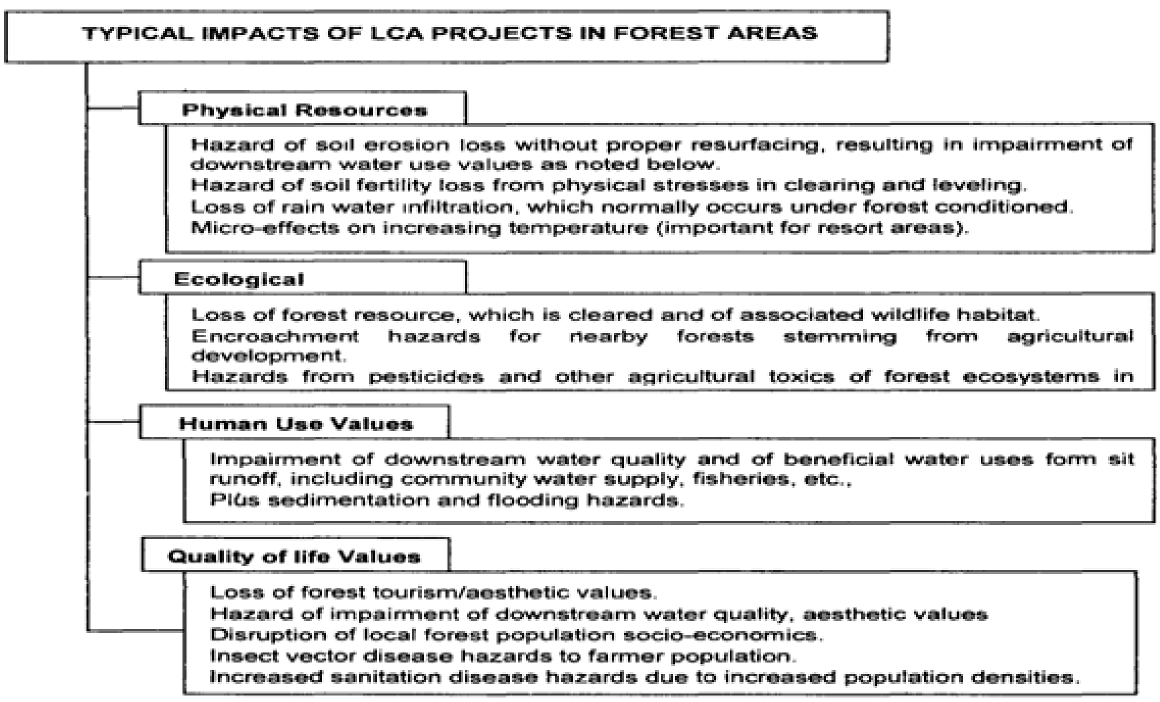
ENVIRONMENTAL IMPACT ASSESMENT & MANAGEMENT

UNIT-1

BASIC CONCEPT OF EIA

EIA is an activity designed to identify and predict the impact of a project on bio-geo-physico-chemical environment and on human health so as to recommend appropriate legislative measures, programmes, and operational procedures to minimise 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 overall 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.



Some major impacts of typical LCA project on environment.

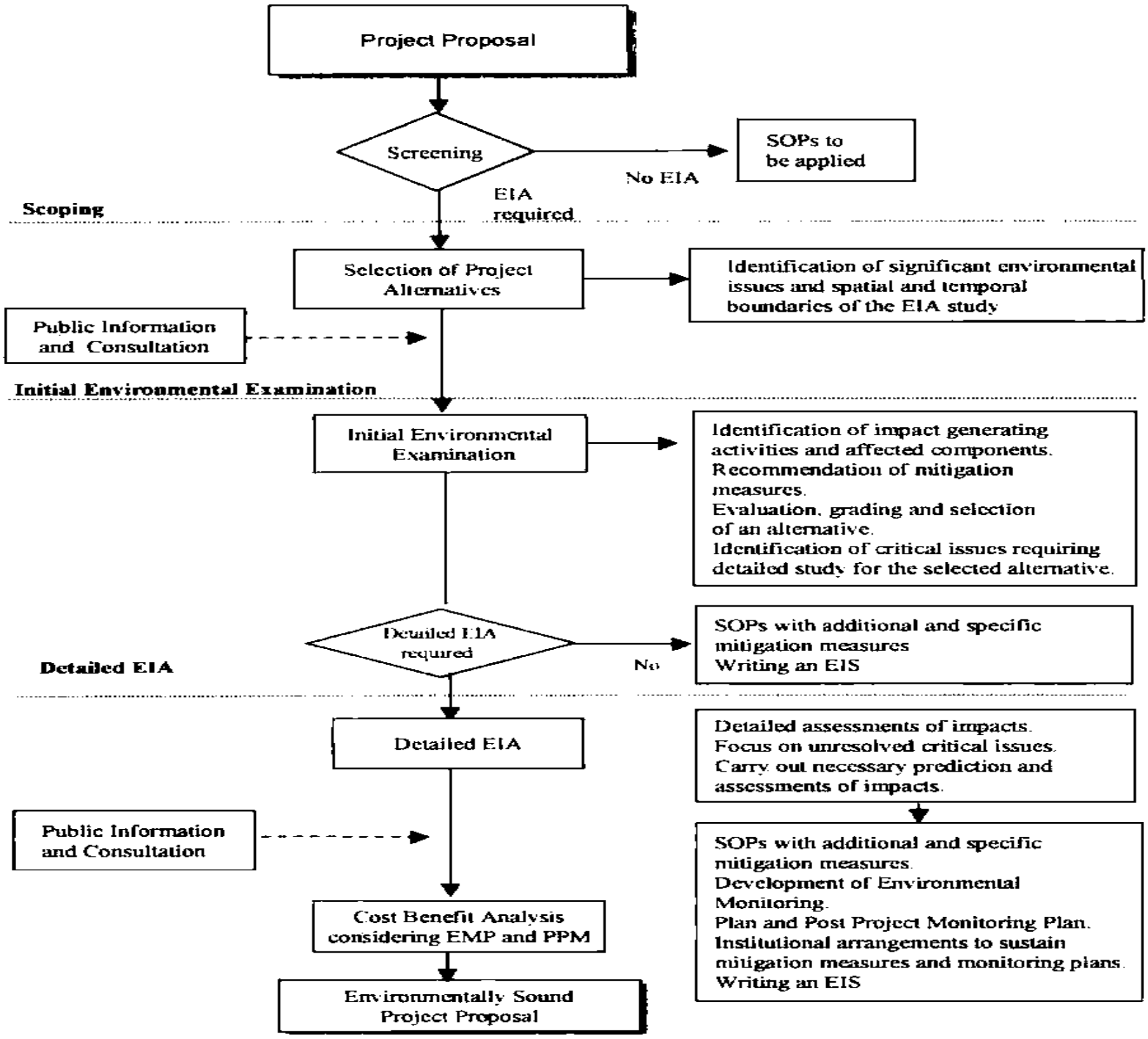
Land Clearing Activities **Soil Erosion**

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).



(SOP)- Standard Operating Procedure

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.

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 neighbourhood effects, must be educated and qualified 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 (tradeoffs) 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 organised and systematic programme 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,
- Determine the range of alternatives.

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 fal1 into three categories

(i) Direct impacts,

(ii) Indirect impacts; &

(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 overal1 adverse cumulative effect. Impacts of some typical projects are discussed below for clear understanding

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 larger 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 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.

Cumulative impacts

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

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 feedback 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 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 basis of a solid plat form 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 re-evaluation, 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.

Factors to be considered for taking decisions based on assessment of significance of an impact.

There are six factors that should be taken into account when assessing the significance of an environmental impact arising from a project activity. The factors are interrelated and should not be considered in isolation. For a particular impact some factors may carry more weight than others but it is the combination of all the factors that determines the significance.

1. ***Magnitude***: Will the impact be irreversible? If irreversible, what will be the rate of recovery or adaptability of an impact area? Will the activity preclude the use of the impact area for other purposes.
2. ***Prevalence:*** Each action taken separately might represent a localized impact of small importance and magnitude but a number of actions could result in a wide spread effect,

3. ***Duration and Frequency****:* The significance of duration and frequency is reflected in the following questions. Will the activity be long-term or short-term? If the activity is intermittent, will it allow for recovery during inactive periods?

4. ***Risk:*** To accurately assess the risk, both the project activity and the area of the environment impacted must be well known and understood.

5. ***Importance****:* This is defined as the value that is attached to an environmental component.

6. ***Mitigations****:* Are solutions to problems available? Existing technology may provide a solution to a silting problem expected during construction of an access road, or to bank erosion resulting from a new stream configuration.

Preparation of Environmental Base Map (EBM)

An important requirement is preparation of an environmental base map (EBM or maps) showing the salient information, This includes the essential background information on the environmental situation so that the reviewer, by referring to this, can readily interpret the report text and especially the conclusions and recommendations. For an

Industrial Development Project EIA thus usually includes demography, land use infrastructure, receiving water, ground water and soil conditions, other industries and their waste streams, institutions, ecological resources, areas of cultural, archaeological and tourist interest/importance.

The EBM should be portrayed as simply as possible (it should not include extraneous information which may tend to obscure the presentation) and for this purpose a schematic type drawing will usually be more appropriate than a map drawn strictly to scale.

Classification of Environmental Parameters

Most EIA guidelines follow the relatively simple methodology in which environmental resources or values are classified into four general categories viz. (a) Natural physical resources. (b) Natural ecological resources. (c) human/economic development resources. And (d) quality-of-life values including aesthetic and cultural values which are difficult to assess in conventional terms.

Environmental parameters include

- Ecology
- Physico-chemical
- Human-Interest

- **Ecology**

  Aquatic
    - Fisheries
    - Eutrophication
    - Aquatic Weeds
    - Species diversity
    - Endangered species

  Terrestrial
    - Forest
    - Wildlife
    - Species diversity

- Endangered species

- **Physico-chemical**

  Land
  - Erosion and Siltation
  - Backwater Effect
  - Bank stability
  - Drainage
  - Soil characteristics

  Surface water
  - Regional Hydrology
  - Silt Load
  - Water Pollution

  Groundwater
  - Regional Hydrology
  - Recharge
  - Water table

  Atmosphere
  - Air pollution
  - Dust Pollution
  - Noise Pollution
  - Water Pollution

- **Human Interest**

  Health
  - Diseases
  - Sanitation
  - Nutrients

  Aesthetic
  - Landscape
  - Recreation

- Socio-Economic
  - Land Loss
  - Crop Production
  - Aquaculture
  - Irrigation
  - Navigation

- ☐ Flood Control
- ☐ Transport
- ☐ Re-settlement
- ☐ Employment
- ☐ Agro-industrial

EIA

UNIT 2

EIA METHODOLOGIES

Introduction

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. 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 has 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.

Criteria for the Selection of EIA Methodology:

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.

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.

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.

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.
(t) **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 ofthe 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.

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 referel1Ce established by the controlling agency.

EIA Methods

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

Ad hoc Methods

Basically ad hoc methods indicatebroad 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.
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. 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 is presented in Table 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.

Table -1

1. Wildlife
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. Health and safety
14. Economic values
15. 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.

Checklist Methodologies

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 generally 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, how to interpret and measure an environmental parameter.

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

(c) Scaling Checklists: that is 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 from 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. Furtherit implicitly assumes that numerical values assigned to impacts can be derived on the basis of expel1 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.

Simple Checklists

Simple checklists represent a valid approach for providing systemization to an EIS and Table 2 presents a list of environmental factors to be considered in construction and operational phases. The checklist also includes information on mitigation.

Table 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						
(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. 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 3. The basis for estimates column presents a simplified, brief listing of key data models needed, if any. for the factor.

Table 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

Important Characteristics of Simple and Descriptive Checklists

I. 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, theyhave professional credibility and usability.
3. Checklists provide a structured approach for identifying key impacts andor 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, andor 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 andor impacts should be accomplished. Inthis regard. Factor-impact quantification and comparison to pertinent standards can be helpful.

7. Factors andor 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. Nevertheless 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 impactsreasonably 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 electing alternatives based on the following criteria

I. 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 I 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 of below Table 4

Table 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

For preparing check lists information expertise at different levels are required. While simple check lists require information of impacts on general environmental factors scaling weighing check lists require more detailed expert knowledge. The assumptions made with respect to:

(a) Environmental factors under consideration

(b) Methodology followed for calculating the index

(c) Weightage assigned to each factor

(d) Aggregation methods adopted across all factors will make weighing scaling check lists methods to differ one from the other.

The various types of scales used in EIA methods are presented in Table 5

Table 5

Different Scales Used in EIA Methods.

Scale	Nature of scale	Examples	Permissible mathematical Transformation	Measure of location	Permissible statistical analysis
Nominal	Classifies objects	Species classification, coding soil types	One-to-one substitution	Mode	Information statistics
Ordinal	Ranks objects	Orderings: - minimum to maximum - worst to best - minor to major	Equivalence to non-monotonic functions	median	Non parametric
Interval	Rates objects in units of equal difference	times (hours) temperature (degrees)	Linear transformation	Arithmetic mean	Parametric
Ration	rates objects in Equal difference and equal ratio	height, weight	multiplication or geometric division by a constant or other ratio scale value		Parametric mean

It is very important to understand which scale has to be used in dealing with different types of data. Nominal scales are used when dealing with descriptive information which is categorized while evaluative information is analysed by ordinal, interval or ratio scales and interval and ratio scales are used to aggregate information into an overall grand index Whatever scale that is used it should be properly defined for clarity. To construct environmental quality Dee et. al., 1972 suggested the following procedure

(a) Data relating to the quality of environment and various factors have to be collected and arrange the environmental factor scale (x axis) such that low or worst value corresponds to zero in the environmental quality scale (y axis)

(b) The Environmental quality scale has to be divided into equal intervals varying between 0 and I and fix appropriate value of the factor for each interval and this process has to be continued until a reasonable curve is obtained.

(c) The above steps a and b have to be repeated by different experts independently such that average values produce group curves.

(d) A review has to be performed ifthere are large variations.

(e) Steps 'a' to'd' have to be repeated by different groups of experts for testing reproducibility.

Using this technique graphs can be constructed for understanding the relationship between actor index and environmental variable.

Battelle Environment Evaluation System" (EES), was developed by Battelle Laboratories ofColumbus, for the US Bureau of Land Reclamation, is an early weightingscaling checklist methodology for water-resources projects, which deals with the environmental factors, as shown in Fig. 2.1. This method was specifically intended for use in the assessment of water resources projects, but is potentially applicable to other types of development. Each of the elements will be assigned an importance weight using the ranked pairwise-comparison technique; resultant importance-weight points (PIUs) are shown in Fig. 2.1 by the numbers adjacent to the four environment categories, in the right-hand corner of the boxes representing the intermediate components and in the parentheses in front of each environmental factor. The higher the number, the greater the relative importance. Impact scaling in the Battelle EES is accomplished through the use of functional relationships for each of the 78 factors (6).

The basic concept of the Battelle EES is that an index expressed in environmental impact units (EIUs) can be developed for each alternative and baseline environmental conditions. The mathematical formulation of this index is as follows:

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

$EIUj$ = environmental impact units for j^{th} alternative

$EQij$ = environmental-quality-scale value for i^{th} factor and j^{th} alternative

PIU_I = parameter importance units for i^{th} factor

Usage of the Battelle EES consists of obtaining baseline data on the 78 environmental factors and, through use of their functional relationships, converting the data into EQ scale values. These scale values are then multiplied by the appropriate PIUs and aggregated to obtain a composite EIU score for the baseline setting. For each alternative being evaluated, it is necessary to predict the anticipated changes in the 78 factors. The predicted-factor measurements are then converted into EQ scale values using the appropriate functional relationships. Next, these values are multiplied by the PIUs and aggregated to arrive at a composite EIU score for each alternative. This numerical scaling system provides an opportunity for displaying system provides an opportunity for displaying trade-offs between the alternatives in terms of specific environmental factors, intermediate components, and categories. Professional judgement to be exercised in the focus should be on comparative analyses, rather than on specific numerical values. Battelle EES is thus based on a hierarchical checklist of 78 environmental parameters. To overcome the problem of comparing and summing up impacts, parameters were weighted so that at they would be related to each other in terms of relative importance predevelopment parameter estimates are transformed into measures of environmental quality. Providing a quantified representation of environmental quality, which can be used in comparison with the post-impact situation. Environmental quality is scaled from 0 (very bad) to 1 (very good) and can be defined in a number of ways. The transformation of a parameter estimate into environmental quality is achieved by using "value functions" devised by a group of experts. Changes that might occur if development were to proceed are projected using predictive techniques. Projected

Check lists are mainly useful for

(a) Summarising information to make it accessible to experts in different fields or decision makers who have little technical knowledge.

(b) Preliminary analysis will be available in scaling check lists.

(c) Information on eco system functions can be clearly understood from weighing methods.

Some of the draw backs of check lists are

1. They are too general or incomplete

2. They do not illustrate interactions between effects

3. The number of categories to be reviewed can be immense, which will create confusion about significant impacts

4. Involves the identification of effects which are qualitative and subjective

Matrix Methods

General Characteristics

In matrix methods interactions between various activities and environmental parameters will be identified and evaluated. Matrix methods are basically generalized checklists where one dimension of a matrix is a list of environmental social and economic factors likely to be affected by a project activity. The other dimension is a list of actions associated with development. These relate to both the construction and operational phases. Making cells representing a likely impact resulting from the interaction of a facet of the development with an environmental feature identifies impacts. With some matrices qualitative representation of impact importance and magnitude are inserted in individual cells.

Matrices provide cause-effect relationships between the various project activities and their impacts on the numerous environmentally important sectors or components. Matrices provide a graphic tool for display impacts to their audience in a manner that can be easily comprehended.

Simple matrices, though able to identify first order effects, cannot show higher interactive effects between impacts. Simple, interaction matrices largely overcome this limitation. But such matrices are generally useful for depicting ecological interactions only for the sake of documentation. While the scale of the interaction is identified, individual actions of the project are not correlated with the resulting impacts on the environmental components.

The most serious criticism of such weighting matrices, which can also be extended to scaling and weighting checklists, is that

(a) They require large amount of information about the environmental components and project activities

(b) Through the inherent aggregation process, decision-making is, in effect, removed from the hands of the decision - makers and the public concerned. A great deal of information that is valuable to decision-making is lost in the conversion to number.

(c) Weights are assigned to environmental components and consequently to impacts without any guarantee that such weights and rating will represent the actual impacts that will be apparent once the project is implemented and operational; what is generally called an objective procedure the assignment of weights and the subsequent quantification is in fact an arbitrary assignment of scales of "environmental quality" based on the value judgment of "experts".

(d) Aggregation of numerical impacts through suitable transformation functions results in the combination of inherently different items into a single index or number and leads to loss of information about the various impacts from the numerous project actions, thereby precluding the possibility oftradeoffs by the decision makers.

Matrices are strong in identifying impacts and unlike checklists. can also represent higher order effects and interaction. Some of the dynamic nature of impacts can also be identified. They can also provide the functions of impact measurement interpretation and evaluation, and can communicate the results in an easily understandable format to their audiences. But they cannot compare alternatives in a single format, and different alternatives need to be assessed and presented separately. The purpose of a matrix is to help the project planner to

I. Identify specific sources of potential environmental impact

2. Provide means of comparing the predicted environmental impacts of the various project options available

3. Communicate in graphic form the

(i) Potentially significant adverse environmental impact for which a design solution has been identified

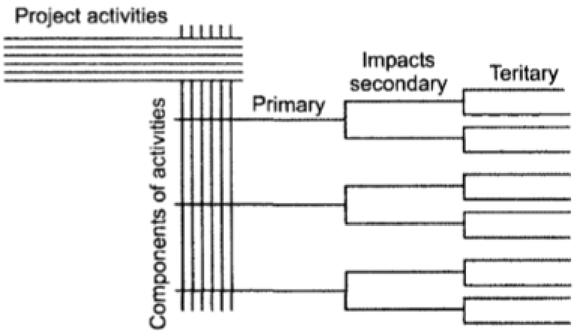
(ii) Adverse environmental impact that is potentially significant but about which insufficient information has been obtained to make a reliable predication

(iii) Residual and significant adverse environmental impact and

(iv) Significant environmental impact

Network Methods

Networks are capable of identifying direct and indirect impacts, higher order effects and interactions between impacts, and hence are able to identify and incorporate mitigation and management measures into the planning stages of a project. They are suitable for expressing ecological impacts but of lesser utility in considering social, human and aesthetic aspects. This is because weightings and ratings of impacts are not features of network analysis. Development of network diagrams Fig. 1 present the potential impact pathways as casual chains will be very useful for displaying first ,secondary, tertiary and higher order impacts.

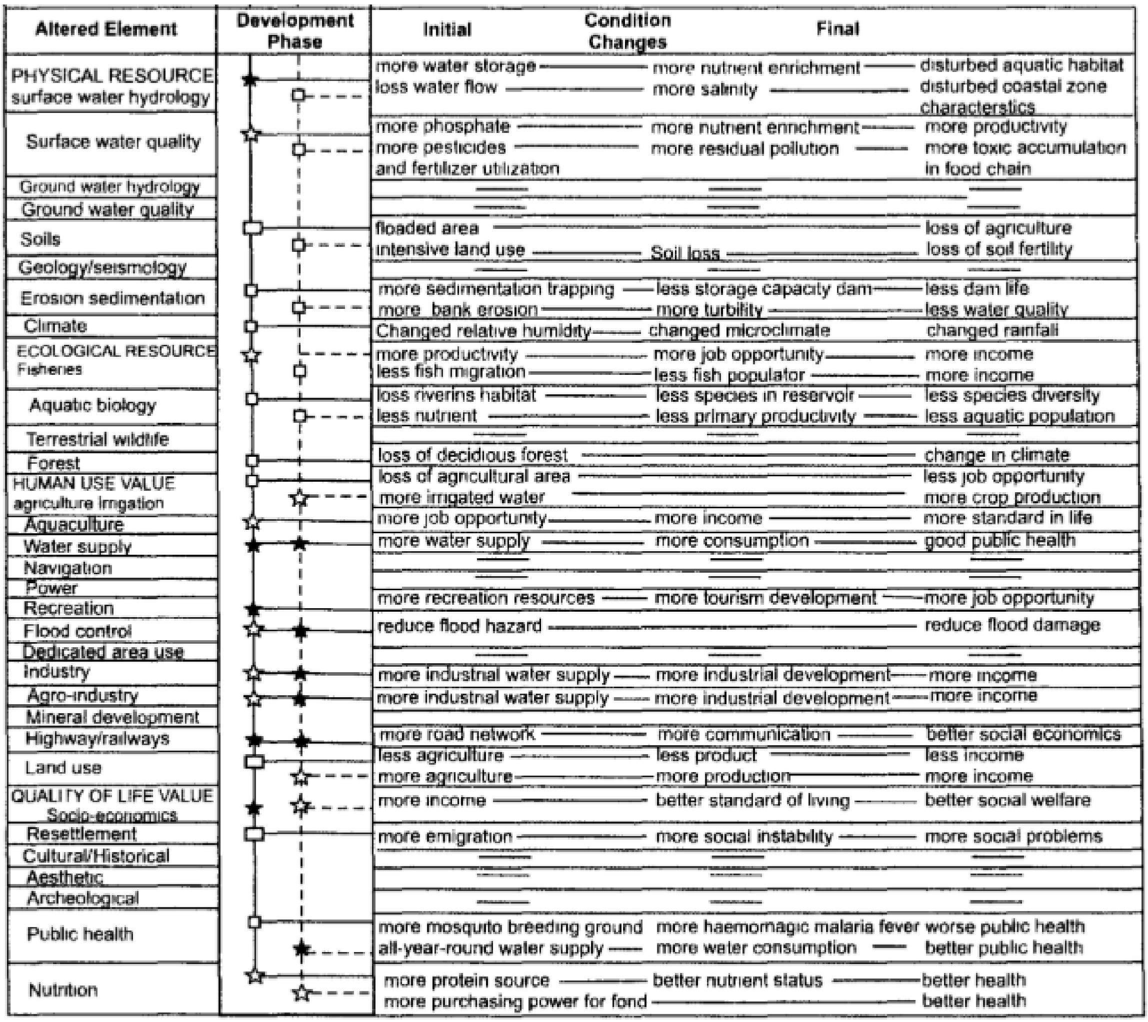


Conceptual model of impact networks.

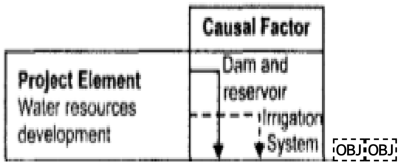
To develop a network a series of questions related to each project activity (such as what are the primary impact areas, the primary impacts within these areas the secondary impact areas the secondary impacts within these areas and so on) must be answered. In developing network diagram the first step 'is to identify the first order changes in environmental components. The secondary changes in other environmental components that will result from first order changes will be then identified. In turn third order changes resulting from secondary changes will be then identified. This process will be continued until the network diagram is completed to the experts' satisfaction. Network analyses are particularly useful for understanding the relationship between environmental components that produce higher order impacts, which are often overlooked in some major projects. Networks can also aid in organizing the discussion of anticipated project impacts. Network displays are useful in communicating information about an environmental impact study to an interested public

Stepped Matrix Technique for Networks

This technique developed by Sorenson (1971) was applied to Nong Pia Reservoir Fig. 2



Stepped matrix for Nong Pla reservoir.

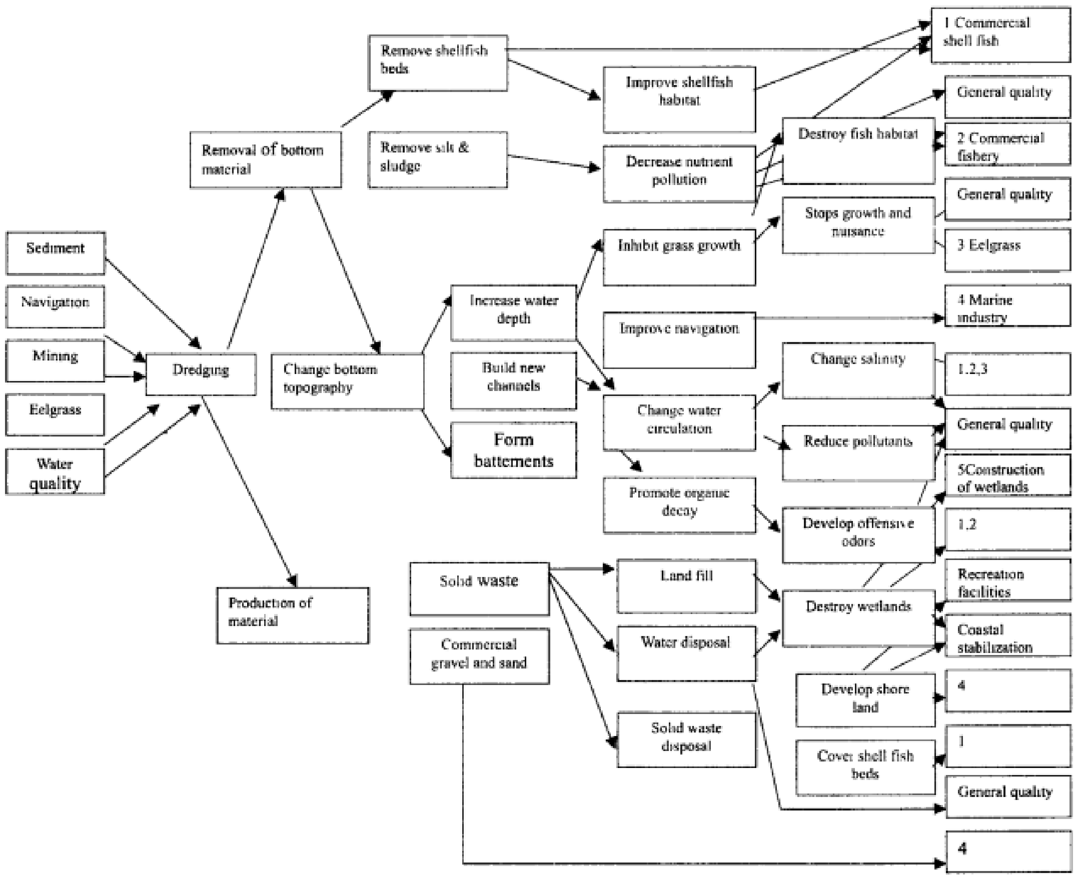


The interpretation of results in the above figure will be as follows

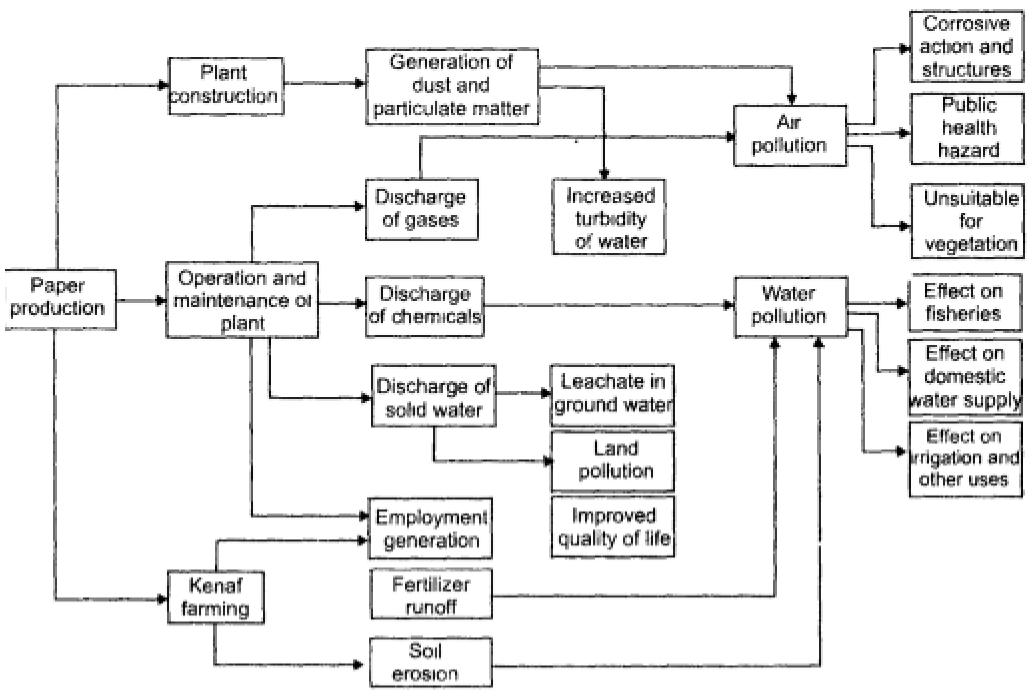
(a) At the upper left hand corner the project elements are entered while the casual factor that may result is shown as an impact under the dam and reservoir.

(b) Reading downwards the impacts are presented as** Major positive, *minor Positive, ## major negative, # minor negative.

Fig. presents the network diagram for a dredging project (Sorenson 1971 (II» wnile Fig. 2.6 presents the network impacts of a Pulp Mill (Lohani and Halim 1983(12».



Network analysis of impacts of a dredging project.

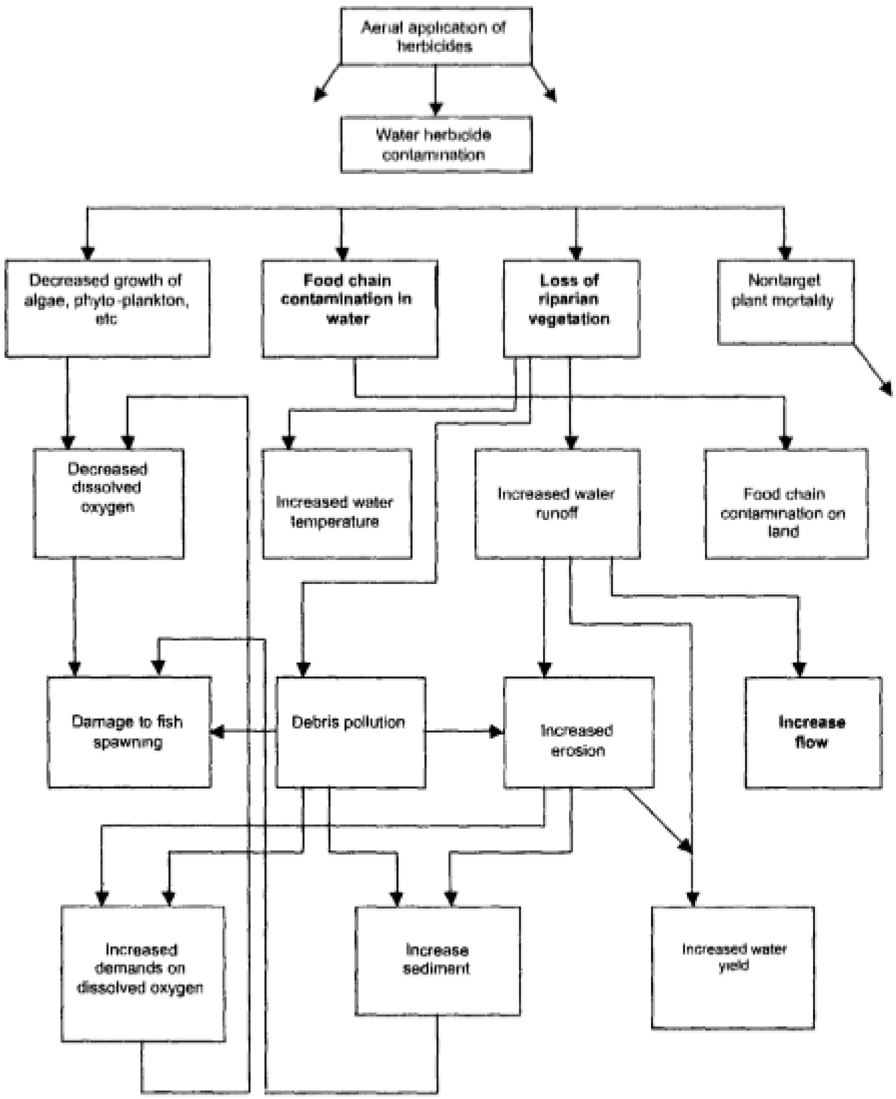


Network of pulpmill impacts.

The primary limitation of the network approach is the minimal information provided on the technical aspects of impact prediction and the means for comparatively evaluating the impacts of alternatives. In addition, networks can become very visually complicated. Networks generally consider only adverse impacts on the environment and hence decision making in terms of the cost and benefit of a development project to a region is not feasible by network analysis. Temporal considerations are not properly accounted for and short term and long term impacts are not differentiated to the extent required for an easy understanding. While networks can incorporate several alternatives into their format, the display becomes very large and hence unwieldy when large regional plans are being considered. Further, networks are capable of presenting scientific and factual information, but provide no avenue for public participation.

The typical networking of impacts of an aerial application of Herbicide program IS

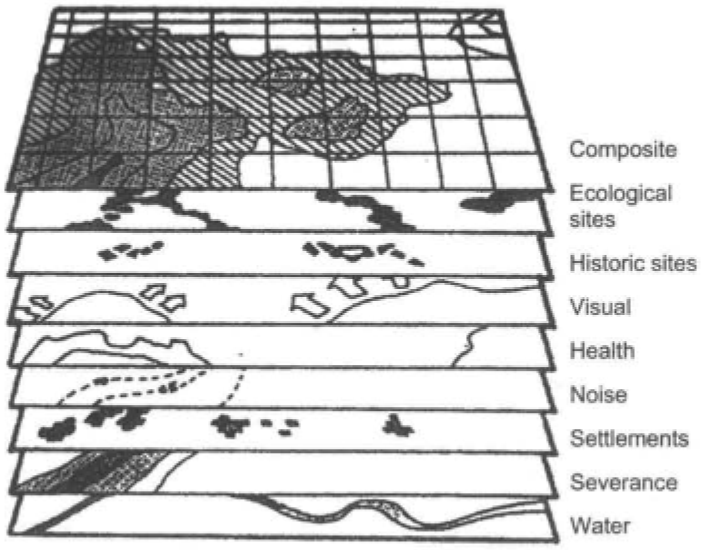
shown in Fig below



Measure diagram for the aerieal applications of herbicide.

Overlay Methods

Overlay methods involve preparation of a set of transparent maps, which represent the spatial distribution of an environmental characteristic (e.g., Extent of dense forest area). Information on wide range of variables will be collected for standard geographical units within the study area which will be recorded on series of maps typically one for each variable. These maps will be overlaid to produce a composite Fig below. The resulting composite maps characterize the area's physical, social ecological,land use and other relevant characteristics relative to the location of the proposed development. To evaluate the degree of associated impacts many project alternatives can be located on the final map and validity of the assessment will be related to the type and number of parameters chosen. Normally to have some clarity the number of parameters that can be overlayed in a transparency map is limited to 10. These methods are widely used for assessing visually the changes in the landscape before and after the activity. Secondly it can be used for preparing combined mapping with an analysis of sensitive areas or ecological carrying capacity. As these methods are spatially oriented they can very clearly show the spatial aspects of cumulative impacts.



Presentation of array of variables in overlay method.

Overlays are very subjective in that they rely on the judgement of the analyst to evaluate and assess questions on compatibility relating to the existing land use patterns and the prospects of the development activity. In practice, overlays are self-limiting because there is a practical limit on the number of transparencies that can be overlaid.

Overlays are useful when addressing questions of site and route selection. They provide a suitable and effective mode of presentation and display to their audiences. But overlay analysis cannot be the sole criterion for environmental impact assessment.

There is no provision for quantification and measurement ofthe impacts nor is it assured that all impacts will be covered. The considerations in overlay analysis are purely spatial, temporal considerations being outside its scope. Social, human and economic aspects are not accorded any consideration. Further, higher order impacts cannot be identified. The methodologies rely on a set of maps of environmental characteristics (physical, social,ecological, aesthetic) for a project area. These maps are overlaid to produce a composite characterization of the regional environment. Impacts are identified by noting the impacted environmental characteristics lying within the project boundaries.

The approach seems most useful as a method of screening alternative project sites or routes, before detailed impact analysis.

Overlays can be useful for industrial EIA of any project for comparing land capabilities existing and projected land uses, road route alternatives and other under parameters, and alternative levels of air quality conditions along with pollution control.

The overlay approach is generally effective for selecting alternatives and identifying certain types of impacts; however, it cannot be used to quantify impacts to identify secondary and tertiary interrelationships.

Geographic information System for Overlays

Geographic information systems are now being used as layered overlay techniques -Computer modules can be used to store the characteristics of the proposed developments and the surrounding area. This enables us to introduce impact weightings into assessment. The computer can perform the complex mathematical operation required when a large number of variables are weighted.

A significant application of GIS is the construction of real world models based on digital data. Modelling can analyse trends identify factors that are causing them reveal alternate paths to solve the given problem and indicate the implications or consequences of decisions. GIS can show how a natural resource will be affected by a decision. Based on satellite data areas that suffer most from deforestation may be identified and analysed on the basis of overlaying data on soil types, the species required, the likely growth and yield and impact of regulatory measures applicable to that area. The impact of various development plans on the environment can be assessed by integrating data on land use with topographic and geological information. Similarly satellite imagery can be periodically used to update maps of indicated land. The spectral features of irrigated and non-irrigated fields can be combined with other data on the fields to derive estimates of demands for irrigation water and devise land management plans. GIS can be used to assess the risk of drought in choosing areas for rain fed crops.

GIS is a powerful management tool for resource managers and planners. Its applications are limited only by the quality, quantity and coverage of data that are fed into the system. Some of the standard GIS applications are integrating maps made at different scales. Overlaying different types of maps, which show different attributes and identifying, required areas within a given distance from roads or rivers, For example by overlaying maps of vegetation and soils a new map on land suitability can be generated and the impact of proposed projects can be studied. Similarly the most favourable zones for the development of shrimp farming outside mangroves can be located. The evaluation of various geospatial methods with reference to various assessment processes are presented in Table below.

Evaluation of geospatial EIA method.

Key Area of the Assessment Process	Criteria	L denotes Criteria completely satisfied P denotes Criteria Partially satisfied N denotes criteria not satisfied
Cost/Time Effectiveness Criteria	1. Expertise requirements	L
	2. Data requirements	P
	3. Time requirement	L
	4. Flexibility	L
	5. Personnel level of effort	P
Impact identification	6 Comprehensiveness	N
	7. Indicator-based	P
	8. Discriminative	N
	9. Time dimension	P
	10. Spatial dimension	L
Impact Measurement	11. Commensurate	L
	12. Quantitative	L
	13. Measurement changes	L
	14. Objective	L
Impact Assessment	15 Credibility	L
	16. Replicability	L
	17. Significance-based	N
	18. Aggregation	P
	19 Uncertainity	N
	20. Alternative comparison	P
Communication	21 Communicability	L
	22. Summary format	L

Cost/Benefit Analysis

Cost/benefit analysis provides the nature of expense and benefit accruable from a project in monetary terms as a common practice in traditional feasibility studies and thus enables easy understanding and aids decision-making. The principal methods available for placing monetary values (costs and benefits) on environmental impacts, a taxonomy of valuation methods, and steps involved in economic evaluation of environmental impacts are discussed under this category. The role of environmental economics in an EIA can be divided into three categories, namely:

I. The use of economics for "benefit-cost analysis" as an integral part of project selection;

2. The use of economics in the assessment of activities suggested by the EIA; and

3. The economic assessment of the environmental impacts of the project.

Environmental economics can aid in the selection of projects in that benefit-cost analysis can be used in the pre-screening stage of the project, and the environmental components can be brought into the process of presenting various options and selecting among them. Doing so eventually leads to a project selection process, which takes the environment into consideration. In the second role, the economic assessment is focused on the cost assessment of environmental mitigation measures and management plans suggested in the EIA. The economic analysis in the EIA may include a summary of the project costs and how such cost estimates would change due to the activities proposed under the EIA. This component can be considered as an accounting of the environmental investment of a project. The third role, which is the economic assessment of the environmental impacts of a project, is geared towards seeking the economic values (of both costs and benefits) of the environmental impacts. These impacts are neither mitigated, nor taken into account in traditional economic analysis of projects. They should be identified by the ETA and sufficient quantitative and qualitative explanations should be given in EIA documents.

The difficulty encountered in the use of these techniques will be that. impacts have to be transformed and stated in explicit monetary terms, and this is not always possible, especially for intangibles like the monetary value of health-related impacts of industrial development.

Cost/benefit analysis of the type for assessment of natural systems is not merely concerned with the effects on environmental quality, but rather, it seeks the conditions for sustainable use of the natural resources in a region. This type of approach is not useful for small scale development projects, but is better suited for the analysis and evaluation of a regional development plan. Even though it may not be possible to place an economic value on environmental losses or gains resulting from a developmental project, decision makers should take into account implied environmental values in their decision-making.

To facilitate the decision making process, therefore, assessors conducting environmental impacts, should not just identify environmental impact, they should also provide information on the implied values of the environmental losses and gains.

The evaluation of site / sites and major design options should be taken together, within the economic and technical limitations imposed by the aim of the project, the combination of project site and project design needed to produce no significant environmental impacts, should also incur the least economic cost to the community.

If, for the preferred site and project option, the assessor has predicted potentially significant environmental impacts, he should consider the cost to the community of any mitigating or abatement measures, and their alternatives before adopting them into the project plan. Whenever there is a choice of measures to mitigate or abate a significant potential impact he should select the solution that will incur the least economic cost to the community.

Assignment-Cum-Tutorial Questions

Unit-1I

A. Questions testing the remembering / understanding level of students

I) Objective Questions

1. Mechanism for linking impacts to specific effected geographical or social groups.
a. Impact Identification
b. Impact Measurement
c. Impact Interpretation and Evaluation
d. Impact Communication

2. _________________ methods are for rough assessment of total impact giving the broad areas of possible impacts and the general nature of possible impacts
a. Ad hoc Methods
b. Checklist Methodologies
c. Weighting and Scaling Checklist Methods

3. ______________Approach is not suitable for impact measurement and does not aid much in the decision - making process
a. Descriptive check lists
b. scaling checklists
c. Weighting and Scaling Checklist Methods

4. Check lists are mainly useful for – pick the correct answer

a. Involves the identification of effects which are qualitative and subjective

b. Summarising information to make it accessible to experts in different fields or decision makers who have little technical knowledge.

c. The number of categories to be reviewed can be immense, which will create confusion about significant impacts

5. Identify environmental factors to be considered in construction and operating phase.
a. land transportation and construction
b. landscaping
c. land use
d. air quality.

6. Criteria for the Selection of EIA Methodology
Ans. Simplicity, Manpower time and budget constraints and Flexibility.

II) Descriptive Questions

1. Describe the EIA methodologies.
2. Discuss about environmental indices for water and air quality
3.Describe matrix method in detail
4. What are the advantages of over laying the techniques?
5.What Matrix methodology? Explain.
6. Briefly explain cost/benefit analysis.

B. Question testing the ability of students in applying the concepts.

I) Multiple Choice Questions

1.Which statement is correct in ad hoc method?

a It gives 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 efficient and requires a considerable effort to identify and assemble an appropriate panel for each assessment.

2. Weighting and scaling checklist methods have reference to various sets of environmental factors and data will be collected in

a. fixed unit.

b. no unit limit

c. selected parameters.

3. In _______________ methods interactions between various activities and environmental parameters will be identified and evaluated.

a. network methods.

b. overlay methods.

c. matrix methods.

4. What is included in an Impact assessment? (Select all that apply)
a. a detailed assessment of the planned project and selected alternatives compared to thebaseline conditions
b.Qualitative descriptions measuring high, medium and low impacts
c. Quantitative descriptions such as indicating the cubic metres of water withdrawn, sewage Produced, and pollutants released
d. All the data collection, analyses, and developed plans summarized together in a well -structured and concise document

5. What isa contingency plan?(Select the best answer)
a.A set of guidelines ensuring that the development project will remain within its boundaries.
b.A plan of actions to prevent an emergency and to be taken when emergencies occur.
c.A plandescribing the measures that will be taken to contain or treat any waste produced by the development project.

6. Impact measurement contains
Ans. Commensurate units, explicit indicators and Magnitude

II) Descriptive Questions

1. Discuss about methodologies for identification of potential environmental impacts of typical engineering projects.
2. Explain about geographic information system for overlays.

3.Explain about checklist methodologiesand other four broad categories of the basic methodologies used in EIA.

4. Discuss in detail about simple and descriptive checklist methods.

5. Differentiate between scaling and weighting and scaling checklist methods.

EIA Unit-3

Prediction and Assessment of Impacts on Soil and Ground Water Environment

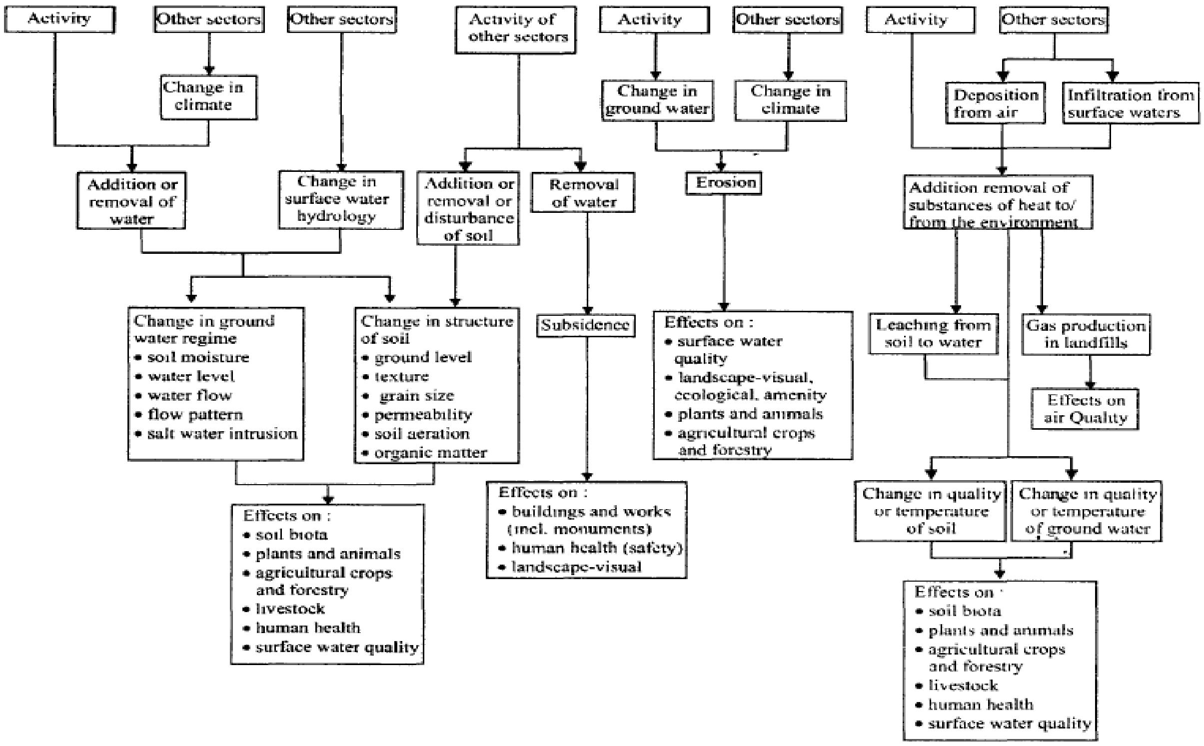
Introduction

Almost every type of action or project can produce changes on the surroundings of the land. Some actions and projects will have direct effect. While others may induce changes or have secondary impacts. The assessment of potential land-use impacts should be comprehensive covering characteristics of the project.

Soils and Groundwater

The integrity of soils and groundwater can be altered by a variety of physical disturbances, including the addition/removal of soil and/or water, compaction of soil. Changes in use of land or ground cover, changes in water hydrology, changes in climate (temperature, rainfall. wind) and the addition or removal of substances or heat (for example. discharge of effluents into groundwater. discharge of effluents or disposal of waste onto land. leaching of contaminants into groundwater. changes in quality of surface water. and deposition of air pollutants on land). The effects of these vary from first order effects of leaching into soil and groundwater to changes in groundwater regime, soil structure (including erosion and subsidence), soil quality or temperature, and groundwater quality or temperature.

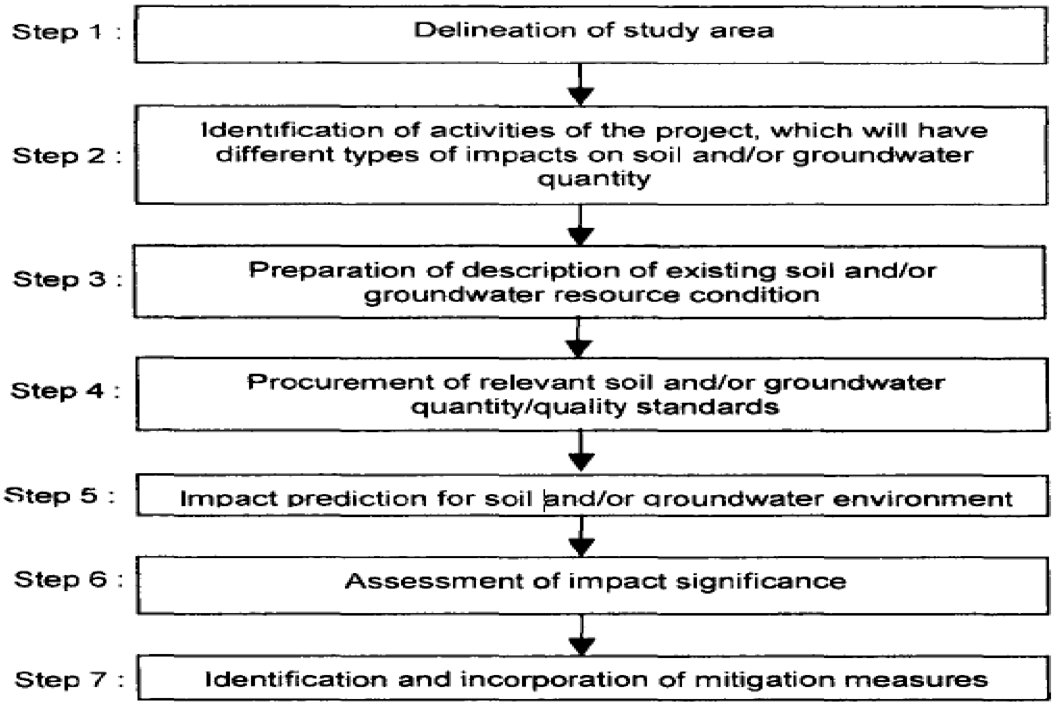
A summary of these effects is presented in below fig



Soil and groundwater effects.

Methodology for the Prediction and Assessment of Impacts on Soil and Groundwater

To provide a basis for addressing soil and/or groundwater environment impacts. a model is suggested, which connects seven activities or steps for planning and conducting impact studies. In below fig. in analyzing environmental impacts, both objective and subjective judgments should be taken into consideration. Objective judgments are defined as those. Which involve or use facts that are observable or veritable especially by scientific methods and which do not depend on personal reflections, feelings or prejudices "subjective" judgments are those which are made on the basis of values, feelings and beliefs. In the context of the environment the objective judgment describes the impact where-as subjective judgment describes how people feel about the' fact'.



Systematic approach for the study of impacts on soil and ground water.

Delineation of Study Area

The delineation of the study area for impact assessment will be very specific based on presence of potential impacts. The study area should reflect the full reach of possible effects within the particular impact discipline that is being considered. The proposed or future land-use map along with committed land-use policies, zoning and development projects should be included in the study area. The map should clearly distinguish between developed and undeveloped land.
Categories shown on land-use map, should be

- Residential
- Commercial and industrial
- Institutional and parks or recreation
- Non-urban mixed

The map could include further divisions, such as separate commercial and industrial activity centres and public vacant lands. The categories to be used will depend largely on the type of project or action being evaluated, the characteristics of the local land area, and the geographic extent of the affected study area.

Identification of Activities, Which Will Have Different Types of Impacts on Soil and/or Groundwater Quantity – Quality Direct Land-Use Impacts on Land

1. **Land forms**: Unique or important physical features that have special importance, as recreational educational or scientific interests may be present in the project area. They may be unique locally or

unique in a larger area. Examples are rock out crops, river gorges, sandy beaches, and lagoons. Such features may also influence local climate.

2. **Soil profile**: The soil profile is related to the chemical and physical nature of the soil and the prevailing climate and therefore has a direct bearing on land capability for agricultural or other purpose. Erosion is the principal process which may alter the soil profile and it can have a direct effect on existing or potential land use, and an indirect effect through siltation on water quality, fishing and land use downstream.

3. **Soil composition**: The chemical and mineral composition of the soil influences its engineering and agricultural capability. Changes in soil composition can occur either by. Subtraction e.g . Acid or alkali leaching or by addition e.g., nitrogen fixation.

4. **Slope stability**: Rock slopes are inherently stable. The environmental effects of slope instability are similar to those for erosion. The scale of the effects is larger in this case.

5. **Seismic**: Stress, Vibration due to explosions and deep well injection operations can have an effect on the stress-strain equilibrium on fault planes. Renewed or increased activity can have major environmental effects for the project site.

6. **Subsidence and compaction**: Subsidence and compaction occur naturally but generally as a gradual and almost imperceptible process. The process can be accelerated however, by underground excavation, vibration or loading. The major effect is on land capability but drainage, groundwater behaviour and landscape could also be affected.

7. **Flood plains Swamps**: Flood plains and swamps are an important part of the drainage pattern as they admit peak flows into the drainage system, Reclamation on natural flood plains or swamps may result in flooding and siltation of other areas during peak flow. Major engineering of a drainage system may either decrease the amount of agricultural land available or may destroy wetland habitats of fish, birds etc.

8. **Land use**: The existing land use and the compatibility with existing or planned use of adjacent land are important components of the environment. Careful site selection is the principal means of controlling them but many mitigating or abatement measures may also be available.

9. **Mineral or engineering resources**: The occurrence of mineral or engineering resources is of strategic and economic importance. Loss of such resources either through wasteful use or through development incompatible with subsequent mining or quarrying proposal can result in long-term economic or social impacts on the community.

10. **Buffer zones**: Buffer zones are spaces which provide natural environmental protection from drainage by external events they are usually vegetated, depending on the purpose and can provide wind breaks, erosion control, sediment traps, wild life shelter, sound insulation and visual screening. Some projects or actions, by their very nature, have direct and obvious impacts of land use by physically

destroying or clearing land and implementing a new use. Here are some examples of this kind of direct land-use revision:

(a) A highway project with a 300 right-of-way width converts whatever the existing land use is to a transportation land- use within that right-of-way width.
(b) A dam constructed to create a reservoir for water supply and recreational use directly converts the previous land use to recreational use.

(c) A regional park constructed on land previously used as pasture directly changes the number of acres of the park into a different use.
(d) A city block of low-income housing structures is demolished to construct a shopping mall, directly converting that land to commercial use.

Environmental Impacts on soil and ground water- A typical Example: Road Construction Project

Impacts and Setting
Soil is an important component of the natural environment, and is a primary medium for many biological and human activities, including agriculture. Its protection in relation to road development deserves considerable attention. In the road itself, in borrow pits, or around rivers and streams, there are many places where damage might occur. Losses can be considerable for the road agency and others. This includes farmers losing crops and land, fishers losing income because of sedimentation in rivers and lakes, and road users being delayed when road embankments or structures collapse. The costs of correcting these problems are often many times greater than the costs of simple preventive measures.

Loss of Productive Soil

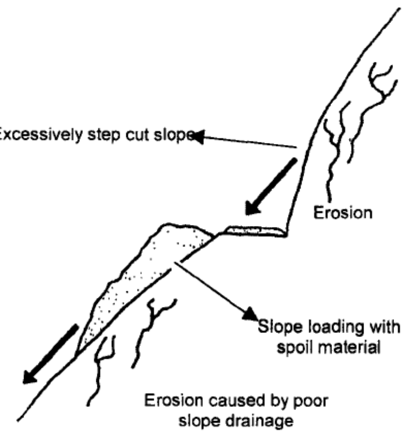
The most immediate and obvious effect of road development on soil is the elimination of the productive capacity of the soil covered by roads. Unfortunately, the best sites for road development (flat and stable) also tend to be ideal for agriculture. The narrow linear character of roads makes the impact of lost land seem minimal, but when the width of the right-of- way is multiplied by its length, the total area of land removed from production becomes much more significant. Soil productivity can also be reduced significantly as a result of compaction with heavy machinery during construction.

Erosion

When natural conditions are modified by the construction of a road, it marks the start of a race between the appearance of erosion and the growth of vegetation. Disturbance during construction can upset the delicate balance between stabilizing factors, such as vegetation, and others which seek to destabilize, such as running water. In some cases erosion might result in cumulative impacts far beyond the road itself affecting slopes, streams, rivers and dams at some distance from the initial impact.

Destabilization of Slopes

Slope stability can be upset by the creation of road cuts or embankments. Excessive steepness of cut slopes, deficiency of drainage, Modification of water flows, and excessive slope loading can result in landslides in Fig. Some soils, such as shale and "quick clays", are known for being difficult to drain and particularly unstable.



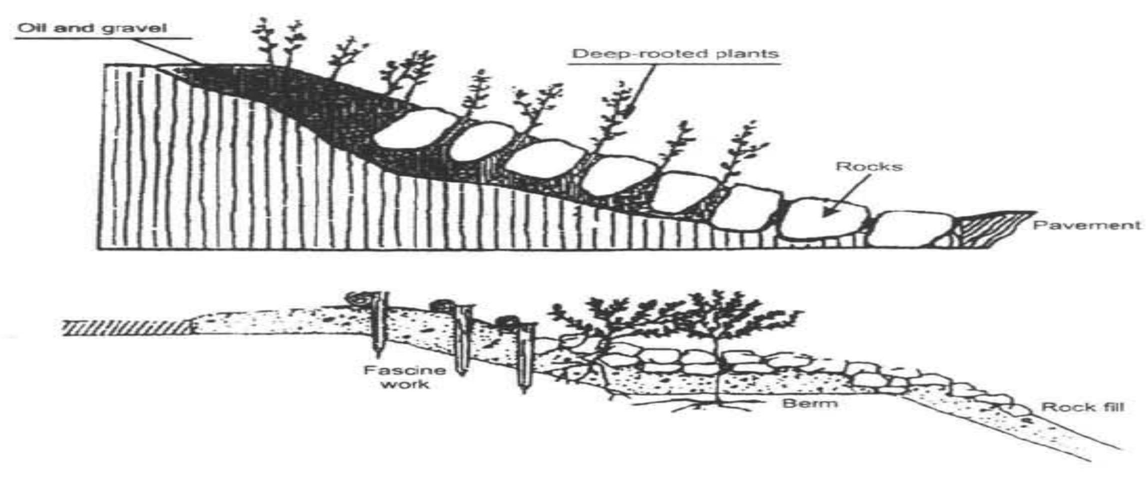
Destabilization of slopes.

Side Tipping of Spoil Materials

Spoil material from road cuttings can kill vegetation and add to erosion and slope stability problems. Large amounts or spoil can be generated during construction in mountainous terrain. Sometimes it is difficult to design for balances between cut and fill volumes of earth at each location, and haulage to disposal sites may be expensive. This creates a need for environmental management of tipped material.

Water Flow Diversions Diversion of natural surface water flows is often inevitable in road projects. Diversion results in water flowing where it normally would flow. Engineering Measures In many cases, vegetation alone may not be enough to prevent erosive damage to slopes and various engineering measures may be needed to complement or replace it (Fig. below). The use of slope retaining techniques may be necessary when

- Slopes are unstable because they are too high and steep;
- Climatic conditions are such that establishment of vegetation is slow or impossible
- There is a risk of internal erosion or localized rupture because of drainage difficulties and
- It is necessary to decrease the amount of earthwork because the road width is limited.



Examples of combined techniques for slope protection.

Description of Existing Soil and/or Ground water Resources Soil Characteristics Background Information on the Soil Environment

Soil Characteristics

Soil characteristics in a given geographical area at a given point of time are a function of both natural influences and human activities. The soil and geological environments are typically associated with the physical and chemical environment. For example, the habitat types and associated vegetation found in an area will be a function of the soil characteristics. Additionally, cultural resources may be related to soil characteristics or possibly, to unique geological features in an area. The relationship between shallow, alluvial aquifers and the flow of surface streams and rivers may need to be explored. Table below summarizes the principal anthropogenic activities, which can cause ground- water pollution. In describing quantity and quality, specific indicator parameters can be utilized. For example, the following represent some of the information, which could be compiled, and the issues, which could be addressed, are:

1. Descriptions should be assembled on groundwater systems in the study area, indicating whether they are confined or unconfined, with the obvious pollution relevance being that unconfined groundwater systems tend to be more susceptible to groundwater contamination.
2. Of particular importance would be the description of karsts aquifer systems. Since these areas can exhibit unique and rapid groundwater flow patterns.
3. Many areas are characterized by the presence of multiple groundwater systems; accordingly, it would be appropriate to describe those geographical areas characterized by multiple aquifer systems.
4. If information exists on the quantitative aspects of the groundwater resource in terms of potentially useable supplies, which could be extracted, it should be summarized.
5. Information should be summarized on the uses of groundwater within the study area, with a more detailed study of this subject to be conducted later.
6. A description of the relationships between local groundwater systems and surface streams, lakes, estuaries, or coastal areas may be important, since mutual quantitative or qualitative influences can occur.
7. Groundwater pollution vulnerability is associated with the question whether or not the project area is in a recharge zone for a given groundwater system. This should be determined because there is greater pollution potential in the recharge zone.
8. Depth of groundwater is a fundamental parameter which could be identified, with the pertinent issue that greater the depth of groundwater. the greater the degree of natural protection.
9. Unsaturated - zone permeability should be described. Here, the "unsaturated zone" refers to that segment of the subsurface environment, which is between the land surface and the water table of an unconfined aquifer system. The unsaturated zone permeability can influence the attenuation of contaminants as they move away from a source of pollution and toward the groundwater system.
10. Aquifer transmissivity should be described. This parameter represents information on the water carrying capacity of the ground water system.
11. Any existing data on groundwater quality should be summarized. If no such data exists, it may be necessary to appropriately plan and conduct a ground water monitoring program. in some unique cases, the quality data may need to be described in terms of aquatic ecosystems. For example, several threatened or endangered aquatic species have been found in springs associated with the Edwards aquifer in central Texas.

Unique Soil or Groundwater Problems

Many geographical areas exhibit special or unique problems that should be addressed in the description of baseline conditions for the soil or groundwater resources in the study area. Examples of these problems include saline seeps, groundwater supplies relative to existing bacteriological or other quality constituents, poor natural quality, and the presence of hazardous waste sites. Dry land farming practices involving irrigation often lead to salt accumulation in surface soils and shallow unconfined aquifers.

Pollution Sources and Groundwater Users

It is appropriate to consider which other potential and actual sources of soil and/or groundwater pollution may exist in the study area, and also to consider current and potential future usage of the groundwater resource for purposes of water supply techniques. Quantitative impact prediction is typically associated with the use of look - alike, or analogous projects for which knowledge and information are available, and/or the utilization of relevant case studies.

Procurement of Relevant Soil and *I* or Groundwater Quantity – Quantity Standards

Land-use restrictions, soil quality standards, soil reclamation requirements, and groundwater quantity - quality standards, regulations, or policies are examples of institutional measures, which can be used to determine impact significance and required mitigation measures. Thus, to determine the specific requirements for a given project area will require contacting appropriate governmental agencies with jurisdiction. The primary sources of information needed for step 3 (Figure 3.2) will be pertinent to the governmental agencies, namely, Central government, State government and/or local agencies. In addition, international environmental agencies may have information pertinent to this step.

Impact Prediction

The prediction of the impacts of a project - activity on the soil and/or ground – water environment(s), or conversely, the potential influence of the environment(s) on a proposed project, can be approached from three perspectives.

1. Qualitative
2. Simple quantitative, and
3. Specific quantitative

In general, efforts should be made to quantify the anticipated impacts; however, in many cases this will be impossible and reliance must be given to qualitative trend and through the spreading of excess sub-soil over the right - of - way during clean-up. In general, the mixing of sub-soil with topsoil will have an adverse impact in soil fertility and soil structure. The severity of the impact will depend on the nature of the sub-soil.

Qualitative Approaches- Groundwater Impacts

A qualitative approach for groundwater - impact prediction involves the fundamental subsurface environmental processes. The fundamental processes in the sub-surface environment can be examined relative to their hydrodynamic (physical), biotic (chemical), aspects. Table below summarizes processes, which may affect constituents of groundwater.

Possible sources of ground water contamination.

Category I	Sources designed to discharge substances
Subsurface percolation (e.g., septic tanks and cesspools)	
Injection wells	
Hazardous waste	
Non-hazardous waste (e.g., brine disposal and drainage)	
Non-waste (e.g., enhanced recovery, artificial recharge, solution mining, and in-situ mining)	
Land application	
Wastewater (e.g., spray irrigation)	
Wastewater by – products (e.g., sludge)	
Hazardous waste	
Non-hazardous waste	

Category II – Sources designed to store, treat, and/or dispose of substances; discharge through unplanned release
Landfills
Industrial hazardous waste
Industrial non-hazardous waste
Municipal sanitary
Open dumps, including illegal dumping (waste)
Residential (or local) disposal (waste)
Surface impoundments
Hazardous waste
Non-hazardous waste
Materials stockpiles (non-waste)
Graveyards
Animal burial
Aboveground storage tanks
Hazardous waste
Non-hazardous wate
Underground storage tanks
Hazardous waste
Non-hazardous waste
Non-waste
Containers
Hazardous waste
Non-hazardous waste
Non-waste
Open burning and detonation sites
Radioactive disposal sites

Category III – Sources designed to retain substances during transport or transmission
Pipelines
Hazarous waste
Non-hazardous waste
Non-waste
Materials transport and transfer operations
Hazardous and transfer operations
Non-hazardous waste
Materials transport and transfer operations
Hazardous waste
Non-hazardous waste
Non-waste

Category IV – Sources discharging substances as consequence of other planned activities
Irrigation practices (e.g., return flow)
Pesticide applications
Fertilizer applications
Animal feeding operations
Urban runoff

Percolation of atmospheric pollutants	
Mining and mine drainage	
	Surface mine – related
	Underground mine – related
Category V – Sources providing conduit or inducing discharge through altered flow patterns	
Production wells	
	Oil (and gas) wells
	Geothermal and heat recovery wells
	Water supply wells
Other wells (non-waste)	
	Monitoring wells
	Exploration wells
Construction excavation	
Category VI – Naturally occurring sources whose discharge is created and/or exacerbated by human activity	
Ground water – surface water interactions	
Natural leaching	
Salt – water intrusion/brackish water upcoming (or intrusion of other poor – quality natural water)	

Source : Office of Technology Assessment, 1984, p. 45.

2. **Simple Quantitative Approaches-Soil Impacts**

Another approach for addressing impacts on the soil environment is to use simple quantitative techniques, with a range of such techniques having been developed. One example of a simple quantitative technique is the use of "overlay mapping"' which has been developed to delineate various land-use compatibilities in given geographical areas. Overlay mapping consists of utilizing a base map of the project study area and different soil or geological features of particular impact concerns of the proposed project. Impact prediction involves identifying where overlaps of particular concerns occur. Overlay mapping can be achieved through the development of hand drawn maps or the usage of computer- generated maps. GIS is a database, which may contain multiple "layers" of data for the same area. Examples of possible layers are topographic data and adorability indices are shown. All layers are referenced to common ground - datum point and orientation, allowing them to be, in essence, overlaid. Data can be input to DIS by either analytical or digital means. An example of the former would be the use of map digitizing, and of the latter, the use of satellite imagery tapes. One of the great benefits of using GIS is its ability to collate data from diverse sources into a consistent form. Regardless of original scale and format the data, once in the GIS, are consistent and constant. They may be output in different forms for checking, and they are available for a variety of analyses. GIS is beginning to be used in impact studies, since it can be a valuable tool for assessing cumulative impacts. GIS can also be used to quantify rates of regional resource loss by comparing data layers representing different years. In addition, GIS can be used to develop empirical relationships between resource loss and environmental degradation

Quantitative Models

Models have been developed to:

- simulate individual processes occurring in soil;
- describe behaviour of substances in soil such as nitrogen, phosphorous. And pesticides (laboratory experiments using column tests and lysimeters may also predict the behaviour of substances in soil);

• predict the behaviour of liquids, which are immiscible with water (for example, mathematical models for oil spills on land which simulate the behaviour of oil on the surface and in the unsaturated zone and its dispersion above the groundwater table);
• simulate the behaviour of gases in soil; or
• predict dispersion of heat released by pipelines or cables, or discharged in effluents.

Assessment of Impact Significance

Several approaches can serve as a basis for interpreting the anticipated project induced changes to the soil and groundwater environments. One approach is to consider the percentage and direction of change from existing conditions for a particular soil or groundwater environmental factor. While this can be helpful, it does presume that quantitative information is available for the baseline conditions for such factors, and that anticipated changes in the factors as a result of a project can be quantified. Another approach for impact assessment is to apply the provisions pertinent to Central, State, or Local laws and regulations related to the soil and groundwater environment to be expected with project conditions. In many cases, these institutional requirements are qualitative; however, they can be used as "yardstick" in evaluating the project and any features the project might incorporate to minimize environmental damage. A third approach for interpreting anticipated changes relies upon professional judgement and knowledge. The anticipated changes could be interpreted in relation to existing information on natural changes; next, the expected impacts could be placed in a historical context. A professional-judgement-based interpretation of anticipated changes may consist of applying rules of the thumb. As an example, concerning soil erosion, the current and anticipated soil erosion patterns from a project area could be compared to regional averages or historical trends. It is generally agreed that a certain amount of soil loss is inevitable. Ideally, the loss should not exceed the rate of soil formation from parent rock and decomposed vegetation, but there is no agreement in the rate of soil formation. A commonly cited, generalized upper limit of permissible or tolerate soil loss is about 11 ton/hour, but the "permissibility" of such a loss depends on many local factors, such as, the fertility and drainage characteristics of the sub-soil. Many soils are vulnerable to a decline in productivity at a rate of loss from erosion considerably lower than 11 ton/hour.

Environmental Analysis

After the above types of factors are considered, the resultant conclusion may not be absolute. Subjective terms, such as, the degree to which the project may induce development, may need to be used, the environmental analysis should yield the best possible prediction of environmental effects based on available information. The
conclusions of the analysis of potential induced development may be that the proposed project or action will - Definitely cause and promote increased density of land use, - Not cause any increase in development over what would occur in the future without the project,
- Not necessarily cause increased development, but perhaps accelerate development slated to occur anyway, and
- Not produce a development impact if local plans and policies stay unchanged, but indeed put into place the incentive for local planning bodies to change local comprehensive plans to permit higher-density land- use.

Other Secondary Effects

Secondary impacts can occur, however, due to changes in land-use or land-use plans. Many of these secondary impacts are not limited to socio-economic effects, but can equally affect natural resources, such as, water quality or wildlife habitat. Increased covering of the earth with impervious surface, such as parking lots or large buildings, can increase the rate and pollutant loading of surface water run-off. Secondary effects of such use can be the increased contamination of both surface water and groundwater resources. A secondary effect may then be the need to construct additional water treatment plants with associated secondary effects of the use of limited public funds.

Identification and Incorporation of Mitigation Measures Mitigation Measures to Prevent Soil Erosion, Compaction and Ground Water Pollution During and After Execution of Any Developmental Project.

1. Use of techniques to decrease soil erosion during either the construction or operational phase of the project. Examples of such techniques include minimization of the exposed time during the construction phase by planting rapidly growing vegetation and the use of sediment - catchment basins. Additionally, as various types of grasses and vegetation have relatively greater or less potential for minimizing soil erosion, the selection of pertinent vegetation for usage should take these characteristics into account. Remove as little vegetation as possible during the development and revegetate bare areas as soon as possible after completion of the project
2. Where possible gentle gradients should be treated and steep slopes avoided.
3. Suitable drainage systems to direct water ways from slopes should be installed
4. Creating large open expanses of bare soil should be avoided. These are more susceptible to wind erosion. If such large areas are created then wind breaks may be a useful mitigation procedure.
5. If the development is near to a water body siltation traps may need to be installed to trap sediment and prevent any damage to the fresh water ecosystem
6. Driving over the soil should be avoided or use wide tyres to spread the weight of vehicles thereby avoiding compaction
7. Few tracks too should bring vehicles to the working area
8. Cultivate the area after compaction has taken place. Rotation of land-use practices in the project area can be adopted to permit natural recovery without the continuing stress related to anyone land-use practice. Examples include the rotation of military training areas, agricultural crops in given geographical areas, and grazing patterns in areas permitted by pertinent governmental agencies.
9. The project can be designed to exhibit greater earthquake resistance if this is a potential concern for the project area. Examples include structural designs for withstanding shocks associated with the occurrence of earthquake
10. For projects involving usage of the groundwater resource, groundwater usage could be decreased.
11. If the potential impact of concern is land subsidence management, techniques to minimize groundwater usage in the area where subsidence is expected to occur could be implemented. These could encompass water conservation measures so as to reduce groundwater requirements.
12. Development of comparative information to enable more systematic site selections, which will, in turn, make maximum usage of the natural attenuation capacity of given environmental settings to prevent groundwater contamination; an example for solid - waste disposal sites is in Bolton and curtis.
13. For projects, which may be of concern because of leachate generation, measures could be taken to immobilize the constituents and prevent their generation.

General Methodology for the Assessment of Impacts on Surface Water EnvironmentIntroduction

Surface water bodies like rivers, streams, canals, ditches, ponds, reservoirs, lagoons, estuaries, coastal waters, lakes etc. which play very important role in the sustainability of any ecosystem and it is very important to assess the impacts of any developmental activity on these surface water environments. Impacts on surface waters are usually caused by physical disturbances (for example, the construction of banks, dams, dikes, and other natural or manmade drainage systems), by changes in climatic conditions, and by the addition or removal of substances, heat, or microorganisms (for example, the discharge of effluents and deposition of air pollutants into water). These activities and processes lead to first order effects as manifested by changes in surface water hydrology, changes in surface water quality, and consequently to higher order effects reflected by changes in sediment behavior, changes in salinity, and changes in aquatic ecology.

Fig. 1 demonstrates the cycle of both surface-water and groundwater hydrology. Because of the dynamic nature of both the quantity and quality influencing processes, natural variations occur in the flow and quality characteristics respectively.

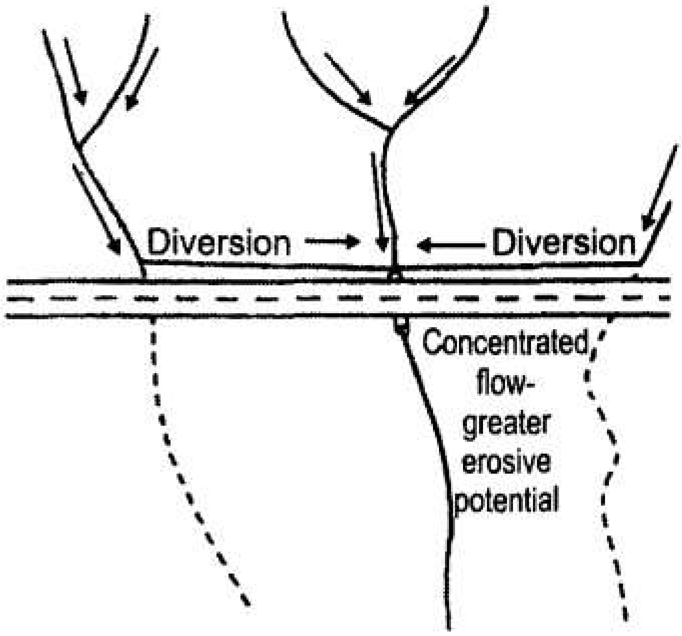


Fig. 1 Concentration of surface water flow.

Projects Which Create Impact Concerns for the Surface-Water Environment

Several developmental activities will result in environmental impacts on surface water bodies. The following are the list of various developmental activities.

which cause significant impacts on surface water resources for which a detailed EIA is normally required:

I. Industrial power plants withdrawing surface water for cooling (this may be of particular concern during low- flow conditions).

2. Power plants discharging heated waste water from cooling cycles

3. Industries discharging process waste waters from either routine operations or as a result of accidents and spills.

4. Municipal waste water treatment plants discharging primary, secondary or treated waste waters.

5. Dredging projects in rivers, harbors, estuaries and or coastal area (increased turbidity and release of sediment contaminants may occur)

6. Projects involving "fill" or creation of "fast lands" along rivers, lakes. estuaries and coastal area.

7. Surface mining projects with resultant changes in surface water hydrology and nonpoint pollution.

8. Construction of dams for purposes of water supply. flood control or hydropower production.

9. River canalization projects for flow improvements

10. Deforestation and agricultural development resulting in non-point source pollution associated with nutrients and pesticides and irrigation projects, leading to turn flows laden with nutrients and pesticides.

11. Commercial hazardous waste disposal sites and/or sanitary landfills, with resultant run-off water and non-point-source pollution; and

12. Tourism projects adjacent to estuaries or coastal area with concerns related to bacterial poIlution.

Before starting EIA on any surface water. one has to understand certain basic characteristics of qualities and quantities of surface water bodies.

Systematic Methods for Evaluation of Impacts of Various Developmental Activities on Surface Water Environment

For assessing the environmental impacts of various human activities on surface water bodies the following six step model Fig. 2 is discussed.

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

The first activity is to determine the features of the proposed project. Theneed for the project, and the potential alternatives, which have already been or may now be, considered.

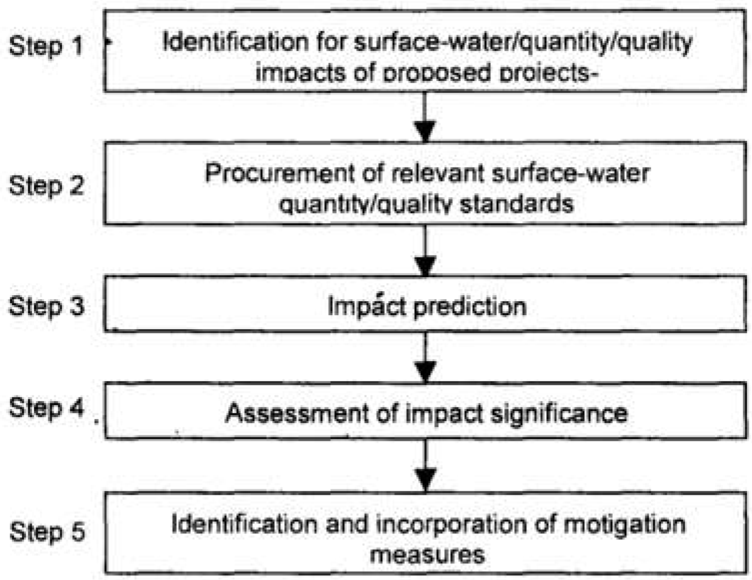


Fig. 2 Conceptual approach to study surface water environment impacts.

The key information relative to the proposed project includes such items as

1. The type of project and how it functions or operates in a technical context, particularly with regard to water usage and waste water generation, or the creation of changes in water quality or quantity,

2. The proposed location of the project,

3. The time period required for project construction,

4. The potential environmental outputs from the project during its operational phase, including information relative to water usage and water pollutant emissions, and waste-generation and disposal needs.

5. The identified need for the proposed project in the particular location (this need could be related to flood control, industrial development, economic development. and many other requirements; it is important to begin to consider project need because it will be addressed as part of the subsequent related environmental documentation), and

6. Any alternatives which have been considered, with generic alternatives for factors including site location, project size, project design features and pollution control measures, and project timing relative to construction and operational phases.

The focus of this step is on identifying potential impacts of the project. This early qualitative identification of anticipated impacts can help in refining subsequent steps

. For example, it can aid in describing the affected environment and in calculating potential impacts. Step! should also include consideration of the generic impacts related to the project type.

There is an abundance of published information generated over the past two decades which enables planners of impact studies to identifY more easily the anticipated impacts of different land- use changes. Fig. 3.

For example, rainfall in highly industrialized regions may consist of acidic precipitation which is introduced to the surface water, and may bring with it natural organics, sediments, and so on;

The summary of cause-effect network for surface waters is presented in Fig. 3

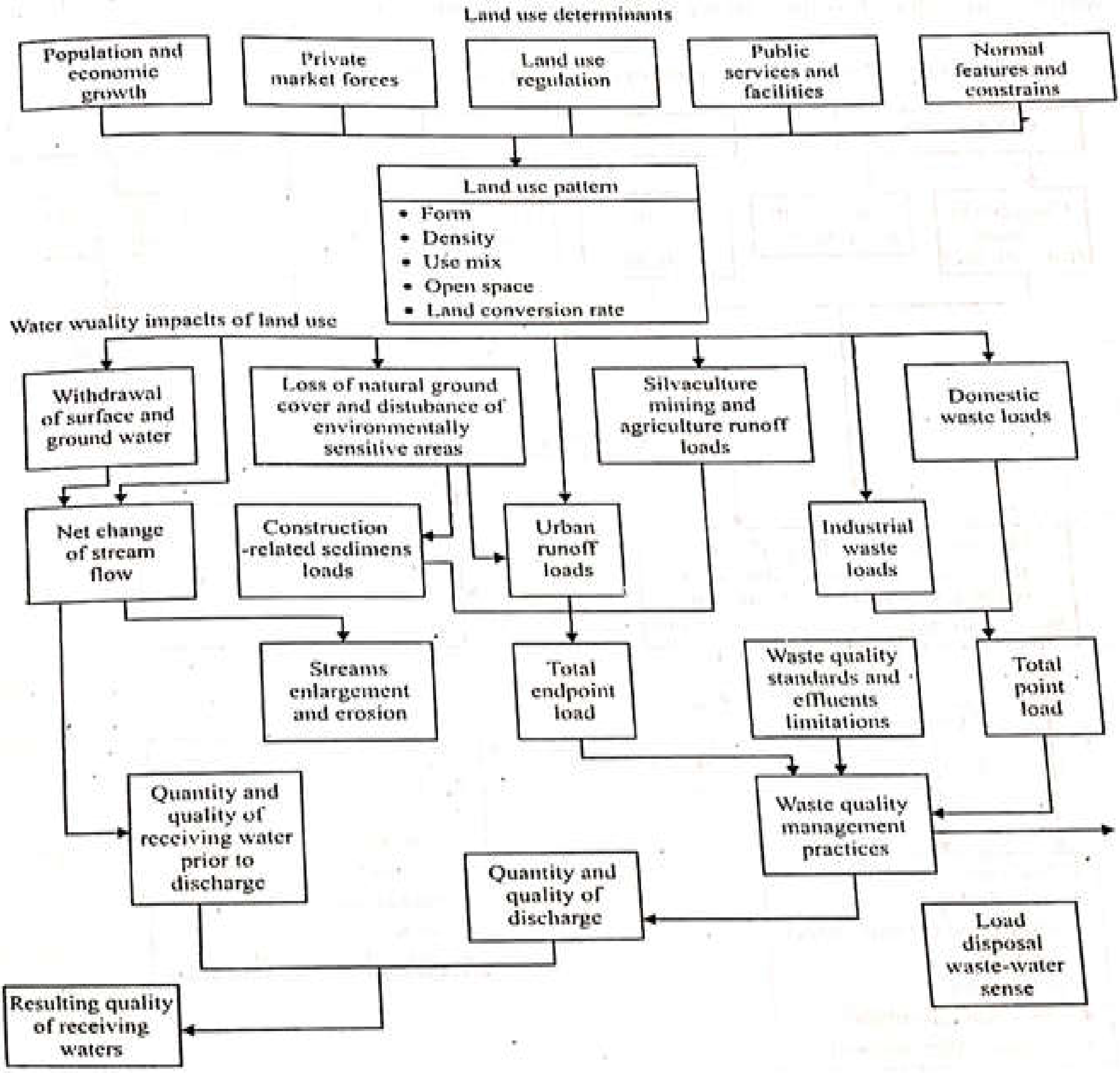


Fig. 3 Schematic diagram of the land-use-water-quality relationship.

Base flow may have elevated the levels of Hanes from the flow of the water .Though the discharge of waste water (treated or otherwise) greatly adds to the organic loading of the surface water and clearing of land for construction, farming. etc., it can also result in increased erosion and sediment load in the surface water.

Water quality can be defined in terms of the physical, chemical, and biological characterization of the water.

Physical parameters include color, odor, temperature, solids (residues), turbidity, oil content, and grease content.

Each physical parameter can be broken into sub-categories. For example, characterization of solids can be further sub-divided into suspended and dissolved solids as well as organic (volatile)and inorganic (fixed) fractions.

Chemical parameters associated with the organic content of water include biochemical oxygen demand (BOD), chemical oxygen demand (COD), total organic carbon (TOC), and total oxygen demand (TOO). It should be noted that BOD is a measure of the organics present in the water; it is determined by measuring the oxygen necessary: Inorganic chemical parameters include salinity, hardness, pH,

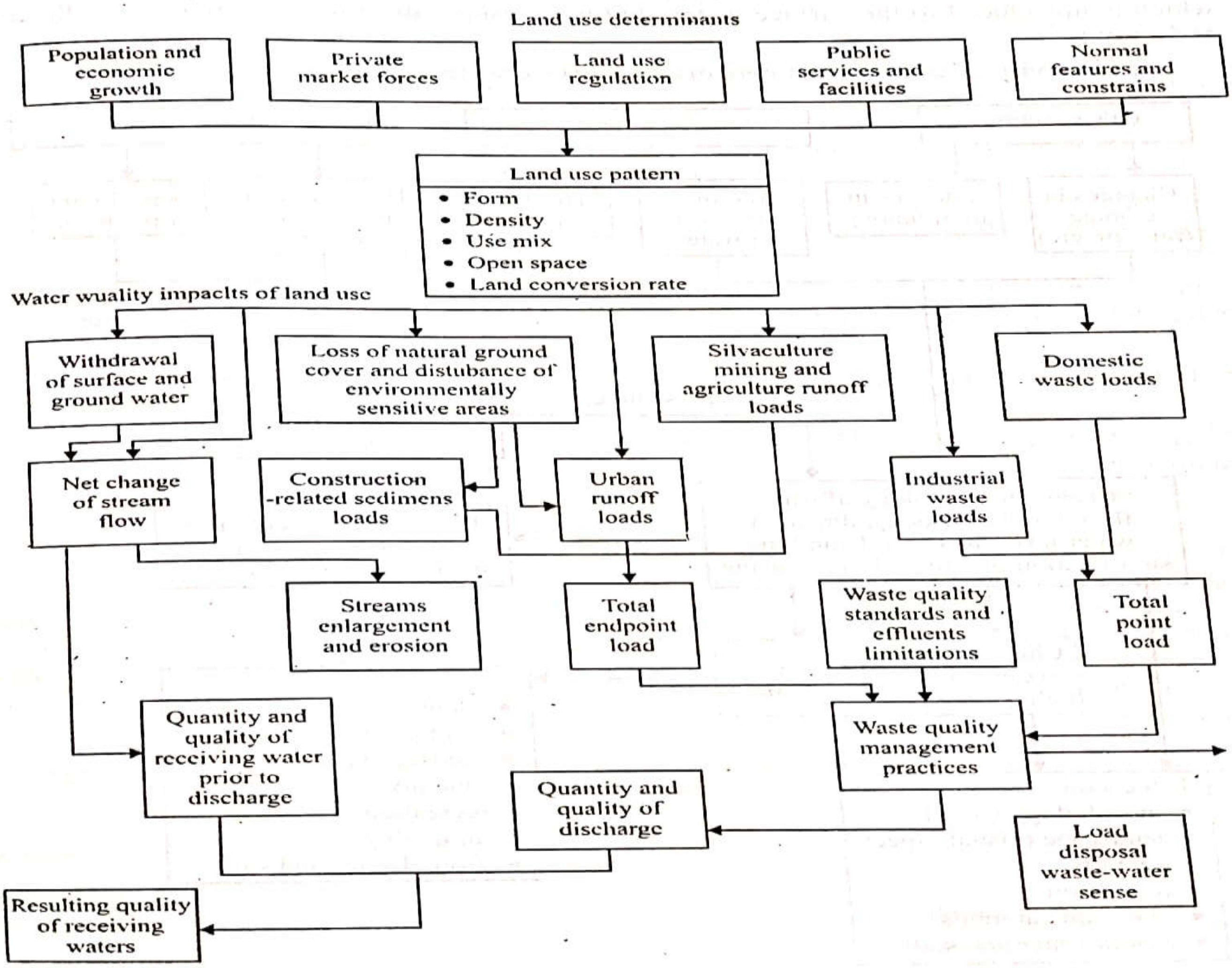


Fig. 4.3 Schematic diagram of the land-use-water-quality relationship.

acidity, and alkalinity. The presence of substances including iron, manganese, chlorides, sulfates, sulfides, heavy metals (mercury, lead, chromium, copper and zinc), nitrogen (organic, ammonia, nitrite) and phosphorus. Biological properties include bacteriological parameters such as coliforms, fecal coli forms, specific pathogens, and viruses. Routine monitoring of biological quality of waters involve indicator groups and relies on two basic assumptions (a) that principal concern is with human faecal contamination of water and (b) that the indicators used will be present in proportion to all pathogenic species of interest. The most common organisms used are colifonn bacteria (total coli forms and faecal colifoms, faecal streptococci and salmonella). Table 4.1 shows some water quality parameters assessed during impacts study

Table 4.1 Presents some common water quality parameters surveyed in the impact assessment.

Variable	*System*	*C*	*H*	*F*	*Notes*
Nutrients					
Phosphorus	R	+	–	–	Several different forms. Much of load transported in sediment.
	L & P	+	–	+	Varies between hypolimnion and epilimnion. Detection often difficult.
Nitrate	R	+	+	+	Usually higher in late autumn/winter.
	L and P	+	+	+	Levels generally increase with amount of flow through system.
Chlorophyll	AS	+	–	+	Used as a general index of standing crop of ***algae***.

Variable	System	C	H	F	Notes
Organic matter					
Biochemical oxygen demand (BOD)	R	+	+	+	A main variable in monitoring sewage outfalls and GQRAs. Can range from < 5 mg/l in clean rivers to 100,000 mg/l in industrial waste.
Chemical oxygen	R	+	–	+	Measures total organic matter which *could* use up oxygen. An alternative to BOD, e.g., where ***non-labile organics*** are suspected.
Metals					
Al, Cu, Cd, Hg, Pb, Zn	AS	+	+	+	Often serious pollutants of frehwaters, Tooxicites usually increase with decreasing pH and water hardness.
Ca, Mg, Na, K	AS	+	+	+	Used to assess water type pbut not quality. Useful in conjunction with other variables to assess likely toxicity of other metals.
Others	AS	+	+	+	Industry-specific surveys may be needed (e.g. silver for electroplating, tin from old mines) but most not routinely covered.
Micro-organics	AS	+	+	+	Defficult to identify unless potential source suspected; so although potentially important rarely included in standard.
General effects	AS	+	+	+	Most are easily detected by sight/smell. Not normally a health problem as polluted water unlikely to be imbibed. Tainting can damage fisheries.
Carcinogenic Effects	AS	+	+	+	Rarely routinely done as particular carcinogen will vary with type of oil, geographic source and batch.
Others					
Ammonia	R	+	+	+	Organic decay product. Toxic to fish, and toxicity increases at high pHs.
	L & P	+	+	+	In large waterbodies, only likely to be high in intensively stocked fiheries. Small stagnant waterbodies may naturally have high levels.
Hydrogen Sulphide	R	+	+	+	Generally as for ammonia.
	L & P	+	+	+	
Cyanide	AS	+	+	+	Very toxic but occurrence limited to particular industries.
Sediment	R	+	–	+	Part of routine monitoring, especially in relation to sewage outfalls.
	L & P	–	–	+	May be of concern in fisheries ad reservoirs (may block filters).
Pathogens	AS	–	+	–	Mainly for faecal contamination, especially for water-areas.

Variable	System	C	H	F	Notes
Dissolved Oxygen	R	+	--	+	A routine variable because many river animals need high levels
	L	+	–	+	Levels vary with depth, time of day and season
	P	–	–	+	Levels often highly variable
PH	as	+	+	+	Interpretation is very use related. Used to qualify other data.
Alkalinity	AS	+	+	+	Used to qualify pH data.
Electrical	AS	+	+	+	Useful as an indication of the levels of other conductivity major variables.
Temperature	AS	+	+	+	Assessing thermal pollution, but mainly used to qualify other data.

System: L = lakes and reservoirs; P = ponds; R = rivers; AS = all systems (usually including ground waters).

C,H,F = purpose: C = conservation; H = human health; F = fisheries. - = infrequently measured (but may be important in specific circumstances); + = fairly frequently measured + = frequently measured.

The two main sources of water pollutants to be considered are nonpoint and point sources Table 4.2.

Non-point sources are also referred to as "area" or "diffuse" sources.

Table 4.2 Non point and point sources of pollutants.

Nonpoint pollutants	Point pollutants
Pollutant from : Urban area, industrial area, or rural run-off *Examples* : sediment, pesticides, or nitrates entering a surface water because of runoff from agricultural farms	*Specific discharge from .* Municipalities or industrial complexes *Example :* Organics or metals entering a surface water as a result of waste water discharge from a manufacturing plant

Step 2 Description of Existing Surface - Water Resource Conditions

Step 2 involves describing existing (background) conditions of the surface water resource(s) potentially impacted by the project.

Pertinent activities include assembling information on water quantity and quality, identifying unique pollution problems, key climatological information, conducting baseline monitoring, and summarizing information on point - and non-point - pollution sources and on water users and uses.

Compilation of Water Quantity - Quality Information

Information should be assembled on both the quantity (flow variations) and quality of the surface water in the river reach of concern, and potentially in relevant downstream.

Water Qualltity

Run-off Over Land

There are a number of standard mathematical models. expelt systems, and field tests using tracers are available to determine movement of the run-off on land and its appearance in surface water bodies which are important in ElA studies as they mainly cause resultant impacts on the hydrology and water qual ity in receiving water bodies. Run-off of pesticides, fertilizers, and other materials toxic to water bodies used for domestic, agricultural, and recreational purposes need special focus as their impacts are significant. A number of Mathematical models are available for predicting run-off for:

- permeable or impermeable surfaces;
- sewered or unsewered areas;
- short-term or long-term predictions; and
- quantity or quality. for example, pesticides. sediments. biological oxygen demand, nutrients, dissolved minerals, bacteria, etc.

The balance between hydrological inputs and outputs to surface run-otT (precipitation minus evapotranspiration, infiltration, and storage equals run-off) are described by mathematical equations based on same principles in all these Runoff Models The basic model may be manipulated to include variables describing relevant processes (for example, erosion, sedimentation ,wash-off of chemicals, adsorption, biodegradation, etc.), in which case they can also be integrated to water quality models for the receiving surface waters.

Extensive calibration and verification for use in specific areas and high level of expert assistance are required for application of all these models. Further substantial information on rainfall, air temperature. drainage network configuration, soil types, ground cover, land use. and management are also essential inputs

The following are some widely used applications where the R:unoffmodels are used

- prediction of traffic poll utant loads washed off road surfaces through sewers after prolonged dry periods (the accumulated load is assumed to be washed offin the first heavy rainfall and enter surface waters); and
- prediction of the run-off of a conservative pollutant applied within a catchment area (the total amount applied is assumed to be uniformly diluted in the total run-off from the catchment).

Flow Models

For several types of fresh water systems.hydrological and hydrodynamic models have been developed for use in environmental assessment for which information on water flow will be highly essential. For estimating time varying flow rates (m3/sec) in rivers. lake<;, and manmade reservoirs many hydrological models which are often constructed based on historical data collected at hydrometric monitoring stations are finding wide application In marine systems models have been used to predict currents and water level in coastal and estuarine environments

Water Quality

The quality emphasis should be on those water pollutants expected to be emitted during the construction and operational phases of the project. If possible, consideration should be given to historical trends in surface - water quantity and quality characteristics in the study area.

Environmental Impact Assessment Methodologies 139

Oxygen Sag Curve - Streeter Phelps Equation

The changes in dissolved oxygen resulting from increased demands for oxygen from bacteria during decomposition and supply of oxygen from natural reaeration are considered in various models accounting organic loading

The Streeter-Phelps equation which represents the oxygen sag curve. Fig. 4.6 depicts how the oxygen concentration C changes with time and distance downstream of a discharge point. The dissolved oxygen deficit, (Cs - C) as a function of demand for oxygen and natural aeration, where Cs is the oxygen saturation concentration. Is described by this equation.The basic equation

$$D_t = \frac{K_1 L_o}{K_2 - K_1} e^{-K1t - K2t + D_0}\ e^{-K2t}$$

where:

Dt is the dissolved oxygen (DO) deficit at t;

L0 is the BOD concentration at the discharge point immediately after mixing (t = 0);

Do is the initial DO deficit at the point of 'Waste discharge;

t is the time or distance downstream;

Kl is the parameter of deoxygenation; and

K2 is the reaeration parameter.

Other processes that affect BOD and resulting dissolved oxygen concentrations, and that can be integrated in this model include algal and plant respiration, benthal oxygen demand, photosynthesis, and nitrogenous oxygen demand.

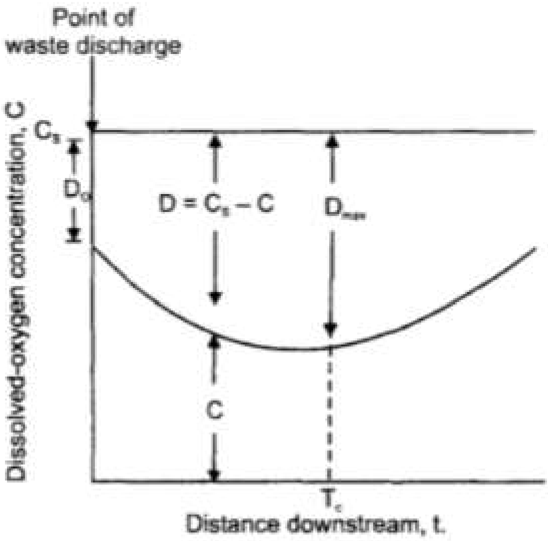


Fig. 4 Oxygen sag curve obtained from the Streeter-Phelps Equation

Prediction and Assessment of Impacts on Biological Environment

Introduction

Many developmental activities are likely to play a major role in the overall reduction of biodiversity, and proper planning at the project level can go a long way in limiting the loss, while still serving the needs of the people for which the project is started. Some development activities have direct impacts on biological systems. For example, clearing of land for infrastructure will destroy vegetation and displace animals. Introduction of contaminants may cause direct mortality of plants and animals. However, in many cases it is changes in the physical environment caused by development that often lead to secondary or high order changes in plants and animals. For example, changes in downstream flow as a result of an upstream dam on a river may change the productivity of fish population. Alternatively, industrial pollution may be transported downstream and move through the food chain and ultimately contaminate the fish and wildlife populations that depend on the river.

The issue of impacts on flora and fauna is much broader than a concern for individual specimens and any useful discussion in this area must be considered in the larger context of biodiversity conservation.

Biodiversity refers to the wealth of species and ecosystems in a given area and of genetic information within populations. It is of great importance at global and local levels. Areas of high biodiversity are prized as store houses of genetic material, which fonn the basis of untold numbers and quantities of foods, drugs, and other useful products. The more species there are, the greater the resource available for adaptation and use by mankind. Species, which are pushed to extinction, are gone forever; they are never again available for use. Preservation of biodiversity is of global concern, but the causes of loss and their solutions are very often local in scale

At the ecosystem level, biodiversity provides flexibility for adaptation to changing conditions, such as those induced by human activity. Diverse systems are better able to adapt because their high degree of species redundancy allows for substitutions, thus facilitating the return t!J the state of equilibrium. Populations, which are genetically highly diverse, are better able to cope with induced reductions in population size and are therefore not as vulnerable to extinction as are less diverse populations

A simplified conceptual model of potential effects on biota is presented in Fig. 5. The complex and dynamic nature of ecological systems imposes difficulties in obtaining adequate baseline data making accurate impact predictions and formulating dependable impact predictions,

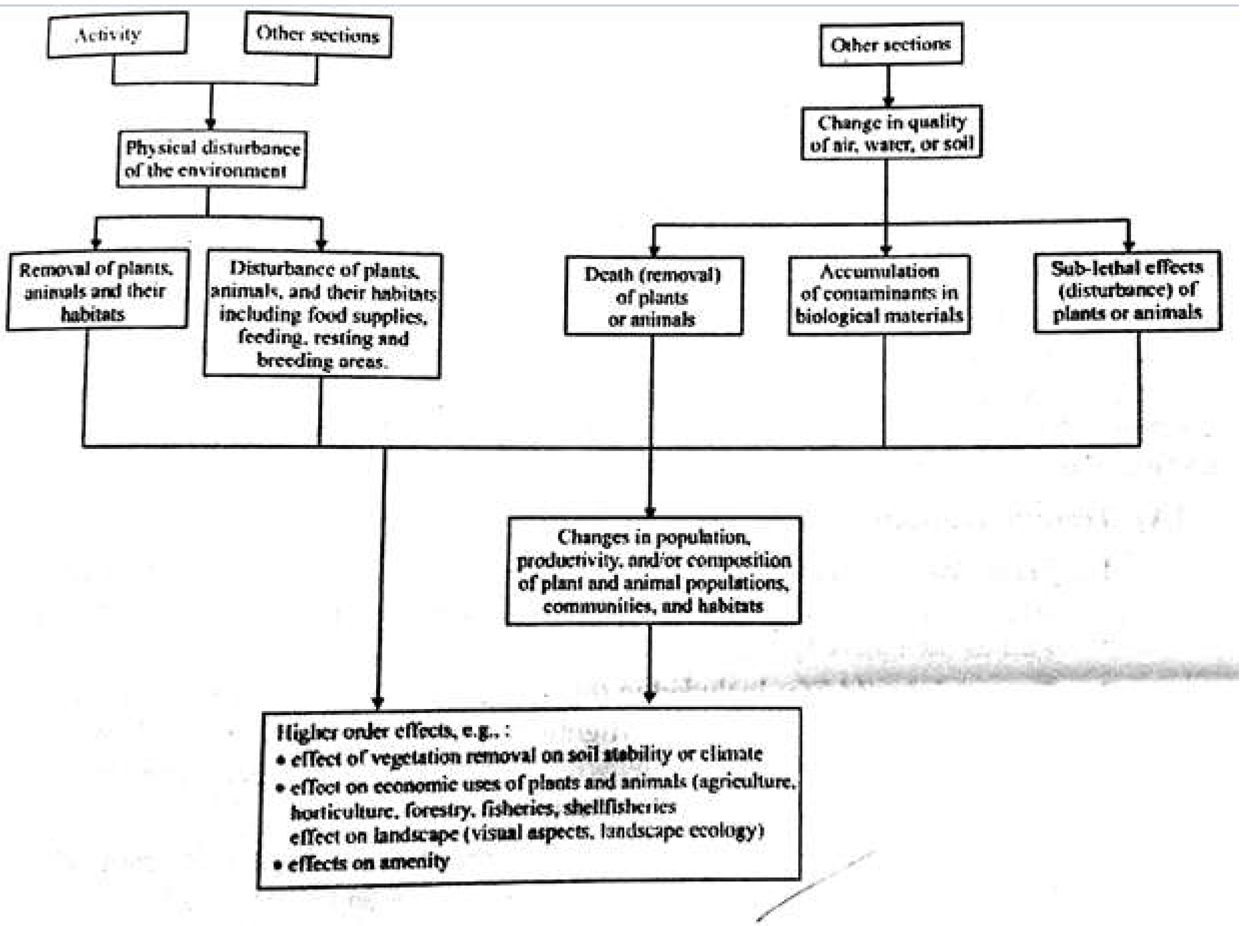


Fig. 5 Summary of cause-effect network for biota (source; ERL 1984).

General Methodology for the Assessment of Impacts on Biological Environment

Prediction and assessment of impacts on the biological environment involve a number technical and professional considerations related to both the predictive aspects and the interpretation of the significance of anticipated changes,

Biological Impact Assessment

The biological assessment of the impact of any proposed project or action, may include

- Results of on-site inspections or surveys
- Views of recognized experts
- Review of literature and other information
- Analysis of effects of the proposed project or action on the species and habitat
- Analysis of alternative actions considered

  The biological assessment should be conducted at a level of detail suitable to the project or action characteristics and the biological requirements of the listed species. This will usually encompass a very large geographic area, sometimes even all the species known, in the entire state or country even though the particular proposed project or action may affect only a very small area. Such a comprehensive approach is appropriate. It remains the ultimate responsibility of the Central/State government not to assist or sponsor any activity that may adversely affect an endangered species in compliance with the Endangered Species Act. The agency must therefore assume a proper share of accountability in identification of the presence of a listed species or critical habitat within the area oflikely project effect.

In many circumstances, the biological assessment will be simple and obvious.

Biological Environment

The biological environment includes plants and animals, the distribution and abundance of the various species and the habitats of communities. Species forming a community are often inter dependent so that a direct environmental effect on one species is likely to have indirect effect on other species. This interference acts primarily through food chains but can also act through one species providing a habitat for another species.

(A) Terrestrial Species

1. Terrestrial vegetation: It includes in its broadest sense to include agricultural crops, pasture, the introduction, proliferation or control of noxious weeds as well as the native species.

2. Terrestrial wild life: Included in this group are native mammals, birds, reptiles, amphibians and invertebrates. Migration routes, resting areas, feeding grounds and water sources concentrate wildlife so that such places are particularly sensitive to developmental project activity.

3. Other terrestrial fauna: Included in this group are domestic and farm animals. Human dependence on such animals extends beyond the food chain to include economics and companionship. Insect and snails are especially important as carriers of parasitic diseases, which afflict the human community.

4. Aquatic'/marine flora: These are important because they provide an important habitat and food for other aquatic marine life and sustain our fresh water or marine fisheries. Mangrove forests, various species sea weeds and kelp are important. The proliferation of fresh water species can have an impact on the economic use of inland waterways.

5. Fish: They are considered separately because they provide an important source of animal proteins. In addition to fresh water and marine fish, invertebrates such as prawns, shellfish, crales and squid should be considered. Species in the brackish- water estuarine environment are of particular importance to man's food chain. 6. Other aquatic marille faulla: Other species that are not of direct economic importance may form a palt of the food chain. Any project, which has a major impact on species populations, can have an equally major indirect impact on the economically important varieties of marine life.

(B) Habitats and communities

In considering the environmental effects of development on habitats and communities the special features of terrestrial, aquatic estuarine and marine ecosystems should be considered separately. Special consideration should be given to bird life in considering wetland habitats.

1. Terrestrial habitats: Swamps, wet lands, bird nesting areas, grazing areas, watering places and migration routes should be considered.

2. Terrestrial communities: Special plant communities at high altitudes or those that are residual in an otherwise altered environment should be considered.

3. Aquatic, estuarine or marine habitats : Nursery and breeding areas near shoreline are considered: Wetlands are important. Damage may occur by siltation. Chemical, physical and biological pollutants may each have major impacts. Oil spills are important in marine environment. Gravel beds are important for spawning.

4. Aquatic, estuarine or marine communities : The food chain relationships involving fish and invertebrates and vegetation are important and should be understood. Siltation and chemical pollution can severely disrupt the balance or the very existence of the community. Project design should aim to leave communities intact and at the very least protect key co:nmunity components such as invertebrates.

Species Population

The viability of population depends on the presence of a suitable environment with adequate resources. All organisms are constantly affected by and interact with a complex of environmental factors including aboitic (physico-chemical factors like water, temperature light, oxygen nutrients toxins pH etc) and biotic factors (which involve interactions between species i.e., competition, predation, parasitism and mutualism. Species can tolerate nonnal short term environmental variations while populations undergo marked temporary fluctuations, they tend to remain stable in long term. Species also may be capable of responding to slow progressive environmental changes by evolving or changing their geographical range. However their adaptations have evolved in response to slow past environmental conditions and may be unable to adjust quickly enough to rapid environmental changes. One of the greatest threats to most species is habitat loss together with associated habitat fragmentation due to urbanization. The key issue which cause irreversible population loss is the ability of the species populations to survive in and move between small isolated habitat patches scattered within an urban or agricultural matrix

Systematic Approach for Evaluating Biological Impacts

To provide a basis for evaluating biological environment impacts, a six-step protocol was formulated for planning and conducting impact studies. This protocol is flexible and can be adapted to various project types by modification as needed to enable the addressing of concerns of specific projects in unique locations-

The various phases associated with the evaluation of biological environment impacts are

I. Identification of the potential biological impacts of the construction and/or operation of the proposed project of activity, including habitat changes or loss of chemical cycling and toxic events, and disruptions to ecological succession;

2. Description of the environmental setting in terms of habitat types, selected floral and faunal species, management practices, endangered or threatened species, and special features (such as wetlands);

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

4. Conducting of impact prediction activities including the use of analogies (case studies), physical modeling and/or mathematical modeling, as based on professional judgment;

5. Use of pertinent information from step 3, along with professional judgment and public input, to assess the significance of anticipated beneficial and detrimental impacts; and

6. Identification, deveiopment and incorporation of appropriate mitigation measures for the adverse impacts.

Fig. 6 gives the relationship among the six steps or activities in the protocol.

The six steps can be used to plan a study focused on biological environment impacts, to develop the scope of work for such study, and/or to review biological-impact information in E As or EISs.

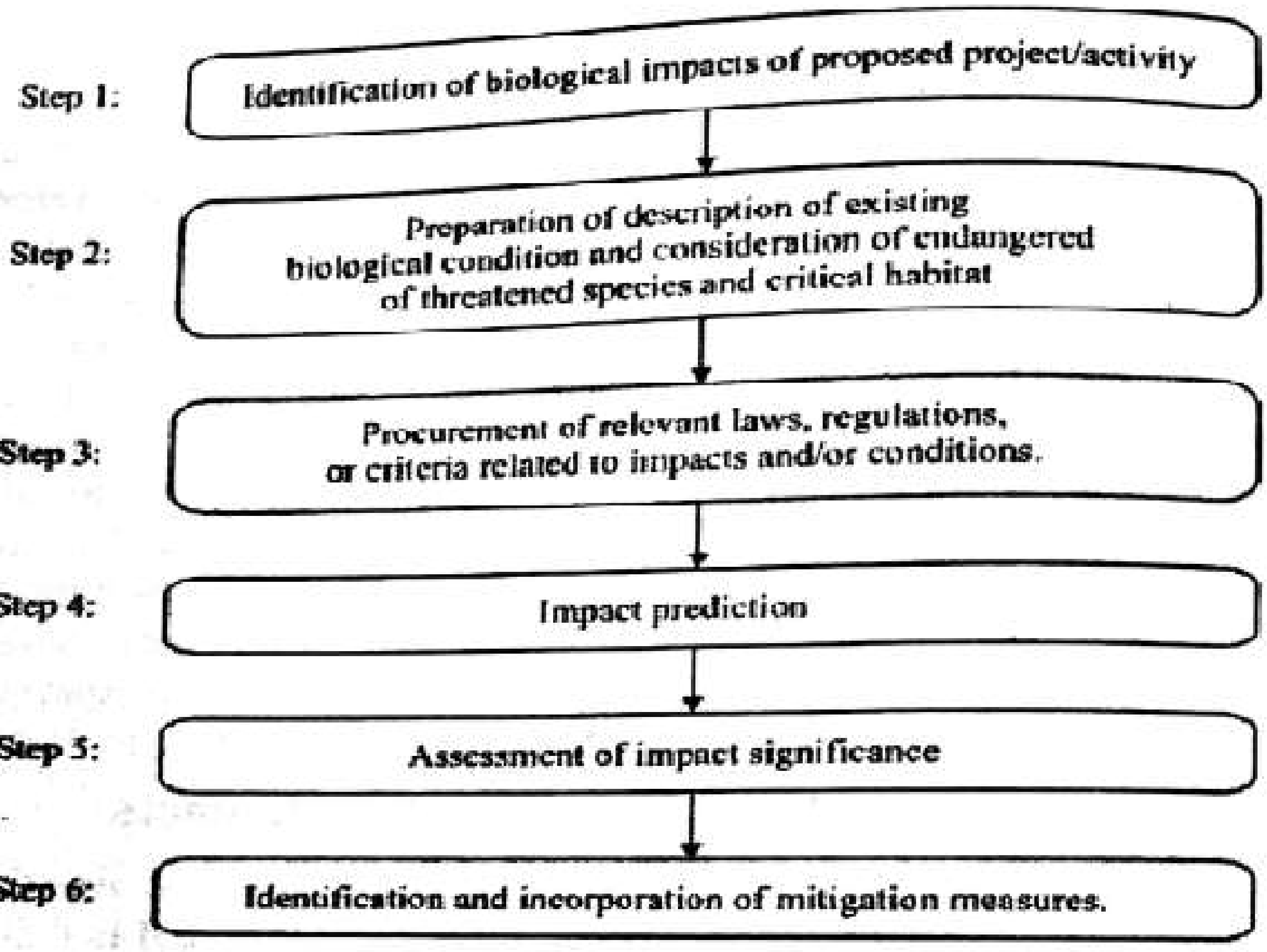


FIG.6six-step protocol for evaluation of biolofical environment impact

Procurement of Relevant Soil and *I* or Groundwater Quantity - Quantity Standards

Land-use restrictions, soil quality standards, soil reclamation requirements, and groundwaterquantity - quality standards, regulations, or policies are examples of institutional measures,which can be used to determine impact significance and required mitigation measures. Thus,to determine the specific requirements for a given project area will require contactingappropriate governmental agencies with jurisdiction.
The primary sources of information needed for step 3 (Figure 3.2) will be pertinent to thegovernmental agencies, namely, Central government, State government and/or localagencies. In addition, international environmental agencies may have information pertinentto this step.

Impact Prediction

The prediction of the impacts of a project - activity on the soil and/or ground – waterenvironment(s), or conversely, the potential influence of the environment(s) on a proposedproject, can be approached from three perspectives.

I. Qualitative
2. Simple quantitative, and
3. Specific quantitative

In general, efforts should be made to quantify the anticipated impacts; however, in manycases this will be impossible and reliance must be given to qualitative trend and through thespreading of excess sub-soil over the right - of - way during clean-up. In general, themixing of sub-soil with topsoil will have an adverse impact in soil fertility and soil structure.The severity of the impact will depend on the nature of the sub-soil.

Qualitative Approaches-Groundwater Impacts

A qualitative approach for groundwater - impact prediction involves the fundamental subsurface Environmental processes. The fundamental processes in the sub-surface environmentcan be examined relative to their hydrodynamic (physical), biotic (chemical), aspects.Table 3.3 summarizes processes, which may affect constituents of groundwater.

Table 3.3 Possible sources of ground water contamination.

Category I	Sources designed to discharge substances
Subsurface percolation (e.g., septic tanks and cesspools)	
Injection wells	
Hazardous waste	
Non-hazardous waste (e.g., brine disposal and drainage)	
Non-waste (e.g., enhanced recovery, artificial recharge, solution mining, and in-situ mining)	
Land application	
Wastewater (e.g., spray irrigation)	
Wastewater by – products (e.g., sludge)	
Hazardous waste	
Non-hazardous waste	

Category II – Sources designed to store, treat, and/or dispose of substances; discharge through unplanned release
Landfills
Industrial hazardous waste
Industrial non-hazardous waste
Municipal sanitary
Open dumps, including illegal dumping (waste)
Residential (or local) disposal (waste)
Surface impoundments
Hazardous waste
Non-hazardous waste
Materials stockpiles (non-waste)
Graveyards
Animal burial
Aboveground storage tanks
Hazardous waste
Non-hazardous wate
Underground storage tanks
Hazardous waste
Non-hazardous waste
Non-waste
Containers
Hazardous waste
Non-hazardous waste
Non-waste
Open burning and detonation sites
Radioactive disposal sites

Assessment of Soil and Ground Water Pollution

LeachillgInto Soil and Groundwater

The volume of leachate percolating through a site can be predicted using mathematicalModels such as the water balance method in sites above the water table. The water balanceMethod calculates leachate flow by balancing flows into and out of a site as follows:

$\blacktriangle S = I - O$

where

I is the inflow volume;
O is the outflow volume;
S is the storage volume; and
D. S is the change in the storage volume.
In the unsaturated zone:

$L=P-R-Evt+ Vd-Evd$
Where

P is the precipitation volume;
*Vd*is the volume of liquid disposed;

L is the leachate volume;

*Evt*is the volume lost to evapo transpiration;

*Evd*is the volume of the liquid disposed lost to evaporation; and

R is the runoff volume.

For predicting long-term effects, the change in storage can be assumed to be zero, evapotranspirationcan be based on existing data or experiments, while run-off can be calculatedusing an empirical model based on surface conditions and slopes.

Darcy's Law

Darcy's Law is the basis for most models of groundwater flow in sites below the water table.The method describes the flow of groundwater through a saturated porous medium. Flow isdependent on the change in head with distance (that is, the hydraulic gradient) and thepermeability of the medium. It is expressed mathematically as:

$Q, = KA(dH)/dL$

where:

Q is the flow (m3/day);
K is the permeability (rn/day);
A is the cross-sectional area (m2); and
*dH/dL*is the hydraulic gradient (that is, the change in the water table elevation per unit change in the horizontal direction).

Assessment of Impact Significance

Several approaches can serve as a basis for interpreting the anticipated project induced changes to the soil and groundwater environments. One approach is to consider the percentage and direction of change from existing conditions for a particular soil or groundwater environmental factor. While this can be helpful it does presume that quantitative information is available for the baseline conditions for such factors, and that anticipated changes in the factors as a result of a project can be quantified. Another approach for impact assessment is to apply the provisions pertinent to Central, State, or Local laws and regulations related to the soil and groundwater environment to be expected with project conditions. In many cases, these institutional requirements are qualitative; however, they can be used as ~ "yardstick" in evaluating the project and any features the project might incorporate to minimize environmental damage. A third approach for interpreting anticipated changes relies upon professional judgment and knowledge. The anticipated changes could be interpreted in relation to existing Information on natural changes; next, the expected impacts could be placed in a historical context.

A professional-judgment-based interpretation of anticipated changes may consist of applying rules of the thumb. As an example, concerning soil erosion, the current and anticipated soil erosion patterns from a project area could be compared to regional averages or historical trends. It is generally agreed that a certain amount of soil loss is inevitable.
Ideally, the loss should not exceed the rate of soil formation from parent rock anddecomposed vegetation, but there is no agreement in the rate of soil formation (9).A commonly cited, generalized upper limit of permissible or tolerate soil loss is aboutII ton/ha/yr, but the "permissibility" of such a loss depends on many local factors, such as,the fertility and drainage characteristics of the sub-soil. Many soils are vulnerable to adecline in productivity at a rate ofloss from erosion considerably lower than II *ton/h/lyr.*

Environmental Analysis
After the above types of factors are considered, the resultant conclusion may not be absolute. Subjective terms, such as the degree to which the project may induce development, may need to be used. The environmental analysis should yield the best possible prediction of environmental effects based on available information. The conclusions of the analysis of potential induced development may be that the proposed project or action will- Definitely cause and promote increased density of land use, - Not cause any increase in development over what would occur in the future without the project, - Not necessarily cause increased development, but perhaps accelerate development slated to occur anyway, and - Not produce a development impact if local plans and policies stay unchanged, but indeed put into place the incentive for local planning bodies to change local comprehensive plans to permit higher-density land- use

Unit-5

Assessment of impact development

Assessment of Impact of development Activities on wildlife

Human activities that affect wildlife and their habitats are pervasive and increasing. Effects of these activities are manifested at all ecological scales, from short-term changes in the behavior of an individual animal through local extirpations and global extinctions. Consequently, understanding the effects of humans on wildlife and wildlife populations, as well as devising strategies to ameliorate these effects, is an increasing challenge for resource managers. Given the conflicting mandate to both encourage human use and to protect sensitive natural resources in national parks, developing reliable strategies for assessing and monitoring the effects of human activities on natural resources is essential to ensuring appropriate stewardship of these resources. The objectives and clear disturbance context, a measure that gauges the response of the wildlife species of interest to the human activity must be selected carefully. The human activities can affect wildlife, distinguish among general types of relevant studies based on different objectives, and identify appropriate measures for gauging wildlife response for different types of studies. Our goal is to provide a conceptual framework to guide studying and monitoring human– wildlife interactions, specifically those deriving from non-consumptive recreational activities.

Classifying human activities

Classifying human activities Virtually all human activities can affect wildlife populations either positively or negatively. Those activities that are likely to have adverse effects can be divided into those that function primarily by altering the physical environment in a relatively permanent way and those that cause changes to an animal's behavior. Activities that alter the physical environment change the amount or the suitability of habitat for a species. Widespread and large-scale examples include activities that directly alter the structure and composition of the landscape, such agriculture, forestry, livestock grazing, and unregulated off-road vehicle use. The land management practices that change the trajectory of ecological succession, including altering the dominant plant communities and the abiotic features of a site. Although there are human activities that cause physical changes to park environments, such as construction of building and roads, or vegetation destruction resulting from overuse of particular areas, most wildlife-related impacts away from these areas likely result from short-term recreational pursuits of visitors.

Types of studies

The wide range of potential information needs and study objectives, we distinguish between two fundamentally different kinds of studies: research and monitoring. These can be classified primarily based on their different objectives and secondarily based on different durations. Impact assessment studies are designed to measure the effects of a planned activity or action within the context of a previously established monitoring program. These are often large-scale studies where the fundamental approach is to establish a monitoring program based on a series of sampling sites, a subset of which is eventually subject to being affected by the impact. The application of these studies is useful to natural resource managers interested in assessing the effects of management actions, such as opening or closing particular trails or other facilities, especially when replication of the impact is impossible. All types of studies benefit from careful application of the basic tools of research design, which include randomization, replication, reduction of error, incorporation of adequate controls, and understanding how the scope of inference for any study is dictated in part by the way study units are selected.

Research studies

Specific resource management questions about human– wildlife interactions are best answered through well-designed research studies, either experimental or observational. Observational studies cannot establish cause-and-effect inferences because of the potential for confounding by additional factors that may have influenced the response measure. Observational studies, therefore, provide only correlative inferences; yet can offer strong evidence when designed carefully.

Monitoring

Ecological monitoring studies almost always focus on quantifying changes in characteristics of resources over time. Consequently, monitoring studies are correlative and can therefore quantify patterns and associations but cannot establish causal links between changes in the resource of interest and changes in levels of human activity or other environmental characteristics. Despite their limited inference relative to randomized experiments, monitoring studies can still provide information that is valuable for understanding and reducing human– wildlife conflicts (Burger et al. 2004) especially when designed as part of an integrated monitoring program that encompasses a range of biotic and abiotic resources. Specifically, by measuring other environmental characteristics that are thought to affect changes in the wildlife response measure of interest (e.g., vegetation structure, food resources, rainfall), the ability to detect temporal and spatial changes in the resource is increased and the likelihood that the observed change was driven by a confounding variable is reduced. Monitoring visitor impacts on wildlife is different than most observational studies because changes in parameters of interest are designed to be measured for long time periods, usually spanning multiple generations. Therefore, well-designed monitoring programs should provide sufficient temporal and spatial coverage as well as the flexibility to address a range of potential impacts, the nature and extent of which may be unknown when the program is being designed.

Choosing an appropriate wildlife response measure

Understanding both the short- and long-term consequences of interactions between humans and wildlife requires that a response measure be chosen that reflects the temporal and spatial scales appropriate to the human activity. Many attempts to understand the effects of human activities on wildlife have focused on measures that are most appropriate for long-term assessment. Although these are clearly important measures, they are not appropriate for assessing all types of human activities because changes in behavior and space use are often overlooked, both of which can have long term consequences for populations. Changes in behavior are consequential because they can ultimately affect reproductive success, survival, and habitat occupancy, which in turn can reduce population viability, especially for rare, threatened, or endangered species.

Table 1: Potential response measures for assessing effects of human activity on wildlife and wildlife populations.

Appropriate study period	Measure
Short-term	Physiological responses — heart rate, stress hormones Behavior and activity budgets Space and habitat-use
Long-term	Reproductive success and productivity Survival or mortality rates Abundance or density Distribution or occupancy rates Species richness Species diversity

As a general guideline, wildlife response measures should reflect the temporal and spatial scales of the human activity of interest, including the type of activity, its daily and seasonal timing, duration, and frequency, especially during initial investigations. The choice of the species or population to study is also critical, because species vary widely in their responses to human activities as do different populations of the same species, which can depend on their previous exposure to the human activity of interest. Assuming the choice of species and populations has been made or was mandated by legislation, the response measure should match the disturbance context, which is defined, in part, by the time scale of the human activity of interest. For most research studies, short-term responses seem most appropriate, whereas for most monitoring studies, long-term responses seem most appropriate. Populations that have long been exposed to a particular human activity may have already responded to the activity or may have become habituated. Because many studies are initiated well after the human activity was established, a conclusion of "no effect" may be misleading because consequential effects may have already occurred.

Planning monitoring studies that include human–wildlife issues

Monitoring studies that include an objective to assess changes in wildlife populations in response to changes in visitor activities will need to quantify human activities carefully. Sampling should be designed to capture the amount, types, and intensity of the human activity as well as how the activity varies spatially and temporally. Carefully quantifying these elements will increase the ability to relate trends in the resource with changes in levels and types of human activity. There are a number of tools for designing studies that can be used to increase the success of a monitoring program while balancing the interrelationships and trade-offs among sampling effort, cost, and the overall ability of the program to detect trends in resources. In general, sampling designs that include elements to reduce sampling variability, such as stratified or cluster sampling, tend to be more efficient than those that do not account for heterogeneity of the response measure across the study area (Thompson 2002). Power analysis can guide some of the more challenging design questions, such as how many samples are necessary to meet study objectives, how large a trend is likely to be detected with a given amount of sampling effort, and what the probability of detecting a particular trend that is considered biologically meaningful might be. Monitoring changes in natural resources requires a detailed statement of goals and a careful choice of parameters to measure. To link monitoring to management, a threshold in the response measure should be identified such that when the threshold is reached.

Assessment of Impact of development Activities on vegetation

Ecologically sustainable development (ESD) involves the effective integration of social, economic and environmental considerations in decision-making processes. Flora species were recorded for each of the vegetation communities surveyed using the random meander method rather than quadrates, to maximize the opportunity of detecting significant or sparsely distributed flora species. Flora unable to be identified during the survey was identified using the online version of the Flora of NSW. Vegetation communities were classified by comparing the floral assemblages to the vegetation mapping. Mapping detailing the approximate extent of vegetation communities were produced at the conclusion of the site visit and by air-photo interpretation.

Vegetation and their Habitats

Given the small area of impact proposed, no detailed fauna surveys were completed within the study area. Rather, a general survey comprising a diurnal bird survey, a reptile survey by turning more than 150 loose rocks, and a survey of fauna habitat was completed by traversing the site and identifying habitat resources that could be used by fauna known from the locality that may use the habitats of the study area. Any fauna species or signs of their past presence such as scats observed opportunistically during the site analysis were recorded. Fauna habitats were classified based on the presence of available resources and their approximate extent mapped.

Flora and vegetation communities

In species richness a total of flora species were recorded during the site analysis including exotic species.

Vegetation Communities

Existing vegetation community mapping for the area shows the study area mapped as Stipa (Austrostipa) scabra – Stipa bigeniculata grass land. The mapping is broad scale in nature and does not discern between areas of native grassland, improved pastures and the like. Live vegetation cover within the site comprises approximately 70% exotic and 30% native species. This vegetation can be classified as non-native due to it comprising grassland with less than 50% live native cover.

Disturbance

The vegetation of study area is in poor condition based on the high ratio of exotic species compared to natives and the overall low numbers of native species present. The presence of exotic pasture species (i.e. barley, phalaris and clover) suggest that the surrounding area has previously been subject to some level of pasture improvement. These and other exotic species have encroached into the study area. Given that the surrounding land use and condition represents an ongoing threat to the condition of the subject land, it is unlikely that natural regeneration of native vegetation would occur. The perimeter and tracks within the site appear to be sprayed with herbicide and, as such, are totally devoid of vegetation. Minor soil erosion is evident in these areas. The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority.

Threatened Flora and Species of Conservation Significance

No threatened flora species of conservation significance or endangered populations were recorded during the site analysis.

Conservation Significance of Vegetation Communities

The vegetation community of the study area comprises an exotic flora content of around 70% cover. This does not warrant any consideration of conservation significance.

Existing Environment of the Study Area

The footprint of the proposed activity is of such small area, that by design alone, direct impacts are minimal. The proposed activity wills however, result in the removal of a small area of modified vegetation that is dominated by exotic flora cover. This section provides the rationale behind establishing the direct impacts of the proposed activity. The study area is considered to provide potential habitat for two threatened reptile fauna. The proposed activity has the potential to result in a number of indirect impacts that may affect species or populations in a manner other than direct loss. Indirect impacts could include the loss of breeding opportunities, further weed invasion and disturbance from construction noise to adjacent habitat. The species is usually found in lightly grazed areas, along roadsides in particular. It appears to be very sensitive to grazing, but responds to disturbance as a colonizer and appears to tolerate mowing. Grows in open bare patches where there is little competition from other species as shown in Fig.1.

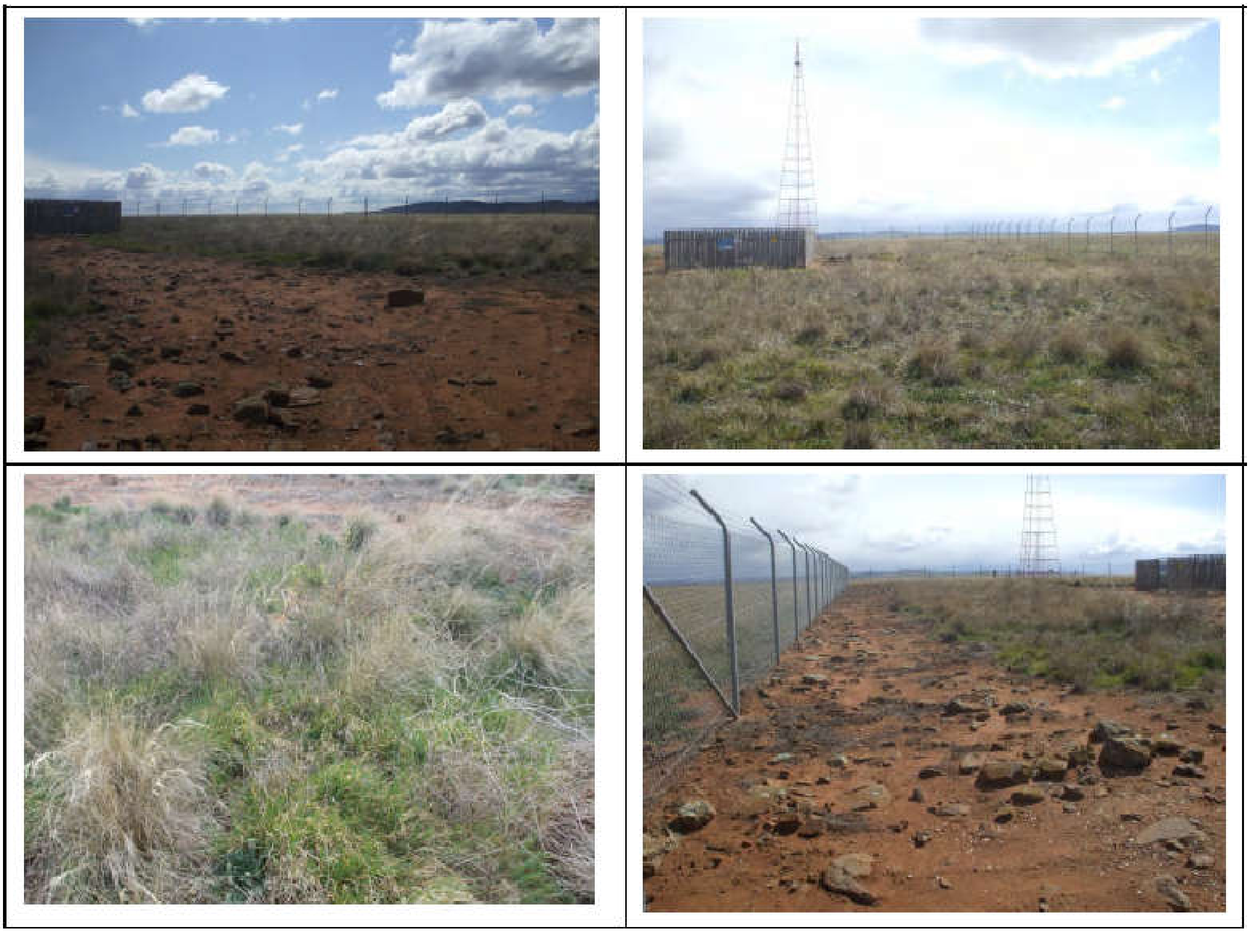


Fig.1: Species grown in unglazed area

When evaluating which threatened species and endangered populations are likely to occur within the study area, the following factors were taken into consideration:

- The presence of potential habitat
- Condition of approximate extent of potential habitat
- Species occurrence within Study Area and wider locality

Consideration of potential habitat then suggests that the species may be presented, either resident or transitory from adjoining habitats. Given the nature of the proposed activity, potential impacts to the species may results from construction associated. The activity including site clearing and excavation. This report provides a series of recommendations aimed at reducing the risk of potential impacts to this species should it occur there. Based on the assessment above, a significant impact is unlikely provided the proposed recommendations with section 6 of this report are fully adopted.

Environmental Audit

An environmental audit is a type of evaluation intended to identify environmental compliance and management system implementation gaps, along with related corrective actions. In this way they perform an analogous (similar) function to financial audits. There are generally two different types of environmental audits: compliance audits and management systems audits. these audits are intended to review the site's/company's legal compliance status in an operational context. Compliance audits generally begin with determining the applicable compliance requirements against which the operations will be assessed. This tends to include federal regulations, state regulations, permits and local ordinances/codes. In some cases, it may also include requirements within legal settlements. These audits may be multimedia or programmatic. Multimedia audits involve identifying and auditing all environmental media (air, water, waste, etc.) that apply to the operation/company. Programmatic audits (which may also be called thematic or media-specific) are limited in scope to pre-identified regulatory areas, such as air. Audits are also focused on operational aspects of a company/site, rather than the contamination status of the real property.

ISO 14001 is voluntary international standard for environmental management systems ("EMS"). ISO 14001:2004 provides the requirements for an EMS and ISO 14004 gives general EMS guidelines. An EMS meeting the requirements of ISO 14001:2004 is a management tool enabling an organization of any size or type to:

1. Identify and control the environmental impact of its activities, products or services;
2. Improve its environmental performance continually, and
3. Implement a systematic approach to setting environmental objectives and targets, to achieving these and to demonstrating that they have been achieved.

Organizations implementing ISO 14001 usually seek to obtain certification by independent Certification Bodies. Certification indicates that the documentation, implementation and effectiveness of the EMS conform to the specific requirements of ISO 14001. This standard is currently being updated to include elements of including a lifecycle perspective and including top management amongst other changes. The draft (DIS) standard ISODIS 14001:2014 is currently the draft standard applicable until the ISO 14001:2015 standard is finalised and published.

Audit tools and technology

The term "protocol" means the checklist used by environmental auditors as the guide for conducting the audit activities. Typically, companies develop their own protocols to meet their specific compliance requirements and management systems. Audit firms frequently develop general protocols that can be applied to a broad range of companies/operations. Current technology supports many versions of computer-based protocols that attempt to simplify the audit process by converting regulatory requirements into questions. Many companies and auditors find these useful and there are several such protocol systems commercially available. Other auditors (typically those with many years of environmental auditing experience) use the regulations/permits directly as protocols. The flow diagram of environmental auditing processes is shown in Fig.1. There are three main types of audit:

1. Pre Audit

2. Audit

3. Post Audit

Fig.2: Environmental auditing processes

There is a long standing debate among environmental audit professionals on the value of large, highly detailed and prescriptive protocols (i.e., that can, in theory, be completed by an auditor with little or no technical experience) versus more flexible protocols that rely on the expertise and knowledge of experienced auditors and source documents (regulations, permits, etc.) directly. However usage of structured and prescriptive protocols in ISO 14001 audits allows easier review by other parties, either internal to the Certification Body (e.g. technical reviewers and certification managers) or external (accreditation bodies). Environmental Site Assessment ("ESA") is generally done in relation to mergers, acquisitions or financing activities. The intent of ESAs is to identify potential sources/existence of property contamination for purposes of clean up costs/liability under US law. ESA's rarely contain a compliance audit component and should not be confused with audits.

Environmental legislation

Environmental legislation is the collection of laws and regulations pertaining to air quality, water quality, the wilderness, endangered wildlife and other environmental factors. The act ensures that matters important to the environment are thoroughly considered in any decisions made by federal agencies. The environmental laws need to consider everything, from the air we breathe to the natural resources we rely on to the plants and animals that share this world with us.

Environmental Legislation Timeline

To preserve air and water quality are not new. These topics, along with many other environmental issues, have been subjected to laws for thousands of years. There's evidence of early law regarding the handling of water and sewage. However, the official timeline of environmental law in the United States did not start until the 20th century. The United States is regarded as a world leader when it comes to development and application of environmental law, and the 1960s are when the process got started. The increase in factories and industrial activities, came a mounting concern about the impact these practices were having on the earth's natural environment. This was also a time when environmentalism

Air quality

Air quality laws govern the emission of air pollutants into the atmosphere. Specialized subsets of air quality laws regulate the quality of air inside buildings. Air quality laws are often designed specifically to protect human health by limiting or eliminating airborne pollutant concentrations. Other initiatives are designed to address broader ecological problems, such as limitations on chemicals that affect the ozone layer, and emissions trading programs to address acid rain or climate change. Regulatory efforts include identifying and categorizing air pollutants, setting limits on acceptable emissions levels, and dictating necessary or appropriate mitigation technologies.

Water quality

Water quality laws govern the release of pollutants into water resources, including surface water, ground water, and stored drinking water. Some water quality laws, such as drinking water regulations, may be designed solely with reference to human health. Many others, including restrictions on the alteration of the chemical, physical, radiological, and biological characteristics of water resources, may also reflect efforts to protect aquatic ecosystems more broadly. Regulatory efforts may include identifying and categorizing water pollutants, dictating acceptable pollutant concentrations in water resources, and limiting pollutant discharges from effluent sources.

Waste management

Waste management laws govern the transport, treatment, storage, and disposal of all manner of waste, including municipal solid waste, hazardous waste, and nuclear waste, among many other types. Waste laws are generally designed to minimize or eliminate the uncontrolled dispersal of waste materials into the environment in a manner that may cause ecological or biological harm, and include laws designed to reduce the generation of waste and promote or mandate waste recycling. Regulatory efforts include identifying and categorizing waste types and mandating transport, treatment, storage, and disposal practices.

Contaminant cleanup

Environmental cleanup laws govern the removal of pollution or contaminants from environmental media such as soil, sediment, surface water, or ground water. Unlike pollution control laws, cleanup laws are designed to respond after-the-fact to environmental contamination, and consequently must often define not only the necessary response actions, but also the parties who may be responsible for undertaking (or paying for) such actions. Regulatory requirements may include rules for emergency response, liability allocation, site assessment, remedial investigation, feasibility studies, remedial action, post-remedial monitoring, and site reuse.

Chemical safety

Chemical safety laws govern the use of chemicals in human activities, particularly man-made chemicals in modern industrial applications. As contrasted with media-oriented environmental laws (e.g., air or water quality laws), chemical control laws seek to manage the (potential) pollutants themselves. Regulatory efforts include banning specific chemical constituents in consumer products and regulating pesticides.

Resource Sustainability in impact assessment

Environmental impact assessment (EA) is the assessment of the environmental consequences (positive negative) of a plan, policy, program, or actual projects prior to the decision to move forward with the proposed action. In this context, the term "environmental impact assessment" (EIA) is usually used when applied to actual projects by individuals or companies and the term "strategic environmental assessment" (SEA) applies to policies, plans and programmed most often proposed by organs of state. It is a tool of environmental management forming a part of project approval and decision-making. Environmental assessments may be governed by rules of administrative procedure regarding public participation and documentation of decision making, and may be subject to judicial review. It including

- Water resources
- Mineral resources
- Forest resources
- Wildlife and plants
- Fish and game

In India, Environmental law is governed by the Environment Protection Act, 1986. This act is enforced by the Central Pollution Control Board and the numerous State Pollution Control Boards. Apart from this, there are also individual legislations specifically enacted for the protection of Water, Air, Wildlife, etc. Such legislations includes

- The Water (Prevention and Control of Pollution) Act, 1974
- The Water (Prevention and Control of Pollution) Cess Act, 1977
- The Forest (Conservation) Act, 1980
- The Air (Prevention and Control of Pollution) Act, 1981

- Air (Prevention and Control of Pollution) (Union Territories) Rules, 1983
- The Biological Diversity Act, 2002 and the Wild Life Protection Act, 1972
- Batteries (Management and Handling) Rules, 2001
- Recycled Plastics, Plastics Manufacture and Usage Rules, 1999
- The National Green Tribunal established under the National Green Tribunal Act of 2010[48] has jurisdiction over all environmental cases dealing with a substantial environmental question and acts covered under the Water (Prevention and Control of Pollution) Act, 1974.
- Water (Prevention and Control of Pollution) Cess Rules, 1978
- Ganga Action Plan, 1986
- The Forest (Conservation) Act, 1980
- Wildlife protection Act, 1972
- The Public Liability Insurance Act, 1991 and the Biological Diversity Act, 2002. The acts covered under Indian Wild Life Protection Act 1972 do not fall within the jurisdiction of the National Green Tribunal.[49] Appeals can be filed in the Hon'ble Supreme Court of India.[50]
- Basel Convention on Control of Transboundary Movements on Hazardous Wastes and Their Disposal, 1989 and Its Protocols
- Hazardous Wastes (Management and Handling) Amendment Rules, 2003

Objectives of environmental audit

The key objectives of environmental audit are environmental management information systems and equipment is performing. Verify compliance with the relevant national, local or other laws and regulations. Minimize human exposure to risks from environmental, health and safety problems. Features of Environmental Audit

1. Management tool
2. Aim of environmental audit
3. EIA
4. Systematic process
5. Documentation
6. Periodic
7. Objective evaluation
8. Environmental performance

Environmental performance audit benefits including

1. Health & Safety Audit
2. Site Audit
3. Activity Audit
4. Process Audit
5. Product Life Cycle audit

Environmental Audit Process

- Collection of data
- Define objectives of audit
- Define scope
- Choose criteria

- Select the team members
- Develop audit plan and protocols
- Address On-site needs Opening conference
- Facility tour • Site/facility inspection
- Evidence
- Records/document review
- Staff interviews
- Initial review of findings
- Closing/exit conference
- Final evaluation of findings
- Drafting of preliminary audit report
- Approval of the management
- Holding of exit conference
- Discussion on recommendations
- Preparation and submission of final report

Contents of EIA report

1. Executive Summary
2. Introduction
3. Objectives
4. Scope
5. Criteria
6. Approach & methodology used
7. Evidences used
8. Findings
9. Conclusion
10. Recommendations
11. Signatures of auditor with date

Types of environmental audits and its advantages

A crucial environmental management tool to evaluate the magnitude of an organization's environmental impacts and extract information about the environmental targets and objectives to lessen the effects is known as **environmental audit**. Relying on standard type and focal point of the audit, there are various types of environmental audits.

Different types of environmental audits

There are three foremost types of audits:

1. Environmental compliance audits
2. Environmental management audits to authenticate if an organization congregates its specified goals.
3. Functional environmental audits for instance, water and electricity.

Environmental audits Objectives

The chief objectives of an environmental audit are:

- Determine the performance level of environmental management information systems and equipment.
- Authenticate compliance with relevant local, national or other rules and regulations.
- Cutback human contact to hazards from environmental, safety and health complications.

Environmental audits Advantages

The advantages, goals and scope of the environmental audit which comprises:

1. Organizations comprehend exactly how to comply with their legal needs
2. Declined and improved environmental impacts and saved energy costs
3. Complying on precise legislative reporting necessities
4. It can help in efforts for sustainable advancement
5. Organizations can display their environmental policy implementation
6. Comprehended environmental contacts of services, products and activities
7. Appropriate management of their environmental hazards
8. ISO 14001 EMS implementation and development understanding

Environmental Audit Protocols

Environmental Audit protocols assist the regulated community in developing programs at individual facilities to evaluate their compliance with environmental requirements under federal law. The protocols are intended solely as guidance in this effort. **The regulated community's legal obligations are determined by the terms of applicable environmental facility-specific permits, as well as underlying statutes and applicable federal, state and local law.** Environmental audit reports are useful to a variety of businesses and industries, local, state and federal government facilities, as well as financial lenders and insurance companies that need to assess environmental performance. The audit protocols are designed for use by persons with various backgrounds, including scientists, engineers, lawyers and business owners or operators. The following protocols provide detailed regulatory checklists and are provided in an easy to understand question format for evaluating compliance.

Steps of an Environmental Audit Management

Step 1: Schedule the Audit

An Environmental Management Representative (EMR) should schedule audits at an appropriate risk-based frequency. Environmental managers can determine how frequently the audit should be performed through consultation with relevant Government Agencies and/or a review of specific project requirements. When scheduling the audit, EMRs should coordinate the timing to minimize disruptions to project operations. They also need to record the audit in each Environmental Management Plan (EMP) using the appropriate template from their Environmental Management Systems (EMS) manual.

Step 2: Plan the Audit

To plan the audit, the EMR needs to establish and document the Area/Contractor to be audited, the reason and scope of the audit, and the contact names for the Area/Contractor. The EMR must also appoint and notify a qualified Lead Auditor or audit members, if required. If warranted, the EMR can appoint his or herself as the Lead Auditor.

Step 3: Conduct the Audit

All relevant personnel in the audit team should meet to discuss the scope of the audit, the proposed audit agenda, the audit objectives, any project personnel that need to be contacted or interviewed, and a tentative time to hold the exit meeting.

Step 4: Develop an Audit Report/Action Plan

The audit team needs to prepare a report based on all the objective evidence that was collected during the audit. This report must be forwarded to the Contractor within 2 days of completion of the audit. The final report must be distributed to the Auditor, Contractor, Independent Reviewer and Environmental Auditor, the State, and all other relevant personnel.

Step 5: Audit Follow-Up

The EMR will follow-up the closing out of any remaining contract items by the Contractor. It can be done separately and can even be done whenever the next relevant audit takes place, depending on how significant the finding is.

Onsite environmental activities

An audit conducted on the premises of a business or other organization. A site audit may involve inspecting records, assets or security procedures. The on-site audit objectives should reflect those of the environmental audit, which are: Verification of legislative and regulatory compliance

1. Assessment of internal policy and procedural conformance
2. Establishment of current practice
3. Status Identification of improvement opportunities

Opening Meeting

Conduct on-site audit Opening Meeting with Office manager and site personnel to

- Introduce audit team members
- Present audit scope and objectives
- Outline the audit approach and methodology
- Address questions or concerns of site personnel
- Rally staff support and assistance

Document Review

- Audit Team member to undertake a review of relevant document such as:
- Management policy Management system documentation
- Operational procedures Records (utility, inventory, monitoring, calibration, training etc.)
- Previous audit reports
- Green management team meeting minutes
- Green suggestion

In particular, to evaluate whether the records are:

- Current
- Properly completed
- Signed and dated
- Consistent
- Meet relevant requirements

Detailed Site Inspection

Conduct detailed site inspections with aid of on-site audit protocols to look for evidence on:

- Compliance with legislative and regulatory requirements
- Conformance with internal policies, procedures and guidelines
- Status of operational practice
- Staff participation in management system implementation

Staff Interview

- To obtain information on Actual practices (current and past)
- Compliance with/or deviation from statutory and departmental requirements
- Awareness of requirements and expectations
- Comments and suggestions

Closing Meeting

The Closing Meeting provides an opportunity at the conclusion of on-site audit to:

- Debrief the senior site management

- Summarise the audit activities and findings
- Highlight system strengths and weaknesses
- Discuss preliminary findings and recommended corrective actions
- Bring up findings requiring immediate attention
- Clarify any outstanding issues
- Address staff questions or concerns
- Agree on reporting schedule and chain of communication

Evaluation of environmental audit data

An environmental audit is a type of evaluation intended to identify environmental compliance and management system implementation gaps, along with related corrective actions. In this way they perform an analogous (similar) function to financial audits. Environmental auditing is essentially an environmental management tool for measuring the effects of certain activities on the environment against set criteria or standards. Depending on the types of standards and the focus of the audit, there are different types of environmental audit. Organizations of all kinds now recognize the importance of environmental matters and accept that their environmental performance will be scrutinized by a wide range of interested parties. Environmental auditing is used to

- Investigate
- Understand
- Identify

These are used to help improve existing human activities, with the aim of reducing the adverse effects of these activities on the environment. An environmental auditor will study an organization's environmental effects in a systematic and documented manner and will produce an environmental audit report. There are many reasons for undertaking an environmental audit, which include issues such as environmental legislation and pressure from customers. Environmental auditing is carried out when a development is already in place, and is used to check on existing practices, assessing the environmental effects of current activities (*ex post*). Environmental auditing therefore provides a 'snap-shot' of looking at what is happening at that point in time in an organization. The International Organization for Standardization (ISO) has produced a series of standards in the field of environmental auditing. These standards are basically intended to guide organizations and auditors on the general principles common to the execution of environmental audits. These are addressed elsewhere in this module. Environmental auditing means different things to different people. Environmental auditing is often used as a generic term covering a variety of management practices used to evaluate a company's environmental performance. Strictly, it refers to checking systems and procedures against standards or regulations, but it is often used to cover the gathering and evaluation of any data with environmental relevance - this should actually be termed an environmental review.

Preparation of environmental report

The audit reports should be clear, timely, concise, and objective; provide a fair summary of all the relevant facts and demonstrate conformity with the related to environmental studies. The scope of an environmental audit can range from an assessment of all environmental aspects of a complex activity (such as large industrial premises) to a focused assessment of a small component of an activity. It includes

- Assess the risk to air quality from a petrochemical complex

- Assess the risk to surface waters and groundwater from a wastewater treatment plant
- Assess whether a landfill cell liner has been constructed in accordance with nominated requirements, thereby minimizing risks to land and groundwater
- Assess compliance of a cattle feedlot with the Victorian Code for Cattle Feedlots or compliance of timber harvesting operations with the Code of Forest Practices for Timber Production
- Identify risks to catchment condition from one or a number of activities

The Environment Protection Authority (EPA or the Authority) will ensure that updates of these guidelines are provided to all environmental auditors. The Authority requires that the proposed works would not be contrary to, or inconsistent with, any applicable policy, likely to cause or contribute to pollution (including unreasonable noise), or likely to cause an environmental hazard. To address these regulatory requirements, an environmental auditor should prepare the application in the form of an environmental audit report regarding the risks caused by the proposed activity that accord with the requirements of section 53V of the Act. Government authorities and agencies may require an environmental audit to be undertaken which involves the assessment of the compliance with, or implementation of, specified codes, policies, strategies or other management or operational guidance. The environmental auditor should work with the client (and consult with the audited if this is a different individual or body from the client) to establish the scope of audit and to ensure that an effective assessment is completed within the context of the nature and scale of the auditee's operation.

Contents of an environmental audit report

Environmental Act states that an environmental audit report must specify the industrial process or activity, waste, substance or noise in respect of which the environmental audit was conducted. State the name of person who has engaged the environmental auditor to conduct the environmental audit (the client). Be signed by the environmental auditor. Specify the results of the environmental audit. The results of an environmental audit report are the findings, conclusions and any recommendations. The process for arriving at these results, and any opinions stated, should be well documented and referenced within the environmental audit report. The report should clearly state the environmental auditor's opinion as to the risks posed by the activity to beneficial uses of segments within the scope of the audit, and provide justification for that opinion.

An environmental auditor must not qualify an audit report to limit reliance on it to the environmental auditor's client (or any other person). Depending on the circumstances, other stakeholders (for example local residents) may also be interested in the outcomes of an environmental audit. Further, the environmental auditor must not disclaim responsibility for the opinion that he or she has expressed (regarding risks posed by the activities to the environment and/or the condition of the premises) on the basis that the environmental auditor has relied on the work of others. It is the role of the environmental auditor to confirm that the data or information on which he or she relies in forming the opinion constitutes an adequate basis for forming that opinion. The environmental audit report may include a section that seeks to provide information to the reader about the uncertainties associated with the environmental auditing process.

Unit-6

Assessment of Impacts of Traffic and Transportation

Introduction

The evaluation of traffic and transportation impacts is closely interrelated to the assessment of land use, social, economic, air quality and noise effects.

Road development can have wide-ranging environmental impacts compared to many other development projects. This is because roads extend over long distances and, by promoting rapid communication, they can catalyze dramatic changes in land- use patterns not only in the immediate vicinity but also in adjacent hinterlands.

Projects or Actions required to be studied for Impacts on Transportation.

The following are examples of types of proposed projects or actions where traffic impacts may become a key issue in the environmental impact assessment:

1. Land-use or comprehensive plans
2. Proposed highway or transit improvements
3. Projects that attract large volumes of traffic such as shopping centers, amusement parks, schools, convention centers, parking structures, or municipal buildings.
4. Major event venues or employment centers
5. Housing developments
6. Changes in bus or parking rates in major urban areas
7. Individual projects that may block or render unsafe pedestrian and bicycle travel or access for the handicapped.

Projects with geographically extensive or long-duration construction periods may also create adverse traffic impacts. In cases where an impact is expected, A maintenance of traffic plan should be prepared by the project designers. The maintenance of traffic plan will describe staged construction activities, detour routes, signing, and other measures to lessen the impact on traffic during construction.

For projects requiring construction-related or permanent truck or heavy equipment access, haul routes should be identified in advance. Mitigation measures, such as, dust control, air quality control, or excise control through limiting hours of operation should be identified and assessed for successful mitigation of impacts to acceptable levels.

Development projects or other activities frequently have impacts on local and regional traffic patterns and transportation systems. The conceptual approach depicted in Figure.8.A.1 can be applied.

Step I Identification of Potential Traffic And Transportation - System Impacts

The first step is to determine the potential impacts of the proposed project on local traffic and/or the transportation system in the ROI. Examples of the key transportation impacts which might occur, include. I. increases or decreases in local-area or regional traffic situations, 2.temporal changes in local-area or regional traffic situations (daily. weekly, monthly, and/or seasonally),

3. construction phase disruptions of existing local-area or regional traffic patterns, and

4.increases or decreases in commuting times and congestion in the local area and/or region.

Quantitative information should be aggregated on expected local and regional traffic change (increases and decreases) which might occur as a result of the construction and/or operation of the proposed project. Particular attention should be given to the timing (daily, weekly, monthly, and/or seasonally) of the expected changes. It is anticipated that the project proponent (or contracted proponent) would have such information. or. if no stich data exists, this information could be developed during discussions with the project proponent.

Step.2 Documentation of Baseline Traffic Information

Certain basic information on the traffic and the transportation system in the vicinity of a proposed project or activity is necessary for describing the affected environment or baseline conditions. Key information includes the following: (I) the type of transportation network and its use; (2) the type and purpose of traffic using the network; and (3) the character of traffic flow for example. periods of maximum and minimum use. This information can be assembled for the majority of cases by,

1.Procuring from the appropriate governmental engineering staff the necessary maps showing the locations of all paved and unpaved roads in the study area. In addition. traffic count information, if available, should be procured from the appropriate governmental engineering staff and local, regional, or national transportation agencies. 2. Making site visits to the study area and collecting ad hoc data on traffic counts for pertinent roads, streets, and highways; such counts should be focused on the peak and minimum periods of usage of the network. The information necessary to accomplish step 2 is assumed to be readily available or easily obtainable.

Step.3 Procurement of Pertinent Standards or Criteria

Traffic Analysis

Vehicular traffic on streets and highways can be assessed by using various standard traffic analysis procedures. Most projects expected to produce traffic impacts will, at the least, require a description of existing, and perhaps historic, traffic volumes. Flow characteristics will change in the future both with and without implementation of the proposed project or action. In other words the analysis should discuss in equal level of detail the future traffic characteristics of all proposed alternatives including the no-built alternative, which will be used as the baseline for comparison with the proposed build alternatives.

Volumes and Levels of Service

Traffic volume data is normally available from the state department of transportation, local planning agencies, or regional metropolitan planning organizations. Raw data is gathered by actually counting traffic volumes throughout the hours of a day at a particular point of a street or highway. Traffic volumes are normally repotted as average daily traffic (ADT) and morning and evening peak-hour traffic. Certain physical characteristics of streets and highways dictate a calculated traffic capacity for that particular facility. Examples of the features entering into the capacity analysis include the lane width, number of lanes, shoulder width, grade (slopes of hills), radii of curves, type of access permitted, and distance between ramps of traffic signals. The type of access permitted can be divided into several categories. There are three basic types of access: 1. **Free access:** at-grade intersections, adjacent joining driveways, and left or right turns possible.

2. **Controlled access:** streets or highways with medians that only permit crossing at designated places, and only right turns on to or off the street permitted except in designated areas.

3. **Limited access:** the freeway, expressway, or turnpike facility where crossings of other highways and streets are grade-separated and access is limited to free-flow interchanges.

An at-grade intersection is the typical stop sign or signal light at ground level. A grade separated crossing occurs where the crossing street is carried over or under the expressway via a structure (bridge). A free-flow interchange provides ramps onto and off a freeway or expressway without requiring the vehicle to stop at the freeway or expressway. Common interchange designs include the diamond and cloverleaf, but there are many varieties, each with specific advantages and disadvantages retarding traffic flow and capacity.

Capacity can be determined for the mainline of the expressway or street and for intersections and interchanges. Capacity analyses for intersections and interchanges are more complicated because characteristics, such as, the number of left-turn lanes, timing of signal red and green cycles, and timing of nearby signals must be factored into the analysis.

Level of service (LOS) is a qualitative measure to describe the flow or operational characteristics of traffic, as perceived by the level of congestion or delay experienced by the motorist .The level of service is a result of the transportation facility's capacity, or ability to accommodate the volume of traffic on the facility. Also, the LOS can be affected by the characteristics of the traffic itself .such as, the percentage of trucks in the total traffic. The levels of service are as follows:

LOS A represents a free flow of traffic. Individual users are unaffected by others and have the freedom to select desired speeds and to maneuver within the traffic stream.

LOS B is in the range of stable flow, but the presence of other users begins to be noticeable. Freedom of speed is unaffected, but there is a slight decline in freedom to maneuver.

LOS C is in the range of stable flow, but marks the beginning of the range where individual users become significantly affected by interactions with others. hindering selection of speed and maneuverability. The general level of comfort and convenience declines noticeably at this level

LOS D represents high-density but stable flow. Speed and freedom to maneuver are severely restricted, and the driver experiences a generally poor level of comfort and convenience. Small increases in traffic volumes will generally cause operational problems at this level.

LOS E represents operating conditions at or near capacity. Speeds are reduced to a low but relatively uniform level, and maneuvering is extremely difficult. Comfort and convenience levels are extremely poor, and driver frustration is generally high. Operations at this level are usually unstable because small volume increases or minor fluctuations will cause breakdowns.

LOS F represents forced or breakdown flows, and these flows exist when the amount of traffic approaching a point exceeds the amount which can traverse the point. Queues form behind such locations. and the extremely unstable operations are characterized by stop-and go waves.

Level of service is governed by traffic density, measured in passenger cars per mile. per lane. The density is converted to passenger cars per hour, per lane using the average speed of the traffic stream. Generally, levels of service A,B, and C are considered good operating conditions with only minor delays. LOS D represents fair to below-average operating conditions. but is sometimes acceptable in urban areas. Levels of service E and F represent extremely congested conditions. Level of service for traffic analysis of signalized intersections is defined in terms of delay. LOS criteria are stated in terms of the average stopped delay per vehicle for a 15 minute analysis period.

summarizes information on a six- category "Level of service" (LOS) delineation used by the U.S. Transportation Research Board. The LOS for a highway,for example, is a qualitative measure of the effect of a number of factors, including speed and travel time. traffic interruptions. freedom to maneuver. safety. driving comfort and convenience .

level of service

The level of service concept

The definition of "level of service" is "a qualitative measure of the effect of a number of factors, which include speed and travel time, traffic interruptions, freedom to maneuver, safety, driving comfort and convenience, and operating costs." It goes on to indicate that "in practice selected specific levels are defined in terms of particular limiting values for certain of these factors" Service level A through F represent the best through the worst operating conditions.

Level of service A represents virtually free-flow conditions, in which the speed of individual vehicles is controlled only by the driver's desire and by prevailing conditions, not by the presence of interference of other vehicles. Ability to maneuver within the traffic stream is unrestricted.

Level of service B, C and D represent increasing levels of flow rate with correspondingly more interference from other vehicles in the traffic stream. Average running speed of the stream remains relatively constant through a portion of this range, but the ability of individual drivers to freely select their speed becomes increasingly restricted as the level of service worsens (goes from B to C to D). Level of service E is representative of operation at or near capacity conditions. Few gaps in traffic are available. The ability to maneuver within the traffic stream is severely limited, and speeds are low (in the range of 30 millions). Operations at this level are unstable, and a minor disruption may cause rapid deterioration of flow to the level of service F. **Level of service F represents forced or breakdown flow.** At this level, stop-and-go patterns and waves have already been set up in the traffic stream, and operations at a given point may vary widely from minute to minute, as also operations in short, adjacent highway segments, as congestion waves propagate through the traffic stream. Operations at this level are highly ustable and unpredictable.

Source: (6). and operating costs. If impacts on local or regional highways are anticipated, it would be appropriate to determine the LOS classifications for the highways in the study area. In addition to the LOS system, local roads and streets in the study area may have been classified by local or regional traffic or transportation authorities, or even by the engineering section of a military installation. The delineation of these classifications would also be appropriate in step 3.

Steps 4 and 5: Prediction of Traffic and Transportation - System Impacts and Assessment of Impact Significance

Step 4 requires the consideration of the changes in terms of increase or decrease or timing in the baseline traffic conditions in the ROJ as a result of the construction and operational phases of the proposed project. The basic mathematical relationship for this step is as follows:

Percentage change in baseline conditions =

Percentage changes can be calculated for each pertinent local or regional road or highway and for each project or activity phase. For example, assume a local road has a baseline average daily traffic (ADT) of 1,000 vehicles, with the peak-hour traffic being 250 vehicles. Further assume that the project-construction phase of 6 mo will add 200 (vehicles) to the ADT, with 150 being associated with the peak hour. The project operational phase will add 75 to the ADT, and none of these vehicles will be associated with the peak hour. The percentage changes are calculated below.

Forecasts

Future traffic volumes can be predicted in a variety of ways. Regardless of the method used, it is extremely important to the environmental analyst that the exact assumptions and methodologies be documented. There should be a review and an agreement by local and state traffic specialists that the applied approach is acceptable and reliable. Results of traffic studies are subsequently used in the analysis of land-use, neighborhood, air quality, and noise impacts. If there is a justified question concerning the development of forecast future traffic volumes, conclusions in these other areas of impact analysis also are in doubt. Methods for forecasting future traffic volumes have become significant issues of controversy in a good many projects.

A relatively simple method sometimes used to predict traffic volumes involves reviewing historic data on traffic growth rates for a particular transportation facility or area and then predicting the future growth rates. The predicted future growth rates may depend on predicted employment or population growth contained within a regional or local comprehensive plan. The future growth rates are then applied to existing traffic volumes to arrive at future volumes for the target year of analysis.

More detailed methods can include the systematic division of an area into sectors or zones and then application of population and employment growth predictions to each sector. Travel origin and destination studies can be done for existing traffic through questionnaires and surveys, and future conditions can be estimated. Predictions are then made to the number of trips originating in a particular zone and traveling to another zone. Computer models are used for the complicated data input required. For individual site analysis, estimates of potential generated traffic can be made by gathering information on the number of future employees, expected number of shoppers at retail centers, number of potential attendees at major sporting events and so on so that total traffic volumes in future years may be predicted. For the evaluation of comprehensive and land-use plans, the permitted density and dispersion of various land- uses will determine the generated traffic and should yield estimates of rates of growth.

Construction Phase

Percent change in ADT = =20%

Percent change in peak hour = =60%

Operational Phase

Percent change in ADT = (100) = 7.5%

Percent change in peak hour = =0%

Since the basic output for step 4 is the percentage change in information in relation to baseline traffic conditions, the next step is focused on how to interpret this percentage change in information (step 5). No transportation criteria or standards provide a delineation of appropriate interpretation method; however, the absolute changes and the LOS should be given consideration.

Burchell, has described a five- component traffic-impact-analysis methodology for development projects. The components are (I) introduction, (2) analysis of existing conditions, (3) traffic characteristics of the development site, (4) future demands on the transportation network, and (5) impact analysis and mitigation recommendations.

The introduction of the traffic-impact analysis should contain a complete project description, including the proposed land use (or uses), the extent of the development, proposed-site-access points, and phasing plans (7).

The next component, the analysis of existing conditions, should address the current volume of traffic using the roadways and the LOS provided to current traffic. Consideration should be given to specific analysis periods, such as, existing peak-traffic times and the times of peak traffic generated by the development project. Recent traffic counts should be procured from agencies covered. New traffic counts should be taken to fill in those critical locations without acceptable historical counts. New roadway counts are taken with an "automatic traffic recorder" (ATR) for a one-week period (including the weekend). The data is tabulated on hourly bases (by direction of travel) with a 24hr volume, or "average daily traffic" (ADT) shown for each roadway in the study area (7). In addition to ADT, turning-movement counts at key intersections may need to be taken and monitored.

Results

Predicted future traffic volumes are applied to the future transportation network, which may or may not be changed over existing street and highway characteristics in view of the type of project being assessed. Normally future traffic volumes are given in average daily traffic (ADT) and AM and PM peak hourly volumes for comparison with existing volumes. For each proposed alternative, including the no-build alternative, future volumes should be presented in either tabular or graphical form. Often a line drawing of the street network is used to represent traffic data with volumes shown at particular locations.

The level of service can be calculated by applying future volumes to the transportation network. Traffic impacts of each proposed build alternative can be compared to those of the no-build alternative. The difference will be the impact of the individual project or action.

For example, a particular arterial street operates at LOS C. Future traffic volumes are expected to grow, and with the future year (say, 10 years from the present) no-build alternative, the street is projected to operate at LOS D. The proposed project being assessed is a major employer, with thousands of new jobs located on this particular stretch of street. When the projected employee traffic is added to the total forecast peak-hour traffic volumes, the street will operate at LOS E, indicating a severe traffic congestion impact caused by the proposed project.

Caution is required in interpreting the above example results as generated traffic. The actual impact is generated traffic on that particular piece of street, leading to increased 380 Environmental Impact Assessment Methodologies congestion during peak hours. It could be described as a change in traffic patterns. Or perhaps ~ particular project will "generate" traditional traffic in a particular town. At the regional level, however, there is debate often over whether a major employer, or a roadway improvement, or other types of traffic impact projects actually generate a net increase in traffic, or just redistribute existing traffic into different patterns throughout the region.

The next aspect of the analysis of existing conditions is to determine the capacities and LOS within the study area. "Capacity" is defined as the maximum number of vehicles that can be expected to travel over a given section of roadway. or a specific lane, during a given time- period under the prevailing roadway and traffic conditions (6. 8). Details on information can then be integrated; for example, Table 1 summarizes average capacity of a two lane road expressed as maximum ADT

Table 1 Capacity of two-line row.

Terrain	C	D	E
Level	7,900	13,500	22,900
Rolling	5,200	8,00	14,800
Mountains	2,400	3,700	8,100

volumes for three levels of service.

Source: (7): Assumes' Peak hour traffic = 10%; 60:40 split; 14% trucks; 4% recreational vehicles; 25 percent no passing (level terrain); 40% no passing (rolling terrain); 60% no passing (mountainous terrain).

Addressing the traffic characteristics of the development site, the third component in the methodology involves developing answers for two questions (7): (I) How much traffic will the proposed site produce? (i.e.• what is the trip distributions?) and (2) which roadways will use site-generated traffic? (i.e., what is the trip distribution?) .

For aggregating the trip generation information there are three approaches, namely, (1) the use of local rates, (2) the use of estimates based on the type and characteristics of the project or activity and (3) the use of national rates.

After the site-generated (project-or activity-induced) traffic is estimated, the next activity is to determine the directional distribution of the traffic. For small sites, it is reasonable to assume that the traffic will arrive and depart in a manner similar to the existing travel patterns. Calculations for large sites often require the formation of a detailed distribution model combining elements of population, employment, travel times, highway network characteristics, and competing uses (7).

The three most typically used methods for estimating trip distribution are based on the use of (I) the existing data, (2) the origin - destination data and (3) a trip - distribution model. The first two methods are self-explanatory. A "trip distribution model" (referred to as a "gravity model") assumes that the number of trips between two zones is proportional to the size of the zones and inversely propol1ional to the square of the distance between the two zones

. Determination of future demands on the transportation network is the fourth component in the traffic-impact-analysis methodology. A "horizon year"' must be determined for each phase of proposed development as well as the subsequent completion, or "buildout" year. The determination of future volumes without the site development (or project or activity) is calculated through the use of (1) growth rates (or trends), (2) the buildup method and (3) the area-transportation plan. The growth-rate method is the simplest to use, and so is most often utilized for relatively small developments or for developments with a buildout for no more than five years into the future. Growth rates (or trends) are determined from historical traffic counts maintained by the appropriate traffic or transportation agencies. In the absence of specific historical traffic counts, growth rates are often indexed to area population growth. For each phase of the development (including final buildout), the existing base volumes are factored upwards by the appropriate growth rate to determine future without-site traffic columns.

The "buildup" method is most appropriately used in an area experiencing moderate to rapid growth. The buildup method combines elements of the growth-rate method with a detailed analysis of approved and anticipated developments within the study area. For each horizon year, the existing volumes are increased by the applicable growth rate .Furthermore, the trip-generation and distribution characteristics of approved and anticipated development. Estimated and added to the area transportation plan unusually project traffic volumes on major streets 20 years into the future (this is analogous to the without-project condition). If the proposed development is on one of these roadways, future volumes may be interpolated to the horizon years.

The next activity involves assigning the site- generated traffic to the study-area roadway and intersections that is, with-project conditions. Finally, for each analysis period being studied, totals for future nonsite and site-related traffic volumes are calculated for the study area. Separate graphics and tabulations of the various components of total future traffic are useful in illustrating site-related changes.

The final component in the methodology constitutes the actual impact analysis and the development of appropriate mitigation recommendations. This component should focus on the LOS with and without the site development. The first activity involves a calculation of the future without project LOS for the analysis periods and horizon years described earlier. After this calculation, a comparison is made of the results with the "acceptable standard"' of the community. For those developments not expected to meet the extant community standard, a determination of recommended improvements necessary to achieve the desired LOS should be developed.

The second activity involves the calculation of the future LOS with the development-site traffic. The results should once again be compared with the community standard and with the results of the future-project analysis to identify changes in the LOS caused by the development and additional improvements that may be required. As an alternative to additional capacity improvements, demand-reduction startegies (mitigation measures) may need to be seriously considered. Examples of these strategies include utilization or development of public transportation, car pools, and van pools; implementation of modified work schedules (flextime or staggered working hours); and parking limitations.

Secondary and Cumulative Impacts

As with many other types of impacts, traffic congestion impacts can cause secondary effects, such as, the following: -Increased noise and air pollution -Adverse visual effects - Delays in emergency vehicle services -Loss of patronage to restaurants or retail establishments due to inconvenience of access -Increase in motorist accidents and decrease in pedestrian safety -Reduction of ability of an area to keep major businesses or to attract new business -Changes in travel patterns of through traffic into the neighborhood as motorists attempt to avoid congested portions of major streets. -Inconsistency with goals and objectives of local land-use or comprehensive plans. It is important to carefully review the results of traffic studies so as to rectify the possible secondary impacts.

Step 6 : Identification and Incorporation of Traffic and Transportation -System Impact Mitigation Measures

Numerous mitigation measures can be employed to offset traffic and transportation impacts. The range of possible mitigation techniques can extend from a regional level to very specific design characteristics of a particular proposed project or action.

"Mitigation measures" in this context are steps that can be taken to minimize the magnitude of the increases in traffic in the RIO. The key approach is either to reduce the traffic or to change the timing of the traffic anticipated '0 be emitted from the project (or activity). Mitigation measures (I) the use of car or van pooling or buses from residential areas for travel to and from military installations, (2) scheduling construction-equipment movement during nonpeak periods in the local area and (3) scheduling troop movements related to training exercises during nonpeak traffic.

Mass Transportation Systems

Proposed new mass transit systems or bus service, or changes in existing systems, can have effects on vehicular traffic patterns on roadways. Traffic impacts may occur at major transit stations or at park-and-ride lots. If trips are transferred from individual vehicles on the roadway network to trains or buses, the system will work more efficiently and effectively. Proposed projects should be evaluated for design features to encourage mass transit use, such as, location near transit stations, or special incentives for employees who carpool.

Changes in parking policies or rates, bus schedules or fares, and train schedules or fares also can cause transportation-related impacts. Particularly in urban areas, a portion of the population will be transit-dependent. Raising fares can sometimes unfairly impact special social population groups, such as the elderly, the low-income and the handicapped. Changes in schedules and fares could cause adverse accessibility effects for transit-dependent employees in addition to affecting medical facilities, shopping and visiting trips.

Pedestrian and Bicycle Travel

All projects should be assessed for possible adverse impacts on pedestrian bicycle access and safety. Local and regional land-use and comprehensive plans should include information on existing designated pedestrian trails or walkways and on bicycle routes. A review of the potential area of impact of the proposed project or action can be conducted to identify major routes for nonmotorized traffic.

Traffic Congestion

A direct means to reduce traffic congestion is to increase capacity on the highways or streets operating at poor levels of service, as adding lanes to the roadway. Ramp meters can be installed to control the timing of the flow on to limited-access highways. Synchronization of signals can improve flow on arterial streets, and intersection operation can be improved with specific traffic control measures, such as left turn lanes or signal cycle timing.

Traffic congestion can also be reduced by changing the characteristics of the traffic. The includes staggered work hours at major employers, incentives for carpools or use of mass transit, or provision of high-occupancy vehicle (HOY) lanes on ramps and lanes of major expressways (for' use of only cars with two or three passengers and/or buses). Message systems that warn motorists of congested areas to avoid and a program for rapid emergency service for broken-down vehicles also assist in mitigating congestion on major routes. Transportation management techniques can be applied at a local level or within a large region.

Environmental Impacts of Highway/Road Development ProjectsDirections

(a) Physical resources

(i) Water hydrology: Highway/Road (H/R) projects that cross waterways can have significant impacts on both the surface water and groundwater hydrology. For example, without the provision of adequate drainage a road can act as a dike separating waters in a stream or swamp, and can possibly lead to increased flood water levels. A change in water hydrology may affect surface water quality as well. Sediment transport, water quantity including alternations in the water, water logging of wells, change in infiltration rates and present stream hydrographies should be described.

(ii) **Surface water quality :** Water quality can be affected during construction and operation of the road. Examples of the former are pollution from runoff and sanitary wastes from construction. Pollution can occur during H/R operation through accidents or spills of transported materials. The effects of pollution on the water's beneficial uses such as community, industrial and agricultural, should be described and evaluated.

(iii) Air quality: There are two main sources of emissions during construction namely, mobile sources and fixed sources. Mobile sources are vehicles involved in construction activities. Fixed-source emissions include non-mobile construction equipment like compressors, and demolition/ excavation/grading activities which produce dust. During the operation phase, air quality is affected primarily by vehicular exhaust; those pollutants of primary concern include suspended particulate matters No, CO, x hydrocarbons and lead Expressways can significantly alter air pollution distribution patterns, resulting in polluted "air tunnels". The existing and expected air pollution patterns along the H/R route should be described according to daily average and maximum conditions. Special attention should be given to "sensitive" areas such as hospitals and adjacent residences.

(iv)Soils: Soils are mainly affected through cut-and-fill operations and soil erosion. Inadequate protection of cut and fill areas (for example, with vegetation), inadequate culvert capacity for streams and poor drainage from the road can result in serious erosion problems. This in turn can damage the road, lead to flooding problems and degrade water resources. The type and origin of soil materials to be used in cut-and-fill operations should be described and the amount of soil involved estimated. The amount of erosion expected, its impacts on resource values and erosion control methods during and after construction should be discussed considered in detail.

(v) Roadways in mountainous terrain: The construction of roadways in mountainous terrain presents special problems concerning the physical environment. Highly unstable geological conditions are worsened by roadway construction on steep slopes. Landslides can destroy sections of newly-completed roadways. Conversely, roadways require reshaping of land both up and down-slope; consequently erosion potential is increased. Both surface-water hydrology and geotechnical factors should be addressed as critical issues governing the construction of roadways in mountainous regions.

(b) Ecological resource

(i) Fisheries: Fisheries specifically, and water ecology generally, can be affected by: (a) erosion during both construction and operation of H/R projects; (b) runoff from highways containing petroleum drippage and spilled materials; (c) spills of toxic and hazardous material; and (d) alterations of water hydrology. Increased accessibility may lead to depletion of listing fisheries. Aquatic ecology and conditions of other aquatic fauna/flora, and the anticipated effects of H/R construction and operation on their items should be described.

(ii) Forestry: The effects of H/R projects on forestry are primarily caused by (a) site clearance for the road-bed and right-of-way; and (b) improved accessibility leading to encroachment by people. Encroachment may involve villagers searching for farmland or firewood, businessmen in fields such as logging and mining, and illegal operators (especially loggers), and so on. The forest composition, the types and number of trees to be cut down during construction, the estimated loss of forest productivity and the estimated impacts of this loss on sub-national and national levels, should be described.

(iii) Wildlife: Wildlife will be .affected in a manner similar to forestry, that is, through habitat loss and encroachment (mainly hunting). The wildlife species likely to be affected by the project should be listed, and those species that are of sub-national/national/international significance should be identified. For significant species, habitat requirements and their behavioral characteristics should be described besides showing the effects of the H/R project on these parameters. If possible, there should be an assessment of the intrinsic value of the wildlife resources in the overall national resource context to determine whether alternative routing can be given to preserving wildlife travel routes, especially for such susceptible species as arboreal animals and deep-forest birds

(c) Human use values

(i) **Navigation**: H/R projects have beneficial effects on navigation by allowing access to navigable waters. Adverse effects could include blocking traditional navigation routes, that might occur when a road bisects a large swamp. The effects of the project on inland/marine navigation and any compensatory measures should be described.

(ii) **Flood control**: Road development can adversely affect flood control existing flood patterns, and flood control systems. The project's effects on these parameters and possible measures to mitigate adverse effects, should all be described.

(iii) Land- use: Land- use patterns can be vertically altered by the effects of H/R projects mainly owing to improved accessibility. For example, forest details may be converted for agricultural use and agricultural areas utilized for industry. The following are the project's effects on the existing land transport patterns:

- Existing agricultural conditions including types and amounts of crops, irrigation practices and marketing practices;

- The types, production capacities, raw materials and markets of industries to be affected by the project, as well as the potentials of new types of industries to be attracted by the H/R projects;

- The types and locations of existing mineral development operations and the projects expected effects, including potentials for new operations.

For all land- use types, the H/R project's effects on environmental and socioeconomic conditions and methods for offsetting any adverse effects should be detailed.

Landscape is a subjective concept that cannot be precisely quantified. It includes a large number of parameters. A study of the relief, vegetation, buildings, hydrograph (water courses), and land division system makes it possible to identify several different landscape units on the site. Each unit is defined as a part of the territory with its own special characteristics (relief, forms of land use, vegetation, buildings, color, etc.) which can be perceived by the eye and enjoyed by the senses. Land-scape units are homogeneous parts of the land-scape which can be defined by such criteria as coherence, readability, hierarchy, harmony, and stability. **Coherence**: A landscape is coherent if its various components (e.g., relief. vegetation, buildings) **harmonize** - if they are aesthetically in keeping with one another. This is a strong feature of truly vernacular land-scapes. Contemporary structures, on the other hand, rarely attempt to relate to their natural setting.

Readability: A landscape is readable if it is easy for the observer to comprehend.

Hierarchy: A landscape with hierarchy is one with a predominant feature.

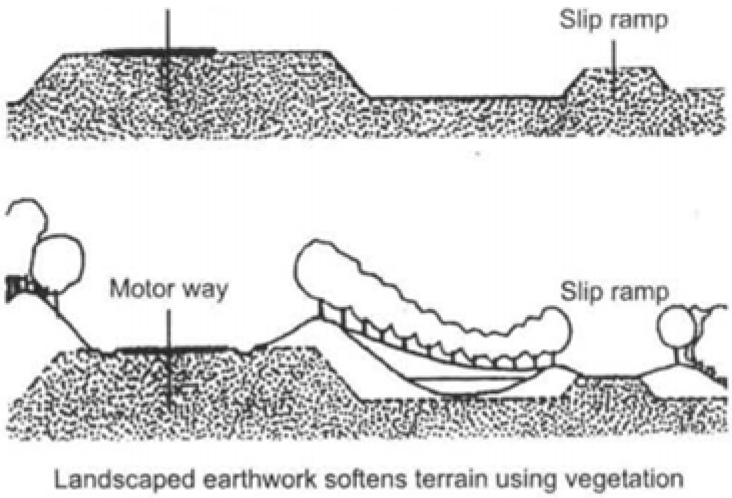


Fig 2 Using vegetation to improve harmony between a road and terrain.
Source : Handbook on impacts of Transportation and Highways published by World Bank.

Harmony: A landscape exhibits harmony if there is a relationship in terms of mass and scale between the various components making up the landscape. It aims for maximum overall coherence compatible with the widest possible diversity Fig. 11.1)

Stability: A stable landscape is one which. although dynamic, retains the same characteristics and qualities through time and space.

Landscape analysis must consider the overall route, and integrate sections which have been studied separately, in order to avoid creating a project which appears splintered and lacking in cohesion.

Remedial Measures

Prevention:

It is not possible to prevent the presence of a road from affecting the surrounding landscape. Even maintenance and rehabilitation works can change the appearance of a road, for example through the use of vegetation and shaping of the roadside.

Mitigation:

The regional landscape design principles should provide guidance in resolving major issues relating to alignment, landscaping maintenance, and the provision of user services.

Alignment: Vertical and horizontal alignment should follow the natural relief as closely as possible within technical constraints such as slopes and radius of curvature.

Curves can accentuates views, while ensuring adequate safety for passing. Coming into close proximity

Slopes on either side of the road can be varied to match the site's natural topography.

Bridges, viaducts, and tunnels can be used across steep terrain rather than high cuts and embankments.

To preserve the landscape's visual and physical continuity. Computer landscape illustration may help. The road agency to visualize the completed road project within the landscape.

Views from the road can be revealed, composed, or reinforced by road layout and design but should also take road speed into account

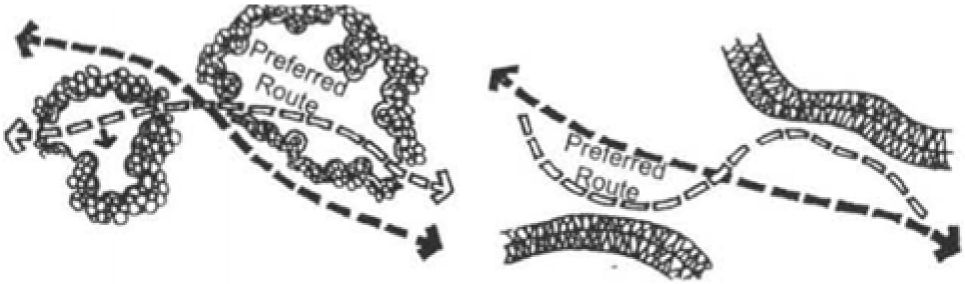


Fig 3) Making the most of landscape features.
Source : Handbook on impacts of Transportation and Highways published by World Bank.

Landscaped earthwork softens terrain using vegetation

Landscaping proposed for the route should

Fit in with local vegetation (trees, shrubs, avenue trees, hedges);

Make use of vegetation to harmonize with or improve the existing landscape;

Be representative of the road's category and function;

Take advantage of natural openings in the existing vegetation;

Frame and underscore the various landscape units crossed;

Suit and underscore the various engineering structures:

Ensure user safety by using the landscape to signal changes in the route, for example, by decreasing the space between avenue trees before entering a curve or village; and

Maintenance

Maintenance of roadside vegetation, slopes, and structures can greatly affect visual appearance and can be enhanced by involving maintenance workers in the planning and management of the roadside environment.

Plant indigenous wildflowers and grasses for a low maintenance (" no mow") roadside.

Avoiding the use of too many different types of noise barriers;

Establishing regulations or fines for littering; and

Regulating billboard and storefront advertising along roads, especially at the entrance to cities or towns, to prevent unsightly proliferation and protect road user safety.

User Services

User services made available to motorists along the roadway can help avoid concerns such as littering or vehicles making indiscriminate stops along the roadway. They also contribute to road safety by allowing drivers to rest or check vehicles and loads during a trip.

General Guidelines for Preparation of TORs for EIA

Some Management Considerations

Transportation projects can have very disruptive effects on forests and wildlife as described in the earlier sections of this report. Careful attention must be paid to site planning so that these disruptive effects are minimized to the extent possible'.

Consideration should be given to the use of enhancement and protection measures funded by the project to offset unavoidable degradation. Enhancement and projection measures may include (a) establishing forest reserves to minimize the effects of encroachment; (b) fencing off and/or policing roads and (c) promoting new rural occupations so that villagers will have economic incentives to protect the forest. An example of the last case is a rural development project in Thailand that increases village income and enhances forest protection by promoting nature tours (5) A similar step can be taken with swamp lands; a further alternative is to use engineering techniques to create a new swamp to replace the old. Whenever special enhancement or protective measures are to be recommended for funding by the project, they should be clearly justified in terms of economics and resource conservation, including projections of the forest/wildlife/swamp status with and without the recommended measures.

I. The feasibility study for the project, to be done by the Project Consultant engaged by the Government, should include an EIA (FS/EIA)

2. The FS/EIA should include, inter alia, study of each of the environment effect found by the Banks lEE to be of significant importance.

3. For each of these items, the consultant will conduct a study, as a part of the overall EIA, sufficient:

(a) To make an assessment, which delineates the significant environmental effects of the project.

(b) To describe and quantify the effects.

(c) To describe feasible mitigation measures for minimizing, eliminating, or offsetting adverse effects and.

(d) To recommend the most appropriate mitigation and/or enhancement measures.

4. The selected significant environmental impacts (SEls) to be studied, as a part of the overall EIA, are the following:

(a) Environmental problems for the major H & R rehabilitation projects.

(i) Does review of experience with existing project indicate any significant environmental projection problems? If so, list and grade them.

(ii) Construction stage (new project)

1. Hazards of silt run-off during construction

2. Hazards of continuing silt run-off from areas not properly resurfaced

3. Other construction hazards (Annex III/I), and

4. Provision of appropriate construction monitoring

(iii) Post- construction operations monitoring

(b) Environmental problems for the major new highway projects

(i) Encroachment on precious ecology

(ii) Encroachment on historical/cultural/monument/areas

(iii) Impairment of fisheries/aquatic ecology and of other beneficial uses

(iv Erosion and siltation

(v) Environmental aesthetics

(vi Noise and vibrations

(vii) Air pollution hazards

(viii) Highway run-off pollution

(ix) Highway spills of hazardous materials

(x) Construction stage problems

1. Erosion and silt run-off

2. Other construction hazards

3. Monitoring

(i) Post-construction monitoring

(ii) Environmental problems for rural roads

(iii) Encroachment into precious ecology

(iv)Encroachment into historical/cultural values

(v) Impairment of fisheries on other beneficial water uses

(vi)Erosion and silt runoff

(vii) Dust nuisances

(viii) Construction stage problem

(ix) Post - construction monitoring