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# The specific methods use for identifying environmental effects and impacts

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## Abstract

*The paper aims to improve practice of environmental impact assessment (EIA) by providing information about how EIAs are, and should be, carried out. This paper focuses on assessment method used in the part of EIA process concerned with analyzing a development's impacts of environmental components.*

## 1. Introduction

Environmental Impact Assessment (EIA) is a systematic process to identify, predict and evaluate the environmental effects of proposed actions in order to aid decision making regarding the significant environmental consequences of projects, developments and programmers.

An environmental impact assessment is an assessment of the possible impact—positive or negative—that a proposed project may have on the environment, together consisting of the natural, social and economic aspects.

The term EIA is also used broadly to include a whole range of social and economic impacts. Social impact assessment (SIA) and economic analysis are seen as being quite distinct from an EIA in the organizations involved, professional skills used, and methodological approaches. No matter how the terms are used, it is important to recognize that impacts on ecosystems, and biogeochemical cycles, are intimately related through complex feedback mechanisms to social impacts and economic considerations. The social impacts of any project that involves environmental changes should be studied in close association with studies of biosphere impacts.

EIA should be applied:

- to all proposals likely to cause potentially significant adverse impacts or add to actual or potentially foreseeable cumulative effects;
- so that the scope of review is consistent with the size of the proposal and commensurate with the likely issues and impacts;
- to provide timely and appropriate opportunities for public and stakeholder involvement, with particular attention given to indigenous peoples and other vulnerable minorities whose cultural traditions and way of life may be at risk;
- in accordance with the legislation, procedure and guidance in force and with reference to international standards of EIA good practice.

EIA should be undertaken:

- throughout the project cycle, beginning as early as possible in the pre-feasibility stage;
- with explicit reference to the requirements for decision-making and project approval and authorization consistent with the application of 'best practicable' science and mitigation techniques;
- in accordance with proposal-specific terms of reference, which should include clearly defined tasks, responsibilities, requirements for information and agreed timelines for their completion;
- to gain the inputs and views of all those affected by or interested in the proposal and/or its environmental impacts.

EIA should address, as necessary and appropriate:

- all relevant environmental impacts, including land use, social, cultural, economic, health and safety effects;
- cumulative effects and area-wide, ecosystem-level and global changes that may occur as a result of the interaction of the proposal with other past, current or foreseeable activities;
- alternatives to the proposal, including design, location, demand and activity alternatives;

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- mitigation measures for each of the main impacts identified;
- sustainability considerations, including the effects of depletion of non-renewable resources, of exceeding the regenerative and assimilative capacity of renewable resources and of reduction of biological diversity, taking account of relevant international agreements and commitments.

EIA should result in:

- systematic identification of the views and inputs of those consulted, including the balance of opinion on major issues and areas of agreement and disagreement;
- comparison of the impacts of the main alternatives considered with an environmental justification for the preferred option;
- best estimate prediction and evaluation of the potentially significant residual effects that cannot be mitigated;
- feasible, cost-effective measures to mitigate the main impacts identified (often called an environmental management plan);
- preparation of an EIA report that presents this information in form that is clear, understandable and relevant for decision-making, noting any important qualifications for the predictions made and mitigation measures proposed;
- resolution of problems and conflicts during the EIA process to the extent this is possible.

EIA should provide the basis for:

- informed decision-making and project approvals, in which the terms and conditions are clearly specified and implemented;
- design of environmentally sound and acceptable projects that meet health and environmental standards and resource management objectives;
- appropriate follow-up, including monitoring, management and auditing, to check for unforeseen impacts or mitigation measures that do not work as intended;
- future improvements in EIA process and practice, drawing on the information from follow up activities.

## 2. Problem identification

When a project or a program is undertaken, it sets in motion a chain of events that modifies the state of the environment and its quality. For example, a major highway construction changes the physical landscape, which may, in turn, affect the habitat of some species, thus modifying the entire biological system in that area. The same highway affects land values, recreational habits, work-residence locations, and the regional economy. These various factors are interrelated, so that the net result is difficult to predict.

One of the problems for the environmental impact assessor, as indicated schematically in Fig. 1, is to identify the various components of environmental change, due to the interacting influences of man and nature. It also implies no value judgment of whether environmental change is good or bad. However, at some stage in the assessment or the decision-making process, such a judgment must be made.

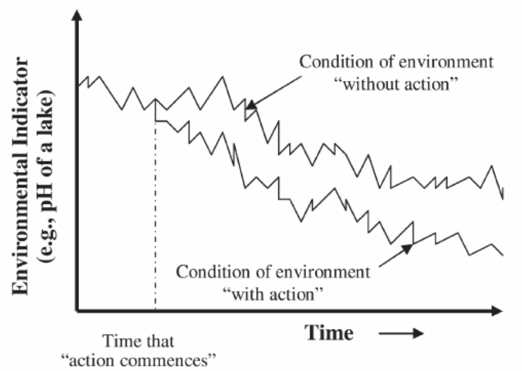


Fig. 1. Conceptual framework for assessing environmental changes

## 3. Impact indicators

An impact indicator is an element or parameter that provides a measure of the significance of the effect (in other words of the magnitude of an environmental impact). Some indicators, such as mortality statistics, have associated numerical scales. Other impact indicators can only be ranked on simple scales such as good-better-best or acceptable-unacceptable.

The selection of a set of indicators is often a crucial step in the impact assessment process, requiring an input from the decision-maker. In the absence of relevant goals or policies, the assessor may suggest some indicators and scales, but he should not proceed with the assessment until his proposals are accepted.

The most widely used impact indicators are those such as air and water quality standards that have statutory authority. These standards integrate in some sense the worth that a jurisdiction places on clean air and clear water. The numerical values have been derived from examination of the available toxicological data relating pollutant dosages to health and vegetation effects, combined with a consideration of best practical technology. Admittedly the evidence is sometimes incomplete and controversial, but the assessor should accept the derived standards. The impact assessment process is not the appropriate forum for debates on the validity of numerical values. A possible exception occurs when, in the absence of national standards, a local decision maker or an overseas engineering firm decides to employ standards borrowed from another jurisdiction. Toxicological evidence based on temperate-zone studies cannot always be confidently extrapolated to the tropics or to the arctic.

After the impact indicators and their scales are selected, their values must be estimated from the predicted values of the environmental effects for each project alternative and for several time-scales.

## 4. Impact estimation

In some defined way, the description of the environment must be collapsed to the behavior of a few variables, which must then be related to the impact indicators.

An objective, although not always achievable, is that for each of the proposed actions and for each of the human concerns, the expected outcomes can be compared on numerical scales. The original measurement units for the impact indicators will normally be quite different: some may be numerical, while others are in the form of a series of classes. At this point in the analysis, therefore, the environmental impact assessor should convert the scale into a comparable set using some system of normalization. In the most primitive system, each indicator is rated as being significant-positive, insignificant, or significant-negative; the numbers of positive and of negative counts are then compared. Because some human concerns are frequently more important than others, however, a series of weights may be assigned to the concerns.

Having estimated the environmental impacts of the proposed action, the assessor next needs to make recommendations. The wisdom of these recommendations depends greatly on the extent to which there is discussion spanning many disciplines among the assessor's staff and advisors. This group of people should include scientists, engineers, sociologists, and economists, each of whom feels a personal commitment and sense of excitement.

## 5. Methods of Impact Identification, Prediction and Significance of Impacts

There are three principal methods for identifying environmental effects and impacts

### 5.1. Checklists for Impact Identification

Checklists are comprehensive lists of environmental effects and impact indicators designed to stimulate the analyst to think broadly about possible consequences of contemplated actions. This strength can also be a weakness, however, because it may lead the analyst to ignore factors that are not on the lists. Checklists are found in one form or another in nearly all EIA methods.

The checklist is designed for users who wish to review the quality of EIS (that is, the environmental information provided by developers) to check their adequacy for decision making and consultation.

Two sets of instructions for using the checklist are provided.

- Firstly for users wishing to review a single EIS to determine whether the information is adequate for decision making and consultation and if not, what more information is needed.

- Secondly for users wishing to review several EIS and grade them for comparative research or monitoring purposes.

Both methods use the same checklist. It is organized in seven sections:

- Description of the project
- Alternatives
- Description of the environment likely to be affected by the project
- Description of the likely significant effects of the project
- Description of Mitigating Measures
- Non Technical Summary
- Quality of presentation

### 5.2. Matrices for Impact Identification

There are several types of matrices used in Impact Identification in EIA. The simple matrix refers to a display of project actions or activities along one axis, with appropriate environmental factors listed along the other axis of the matrix. When a given action or activity is anticipated to cause a change in an environmental factor, this is noted at the intersection point in the matrix and can be further described in terms of magnitude and important considerations. Many variations of the interaction matrix have been utilized in EIA.

| | | Pre-construction | | | Construction | | | | | | | | | | | | | Operation | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Project Activity / Resources | Land acquisition | Delineation | Survey | Site Clearance | Workforce Camp | Water Source | River Training | Excavation | Embankment | Disilting Basin | Pump House | Intake | Access road | Culverts | Canal | | Water Sharing | Water users Group | Maintenance | |
| Physical | Climate | | | | | | | | | | | | | | | | | | | | |
| | Hydrology | | | | | | | | | | | | | | | | | | | | |
| | Water Quality/Water Source | | | | | | | | | | | | | | | | | | | | |
| | Geology/Soil | | | | | | | | | | | | | | | | | | | | |
| | Topography | | | | | | | | | | | | | | | | | | | | |
| | Air and Noise | | | | | | | | | | | | | | | | | | | | |
| Biological | Forest | | | | | | | | | | | | | | | | | | | | |
| | Wildlife | | | | | | | | | | | | | | | | | | | | |
| | Aquatic Life | | | | | | | | | | | | | | | | | | | | |
| | Biodiversity | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| Socio-economic | Education | | | | | | | | | | | | | | | | | | | | |
| | Economy | | | | | | | | | | | | | | | | | | | | |
| | Gardener Issues | | | | | | | | | | | | | | | | | | | | |
| | Institutions | | | | | | | | | | | | | | | | | | | | |
| | Culture | | | | | | | | | | | | | | | | | | | | |
| | Population | | | | | | | | | | | | | | | | | | | | |
| | Health | | | | | | | | | | | | | | | | | | | | |
| | Land use | | | | | | | | | | | | | | | | | | | | |

Fig. 2. Interaction matrix used in EIA

The assessment matrix involves testing specific elements of a project proposal (i.e. design, sitting, construction, operations) against a series of environmental indicators.

The matrix has indictors in the columns and elements of the project proposal in the rows. Each cell of the matrix is given a rating criteria based on the level of impact of each element of the proposal on the corresponding environmental indicator. The rating criteria is determined by the the person undertaking the assessment and is visually represented by a symbol/color in the cell. Further comments can be added to the assessment matrix providing suggestions for alternatives or mitigation proposals.

**5.2.1. Leopold matrix.** This method was developed by Leopold et al. (1971), and it has been used for the identification of impacts. It involves the use of a matrix with 100 specified actions and 88 environmental items. In constructing the matrix, each action and its potentiality for creating an impact on each environmental item must be considered. Where an impact is anticipated, the matrix is marked with a diagonal line in the interaction box. The second step in using the Leopold Matrix is to describe the interaction in terms of its magnitude (M) in the upper section and importance (I) in the lower section of each box.

The magnitude of an interaction or impact is represented by numerical scale; it is described by the assignment of a numerical value from one to ten. The value, ten represents the largest magnitude and the value, one represents the lowest magnitude, whereas values near five represent impacts of intermediate magnitude. Assignment of a numerical value for the magnitude of an interaction is related to the extent of any change (for example, if noise levels in a village were expected to increase by 20 dB(A), this is a large increase at night and may score 8 or even 9). The scale of importance also ranges from one to ten. The higher the value, the higher the importance; the lower the value, the lower the importance. Assignment of a numerical value for importance is based on the subjective judgment of the multi-disciplinary team working on the EIA. Plus (+) or minus (-) can be used to show whether an impact is beneficial or adverse.

| Priority Value | Propose Action / Resources | Immigration of Labour | Dam Construction | Transmission line | Reservoir Filling | Heavy Metal Discharge | Growth of Aquatic Weeds | Relocation of Inhabitants | Total: Leopold Method | Total: Lohani & Thanh |
|---|---|---|---|---|---|---|---|---|---|---|
| 10 | Health | 5 / 8 | 4 / 6 | | 5 / 8 | 4 / 7 | 6 / 6 | | 24 / 35 | 1680 |
| 8 | Biodiversity | | 3 / 4 | | 3 / 6 | 3 / 7 | 5 / 5 | | 14 / 22 | 608 |
| 7 | Archaological Artifacts | 4 / 6 | | | 8 / 8 | | | | 12 / 14 | 616 |
| 6 | Tourism | | | 7 / 6 | 7 / 6 | | | | 14 / 12 | 504 |
| 5 | Downstream Water Pollution | | 7 / 7 | | 7 / 8 | 2 / 4 | | | 16 / 19 | 565 |
| 4 | Social and Economic Aspects | | | | | | | 8 / 7 | 8 / 7 | 224 |
| 3 | Forestry | | 4 / 2 | | | | | | 4 / 2 | 24 |
| 9 | Fishery | | 2 / 5 | | | 2 / 5 | | | 4 / 10 | 180 |
| 1 | Navigation | | | | 6 / 5 | | | | 6 / 5 | 30 |
| 2 | Aquatic Plants | | | | 6 / 6 | | | | 6 / 6 | 30 |
| | Leopold Method | 9 / 14 | 20 / 24 | 7 / 6 | 42 / 47 | 11 / 23 | 11 / 11 | 8 / 7 | | |
| | Lohani & Thanh | 64 | 103 | 42 | 286 | 67 | 61 | 56 | | |

Fig. 3. Leopold-type assessment matrix

**5.2.2. Modified Graded Matrix (MGM)** Lohani and Thanh used another grading system in which relative weights are assigned to each development activity. If the relative priority of development activity is determined, the total value of a particular activity is the sum of the vertical column represented by that in the matrix, multiplied by the priority value. Finally, the total value of all the interactions is the sum of all horizontal values in the matrix. This method is particularly helpful in identifying major activities and in defining areas where attention is mostly needed in the process of analysis.

**5.2.3. Impact Summary Matrix (ISM)** An impact summary matrix can clearly identify the potential impact areas, predict the impact severity, specify the corresponding mitigation measures, and help in identification of agencies responsible for implementing mitigation measures. This kind of matrix is simple, covers all the aspects, and provides a complete overview of EIA in summary form. Additionally, it provides an easy guide for decision-makers.

### 5.3. Flow diagrams

Flow diagrams are sometimes used to identify action effect- impact relationships. The flow diagram permits the analyst to visualize the connection between action and impact. The method is best suited to single-project assessments, and is not recommended for large regional actions. In the latter case, the display may sometimes become so extensive that it will be of little practical value, particularly when several action alternatives must be examined.

## 9. Conclusion

Pollution and pollution control is one of the major problems in developing countries. The rapid assessment procedures provide a method for developing pollution inventories and recommending pollution control strategies.

Most methods are best used during the impact identification stage of EIA. To be effective they must be used with other tools or rely expert judgment.

Checklists and matrices are good tools for organizing and presenting the large amount of information that must be processed in EIAs. Matrices also help to represent the interactions between project activities and environmental components. Sectorial guidelines help bring collective experience with environmental impacts of specific project types to bear during initial assessments.

Network diagrams are one of the best ways of representing these causal chains. These networks help in visualizing and understanding the basic relationships between environmental components that may trigger higher order impacts.

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