CHAPTER 1

Fundamental Approach to Environmental Impact Assessment (EIA)

1.A BASIC CONCEPTS OF EIA

1.A.1 Introduction

EIA is an activity designed to identify and predict the impact of a project on biogeophysico-chemical environment and on human health so as to recommend appropriate legislative measures, programs, and operational procedures to minimize the impact.

EIA is an exercise to be carried out before any project or major activity is undertaken to ensure that it will not in any away harm the environment on a short-term or long-term basis. Any developmental activity requires not only the analysis, the monetary costs and benefits involved and of the need of such a project but also most important, it requires a consideration and detailed assessment of the effect of a proposed development on the environment.

Often the results of manually-produced changes cause degradation in the surrounding environment. Although the proposed project or plan has a good intent and addresses an identified problem, or solves it, the ramifications of the project may be serious. For instance, it may result in degradation of the human environment offsetting the possible benefits of the proposed project or plan. The aim of environmental impact assessment is to assess the over all impact of development project on the environment.

An impact can be defined as any change in the physical, chemical, biological, cultural or socio-economic environmental system as a result of activities relating to a project.

Major impacts of typical Land Clearing Activities (L.C.A) project on environment are shown in Fig. 1.1.

Salient Features of EIA

(a) The EIA procedure identifies the possible positive and negative impacts to the environment resulting from a proposed project. These impacts are identified over both "short-term" and "long-term" time frame;

(b) The EIA provides for a plan, which upon implementation, will reduce or offset the negative impacts of a project resulting in a minimum level of environmental degradation. This minimization may be a result of implementation of a project alternative or project modifications or environmental protection measures, which

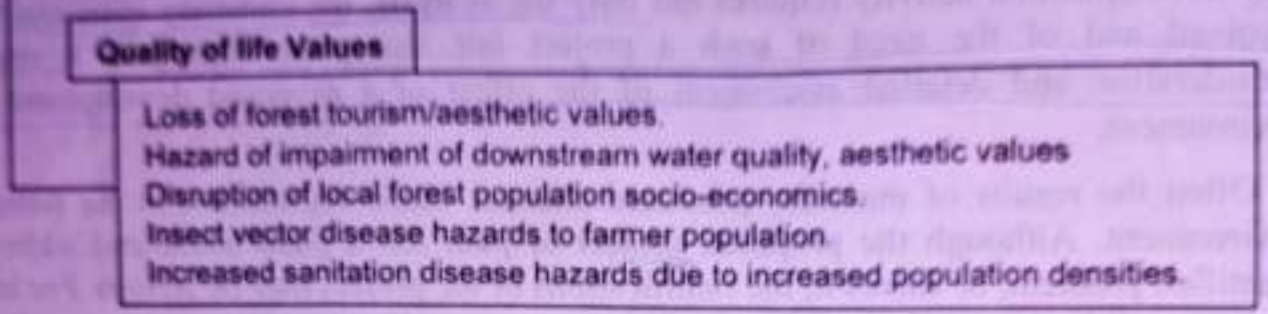


Fig. 1.1 Some major impacts of typical LCA project on environment.

simply reduces the number or magnitude of negative impacts. The plan may also result in utilization of positive impacts for enhancement measures which offset negative impacts;

c) To measure the level of plan implementation and the degree of effectiveness of the above environmental protection provisions, the EIA provides a monitoring programme. This programme will be also designed so that it identifies the parameters of uncertainty and measures the related impacts.

EIA is not negatively oriented towards development of a project. The development of natural resources for economic benefit is desirable. Whether resource development programs prove to be beneficial or destructive depends largely on how far scientific knowledge is obtained in their formulation and the ability of the government agencies to control their implementation. Environmental impact is any change to the environment, whether adverse or beneficial wholly or partially resulting from an organization's activities, products or services.

Development projects go hand in hand into environmental impact and hence before any project is undertaken, the damages in relation to its benefits should be assessed. EIA has found wide utility both in developed and developing countries in achieving development in an environmentally sound manner, either at national or regional scale or at the level of individual development project. Considerable research has been carried out on procedural and methodological issues related to EIA in the past, and an acceptable standard of practice, against which EIA can be reviewed has not emerged. However, despite ample evidence to support the usefulness of EIA, its effectiveness and efficiency are being increasingly questioned. Criticism leveled against EIA include (a) Tokenism (b) unrealistic time constraints (c) Failure to accommodate uncertainity (d) Poor coordination and poorly stated objectives (e) Inadequate research (f) limited use of protective techniques and limited study of indirect and cumulative consequences and (g) being too descriptive and voluminous.

EIA is being criticised for becoming an end in itself and rather than the means to a more balanced process of decision-making. More specifically, the accuracy and precision of impact prediction is being questioned as is the appropriateness of mitigation and the effectiveness of its implementation. A number of studies have, therefore, been undertaken to review EIA methodology in the light of operational experience. Actual effects caused by a project are being compared with predicted effects. Models are being revalidated and appropriate methodologies and models are being used. Follow-up or post operational studies are being conducted.

In the context of EIA, audit refers to (a) the organization of monitoring data to record change associated with a project and (b) the comparison of actual and predicted impacts. Audit can be applied to both pre-project and post-project approval stages. EIA necessarily does not reject a project but does as in rare cases. By conducting an early EIA, a timely and suitable modification in the project can be incorporated which ultimately may help the project itself.

1.A.2 EIA Procedure

The entire EIA procedure can be divided into two complementary tasks or sub-reports, (i) the Initial Environmental Examination (IEE) and (ii) the Full-Scale Environmental Impact Assessment (EIA).

1.A.2.1 Initial Environmental Examination (IEE)

IEE is a means of reviewing the environmental integrity of projects to help determine whether or not EIA level studies can be undertaken. In this sense IEE can be used for project screening to determine which projects require a full-scale EIA. IEE will have several other uses for ensuring project-oriented environmental management as well as minimizing the effort, expense, and delay in carrying out such planning. IEE involves assessing the potential environmental effects of a proposed project that can be carried out within a very limited budget and will be based on the available recorded information or on the professional judgment of an expert. If the IEE results indicate that a full-scale EIA is not required, then, any environmental management parameters, such as, environmental protection measures or a monitoring programme can be adapted to complete the EIA for such a project.

If on the other hand, full-scale EIA is required, IEE can be of great help as a mechanism to determine and identify key issues that merit full analysis in EIA and to designate the issues that deserve only a cursory discussion. It may also identify other environmental review and consultation requirements so that necessary analyses or studies can be made concurrently with EIA. This would reduce delay and eliminate redundant or extraneous discussion from EIA reports. IEE is a means of providing the most efficient and feasible preparation of adequate environmental management plans with or without the requirement of a full scale EIA. Therefore, for most Industrial Development Projects, IEE is desirable simply from the economic point of view.

1.A.2.2 Important Steps in Full Scale Environmental Impact Assessment (EIA)

A multidisciplinary approach to environmental impact analysis is crucial to the decision-making process and to an equal consideration of all areas of potential impact, when the tradeoffs of particular alternatives are evaluated. Therefore, the professional assessing impacts within a particular area of impact, such as, natural resources, air quality, and neighborhood effects, must be educated and quantified within the disciplinary area.

Impact assessment methods are classified into following analytical functions: Scope identification, prediction, and evaluation.

Methods of identification of environmental impacts can assist in specifying the range of impacts that may occur, including their special dimensions and time frame. This usually involves the components of the environment affected by the activities of the project. The natural environment of man consists of air, water, land, noise, flora and fauna etc., while the man-made environment consists of socio-economic aspects, aesthetics, transportation etc.

Predictive methods will define the quantity or special dimensions of impact on an environmental resource. It can differentiate between various project alternatives in terms of questions covering "how much?" or "where?" the impact may occur.

Methods of evaluation determine the groups (facility users or populations) that may be directly affected by the project or action. They will communicate to the decision maker what the deficiencies (trade offs) are between possible alternatives or courses of action and the impacts associated with each alternative but of the number of available tools and techniques for E.I.A, only a few look simple and suitable for developing countries.

Analytical Functions Associated with the Environmental Impact Assessment

Analytical functions associated with the environmental impact assessment are

(a) *Defining scope of a EIA*

1. Important issues and concern,
2. Areas of less concern for the present acts, and
3. Regulations requirement.

(b) *Identification*

1. Description of the existing environment system,
2. Determination of the components of the Project, and
3. Definition of the environment modified by the project (including all components of the project).

(c) *Prediction*

1. Identification of environmental modifications that may be significant,
2. Forecasting of the quantity and spatial dimensions of change in environment identified, and
3. Estimation of the probability that the impact (environmental change) will occur (time period).

(d) *Impact Evaluation and Analysis*

1. Evaluation of least environmentally damaging alternatives,
2. Critical assessment of impacts, and
3. Preparation of draft and final impact statements.

Defining the Scope of EIA

It is necessary to define the scope of EIA at the early stages of environmental impact assessment so as to reinforce a commitment to an organized, and systematic program of agency and public participation in the environmental process. The public must be made aware in order to be able to make informed choices. Scoping refers to early coordination with interested and affected agencies and the public.

Scoping identifies important issues and concerns, areas of no concern for a particular project or action, and other legislative or regulatory requirements.

Purpose of Scoping

Scoping is used to

- Define the proposed action,
- Enlist the cooperation of agencies,
- Identify what's important,
- Identify what's not important,
- Set time limits on studies,
- Determine requirements of the study team,
- Collect background information,
- Identify required permits,
- Identify other regulatory requirements, and
- Determine the range of alternatives.

The scoping process should be specifically designed to suit the needs of the individual project or action being proposed. It can be a formal, extensive process or an informal, simple process. There are many options for the extent and format of meetings, mailings, and agency and local group contacts.

Identification of Impacts on the Environment by Preliminary Overview Assessment

Often the first step in an environmental impact assessment is a preliminary overview of the proposed project alternatives and locations. Several steps are included in the overview. First,

the project alternatives and characteristics must be reviewed with reference to the following pertinent questions. Is the project a building, a highway, a park, or a land-use plan? What are the characteristics of the setting? Is the potentially affected area urban or rural, natural or made by human beings?

The purpose of the preliminary assessment is to identify the potential for significant environmental impacts of the initial set of alternatives. Results then function to refine the alternatives and to determine the appropriate subsequent environmental documentation. A few examples of the types of questions included in an initial assessment overview, in areas of potential physical, biological, social and economic impacts, are as follows: Will the proposal either directly or indirectly:

- modify a channel or a river or a stream?
- reduce the habitat of any unique, threatened, or endangered species?
- divide or disrupt an established community?
- require the displacement of businesses or farms?

In the identification of impacts one should establish the already existing state and clearly identify,

1. What will happen if the project does not come into existence?
2. What will happen if the project comes up? The impacts of a project can be depicted only through certain parameters.

Some typical expected changes in environment and human aspects by various project activities are presented in Tables 1.1 and 1.2.

Table 1.1 Possible impacts of various project activities on the various components of environment

Component	Important Considerations
Air	Degradation, type of emissions released and the extent to which they affect air quality, creation of excess noise and the effect on man.
Water	Availability, use and quality of water, effects on the aesthetics and aquaculture potential of the ecosystems, effect on the canal system, depletion of ground water, pollution of waters by hazardous and toxic substances, effect on temperature and siltation capacity.
Solid waste facilities	Excess generation of solid waste stress on the existing.
Vegetation	Destruction of forest cover, depletion of cultivable land, changes in biological productivity, changes in the species diversity and hastening the disappearance of important species.
Energy and natural resources	Effects on physio – chemical characteristics of soils, effect on stability or instability of soils.

Table 1.1 *Contd...*

Component	Important Considerations
Soils and local geology	Impact on availability of energy sources in the area. Thermal power generation, natural gas consumption and effect on local natural resources
Processes	Floods, erosion, earth quake, depositions, stability, and air movements
Man-made facilities and activities	Structures, utility networks, transportation, and waste disposal
Cultural status	Employment situation, life style of people, and health services
Ecological relationship	Food chain, diseases/vectors

Table 1.2 Impacts of various project activities on certain human aspects

Economic and occupational	Displacement of population, reaction of population in response to employment opportunities, services and distribution patterns,; property values.
Social pattern or life style	Resettlement; rural depopulation: population density food, housing, material goods, nomadic; settled: pastoral clubs, recreation ; rural; urban.
Social amenities and relationships	Family life styles, schools; transport, community feelings disruptions, language; hospital clubs, neighbours
Psychological features	Involvement, expectations, stress, work satisfaction challenges, national or community pride, freedom of chores, company or solution; mobility
Physical amenities (intellectual, cultural, aesthetic and seasonal)	National parks; wild life, art galleries, museums, historic and archaeological monuments, beauty, Land scape, wilderness, quiet; clean air and water.
Health	Freedom from molestation; freedom from natural disasters
Personal security	Changes in health, medical services, medical standards
Regional and traditional belief	Symbols: taboos; values
Technology	Security hazards, safety measures: decommissioning of wastes; congestion, density
Cultural	Leisure; fashion and clocking changes; new values
Political	Authority, level and degree of involvement priorities, structure of decision – making responsibility and responsiveness, resources allocation: local and minority interest: defence need contributing or limiting factors, to
Legal	Restructuring of administrative management: changes in taxes, public policy
Aesthetic	Visual physical changes, moral conduct, sentimental values
Statutory laws	Air and water quality standards, nation building acts, noise abatement byelaws.

Some of the selected relevant environmental parameters are :

1. Crop productivity,
2. Air quality,
3. Water quality of aquatic resources,
4. Nutrient status of water,
5. Drinking water quality and
6. Availability of agricultural land.

Classification and Prediction of Impacts

Impact Types

Environment impacts arising from any development projects fall into three categories

(i) Direct impacts,
(ii) Indirect impacts; and
(iii) Cumulative impacts.

These three groups can be further broken down according to their nature, into

- Positive and negative impacts;
- Random and predictable impacts;
- Local and widespread impacts; and
- Short – and long term impacts.

An interdisciplinary approach helps in assessing environmental impacts. The analysis considers potential consequences which may be long-term and short-term; direct and indirect, secondary, individual and cumulative; beneficial and adverse. Environmental issues are inter disciplinary, inter active, biological and probabilistic.

Indirect, or secondary effects are those that may occur remote as they are in distance or time from the actual proposed project. An example is the construction of a major employment center, which may have direct effects related to aesthetics in the area, traffic at nearby intersections, removal of natural vegetation, or interference with natural water ways. Additional employment opportunities in the location, however, may prompt additional housing or commercial uses to support employees. Potential impacts of this housing or additional business activity would then be a secondary, or indirect effect of the construction of the employment center and should be evaluated to the best extent possible in the environmental analysis.

Cumulative impacts occur in those situations where individual projects or actions may not have a significant effect, but when combined with other projects or actions, the individual project's incremental contribution of adversity may cause an overall adverse cumulative effect.

Impacts of some typical projects are discussed below for clear understanding.

Examples of Various Types of Impacts that Occur in a Typical Road Development Project

Direct Impacts

Direct impacts are caused by the road itself- that is to say, by road building processes such as land consumption, removal of vegetation, and severance of farmland. For example, the removal, of gravel material from a borrow pit, for use in surfacing the road, is an obvious direct impact of road construction. In this case, the land area in which the pit site is located has been directly affected by activities associated with the road project.

Direct impacts are generally easier to inventory, assess and control than indirect impacts, since the cause effect relationship are usually obvious.

Indirect Impacts

Indirect impacts (also known as secondary, tertiary, and chain (impacts) are usually linked closely with the project, and may have more profound consequences on the environment than direct impacts. Indirect impacts are more difficult to measure, but can ultimately be more important. Over time they can affect largest geographical areas of the environment than anticipated. Examples include degradation of surface water quality by the erosion of land cleared as a result of a new road Fig. 1.2 and urban growth near a new road. Another common indirect impact associated with new roads is increased deforestation of an area, stemming from easier (more profitable) transportation of logs to market, or the influx of settlers. In areas where wild game is plentiful, such as Africa, new roads often lead to the rapid depletion of animals due to poaching.

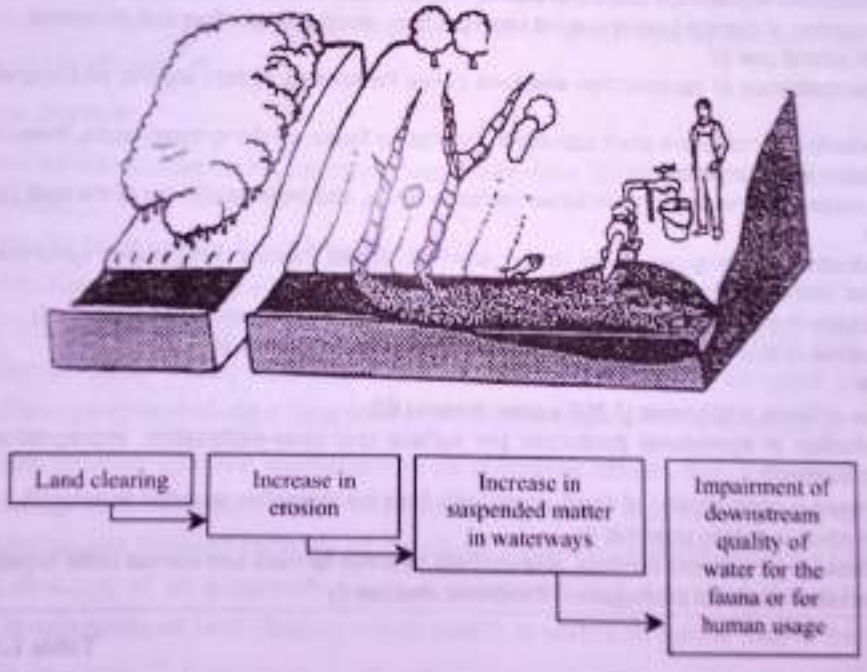


Fig. 1.2 Indirect impacts : the example of land clearing.

Some potential Direct and Indirect impacts are summarised in Table 1.3.

Table 1.3 Potential direct and indirect environmental impacts of a typical road construction project in mangroove swamp and rice growing area.

Direct Impact (D); indirect impact (I)
Soils
Compaction of alluvial soils by earth moving equipment (D)
Erosion and modification of surface relief of borrow zones (275,000 square meters) (D)
Loss of topsoil (165 hectares)in the borrow areas(D)
Over-exploitation of agricultural soils due to future development in a zone sensitive to erosion (I)
Irreversible salinization and acidification of mangrove swamp soils (I)
Water
Modification of flowing surface water in borrow areas, causing erosion and silation (I)
Modification of water flows during construction (stream diversion, modification of water table recharging) (D)
Sedimentation near crossings of presently cultivated flood pain (D)
Modification of surface and subterranean water flows and resulting drying or flooding (I)
Pollution of water tables by equipment lubricants, fuels, and detergents (D)
Displacement of salinity threshold into the mangrove swamp zone: effect on fauna and flora, impregnation of soils
With tannin, erosion of coastline (I)
Flora
260 hectares of deforestation and undergrowth clearance (D)
Destruction of plantings (28, 00 oil palms, 1,600 various trees)(D)
Reduction of cornice forests around swamps, from modified water flow and increased agricultural use (I)
Disappearance of reproduction and food zones for species of fish, aquatic and migratory birds (I)
Reduction of mangrove plant population (habitat for fauna, purifying micro fauna, firewood (D)
Erosion of the coastline (I)
Increase in farming activity, reduction of fallow times, and impoverishment of the soils (I)
Fauna
Reduction in mangrove fauna (crabs, shrimps, egrets, herons, kingfishers, spoonbills, ibises, terns, and other species (I)
Increase in poaching during the works period, and subsequent hunting and fishing (I)
Increase in tourism (Tristan Island, the center for many migratory birds)(I)
People
Loss of farms and homes (1,300 square meters) (D)
Reduction in agricultural production per surface unit (over-exploitation, impregnation of soils with tannin)(I)
Increase in consumption of wood, particularly from the mangrove swamps: erosion (I)
Reduction in fishing potential (I)
Increase in land tenure conflicts, and conflicts between farmers and nomad cattle breeders (I)
Increase in speed of propagation of endemic disease (I)

Table 1.3 *Contd...*

Direct Impact (D); indirect impact (I)
Positive Impacts
Providing all weather road link for coastal population with major urban markets, institutions and goods (D)
Sale of dried fish products (90 percent of national production) increased through quicker transport and access (D).
More effective sale of rice from industrial growers (35, 00 hectares) and small-scale growers (D)
Creation of jobs, Improved access to medical help etc. (I)

Source: SETRA

Impact prediction and assessment is the major step in the environmental assessment process. It involves projection of environmental setting into the future with out the proposed action and predicting the impact and assessing the consequences.

Taking a holistic approach of impacts is very important as many times synergetic relationship between impacts occur which have to be closely examined, since indirect effects frequently lead to synergetic impacts.

It is with indirect effects that impact linkages between the natural and social environment often take place. For example, the appropriation of land to build a road may displace farmers, and may interfere with their cropping pattern and force them to use another water supply. This change could result in a depletion of a groundwater aquifer, intensification of new land clearing, erosion, water runoff contamination with added fertilizers and pesticides, etc.

Cumulative Impacts

The process of cumulative environmental change can arise from any of the four following types of events:

(i) Single large events, i.e., a large project;
(ii) Multiple interrelated events, i.e., road project with a region;
(iii) Catastrophic sudden events, i.e., a major landslide into a river system; and
(iv) Incremental, widespread, slow change, such as a poorly designed culvert or drainage system along a long road extending through a watershed.

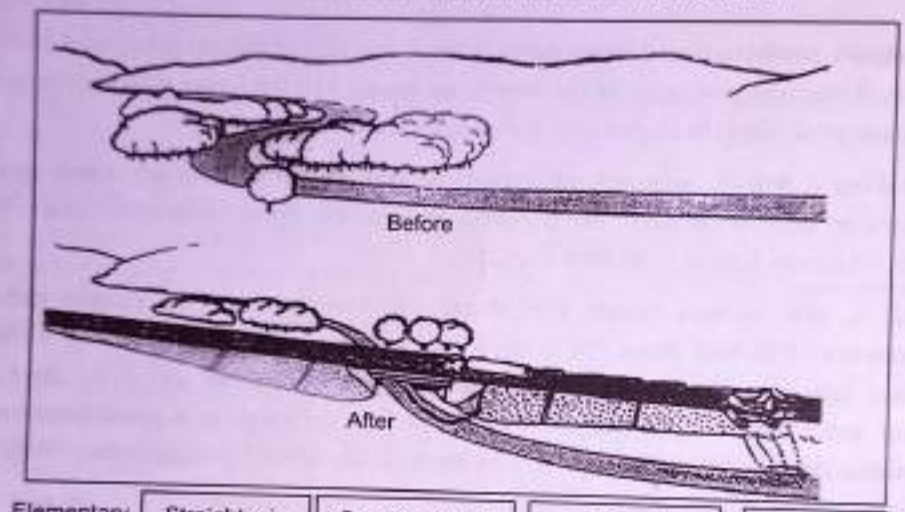
These can generate additive, multiplicative or synergetic effects, Fig. 1.3 which can then result in damage to the function of one or several ecosystems (such as the impairment of the water regulation and filtering capacity of a wetland system by construction of a road across it), or the structure of an ecosystem (such as placement of a new road through a forest, leading to in-migration or land clearing which results in severe structural loss to the forest).

A cumulative impact, in the context of road development, might be the de-vegetation and eventual erosion of a roadside pullout. Roadside vegetation is damaged by vehicle and foot traffic, and the soil is left unprotected. Subsequent rainfall causes erosion and siltation of

nearby watercourses. The vegetation never has enough time to recover (because of high traffic volume on the road), and the problem is exacerbated over time.

As this example, illustrates, cumulative effects assessment is a complex process which requires extensive knowledge of ecological principles and ecosystem response mechanisms.

- Temporal and spatial boundaries for the assessment have been defined;
- Measurable variables have been chosen; and
- The relationships between the chosen variables have been established.



Elementary actions	Straightening of stream	Suppression of vegetation	Road operation	Works
Direct effects	• Increase in water speed • Reduction of diversity • Discontinuity due to water works	• Opening up to light • Rise in temperature	• Risk of chronic seasonal, accidental pollution	• High rate of suspended matter • Risk of pollution

Synergy → **Significance impairment of biological quality of the stream**

Each elementary action produces a certain effect or a risk that can be limited, but the combination of such actions and therefore their consequences may be the source of significant effects. In this example, steps can be envisaged with reference to each elementary action, in order to avoid the synergy effect.

Fig. 1.3 Cumulative impacts : the example of a stream.

The cumulative effects of the proposed road project on the local environment can then be evaluated by

- Compiling a list of activities that are part of the proposed project;
- Estimating the changes that will occur in the measurable variables as a result of these activities; and
- Estimating the effects that the changes in each of the measurable variables will have within the area defined by the spatial and temporal boundaries.

Cumulative effects assessment is an effective impact assessment tool, but it must be carried out properly in order to produce reliable results.

Ecosystem Function Impacts

Technically a subset or variant of cumulative impacts, ecosystem function impacts, which disable or destabilize whole ecosystems are the most dangerous and often the least likely to manifest themselves over a short period of time. Many road-related examples deal with roads which need to traverse watersheds in which surface and subsurface water movement is complex. One striking example is the high way constructed across a mangrove forest (100 ha in size) along the Caribbean coast. It was not fully understood at the planning stage to what extent the fresh and sea water needed to mix in order for the healthy forest to survive on both sides of the road. As a result, most of the forest has died off on one side the waters were not saline enough, and on the other there was not enough mixing with fresh water. The effect on the ecosystem was devastating and the impact on the local population which used the mangrove forest area was severe. Almost certainly, no sign of this impact appeared until two to three years after the road was built. A second example could develop in situations where roads bisect wildlife migration routes, which can inflict stress on the migratory population for many generations, or even permanently, and cause instability increased mortality, and possibly catastrophic decline

Assessment of Significance of an Impact

The determination of *significance* is defined in terms of context and intensity. *Context* refers to the geographical setting of a proposed project or action. When a proposed shopping center is evaluated, the context for the determination of significance in the immediate setting and the general community or area of influence, but not any country as a whole.

Intensity refers to severity of impact

- The degree to which the proposed action affects public health or safety
- The presence of unique characteristics in the geographic setting or area, such as, cultural resources, parklands, wetlands, ecologically critical area, or wild and scenic rivers
- The degree at which the effects are likely to be highly controversial
- The degree at which the action would establish a precedent for further actions with significant effects.
- The degree at which the possible effects will be highly uncertain or involve risks
- The degree of effect on sites listed in the Central Court Register of Historic Places
- The degree of effect on the threatened or endangered species or their habitats
- Whether the action conflicts with other Central, State, or local laws or requirements

In order to be able to predict and assess the impacts associated with a proposed action, it is necessary to describe the environmental setting in which the proposed action is to take place. This gives the baseline information against which prediction and assessment can be made and provides input information for preparation of EIA.

Impact Evaluation and Analysis

The purpose of an environmental impact evaluation and analysis, or evaluation, is to comparatively evaluate alternative courses of action. The range of alternatives considered must include a no-action or no-build alternative and other reasonable courses of action. The major steps of predicting, analyzing and judging environmental impacts in which objective and subjective judgements should be made are as follows:

1. Identifying major activities
2. Selecting environmental components
3. Selecting types of impacts
4. Assessing the possibilities and or probabilities of occurrences
5. Determining the degree and time frame of impacts
6. Designating impacts as positive, neutral or negative
7. Determining trade-offs among activities and impacts.

EIA is intended to provide decision makers with an understanding of the environmental consequences of a proposed project or action. This objective is achieved by the use of environmental information which is often characterized by scarcity and uncertainty, predictive techniques for which error margins are not known, and evaluation methods, which assess and present this information to decision makers. As a result, there is a need for feed back mechanism in EIA which involves the transfer of knowledge from the actual environmental effects of a project or action rather than simply the predicted consequences. This feedback mechanism is provided by the post-project monitoring of environmental quality through Environmental Audit (EA).

Evaluation of Least Environmentally Damaging Alternatives

One of the most important contributions of an initial overview assessment is the early input of environmental considerations for the design or development of the project, action, or plan. If coordination is efficient among the various members of the team for the project or action, the information provided by an initial overview can lead to better projects with fewer environmental impacts. These "least environmentally damaging" alternatives are then the ones evaluated in the subsequent detailed environmental studies, and public and agency review process.

The development and analysis of alternatives form the very core of environmental impact assessment which is nothing but a comparative analysis of alternatives. Environmental Impact Statements are often titled Draft (or Final) Environmental Impact Assessment Alternatives Analysis. The driving impetus for conducting environmental impact studies is to make comparative study of the effects of the proposed alternatives so as to be able to arrive at a better decision- making.

Because of its importance in the impact analysis, the study of alternatives should be a thorough and systematic process. It should include input from Central and State governments, local agencies and the general public. Decisions made at every phase of analysis should be logical and documented on the bases of a solid platform of evaluation criteria. The alternatives section of the Environmental Assessment/Finding of no significant Impact or the Draft and Final Environmental Impact Statements is the most noteworthy portion of the environmental document.

Thus the objectives of environmental impact assessment are :

1. To examine and select the best from the project options available
2. To identify and incorporate into the project plan appropriate abatement and mitigating measures
3. To predict significant reticular environmental impact
4. To determine the significant residual environmental impact predicted
5. To identity the environmental costs and benefits of the project to the community

Examination of Project Alternatives

The necessity to develop alternatives is warranted by the deficiencies, if any, in the existing position. Similarly, the need for transportation projects is based on the deficiencies of the existing transportation system, such as, lack of safety, and inability to handle existing or projected traffic volumes, and meet air quality standards for a region. A National Forest Management Plan may need updating because of a regulatory requirement for periodical reevaluation, a change in use, demand or objectives, or because the present management techniques may not be producing the desired results. For instance, a more spacious jail may be proposed since the present jail is congested. Similarly a new low-income housing project may become imperative on account of shortage of houses as against the demand.

Thus a need–based project should take into account the following :

1. The deficiencies in the existing circumstances,
2. The present projected and specific needs
3. The goals and objectives of these needs.

The first section of any Environmental Assessment (EA) or Draft Environmental Impact Statement should thus be a consideration of purpose and need. It should logically lead to the adopted list of goals and objectives for a proposed project or action plan. Depending on the type and size of this project or action plan, review of and concurrence with the purpose-and-need summary should be obtained from Central or State Govt., or local agencies.

Developing a Preliminary Range of Alternatives

The development of an initial range of alternatives will logically follow; an analysis of purpose-need activity. For this purpose, all possible alternatives that satisfy the goals and objectives, as well as action plans even if they are outside the jurisdiction of the project sponsoring agency must be considered.

1.B.7 Preparation of an EIA Report

Numerous techniques are available for the assessment of environmental impacts and preparation of EIA reports. Alternative assessment techniques are continuously developed and utilized. The project proponent is free to select the method most appropriate for the specific situation.

The manual presents a recommended standard format for the organization of EIA reports. Essential steps to complete an environmental impact assessment include:

1. Describe the proposed project as well as the options
2. Describe the existing environment
3. Select the impact indicators to be used
4. Predict the nature and extent of the environmental effects
5. Identify the relevant human concerns
6. Assess the significance of the impact
7. Incorporate appropriate mitigating and abatement measures into the project plan
8. Identify the environmental costs and benefits of the project to the community
9. Report on the assessment.

The sequence may be repeated for a number of project options and for a selected project concept with mitigating or abatement measures incorporated.

However, the following is a standard format for EIA reports as per Central Pollution Control Board of India.

(a) ***Introduction*** : This constitutes the purpose of the report, extent of the EIA study, and a brief outline of the contents and techniques.

(b) Description of the project.

(c) ***Description of the existing environment*** : This first requires identification of the project "area of influence". The environmental resources within the "area of influence" are then identified as physical resources, ecological resources, human and economic development values, and quality-of-life values.

(d) Anticipated environmental impacts and plans for protection as follows :

(i) *Item-by-item review* : impacts resulting from project implementation are evaluated and quantified wherever possible;

(ii) *Mitigating and offsetting adverse effects* : a plan is presented for offsetting or compensating for significant adverse impacts and for enhancement of positive impacts;

(iii) Identification of irreversible impacts and irretrievable commitments of resources;

(iv) Identification of impacts during construction and appropriate protection measures.

(e) ***Consideration of alternatives*** : for each alternative considered the probable adverse impacts are identified and related to the proposed project and other alternatives.

(f) ***Monitoring programme*** : this is so designed that the environmental agency receives monitoring reports which will ensure that all necessary environmental protection measures are being carried out as listed in the approved project plan.

(g) ***Summary and conclusions*** : the summary and conclusions section is prepared in such a way that it is a complete and comprehensive document in itself. This section includes;

(i) a review of gains versus losses in environmental resources and values, and of the overall net gains which presumably justify the project.
(ii) an explanation of how unavoidable adverse impacts have been minimized, offset and compensated for;
(iii) an explanation of use of any replaceable resources,
(iv) provision for follow-up surveillance and monitoring.

1.B.8 Environmental Monitoring and Management Plan

An appropriate plan should be developed and described for constant monitoring to ascertain the impact of the project on those applicable environmental parameters, which are specially sensitive for the project under consideration. These will usually include environmental resources within the industrial plant (for example, occupational health) and those in the region affected by plant establishment and operations.

It is recognized that most developing countries generally have expressed little interest in funding and implementing monitoring programmes of this type probably because of the lack of appreciation by decision- makers of their vital role in ensuring optimal overall economic and environmental project benefits.

1.B.9 Draft and Final Environmental Impact Statements

The most detailed procedure for analyzing potential environmental impact of alternatives of a proposed project or action is the Environmental Impact Statement process. The DEIS contains the final results of environmental studies of proposed alternatives which are available for public and agency review. The DEIS is a "draft" because it compares all proposed alternatives and is the document upon which the decision to proceed with any particular alternative is made. The DEIS also is the tool through which public and agency input is incorporated into this decision-making process. The E.I.S represents a summary of environmental inventory and the findings of environmental assessments.

The alternatives section of the DEIS contains a detailed description of each proposed alternative, including physical characteristics, operating features, costs, schedule, description of the construction process, and all other relevant features of the proposed action. Certain basics, which are required to accomplish an environmental assessment, are related to description of the environmental setting, impact prediction and assessment and preparation of E.I.S.

The *Affected Environment* section of the DEIS contains information on the existing setting. Although the organization and format vary, the following areas may be included.

Land use and zoning

Social and neighborhood characteristics

- Demographic characteristics
- Housing
- Travel patterns
- Stability

- Pedestrian and bicycle travel
- Community activities and services (fire, police, hospitals, schools, churches, day care and so on)
- Recreational facilities

Economic factors

- Taxes
- Existing business community
- Proposed developments

Traffic and Transportation Energy

Historic and archaeological resources Visual resources Air quality Noise levels Geology and soils including farmland Environmental health and public safety (hazardous wastes)

Water Resources

- Groundwater
- Surface water
- Water supply and wastewater systems
- Wild and scenic rivers
- Wetlands Flood plains and coastal zones.
- Vegetation and wildlife.

The *Environmental Consequences* section of the DEIS contains the results of the assessment of impacts. The assessment can be organized by impact category or by alternative; the usual format is by impact category.

This section focusses on relevant environment issues and impacts. Some areas of potential effect must be included regardless of expected impact. Resources protected by statute, regulation, or executive order must be addressed in all the environmental documents. When such protected resources do not exist within the area or will not be affected, the EIS must document that the resource was considered in compliance with the applicable regulation, and statements must be made why the resource will not be affected the regulation does not apply.

1.B.10 Impact Analysis

Analysis of environmental impacts begin with a description of the existing environment, the assembly of relevant information and data and finally the evaluation and analysis of degree of impact. Considered impacts must include direct and indirect effects. cumulative effects, and long- term and short-term effects. In the analysis process. potential mitigation measures are developed and explored.

The preparation of separate methodologies and technical reports supporting the DEIS have to be in accomplice with the area of discipline and contain the detailed information on existing conditions, methodologies, analysis, and results. The technical reports are then summarized in the DEIS.

Technical reports supporting a DEIS can be prepared for

- Socioeconomic impacts, which include community impacts, land use, economic impacts, visual effects, relocations, traffic and pedestrian and bicycle travel
- Natural resources, which include water quality, vegetation, wildlife, scenic rivers, floodplains, wetlands, and coastal zones, and
- Air quality

1.B.11 Format and Content of a Draft Environmental Impact Statement (DEIS)

After completing the analysis DEIS should have at least the following components:

Cover sheet Summary Table of Contents

(i) Purpose of and Need for Proposed Action
(ii) Alternatives
(iii) Affected Environment
(iv) Environmental Consequences

List of Agencies, Organizations, and Persons to whom copies of the DEIS are sent should be given as Index in Appendices

The language of EIS must be concise and clear, and the data and the information must be relevant.

1.B.12 DEIS Processing

When the DEIS is completed, it is circulated among the Central, State, and Local agencies concerned. In some cases the summary of the DEIS can be circulated instead of the entire document. Notices have to be published in newspapers to notify to the public of the availability of the DEIS and the locations in the community where it will be reviewed.

After the public hearing and the review period, the comments received are evaluated, and a required additional analysis is conducted. Alternatives and mitigation measures may be revised based on the comments received and the responses are prepared to each substantive comment.

Based on the review of the comments and the results of additional studies, the sponsoring agency selects the preferred alternative. This selection process should be a systematic evaluation procedure. The process then continues for the preparation of the Final EIS.

1.B.13 Final Environmental Impact Statement (FEIS)

The FEIS document is the preferred alternative consisting of the DEIS with modifications. In some cases, where minor changes are required, the abbreviated form of the FEIS can be used which merely attaches the required changes or findings to the DEIS.

CHAPTER 2

EIA Methodologies

2.1 Introduction

In this Chapter some simple and widely used EIA methods are described along with criteria to be followed for choosing most appropriate method in a given situation.

Many times an EIA analyst or the person charged with the preparation of an EIA report, is faced with a vast quantity of raw and usually unorganized data. Hence, each technique and method for the evaluation of impacts should have the following qualities and characteristics (1):

1. It should be systematic in approach;
2. It should be able to organize a large mass of heterogeneous data;
3. It should be able to quantify the impacts;
4. It should be capable of summarizing the data;
5. It should be able to aggregate the data into sets with the least loss of information because of the aggregations;
6. It should have a good predictive capability;
7. It should extract the salient features, and
8. It should finally be able to display the raw data and the derived information in a meaningful fashion.

Each of the different methodologies for the assessment of environmental impacts of development projects have their advantages and disadvantages and their utility for a particular application is largely a matter of choice and judgment of the analyst. Nevertheless, some objective criteria exist in making such a choice and these are stated below under the key areas that involve the assessment process.

2.2 Criteria for the Selection of EIA Methodology

2.2.1 General

(a) ***Simplicity :*** The methodology should be simple so that the available manpower with limited background knowledge can grasp and adopt it without much difficulty.

(b) ***Manpower time and budget constraints :*** The methodology should be applied by a small group with a limited budget and under time constraints.

(c) ***Flexibility*** : The methodology should be flexible enough to allow for necessary modifications and changes through the course of the study.

2.2.2 Impact Identification

(a) ***Comprehensiveness*** : The methodology should be sufficiently comprehensive to contain all possible options and alternatives and should give enough information on them to facilitate proper decision-making.

(b) ***Specificity*** : The methodology should identify specific parameters on which there would be significant impacts.

(c) ***Isolation of project impacts*** : The methodology should suggest procedures for identifying project impacts as distinguished from future environmental changes produced by other causes.

(d) ***Timing and duration*** : The methodology should be able to identify accurately the location and extent of the impacts on a temporal scale.

2.2.3 Impact Measurement

(a) ***Commensurate units*** : The methodology should have a commensurate set of units so that comparison can be made between alternatives and criteria.

(b) ***Explicit indicators*** : The methodology should suggest specific and measurable indicators to be used to qualify impacts on the relevant environmental parameters.

(c) ***Magnitude:*** The methodology should provide for the measurement of impact magnitude, defined as the degree of extensiveness of scale of the impact, as distinct from impact importance, defined as the weighting of the degree of significance of the impact.

(d) ***Objective criteria*** : It should be based on objective criteria and the criteria should be stated explicitly.

2.2.4 Impact Interpretation and Evaluation

(a) ***Significance*** : The methodology should be able to assess the significance of measured impacts on a local, regional and national scale.

(b) ***Explicit criteria*** : The criteria and assumptions employed to determine impact significance should be explicitly stated.

(c) ***Portrayal of "with" and "without" situation*** : The methodology should be able to aggregate the vast amounts of information and raw input data.

(d) ***Uncertainty*** : Uncertainty of possible impacts is a very real problem in environmental impact assessment. The methodology should be able to take this aspect into account.

(e) ***Risk*** : The methodology should identify impacts that have low probability of occurrence but a high potential for damage and loss.

(f) ***Depth of analysis*** : The conclusions derived from the methodology should be able to provide sufficient depth of analysis and instill confidence in the users, including the general public.

(g) ***Alternative comparison*** : It should provide a sufficiently detailed and complete comparison of the various alternatives readily available for the project under study.

(h) ***Public involvement :*** The methodology should suggest a mechanism for public involvement in the interpretation of the impacts and their significance.

2.2.5 Impact Communication

(a) ***Affected parties :*** The methodology should provide a mechanism for linking impacts to specific effected geographical or social groups.

(b) ***Setting description :*** It should provide a description of the project setting to aid the users in developing an adequately comprehensive overall perspective.

(c) ***Summary format :*** It should provide the results of the impact analysis summarized in a format that will give the users, who range from the lay public to the decision makers, sufficient details to understand it and have confidence in its assessment.

(d) ***Key issues :*** It should provide a format for highlighting the key issues and impacts identified in the analysis.

(e) ***Compliance :*** One of the most important factors in choosing a methodology is whether it is able to comply with the terms of reference established by the controlling agency.

2.3 EIA Methods

2.3.1 List of Environment EIA Methods

The following are the important methodologies of utility for assessing the impacts of developmental activities on the environment.

1. Adhoc methods
2. Checklists methods
3. Matrices methods
4. Networks methods
5. Overlays methods
6. Environmental index using factor analysis
7. Cost/benefit analysis
8. Predictive or Simulation methods

Impact assessment methodologies range from simple to complex and are also progressively changing from a static, piecemeal approach to the one that reflects the dynamism of nature and the environment (2). Consequently, the trend is away from mere listing of potential impacts towards more complex modes whereby the methodology can identify feedback paths, higher order impacts than merely those apparent, first order ones, and uncertainties. In short, the methodological trend is approaching an overall management perspective requiring different kinds of data different in formats and varying levels of expertise and technological inputs for correct interpretation. It is important to understand their drawbacks in order to determine which of the methods are most appropriate. An evaluation of various methodologies (3) is presented in Table 2.1.

Table 2.1 Summary of current EIA methodology evaluation

Criteria	Check lists	Over-lay	Net-work	Matrix	Environ-mental index	Cost/ benefit analysis	Simulation modeling workshop
1. Comprehensiveness	S	N	L	S	S	S	L
2. Communicability	L	L	S	L	S	L	L
3. Flexibility	L	S	L	L	S	S	L
4. Objectivity	N	S	S	L	L	L	S
5. Aggregation	N	S	N	N	S	S	N
6. Replicability	S	L	S	S	S	S	S
7. Multi-function	N	S	S	S	S	S	S
8. Uncertainty	N	N	N	N	N	N	S
9. Space-dimension	N	L	N	N	S	N	S
10. Time-dimension	S	N	N	N	S	S	L
11. Data requirement	L	N	S	S	S	S	N
12. Summary format	L	S	S	L	S	L	L
13. Alternative comparison	S	L	L	L	L	L	L
14. Time requirement	L	N	S	S	S	S	N
15. Manpower requirement	L	S	S	S	S	S	N
16. Economy	L	L	L	L	L	L	N

Legend : L = Completely fulfilled, or low resource need.
S = Partially fulfilled, or moderate resource need.
N = Negligibly fulfilled, or high resource need.

Source: *Environmental Impact Assessment: Guidelines for Planners and Decision Marker, UN Publication S1/1 SCAP/351/ESCAP, 1985 (1)*

2.3.2 Ad hoc Methods

Basically ad hoc methods indicate broad areas of possible impacts by listing composite environmental parameters (for example flora and fauna) likely to be affected by any development.

Ad hoc methods involve assembling a team of specialists to identify impacts in their area of expertise. In this method, each environmental area, such as, air, and water, is taken separately and the nature of the impacts, such as, short-term or long term, reversible or irreversible are considered. Ad hoc methods are for rough assessment of total impact giving the broad areas of possible impacts and the general nature of these possible impacts. For example, the impacts on animal and plant life may be stated as significant but beneficial.

In the ad hoc methods, the assessor relies on intuitive approach and makes a broad-based qualitative assessment. This method serves as a preliminary assessment which helps in identifying more important areas like :

1. Wild life
2. Endangered species
3. Natural vegetation
4. Exotic vegetation
5. Grazing
6. Social characteristics
7. Natural drainage
8. Groundwater
9. Noise
10. Air Quality
11. Visual description and services
12. Open space
13. Recreation
14. Health and safety
15. Economic values
16. Public facilities

The ad hoc methods, while being very simple can be performed without any training, merely present the pertinent information of a project's effects on the environment without any sort of relative weighting or any cause-effect relationship. It provides minimal guidance for impact analysis while suggesting broad areas of possible impacts. It does not even state the actual impacts on specific parameters that will be affected

The ad hoc method has the following drawbacks :

(a) It gives no assurance that it encompasses a comprehensive set of all relevant impacts;

(b) It lacks consistency in analysis as it may select different criteria to evaluate different groups of factors; and,

(c) It is inherently inefficient, as it requires a considerable effort to identify and assemble an appropriate panel for each assessment.

As the expert judgement in assessing the primary impacts is done in an ad hoc manner it cannot be replicated making it to review or analyse the conclusions in EIA. As considerable amount of information about the social, economic, biological and physical environment are to be collected and analysed in EIA of any project activity ad hoc methods fail to do this in any meaningful way.

Because of the above drawbacks, it is not recommended as a method for impact analysis. It is after all ad hoc method and has utility only when other methods cannot be used for lack of expertise, resources and other necessities.

2.3.3 Checklist Methodologies

Introduction

Checklist methodologies range from listings of environmental factors in highly structured approaches involving importance weightings for factors and application of scaling techniques for the impacts of each alternative on each factor.

Checklists in general are strong in impact identification and are capable of bringing them to the attention and awareness of their audiences. Impact identification is the most fundamental function of an EIA and in this respect, all types of checklists, namely simple, descriptive, scaling and weighting checklists do equally well.

Checklists are of four broad categories and represent one of the basic methodologies used in EIA. They are:

(a) ***Simple Checklists :*** that are a list of parameters without guidelines provided on how to interpret and measure an environmental parameter.

(b) ***Descriptive Checklists :*** that includes an identification of environmental parameters and gnidelines on how parameter data are to be measured.

(c) ***Scaling Checklists :*** that are similar to descriptive checklist with the addition of information basis to subjective scaling or parameter values.

(d) ***Scaling Weighting Check Lists :*** are capable of quantifying impacts.

"Simple checklists" represent lists of environmental factors, which should be addressed; however, no information is provided on specific data needs, methods for measurement, or impact prediction and assessment. "Descriptive checklists" refer to methodologies that include lists of environmental factors along with information on measurement and impact prediction and assessment.

Scaling and weighting inherent in the latter types of checklists facilitates decision-making. Such checklists, apart form being strong in impact identification, also incorporate the functions of impact measurement and to a certain degree of interpretation and evaluation, and it is those aspects that make them more amenable to decision- making analysis.

But the impact of scaling and weighting is, nevertheless, subjective and this poses the danger that society holds all diverse impacts to be equally important. Further, it implicitly assumes that numerical values assigned to impacts can be derived on the basis of expert knowledge and judgement alone.

Scaling and weighting checklists, while capable of quantifying impacts reasonably well, albeit using subjective estimates, make no provision for assessing dynamic probabilistic trends or for mitigation, enhancement and monitoring programmes. Identification of higher order effects, impacts and interactions are outside their scope. But simple and descriptive checklists offer no more than this. They merely identify the possible potential impacts without any sort of rating as to their relative magnitudes.

Methods that involve scaling and weighting and the consequent aggregation remove decision making from the hands of decision makers. Further they incorporate into one number various intrinsically different impacts and this deprives the decision maker of the possibility of tradeoffs.

In check lists methods impacts will be tabulated in the form of cells with information either in the descriptive form which give information of the possibility or potential existence of an impact while in the scaling or weighing methods the magnitude or importance of the impact as shown in Table 2.2.

Simple Checklists

Simple checklists represent a valid approach for providing systemization to an EIS and Table 2.2 presents a list of environmental factors to be considered in construction and operational phases. The checklist also includes information on mitigation.

Table 2.2 Environmental factors to be considered in construction and operating phase.

Check List Method

	Construction Phase				Operating phase	
	Beneficial	Adverse effect	No. effect	Beneficial effect	Adverse effect	No. effect
(A) Land Transportation and Construction						
(a) Compaction and settlement						
(b) Erosion						
(c) Ground cover						
(d) Deposition						
(e) Stability (slides)						
(f) Stress – strain (earth peaks)						
(g) Floods						
(h) Waste control						
(i) Drilling and blasting						
(j) Operational failure						
(B) Land Use						
(a) Open space						
(b) Recreational failure						
(c) Agricultural						
(d) Residential						
(e) Commercial						
(f) Industrial						
(C) Water Resources						
(a) Quality						
(b) Irrigation						
(c) Ground water						
(D) Air Quality						
(a) Oxides (Sulfur, carbon, nitrogen)						
(b) Particulate matter						
(c) Chemical						
(d) Odors						
(e) Gases						
(E) Service System						
(a) Schools						
(b) Police						
(c) Fire protection						
(d) Water and power system						
(e) Sewerage system						
(f) Reuse disposal						
(F) Biological conditions						
(a) Wild life						
(b) Trees, shrubs						
(c) Gases						

Table 2.2 *Contd...*

	Beneficial	Construction Phase Adverse effect	No. effect	Beneficial effect	Operating phase Adverse effect	No. effect
(G)	**Transportation systems**					
	(a) Automobiles					
	(b) Truckling					
	(c) Safety					
	(d) Movement					
(H)	**Noise and Vibration**					
	(a) On – site					
	(b) Off – site					
(I)	**Aesthetics**					
	(a) Scenery					
	(b) Structures					

Descriptive Checklists

Descriptive checklists are widely used in environmental impact studies. For example, Carstea developed a descriptive checklist approach for projects in coastal areas. The methodology addresses the following issues, actions, and projects: riprap placement, bulkheads; groins and jetties; piers, dolphins, mooring piles, and ramp construction; dredging (new and maintenance); outfalls, submerged lines, and pipes; and aerial crossings. For each of the items, environmental impact information was provided on potential changes in erosion, sedimentation, and deposition; flood heights and drift; water quality; ecology; air quality; noise; safety and navigation; recreation; aesthetics; and socio-economics.

Several descriptive checklists have been developed for water resources projects. For example, Canter and Hill suggested a list of about 65 environmental factors related to the environmental quality account used for project evaluation in the United States. For each factor, information is included on its definition and measurement, prediction of impacts, and functional curves for data interpretation (where one was available or easily developed).

A portion of a descriptive checklist containing several factors for housing and other land development projects are shown in Table 2.3. The basis for estimates column presents a simplified, brief listing of key data models needed, if any, for the factor.

Table 2.3 Descriptive checklist for land development projects

Factor	Bases for Estimates
I. Local economy	
Public fiscal balance Net change in government fiscal flow (revenue less expenditures)	Public revenues: expected household income, by residential housing type, added property values Public expenditures: analysis of new-service demand, current costs, available capacities by service

Table 2.3 Contd..

Factor	Bases for Estimates
Employment Change in numbers and percent Employed Unemployed, and Underemployed, by skill level	Direct from new business, or estimated from floor space, local residential patterns, expected immigration, current unemployment profiles
Wealth Change in land values	Supply and demand of similarly zoned land, environmental changes near property
II. Natural environment **Air quality** Health Change in air pollution concentrations by frequency of occurrence, and number of people at risk.	Current ambient concentrations, current and expected emissions, dispersion models, population maps
Nuisance Change in occurrence of visual (smoke, haze) or olfactory (odor) air quality nuisances, and number of people affected	Baseline citizen survey, expected industrial processes, traffic volumes
Water quality Changes in permissible or Tolerable water uses, and Number of people affected for each relevant body of water	Current and expected effluents, current ambient concentrations, water quality model
Noise Change in noise levels and Infrequency of Occurrence, and Number of people bothered.	Changes in near by traffic or other noise sources and in noise barriers: noise-propagation model or nomographs relating noise levels to traffic, barriers, etc.; baseline citizen survey or current satisfaction with noise levels

Important Characteristics of Simple and Descriptive Checklists

1. Simple and descriptive checklists consider environmental factors and/or impacts, which can be helpful in planning and conducting an EIS, particularly if one or more checklists for the specific project type can be utilized.
2. Published agency checklists and/or project specific checklists represent the collective professional knowledge and judgement of their developers; hence, they have professional credibility and usability.

3. Checklists provide a structured approach for identifying key impacts and/or pertinent environmental factors for consideration in impact studies. More-extensive lists of factors of impacts do not necessarily represent better lists, since relevant factors or impacts will need to be selected. Checklists can be easily modified (items can be added or deleted) to make them more pertinent to particular project types in given locations.
4. Checklists can be used to stimulate or facilitate interdisciplinary team discussions during the planning, conduction, and/or summarization of EISs.
5. In using a checklist it is important to carefully define the utilized spatial boundaries and environmental factors. Any special impact codes or terminology used within the checklist should also be defined.
6. Documentation of the rationale basics to identifying key factors and/or impacts should be accomplished. In this regard, factor-impact quantification and comparison to pertinent standards can be helpful.
7. Factors and/or impacts from a simple or descriptive checklist can be grouped together to demonstrate secondary and tertiary impacts and/or environmental system interrelationships.
8. Important weights could be assigned to key environmental factors or impacts; the rationale and methodology for such importance weight assignments should be clearly delineated.
9. Key impacts, which should be mitigated, can be identified through the systematic usage of a simple or descriptive checklist.

Scaling Checklists

Simple and descriptive checklists in general are strong in impact identification and are capable of bringing them to the attention and awareness of their audiences. Impact identification is the most fundamental function of an EIA and in this respect, all types of checklists simple, descriptive scaling and weighting checklists do well. But simple and descriptive checklists offer no more than this. They merely identify the possible potential impacts without any sort of rating as to their relative magnitudes. As a result they are most applicable at the IEE stage of an assessment.

The Oregon Scaling Check- list methods go a step further and provide an idea of the nature of the impact by means of assigning a textual rating of the impact as long- term, direct, and so on. Nevertheiess this approach is not suitable for impact measurement and does not aid much in the decision - making process. Rather it identifies the impacts and leaves the interpretation to the decision makers.

The element of scaling and weighting that is inherent in the latter types of checklists makes it easier for decision - making. Such checklists, apart from being strong in impact identification, also incorporate the functions of impact measurement and to a certain degree those of interpretation and evaluation and it is these aspects that make them more amenable for decision - making analysis.

Scaling and weighting checklists, while capable of quantifying impacts reasonably well, albeit using subjective estimates, make no provision for assessing dynamic probabilistic

trends or for mitigation, enhancement and monitoring programmes. Identification of higher order effects, impacts and interactions are outside their scope.

Methods that involve scaling and weighting and the consequent aggregation remove decision-making from the hands of decision-makers. Further they incorporate into one number various intrinsically different impacts and this deprives the decision - maker of the possibility of trade-offs.

Weighting and Scaling Checklist Methods

As descriptive checklists cannot rank various alternatives, various methods were developed for selecting alternatives based on the following criteria

1. Appropriate set of environmental factors which are likely to be significant for the activity for which EIA has to be carried out are to be fixed (for example, wild life, habitat etc) :
2. The units of measurement for each factor (e.g., hectares conserved) have to be determined
3. Data on a fixed unit (100 or 1000 hectares) with reference to various sets of environmental factors have to be collected
4. The interval scale (0-0.1) for each environmental factor has to be fixed and the data is converted into environmental factor index by normalizing the scale over maximum and minimum values and determining weight of each environmental factor.
5. Establish the method of aggregation across all the factors established.

The following example where two factors (Wild life habitat in hectares and employment increase in jobs) for two alternatives are considered will explain how scaling weighing method can be applied. In this example the environmental factor data has been scaled to an index (0 is worst and 1 is best) Scaling was done by dividing the factor data by maximum values for both alternatives. Two aggregation methods were followed:

(a) Assuming all factors is equally weighted following simple addition indicates alternative 2 should be preferred.

(b) In weighing scale weights of 0.8 for employment and 0.2 on wild life make first alternative preferable Table 2.4.

Table 2.4 Addition and weighting of factor indices for two alternatives

Factors	Weights	Alternative one			Alternative two		
		Raw data	Scaled	Weighted	Raw data	Scaled	Weighted
Wildlife Habitat preserved (ha.)		5000			10000		
Employment increase (jobs)		5000			3000		
Wildlife Habitat index	1		0.5			1	
Employment increase index	1		1			0.6	
Wildlife habitat weighted index	0.2			0.1			0.2
Employment increase weighted index	0.8			0.8			0.48
Grand index		n/a	1.5	0.9	n/a	1.6	0.68