible socio-economic impacts and their mitigative measures

Possible Impacts	Some mitigative measures

	Lifestyles, travel patterns and social as well as economic activities etc. are affected by the intervention of projects.	▪ sitting the project far from human settlement area to reduce disruption of social and cultural way of life; and disturbance, nuisance from noise, dust etc; ▪ implementation of appropriate technology that reduce disruption ▪ ensure that project site is not located in sensitive areas like major flood plains; inundation areas; etc;
	Health and social problems like disease, alcohol abuse and unemployment are often brought with new settlers	▪ sitting the project far from human settlement area reduces disruption of social and cultural way of life; and disturbance, nuisance from noise, dust etc; ▪ employing the local people to reduce the number of immigrants ▪ conduct awareness raising program ▪ establishment of health centers
	Loss of traditional sense of self-identity because of new settlers	▪ aware the project so that it can keep the norms/bylaws of indigenous people.
	Inundation of farmlands like loss of agricultural, forest or grazing lands by huge amount of waste generated from the project, for example from mine tailings.	▪ wastes generated from the project have to be properly disposed. ▪ minimize the amount of wastes released to the area by using alternative technologies, processes etc. ▪ ensure that project site is not located in sensitive areas.
	Destruction of resources by fire, which can be generated from an activity	▪ giving due attention to blasting and combustible raw materials that generate fire ▪ provide fireproofing structures, safety buffer zones around the plant boundary, escape routes and others. ▪ provide fire protective instruments. ▪ precaution measures as fire proofing instruments have to be used. ▪ curative measures have to be in place
	Land use and tenure conflict	▪ compensation may need to be considered for those

	may occur when the area is occupied	whose housing, land resources, welfare or livelihood are directly affected by projects, ▪ use integrated and intensive utilization of land. ▪ give employment opportunity
	Physical conflict may breakout between settler and the indigenous people as the latter try to reclaim their heritage	▪ provide short-term support and/or skills or an alternative livelihood to minimize the effect. ▪ aware the project so that it can keep the norms/bylaws of indigenous people.
	increase competition between indigenous and the project for existing resources	▪ allow sufficient time and money for public participation to ensure the planning of a project; ▪ increase the supply of resources and services. ▪ use of alternative technologies that efficiently utilize the resources
	People are exposed to further social and economic crises when they are resettled to new area as their original place is occupied by project	▪ preconditions have to be fulfilled for settlers when resettlement is found to be mandatory; ▪ conducting awareness raising program on the resettlement program ▪ involve/participate the community in the whole process of the project

7.7. Possible impact on cultural heritages and their mitigative measures

Possible Impacts		Some mitigative measures
	Historical relics, burial sites and other objects may be affected when the area is occupied by projects.	▪ consider alternative sites for project establishment to avoid the impact ▪ avoid establishment of projects across or in known cultural, historical sites or landscapes having scenic value;
	Scenic value or the appearance of landscape may be impaired because of different activities for instance massive excavation of sand etc.	▪ avoid the damages of historical relics, burial sites, other objects, and landscapes; ▪ relocate artifacts or ruing from a site when it is mandatory and possible; ▪ if possible avoid the natural landscape disturbance, if not compensate by rehabilitation measures;
	Cultural monuments and archeological sites may be damaged by different activities for instance massive excavation of sand etc.	▪ involving the indigenous people in the whole process of planning and implementation of projects ▪ maintaining or repairing with out changing its original design; ▪ honoring norms and taboos before the implementation of projects
	Subsequent breaching of dams may also result for local earthquake. Or Landslides/unsuitability or danger of rock falling at the faces etc. may lose scenic values	▪ structural, soil and rock stabilization; control of ground water levels, vegetative stabilization, and site surveillance is required; ▪ daily follow up of sensitive has to be carried out; ▪ establish projects in relatively stable areas
	Spoiling of landscapes or recreational areas could be occurred when projects are established in the vicinity area	▪ appropriate site for waste disposal has to be selected and dispose properly; ▪ conduct reuse and recycling methods
	Change of channeling of waterway may result in loss of	▪ water flow modification should not affect the scenic value of landscape/cultural heritages in down stream

	aesthetic value	areas. ▪ consider alternative site for project establishment
	Loss of scenic value of an area due to deforestation	▪ take the advantage of natural openings in the existing vegetation; or use bare areas

7.8. Possible of noise impacts and their mitigative measures

Possible Impacts		Some mitigative measures
	Continuous noise exposure creates communication problem, behavioral and health effects,	▪ establish the project far away from noise sensitive areas; ▪ provide protective measures for workers in the project ▪ keep the noise at a standard level ▪ use of noise barriers are among the most common mitigative measures ▪ install sound dampers in ventilation systems in stationed sources ▪ enclose machine or use sound barrier walls to reduce the effect of noise ▪ consider wind direction at the design stage in terms of sources of noise to minimize its effect; ▪ reduce noise at the sources to minimize its effect on wildlife and people living along or around the project;
	Vibration can cause detrimental effect on structures particular to cultural heritage sites, standing near the project	▪ establish the project far away from noise sensitive areas (buildings) ▪ install sound dampers in ventilation systems in stationed sources. Enclose machine or use sound barrier walls to reduce the effect of noise. ▪ reduce noise at the sources to minimize its effect on wildlife and people living along or around the project;
	Noise can cause wild animals to leave their original habitat that may exposes them to further danger	▪ establish the project far away from noise sensitive areas; ▪ use of noise barriers are among the most common metigative measures

		▪ consider wind direction at the design stage in terms of sources of noise to minimize its effect. ▪ reduce noise at the sources to minimize its effect on wildlife and people living along or around the project; ▪ use alternative technologies that reduce noise ▪ regulating the sound level to a fairly a constant level

7.9. Possible impacts on human health and safety; and their mitigative measures

Possible Impacts		Some mitigative measures
	Transmission of disease between human and from plants/animals to humans	▪ sanitary or precaution measures can be accomplished through a comprehensive health awareness campaign ▪ curative measures should be in place
	Fire, explosions, emission of toxic gases, vapors, dust, emission of toxic liquid, radiation and their cumulative effects badly affect human health in and around the project	▪ establishing projects far away from settlements ▪ curative measures have to be in place if accidents from different activities can happen. ▪ provide fire proofing of structures, safety buffer zones around the plant boundary, escape routes and others. ▪ store properly easily flammable/explosive gases or toxic chemicals. ▪ preventive/protective instruments have to be provided
	Health effects on workers due to fugitive dust, material handling, and noise, mechanical or chemical contact can be occurred.	▪ prevent accidents through proper design of projects ▪ train responsible personnel how to properly handle chemicals; ▪ use protective measure, for example ear/eye masks etc.
	noise and congestion may be created and pedestrian hazards could be aggravated by heavy trucks	▪ site selection can be taken as preventive measures..
	Death and injuries to human beings and damages to property could be happened in factories,	▪ facility should implement a safety and health program designed to identify, evaluate, monitor and control health hazards

	roads etc.	▪ site selection can be taken as a preventive measure to minimize risk of accidents especially in road projects. ▪ prevent accidents through proper design of projects ▪ use protective measure, for example ear/eye masks etc.
	Extraction of sand or gravel may from unnecessary pond, which creates suitable condition for malaria and water vector borne disease	▪ sanitary or Precaution measures can be accomplished through a comprehensive health awareness campaign. ▪ avoid stagnating water and give consecutive awareness to reduce the occurrence of malaria and other related diseases.
	In mining activities workers are injured when rocks/soils are collapsed,	▪ proper design has to be done well in such away that rocks doesn’t collapse. ▪ curative measures have to be in place

The above possible impacts may or may not be occurred in any project. During predicting these impacts what are the possible causes for their occurrence should be elaborated well. All direct and indirect impacts that may be occurred due to the implementation of the project should be speculated at this stage.