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WORKSHOP

ENVIRONMENTAL IMPACT ASSESSMENT
USING GIS AND MCE

LECTURE NOTES

ENVIRONMENTAL IMPACT ASSESSMENT

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1. INTRODUCTION

Why Environmental Impact Assessment?

> '*It is necessary to understand the links between Environment and development in order to make Development choices that will be economically efficient, socially equitable and responsible, and ecologically sound*

Adapted from Agenda for Change, a plain language version (Palewas, 1994)

Natural resource development involves human intervention and manipulation of the environment to achieve some desired goal. This is a process as old as mankind itself. However, the scale and complexity in resource development (e.g. large dams, industrial plants, infrastructure projects) in which environmental problems manifest themselves has, since the late sixties, increased from local to global and has resulted in collective (public and governmental) awareness and action.
The concept of Environmental Impact Assessment (EIA) evolved in this period as a result of a fundamental change in the way of thinking about environment and development. Attempts were made to replace the economic growth approach by the concept of sustainable development "that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland Report 1987, in: Palewas, 1994).
One of the basic premises for sustainable development is the recognition that environment and development are not mutually exclusive but complementary and interdependent and actually, in the long run, mutually reinforcing (Ahmad and Sammy, 1985).
In defining sustainable development and environmental quality, the scale at which decisions have to be taken is important as well.

In environmental policy various options or a combination of these are considered:

- Insurance of environmentally sound growth;
- Abatement of environmental pollution;
- Prevention of environmental deterioration;
- Prediction of consequences of changes in life style;
- Emphasis of environmental considerations in decision making;
- Alleviation or mitigation of harmful environmental effects.

The increased awareness of the need for sustainable development has also broadened the range of issues that need to be examined in the assessment of the potential impacts of proposed projects and programmes. Not only the purely economic effects of development activities, but also the biophysical and socio-cultural impacts should be incorporated in the decision making process.
An increase of environmental research followed, through which a large amount of information was made available to support environmental decision-making. Due to an often-limited knowledge of the environment, of the complexities in the cause-effect chains and long response times, this information is often incomplete, uncertain and difficult to handle. This has created a need for more effective decision support techniques (Janssen, 1992).
One of the (legal) tools to support effective decision-making regarding proposed development activities is ***Environmental Impact Assessment (EIA)***.

2. WHAT IS ENVIRONMENTAL IMPACT ASSESSMENT?

Although at present the term Environmental Impact Assessment is widely used, there is no clear, concise definition of EIA (Ahmad and Sammy, 1985; Pawelas, 1994).
EIA is an evaluation procedure that helps planners and decision-makers to understand the environmental impacts of a proposed project or activity. Definition of EIA depends also on the role of EIA in the decision-making process. Palewas (1994, pg. 15) refers to several descriptions of EIA given by a number of authorities. Wood (1995, pg.1) quotes the formal description of EIA by the UK Department of the Environment:

'EIA is essentially a technique for drawing together, in a systematic way, expert qualitative assessment of a project's environmental effects, and presenting the results in a way which enables the importance of the predicted effects, and the scope for modifying or mitigating them, to be evaluated by the relevant decision-making body before a decision is given. Environmental assessment techniques can help both developers and public authorities with environmental responsibilities to identify likely effects at an early stage, and thus to improve the quality of both project planning and decision-making'.

EIA is used according to two principal functions (Kennedy, 1988; in: Wathern, 1992):

- as ***a planning tool*** to minimise adverse impacts caused by a development activity; emphasis is on the methodologies and techniques for identifying, predicting and evaluating the environmental impacts of a proposed project or programme. Increasingly, EIA is also being viewed as a key mechanism for involving the public in the planning process through stakeholder analysis.
- as ***a decision-making instrument*** to decide upon the acceptability of a project based on its environmental costs.

In principal, EIA should lead to the abandonment of environmentally unacceptable actions and to the mitigation to the point of acceptability of the environmental effects of proposals, which are approved. In most of the Western countries EIA is fully incorporated in the decision-making process.
Practical experience from Thailand and the Philippines, the two countries with the longest EIA experience in Asia, show that out of several thousands of impact statements processed during the past decade, ***not a single project*** was denied clearance due to environmental reasons. In other words, those countries use EIA as a planning tool. The consequence of this state of affairs is obvious: it is not the impact evaluation but the environmental management that should be the heart of the EIA process. *EIA is not a procedure for preventing actions with significant environmental impacts from being implemented. Rather the intention is that actions are authorised in the full knowledge of their environmental consequences* (Wood, 1995).
If used properly, EIA can help to achieve the following benefits:

- Avoiding mistakes that can be expensive and damaging in ecological, social and economic terms
- Avoiding conflicts and increasing project acceptance
- Integrating short-term needs with long-term goals
- Addressing transboundary issues
- Improving project design and reducing capital and operating costs
- Improving institutional co-ordination
- Considering alternative projects and designs
- Improving accountability and transparency in planning and decision-making.

2.1. Environmental impacts and effects

Human activities lead to changes in the environment alongside the natural changes inherent in the functioning of the environmental system (Palewas, 1994). A change may in turn affect human beings and their use of the environment. Man-induced changes in environmental conditions may have positive or negative consequences, which are called impacts or effects. ***The terms 'impacts' and 'effects' are used synonymously***, although some authors differentiate between effects (changes in the environment) and impacts (the consequences of these changes) (ERL, 1981; Munn, 1979). No matter how the words are defined, an environmental impact implies a human-oriented judgement of environmental changes and the consequences of these changes. An impact can be described in terms of its magnitude and significance, terms to be dealt with more in detail in section 7.1.2.

2.2. Environmental Impact Assessment (EIA) and Environmental Impact Statement (EIS)

The terms EIA and EIS are often used interchangeably by several authors, while they do not represent the same thing (Ahmad & Sammy, 1985).
Both terms originate from the U.S. NEPA (National Environmental Policy Act) and the Council on Environmental Quality (CEQ) regulations following it. In this context EIA is a brief examination conducted to determine whether or not a project requires an EIS. The CEQ has established a set of guidelines, which identify those projects for which a full environmental study would be required. If the project is found to be exempted by the guidelines, a statement of negative findings is filed. If not, work on the full environmental study proceeds and the findings are reported in an EIS. Thus, EIS represents the fundamental activity, while EIA is simply an introduction to it. This procedure is specific for the USA. In most of the world the interpretation of EIA and EIS is far different.
In the Netherlands, EIA is known as MER (Milieu Effect Rapportage) and in Canada and the United Kingdom as Environmental Assessment. The EIS (EIA report) becomes an environmental statement in Britain, a 'milieu effect report' (mer) in the Netherlands, and an environmental impact report in California and New Zealand. The Commonwealth of Australia has both an EIA and a public environment report.

Generally, EIA is used to include the technical aspects of the environmental study, including data gathering, prediction of impacts, comparison of alternatives and the framing of recommendations. EIS (if the term is used at all) refers to the document containing a comprehensive description of the environmental impact to be expected from a specific project or plan. In contrast to the US definitions, EIA is in this context the technical activity, for which the EIS is a necessary reporting device.

Note: Other relevant definitions and descriptions related to EIA can be found in the ***glossary***.

3. HISTORY OF ENVIRONMENTAL IMPACT ASSESSMENT

Environmental Impact Assessment (EIA) originates from the National Environmental Policy Act (NEPA) prepared in the United States in 1969 and signed into law by the President in 1970. It was the first legislation for EIA, requiring analysis of the environmental impacts of major federal actions significantly affecting the environment. NEPA has two major parts, one outlining the National Environmental Policy and the other establishing the Council on Environmental Quality (CEQ).

Australia, Canada, New Zealand, Colombia, Thailand, France, Ireland and West Germany soon introduced EIA provisions as part of their planning process.
In September 1987 the Dutch parliament in the Netherlands approved EIA legislation as part of the Environmental Protection (General Provisions) Act and EIA became operational and compulsory for specific activities.
Several international agencies have incorporated EIA in their development programmes. In 1974 the Organisation for Economic Corporation and Development (OECD) recommended that member governments adopt EIA procedures and methods, and more recently, that they use EIA in the process of granting aid to developing countries (Wood, 1995, pg.4).
In 1988 the European Commission (EC) introduced a set of guidelines on EIA, urging member countries to incorporate these guidelines in their national legislation. At present many of the EC countries are independently implementing or considering various EIA procedures, generally modified after the original American Model.
The United Nations Environment Programme (UNEP) has also made recommendations to member stated regarding the establishment of EIA procedures and has adopted goals and principles for EIA.
The World Bank introduced in 1989 its operational directive on environmental assessment and in 1992 the Asian Development Bank (ADB) published its World Development Report in advance of the UN Conference on Environment and Development in Rio de Janeiro. The operational directive mandates an EA for all projects that might have a significant negative impact on the environment, so that problems can be tackled early in the project phase (Gilpin, 1995).
A more detailed description of other agencies involved in EIA can be found in Palewas (1994) and Gilpin (1995).

The environmental and natural resources problems of developing countries are by now also the object of global concern. Especially since the UN Conference of the Human Environment in Stockholm in 1972, governments of many developing countries have recognised the importance of environmental management. A serious problem, however, is the inability of government institutions to implement environmental policies, such as EIA.
The required legislation and setting up of appropriate institutions were initiated mainly during the second half of the 1970's and in the 1980's. Of recent, many countries have made EIA an integral component of the project planning process.
The external support of organisations as UNEP, USAID, WHO and OECD was crucial in the promotion of EIA in the less developed countries (Palewas, 1994). Among the activities promoting EIA were: advice and financial support for collection of baseline information and preparation of the EIS, environmental monitoring programmes, EIA training for government officials, scientists and representatives of social groups, and assistance at institutional development of EIA procedures.

4. THE ACTORS IN THE EIA PROCESS

Several stakeholders are involved in the EIA process and this may vary depending on the institutional framework and the role of EIA in planning and decision-making (Palewas, 1994, pg. 17). The following parties are involved in the EIA process in the Netherlands (Scholten, In: Biswas, 1992; Ministry of VROM, 1995):

- **Proponent (or Initiator, developer)**: a private enterprise or governmental agency intends to undertake a project and therefore wants a decision on its proposed activity. The proponent must prepare the EIS. The proponent can be the same as the competent authority deciding on the project.

- **Competent authority (or decision-maker, authoriser)**: the relevant government agency deciding on the proposed project and responsible for a correct EIA procedure. This authority can be at the national or at the local level, depending on the decision required. In case of multiple decisions, there can be multiple competent authorities, one of which may be appointed as co-ordinating the procedures. The competent authority draws up the guidelines, which information the EIS (mer) should contain, and reviews the finished statement on the basis of the legal requirements and the guidelines.

- **Advisors** may advise the competent authority about the way and the conditions concerning the implementation of the activity. Pursuant to the EIA regulation a number of legal advisors was appointed:

  ⇒ The Regional Inspector for Environmental Protection of the Ministry of the Environment (VROM)
  ⇒ The Principal Director for Agriculture, Nature and Outdoor Recreation of the Ministry of Agriculture,
  Nature Management and Fisheries (LNV). Depending on the proposed project other advisors may be
  called in, such as representatives of surrounding municipalities.

- **Commission for EIA**: an independent commission of experts on the various activities subject to EIA. For every project, the Commission appoints a working group advising the competent authority on the guidelines for the EIS. After the proponent has delivered the EIS, the Commission reviews its contents on its scientific quality (correctness), completeness and relevance of the presented information for the decision that has to be made (quality). In countries where there is no independent commission on EIA, it is usually the competent authority that reviews the assessment, or the reviewing/advising function may be given to regulatory agencies and the public.

- **The public**: every person or organisation, legal or private, may give their opinion on the guidelines and the EIS. The public can present its views and comments both in written form and orally during public hearings.

- **Study group/team (impact assessors, consultants)**; is carrying out the actual environmental impact study and preparing a report of the assessment for the decision-makers. They are also called the EIA professionals, the people working in specialised technical and environmental research units of governmental or private agencies.

5. ENVIRONMENTAL IMPACT ASSESSMENT PROCESS

EIA is carried out in support of decision making about activities, which may have negative impacts on the environment. Depending on the role of EIA in the decision making process, national EIA procedures may vary from country to country. However, the EIA procedures used by different countries and agencies follow a more or less similar pattern as the original EIA process from NEPA. A general framework of the EIA process is schematically represented in Figure 5.1 and is build up of a series of iterative steps (After Wood, 1995):

- consideration of alternative means of achieving objectives
- designing the selected proposal (proposed activity)
- determining whether an EIA is necessary (screening)
- deciding on the topics to be covered in the EIA (scoping)
- preparing the EIA report (i.e., among other things, describing the proposal and the environment affected by it and assessing the magnitude and significance of the impacts)
- reviewing the EIA report on its adequacy
- making a decision on the proposal, using the EIA report and the opinions expressed about it
- monitoring the impacts of the proposed activity if it is implemented.

As indicated in Figure 5.1, the EIA process is cyclical. The results of the impact assessment at the scoping stage or later may require the proponent to return to the design stage to increase the mitigation of impacts. Consultation and public participation should be important inputs at each stage of the EIA, as well as the mitigation of environmental impacts.

5.1. EIA process in the Netherlands

In the Netherlands, EIA is carried out according to a legal and structured procedure, which is fully incorporated in the decision-making process. The Act on EIA prescribes a number of steps and most of these steps are bound to time limits, which are set to avoid unnecessary delays due to the application of EIA. The time limits apply to the competent authority, the Commission for EIA and the public. The proponent is exempted from time limits and may determine its own time schedule (Scholten, in: Biswas, 1992).
The administrative and procedural steps in EIA are shown in Figure 5.2 and Table 5.1.

Wood (1995), in comparing seven different EIA systems, noted the Dutch system to be the strongest European EIA system, emphasising particularly the following features:

- The EIA process is integrated into existing decision making procedures.
- The EIA process is not confined to projects
- There are statutory requirements related to the treatment of alternatives, to scoping (including the preparation of project-specific guidelines), to the review of EIA reports and to the monitoring of the impacts of implemented projects.
- Provisions for public participation are made both at the scoping and at the EIA report review stage, and there is a third party right for appeal against decisions.
- The Dutch EIA Commission plays a central and very influential role in the EIA process generally and at the scoping and EIA review stages in particular.

Figure 5.1 Environmental Impact Assessment process (Source: Wood, 1995, pg. 6)

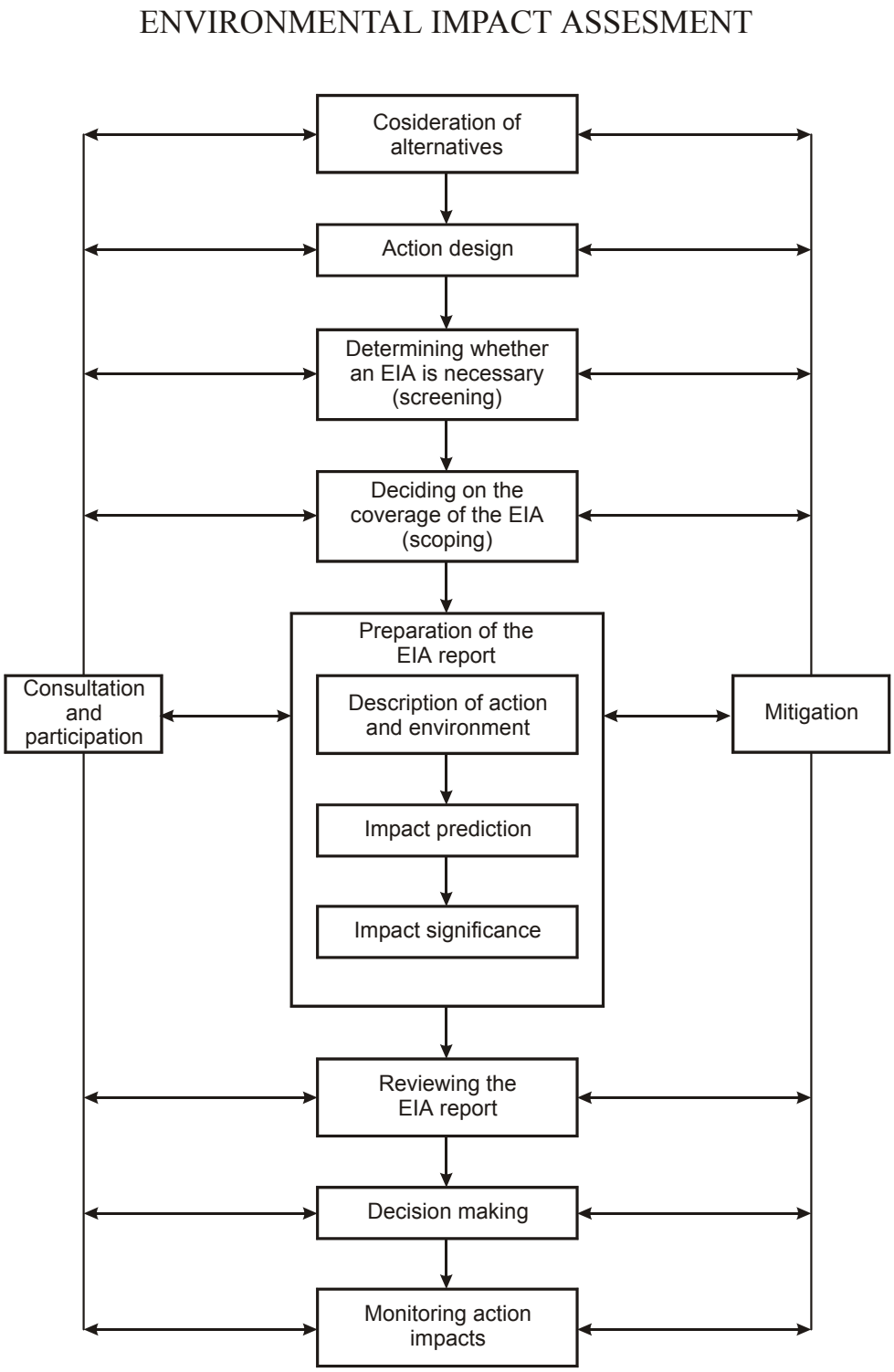


Figure 5.2 Main steps in The Netherlands EIA process (Source: Wood, 1995)

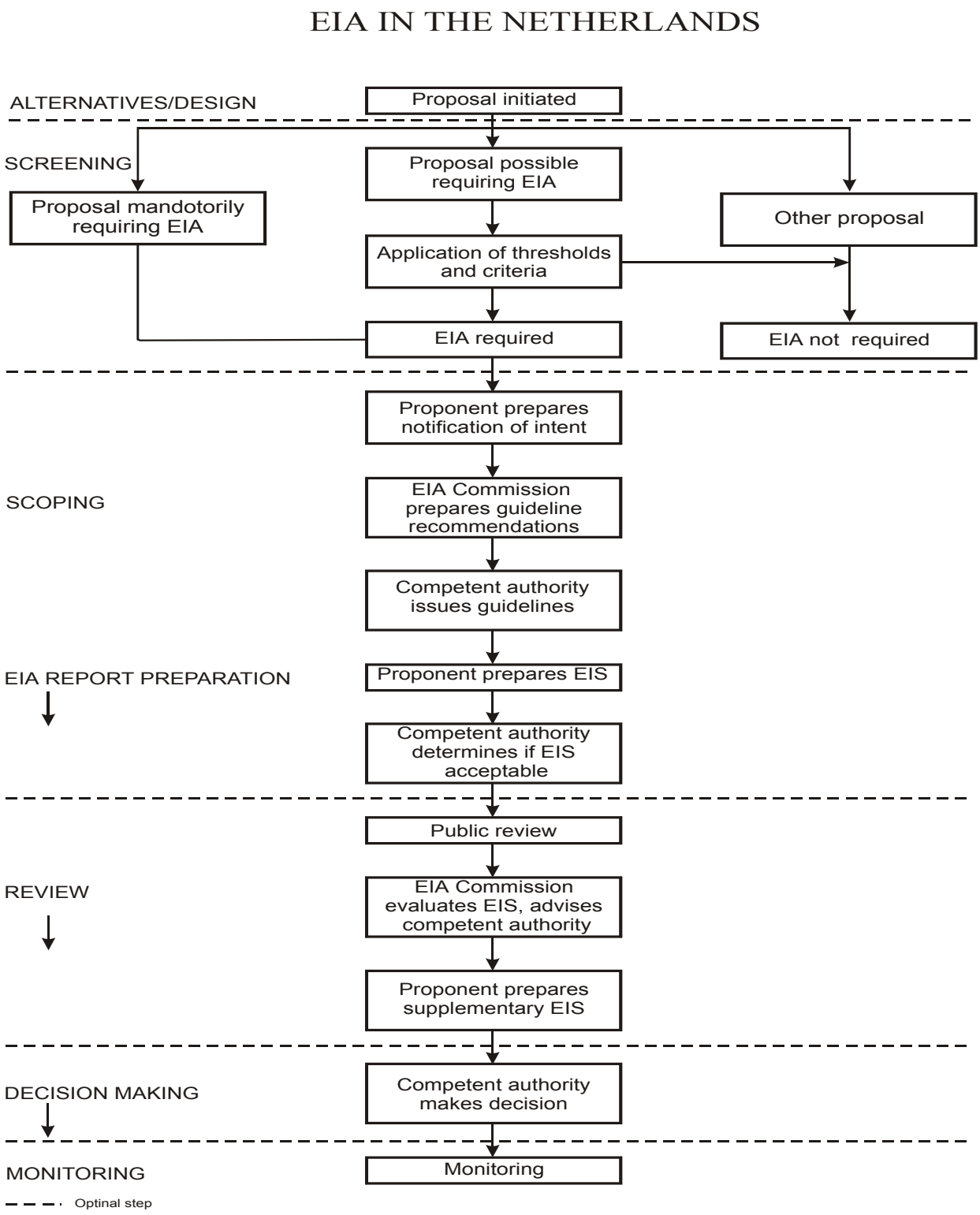


Table 5.1. The procedural steps in EIA.

Phase	Dominant participant	Time limit
1. ***Preparatory work*****,** including matching of the EIA-process with the decision-making procedural steps by the competent authority and the preparation of a notification of intent by the proponent.	CA + Pr	unlimited
2. ***Publication of the notification of intent (NI)***, announcement of the start of the EIA by the competent authority	CA	
3. ***Public review*** and ***Guideline recommendations***	P + A C	4 weeks
4. Establishment of the ***guidelines*** for the EIS within 13 weeks after publication of the notification of intent or starting document)	CA	< 13 weeks after NI
6. ***Preparation of the EIS***	Pr	unlimited
7. ***Submission of the EIS*** to the competent authority and ***preliminary review*** of the EIS by the competent authority with regard to its acceptability	Pr + CA	6 weeks
8. ***Publication of the EIS*** together with the application or draft plan, within 8 weeks after preparation of the EIS	CA	8 weeks
9. ***Public review and advice***	CA+A+C+P	4 weeks
10. ***Evaluation of the EIS*** and advice to CA	C	5 weeks
11. ***Decision*** on the activity with consideration of environmental impacts and outcome of public review	CA	
12. ***Possible appeal against the decision***	P + Pr + A	
13. ***Monitoring*** after implementation of activity with possible application of ***mitigating measures*** to be decided upon by the CA	Pr + CA	1-5 years

Pr = Proponent; CA = Competent Authority; P = Public
A = Advisors to the CA; C = Commission on EIA

6. SCREENING: IS EIA NEEDED?

The legislation stipulates that an EIA has to be carried out in the case of activities, which may have significant detrimental impacts on the environment. ***Screening*** is the most common mechanism to determine whether or not a proposed activity requires an EIA and the level at which that assessment should occur. Screening has two objectives (Tomlinson, 1984):

- Clear identification of projects requiring EIA.
- Quick and easy operation in order to avoid unnecessary delay in the process.

A variety of proposed activities can be subject to EIA:

- A ***project or construction EIA*** involves a concrete (operational) project such as the construction of technical installations or a golf course
- A ***strategic EIA*** requires a strategic decision and entails the assessment of plans, programmes and policies, also called specifically a ***plan EIA***, a ***programme EIA*** or a ***policy EIA***, respectively. A plan EIA may include national, regional or local land use or management plans. A programme EIA involves sector programmes like waste processing or energy supply. A policy EIA may include, in case of transport improvement, a choice between a highway or a railway.
- A ***location EIA*** concerns the location of industrial or housing areas. A location EIA can be part of a project or strategic EIA.

Four approaches are used in the selection of activities to be submitted to EIA:

- **Decision-makers discretion**. The need for EIA is individually assessed on a case-to-case basis. Either the decision-maker decides if an EIA is required, without any assistance. Or, the decision-maker makes the screening decision acting on advice received as a result of a structured initial review of the proposal. Or, the review might be carried out according to a set of guidelines or criteria.
- **Initial Environmental Evaluation (IEE)**. All activities are considered and through a process of self-assessment and initial ***screening*** the need to apply EIA is determined. IEE's are low-cost environmental evaluations that make use of information already available. The screening is done by the proponent and the competent authority, usually by means of an Initial Environmental Evaluation (IEE, CANADA), or an Environmental Assessment (EA, USA) or an Environmental Information Report (EIR, INDONESIA). Based on these reports, it is determined whether EIA is needed or not.
- **Screening via policy delineations**. Such an approach is based on regulations and guidelines in line with the environmental policy of a particular country. Many countries have developed lists of projects requiring EIA (a ***positive list***) and some have lists of projects exempted from EIA (***negative list***). In the Netherlands a positive list ***with threshold values*** is established. For activities exceeding the threshold values an EIA is mandatory. This approach is recommended by the EC guidelines for EIA. To find out which activities are relevant, the possible consequences of all kinds of activities have been scrutinised. Zimbabwe and Tanzania have a positive list, but no threshold values are included.

6.1. Who is responsible for screening?

The responsibility for screening depends on the screening approach. Clearly the decision-maker is responsible when screening is done based on the decision-maker's discretion. In an IEE the proponent and competent authority are responsible.
In the Netherlands, screening is actually not a part of the EIA process itself, since a 'positive list' exists with actions for which EIA has to be carried out. These activities subject to EIA are listed in the Environmental Impact Assessment Decree 1994 (Bulletin of Acts, Orders and Decrees 540, 1994). In Table 6.1 a summary of activities for which EIA is compulsory in the Netherlands is given. Currently the list has been extended as a result of national and European Community evaluations of the Dutch EIA regulations (Holder, V. ten, CEIA, unpublished).
The list contains three columns:

- Activities for which EIA is required
- Threshold values beyond which EIA must be applied
- Decisions which involve mandatory EIA

For many activities on the list a threshold has been indicated in the form of a dimension or surface area or production volume. This means that EIA is only applied to the larger projects and major plans. In a number of cases, particularly if infrastructure works are involved, the mandatory EIA is also coupled to the location where the proposed activities are planned. If this is an ***environmentally sensitive area***, an EIA has to be carried out. Environmentally sensitive areas are areas with unique or critical resources and environmental conditions. This would apply for instance to the landing of pipelines for gas exploitation in the Wadden area, a protected estuary in the North of the Netherlands.

Threshold values can be:

- in numbers (number of houses to be constructed)
- in size (industrial areas, military training areas)
- in weight or volume (tons of domestic waste)
- in diameter (pipelines)
- in capacity (refining capacity of oil refineries)
- in chemical composition (chemical industries)
- according to designated geographical area (nature areas)

Table 6.1. Example of activities subject to EIA in the Netherlands (Source: VROM, 1995)

Infrastructure • roads, motorways, highways • railways and tramways • ports, marinas and airfields • waterways • pipelines, pylons and high-tension transmission cables **Water management projects** • dikes, land reclamation • lowering of surface water level • groundwater abstraction • sand extractions **Recreational or tourist facilities** • golf courses • stadiums and theme parks	**Projects in rural areas** • land improvement projects • extension of industrial and residential areas • military training grounds **Waste treatment and processing** • waste incineration plants • waste recycling plants • landfill sites **Energy and industry** • oil and gas extraction • power plants • chemical plants and refineries • offshore mining

In Appendix A1, a list is given of development projects, assisted by the Netherlands, for which an EIA is needed. Appendix A2 is a list of sensitive areas. Any project out of the list in Appendix A1 to be located in a sensitive area will be subjected to EIA.

7. SCOPING: WHICH ISSUES AND IMPACTS TO CONSIDER?

The extent of environmental problems has increased from local and regional (deforestation, waste, and noise) to continental (acidification) and even global (ozone layer, greenhouse effect). Therefore, different developments and activities have different impacts and risk patterns. Mines cause different sets of environmental effects than a sanitary sewage plant or the construction of an international airport.
Scoping is needed to decide what are the most relevant impacts, how to predict them and how to measure them. But not all these potential effects are important for the decision making. The scoping may differ in each environmental situation.
The next section will mainly deal with the step called 'scoping' in the EIA process. First the term environment is explained. Next, the main aim of scoping is highlighted, followed by the different activities to reach these aims.

7.1. Environment

Environment, in its broadest sense, embraces the conditions or influences under which any individual or thing exists, lives or develops (Gilpin, 1995). Until the 1970s environmental studies were focused on the natural environment giving little consideration to the man-made features and the interrelationships between natural and socio-economic components of the environment (Palewas, 1994, pg.11). In the course of time the word 'environment' evolved with the following components:

- the abiotic factors (land, water, air, etc.)
- the biotic factors (flora, fauna, ecology, biodiversity)
- the built environment (infrastructure, buildings, monuments)
- aesthetic, scientific and historical (natural and cultural) values
- the interrelationship between these elements

The European Commission, the governing body of the EC, has defined the environment as 'the combination of elements whose complex inter-relationships make up the settings, the surroundings and the conditions of life of the individual and of society, as they are or as they are felt. Most approaches place humanity at the centre of things, leaving no room for compassion to other species. Perhaps the evolution of the word 'environment' still has some way to go (Gilpin, 1995, pg.1).

7.2. Scoping

Usually, a decision regarding a proposed activity will be taken on account of some selected issues of clear significance. Similarly, the consideration of alternatives to the proposed action should be limited to a subset of reasonable variants. The process of identifying the issues to be considered, and developing and selecting the alternatives, is called ***scoping*** (Palewas, 1994).
The overall aim of scoping is to ascertain, from all project's possible impacts and from all the alternatives that could be addressed, those that are the key (significant) ones. The main issues to consider in scoping are:

- appropriate boundaries of the EIA study
- key stakeholders
- relevant key issues and concerns

- likely significant impacts
- reasonable set of alternatives and mitigation measures
- effective method(s) to be used in the EIA study
- terms of reference (guidelines) for the EIA study

7.3. Stakeholder and public involvement

Each country developed its own approach to scoping in terms of involvement of interested parties. It depends generally on the ability and willingness of the parties involved, and also on how serious scoping is considered (Palewas, 1994, pp. 30-31). The involvement of interested parties in scoping may comprise the following issues:

- responsibility for scoping
- notifying and informing interested parties
- obtaining views and concerns from the participants in scoping

Stakeholder involvement does not necessarily mean public involvement. For example, the Ministry of Agriculture may be involved as a stakeholder, but this does not mean public involvement has occurred. Involvement of interested parties should be as early as possible in the EIA process, before the scoping starts.
Responsibility for scoping may rest with the authorising agency or a developer. However, it is recommended to set up a special scoping group as a body defining the scope of the study and preparing specific guidelines for a particular EIS. In the Netherlands the independent Commission EIA plays a large role in this.

7.4. Identification and quantification of environmental effects

Environmental impact studies usually concern a large number of environmental aspects implying that various experts have to be included.
Potential effects are distinguished according to the two phases of the proposed activity:

- Construction phase
- Operation phase

A selection of potential effects is done on the basis of the possible occurrence of the effects on the one hand and their magnitude and significance on the other hand.
For the identification of environmental effects of a proposed activity, ***checklists*** can be of help to select ***environmental aspects*** (not impacts!) that may be of importance in the area. Those identified can then be used to form one axis of an interaction matrix (activities versus environmental aspects) which can be used to identify ***potential effects***. After the identification of relevant environmental effects, the magnitude and significance of the effects have to be determined. Finally, different priorities can be assigned to different effects.

Note: Several examples of checklists or impact matrices exist (see also section 11.1). In most EIA literature they can be found under ‘methods’ (a.o. Biswas and Geping, 1987).

7.4.1. Environmental aspects

There are two broad categories of environmental aspects (or theme's, or components) that can be distinguished, i.e. ***ecological*** (physical and biological) and ***socio-economic*** (social, aesthetic and economic) aspects.
The physical environment is concerned with geomorphology features, soils, water resources and climatic conditions.
The biological aspect is related to the distribution, composition, structure, diversity and relations of plant and animal communities. Many of the biological aspects are related to physical ones.
The economic impact assessment is often based on a cost-benefit analysis and on the identification of the possible recipient of the beneficial or detrimental effects.
The assessment of the aesthetic impacts would include visual changes of the landscape and other changes of historical or archaeological sites. The social impact assessment deals with the effects on the behaviour, the economy and the health of the human population. In a particular case, the environmental impact assessment is concerned with the quality of the environment for the human society. In this case an important aspect of the EIA is the perception of environmental quality, or quality of life, consisting of aesthetic, recreational, economic and health qualities.

In the Netherlands, socio-economic factors do not form part of the environment. In many countries, e.g. Canada, Indonesia, they are considered in the EIA. They include employment, living standard, social and cultural welfare, position of ethnic minorities, etc.
In Table 7.1 the main environmental aspects are indicated which a mining project should encompass during the scoping phase.

Table 7.1. Main environmental aspects identified for a mining project.

Physical-chemical			Biological		Cultural			Socio-economic		
Earth	*Water*	*Atmosphere*	*Flora*	*Fauna*	*Land use*	*Recreation*	*Aesthetic*	*Social*	*Quality of life*	*Economic*
Landform	Surface water	Climate	Trees	birds	forestry	fishing	scenery	demography	health	employment
Rocks	Ground water	Temperature	Shrubs	land animals	agriculture	boating	landscape	accomodation	safety	wage levels
Soils			Grasses	fish and	fishery	hunting	parks and	local	noise	training
Mineral			microflora	shellfish	residential	swimming	reserves	services		
resources			endangered	benthic	industrial	camping	monuments	crime		
			species	organism	mining and	hiking	historical			
				insects	quarying		sites			
				endangered						
				species						

7.4.2. Identification of effects

Environmental impacts or effects can be divided into the following different categories (Palewas, 1994,
pp. 13-14):

- ***Beneficial-adverse effects***; the positive and negative effects of a proposed activity.
- ***Direct-indirect affects***; direct effects are directly related to a proposed action and can be easily envisaged by a single parameter. Indirect effects are related to activities induced by the implementation of a proposed action. For instance, a new highway near an existing town may generate a link between traffic and town commerce with indirect effect (induced action) being the town growth.

- ***First order (primary)-higher order effects***; first order effects are the immediate consequences of a proposed activity, e.g. local pollution of a plant. Second order effects are the consequences of the first order effects, e.g. impoverishment of aquatic species. Third order effects are the consequences of the secondary effects, and so on.

  As it might become apparent, the boundary between indirect and higher order effects is diffuse. Therefore, both terms are used interchangeably.
- ***Reversible-irreversible effects***; effects are reversible if the environmental changes caused by an action can be reversed, either through natural processes or artificially by direct human intervention. Once the reinstatement of original conditions is impossible, the effects are called irreversible.
- ***Short term-long term effects*** refer to the impact duration, however in relation to phases of the proposed action rather than setting precise time limits.
- ***Transboundary effects*** embrace a variety of impacts reaching beyond administrative borders. To date, the international consequences of many major negative impacts, e.g. climate change, pollution
  of international rivers, should emphasise specific institutional and legal procedures.
- ***Cumulative effects*** refer to the temporal and spatial accumulation of change within environmental systems in an additive or interactive manner.

7.4.3. Defining criteria

After the identification of relevant environmental effects per environmental aspect, an environmental ***criterion*** for each environmental effect has to be defined and agreed upon. The aim in this stage is to define criteria for each effect against which to judge the need for further investigation. These criteria may be based on:

- issues of concern to the community
- relevant norms or standards, originating from different interest sectors
- policy objectives for environmental protection.

The establishment of such set of criteria is often an iterative process of discussions between the study team, the representatives of interest groups, the planning agency and the decision-makers. As much as possible the criteria should be defined so as to represent unique characteristics or descriptions of the physical and socio-economic environment and a comprehensive list should be compiled of such criteria as they relate to the effects of the particular project.

7.4.4. Quantification of effects

Knowing the pattern of effects and their magnitude and significance, only those effects, which justify further study, can be defined.
The next step is therefore to determine the ***magnitude*** (nature and extent) of the potential environmental effects and to assess their ***significance***.
The magnitude is the size of an impact expressed as a measurable value of impact parameter, e.g. the concentration of pollutant(s) in a river or the loss of habitat (in ha) of breeding birds.
The significance of an impact involves the institutional, technical and public interests likely affected by the project.

Information about the ***magnitude*** of environmental effects includes:

- the environmental characteristics/aspects which are likely to change
- the magnitude of the change in these characteristics
- the frequency and duration of the change
- the geographical extent of the impacts (local, regional, national, global)
- the groups and interests in the community that are affected (including economic interests, minority groups, recreation, conservation, etc.)
- the reversibility or irreversibility of effects.
- the possibilities for mitigation
- the possible use of non-renewable resources
- the likelihood of establishing a precedent for future activities which cumulatively may have a much greater impact in the long term.

The ***significance*** of effects may be related to:

- the importance or uniqueness of the affected environment, people or interests
- the controversy of the effects
- the violation of legal standards or policy objectives for environmental protection
- the threat to endangered or protected species or habitats, or to protected sites (historical, archaeological,
  natural, scientific).

Significant issues are usually distinguished in EIA using an appropriate set of criteria. Such scoping guidelines may include a series of questions, as, for example, is prepared by the Canadian Federal Environmental Impact Assessment Review Office (FEARO 1985).
Another approach to determine whether effects are significant is taken from the California Environmental Quality Act (CEQA, Bassand Herson, 1991, after Canty Canter 1993, in Palewas, 1994, pg. 33), and shown below in Table 7.2.

7.4.5. Assigning weights

Depending on the importance of the threshold or criterion against which the effect is measured, different ***weights*** (priorities) can be assigned to different environmental effects. For example, an air quality standard may be used as the threshold of significance for an air pollutant. Because it is a legal standard it is assigned highest priority. An accepted norm would be assigned priority two, whereas a threshold based on a particular group's preference would be assigned lower priority.
Experts assigning numerical weights to each of the identified effects determine the relative importance of effects. An example of such a weighting system is the Environmental Evaluation System (Dee et al., 1973, pg. 527; in: Biswas & Geping, 1987).

Table 7.2. Checklist of effects normally considered as significant in the CEQA.

A project will have a significant effect if it will:

- conflict with adopted environmental plans and community goals
- have substantial demonstrable negative aesthetic effects
- substantially interfere with the movement of resident or migratory fish or wildlife
- breach published standards relating to solid waste or litter control
- substantially degrade water quality
- contaminate a public water supply
- substantially degrade or deplete ground water resources
- substantially interfere with ground water recharge
- disrupt or adversely affect a cultural resource
- induce substantial growth or concentration of population
- cause a traffic increase that is substantial in relation to existing street traffic load and capacity
- displace a large number of people
- encourage activities requiring a large amount of fuel, water or energy
- use fuel, water or energy wastefully
- substantially increase ambient noise levels
- cause substantial flooding, erosion or siltation
- expose people or structures to major geologic hazards
- extend a sewer trunk line with capacity to service new development
- substantially diminish habitat for fish, wildlife or plants
- create a potential public health hazard or expose people, animals or plants to hazards
- conflict with established recreational, educational, religious or scientific uses
- violate any ambient air quality standard, contribute substantially to an existing or projected air quality violation, or expose sensitive receptors to substantial pollutant concentrations
- convert prime agricultural land to non agricultural use or impair productivity of prime agricultural land
- interfere with emergency response plans or emergency evacuation

Summarising, an example of the whole process of identification and quantification of impacts, e.g. selection of environmental aspects, identification of environmental effects, criteria and criteria scores, and weight assignment, is given below. The data are part of the impact assessment method of the EIA study on Twente Conurbation, carried out by the Grontmij in 1995, and used in the case study EIA Twente Conurbation.

Environmental aspect*: *priority	Water and Soil			
Effect W1:	(change in) protection of drinking water extraction areas			
Criterion: 30%	location of groundwater protection areas (gpa)			
Criterion scores:	1	=	gpa Enschede-Weerseloseweg	
	20	=	gpa Hasselo	
	50	=	gpa Hengelo	
	100	=	other area	
Effect W3:	(change in) sensitive wetland areas			
Criterion:	sensitivity of wetland areas			5%
Criterion scores:	1	=	very sensitive wetland area	
	30	=	sensitive wetland area	
	100	=	other area	

7.5. Formulation of alternatives

The development of alternatives and the assessment of impacts of a proposed activity for each of the alternatives are the core of any EIA.
The consideration of alternatives to a proposed action provides a means by which project assumptions, aims and needs is examined. The examination of different ways of achieving a stated objective may assist the decision-maker in choosing an alternative, which has the least adverse and greatest beneficial and socio-economic consequences (Palewas, 1994, pg.33). The search for alternatives must be well documented and taken place before, not after, a choice has been made.

Alternatives can be generated at all levels of decision-making (Scholten, CEIA, pers. communication):

- ***Policy alternatives*** which can achieve the policy objective following different solutions. For example, electricity demands can be met by generating electricity in power plants using fossil fuels, wind energy, hydro-power or nuclear power, or it can be imported from other countries where a surplus exist. Or, in case of transport improvement, a choice has to be made between a railway or a highway.
- ***Site or alignment alternatives*** for urban or industrial facilities, infrastructure, land reclamation, etc. Site alternatives depend upon a wide range of factors. Sites may be preferable for the developer based on financial considerations or efficiency reasons (such as transport costs in the supply or removal of products; location near the supply of resources or other services). In a wider context some sites may be preferable for a larger community for reasons of environmental concern (sustainability).
- ***Implementation alternatives*** dealing with size, appearance, accessibility, physical components, emissions, waste management, energy consumption, transportation requirements, etc.

In the Netherlands there are at least three different kinds of alternatives in each EIA:

- The ***proposed activity*** which has the preference of the proponent.
- The ***no-go or zero alternative***, which represents the situation if the proposed activity is not carried out. It is specifically required to consider the existing trends in impacts and as a reference for other alternatives. In the EIA it must be explained whether the no-go situation can be a real alternative or not. For example, when instead of constructing a new electricity-generating plant, power can be imported from elsewhere. Or, in certain circumstances this consideration may not be reasonable because previous policy or legislative decisions have mandated the activity.
- The ***most environmental friendly alternative*** (MEF) which can offer the best protection to the environment, e.g. by applying the best technical solutions and mitigating measures, or, in the case of site selection, by cutting on transportation demand.

The ways of identifying alternatives and mitigation measures seem to be project specific. A useful approach might be to divide the proposed activity into sub-activities, measures or decisions, and then search for possible variants for each of these sub-activities, and finally cluster the variants into relevant alternatives.

7.6. Mitigation

Mitigation stands for measures taken to limit the severity of environmental effects of a proposed action. In the EC Directive 85/337 mitigation is defined as 'measures envisaged to avoid, reduce and, if possible, remedy significant adverse effects' (CEC, 1985, in Glasson, 1994, pg. 134). In the box below the guidance on mitigation measures provided by the UK Government is set out.

- Site planning
- Technical measures, e.g.
  - process selection
  - recycling
  - pollution control and treatment
  - containment (e.g. bunding of storage vessels)
- Aesthetic and ecological measures, e.g.
  - mounding
  - design, colour, etc
  - landscaping
  - tree planting
  - measure to preserve particular habitats or create alternative habitats
  - recording of archaeological sites
  - measures to safeguard historic buildings or sites

Mitigation measures must be planned in an integrated and coherent way to ensure that they

are really effective, that they do not conflict with each other, and that they do not merely shift a problem from one medium to another.
Like many elements in the EIA process, mitigation is not limited to one stage in the assessment.

Although it may follow logically from the prediction and assessment of relevant effects, it is in fact inherent in all aspects of the EIA process (Glasson, 1994).

Mitigation options are:

- Alternative ways of meeting the need
- Changes in planning and design
- Improving monitoring and management
- Monetary compensation
- Replacing, relocating or rehabilitating

Mitigation measures are usually discussed and documented for each environmental aspect and related effects. An example of a section of a summary table for impacts and mitigation measures as a result of the establishment of a petrochemical plant is given below:

Impact	***Mitigation measures***
• 400 acres of prime agricultural land would be lost to accommodate the petrochemical plant.	The only full mitigation measure for this impact would be to abandon the project.
• Additional lorry and car traffic on the adjacent hilly section of the motorway increase traffic volumes by 10-20% above those predicted on the basis of current trends.	A lorry crawler lane on the motorway, funded by the developer, will help to spread the will volume, but effects may be partial and short-term.
• The project would block the movement of most terrestrial species from the hilly areas in the east to the wetlands in the West	A wildlife corridor should be developed and maintained along the entire length of the existing stream running through the site. The width of the corridor should be at least 75 ft.

Mitigation measures are of little value unless they are implemented. Hence there is a clear link between mitigation and monitoring. Monitoring, which is discussed in section 10, must include the effectiveness of mitigation measures. The latter should therefore be devised with monitoring in mind.

7.7. Guidelines or TOR for the Environmental Impact Statement (EIS)

Specific guidelines are in fact the summary of the findings of the scoping activities. As a minimum, specific guidelines should include all key agreements reached during the scoping period on issues and alternatives. In most countries more detailed guidelines are required, which should include:

- The objective of the activity
- Agreed significant issues
- An outline of the environmental system to be studied with identified key interactions, feedback's, system boundaries and uncertainties
- Data requirements regarding the environmental setting of an action in order to address the raised issues and project alternatives
- Guidance on methods and techniques for impact prediction, assessment and presentation
- EIA organisation (e.g. timing, meetings, necessary baseline surveys).

The specific guidelines are not a rigid guidance, it is possible that during the investigations new problems may arise or other alternatives become apparent. They should not be discarded but rather considered during an additional meeting with stakeholders (Palewas, 1994, pg.34-35).

In the Netherlands, the Commission on Environmental Impact Assessment prepares guideline recommendations. At the end of the scoping period specific guidelines are issued by the Competent Authority.

An example of guidelines prepared for an EIA study on a cross-channel connection of the Westerschelde in the Province of Zeeland, the Netherlands, is given in Appendix B.

8. EIA REPORT OR ENVIRONMENTAL IMPACT STATEMENT (EIS)

The outcome of the EIA study is usually a formal (set of) document(s) called Environmental Impact Statement (EIS). Some EIA procedures, e.g. in USA, may involve a phased preparation of the EIA, including a draft statement and a final one after the review (Palewas, 1994, pg. 43). The draft EIS is carried out by the impact study group and is submitted by the proponent along with the application for project authorisation, to the competent authority. Copies of the draft EIS are disseminated to the interested parties and, if possible, to the public, in order to receive comments on the assessment. This so-called EIS review stage is also applicable in EIA systems without a two-phased EIS. After reviewing the EIS, the study team should incorporate substantive comments, issues and views into the final EIS.

In the Netherlands, specific guidelines are drawn up for each EIS (m.e.r.)
Though the content of an EIA may differ per country, a general EIS must include (Ahmad and Sammy, 1985, VROM, 1995):

- Objectives of the proposed activity
- Relevant previous and future government decisions
- Proposed activity and reasonable alternatives

  ⇒ discussion of all options considered
  ⇒ no-action or zero-alternative
  ⇒ identification of alternative preferred by the proponent
  ⇒ mitigation measures

- Existing state of the environment and the probable environmental development without the proposed activity; this will give the basic information for prediction and assessment
- Environmental impacts of the proposed activity and each of the alternatives; this phase includes impact identification, prediction and quantification
- Impact interpretation and evaluation; this may include two activities:

  ⇒ Comparison of impacts of the alternatives with the existing situation and including autonomous developments
  ⇒ Identification of the relevance of changes in ecosystems due to an impact

- Gaps in knowledge and information
- Monitoring programme
- Summary and conclusions

The EIA report is to be used by all interested and affected parties in order to facilitate sound environmental decision-making.

In the box below a general structure of an ideal EIA report is presented.

Cover page
- Title of the proposed project
- Location
- Proponent(s)
- Lead consultant(s) – EIA coordinators
- Contact address
- Decision-making authority (where the report is submitted)
- Date of submission

Non technical executive summary
- Brief concise overview in clear understandable language/terms
- Major findings and recommendations

The summary can be part of the EIS or stand-alone.

Table of contents (with page numbers!)
- List of sections and sub-sections
- List of tables
- List of figures
- List of appendices

Introduction
- Background of the study (problem and aim)
- Status (initial or full EIA is required)
- Justification for the EIA
- Structure of the report (how to read the report)

Description of proposed activity
- Construction phase
- operation phase

Description of present environment
- Site description (environmental aspects or themes)
- Expected autonomous developments

Identification, prediction and assessment of potential effects
- Nature and extent of effects
- Criteria and criterion scores
- Assessment methodology (incl. assumptions/limitations)
- Mitigation measures

Alternatives
- Formulation of alternatives (why which one(s) chosen)
- Comparison of alternatives

Public consultation
- Public participation and information programme

Gaps in knowledge
- incomplete or unavailable information

Conclusions and recommendations

References

Appendices

9. EIS REVIEW

Although the exchange of information, views and comments may take place at several stages of the EIA process, the EIS review was particularly designed after the publication of the EIS, to review the results of the impact assessment study. In many countries this is the still the only opportunity interested parties have to comment or express their point of view. This format of consultation may inhibit the communication between study team, proponent and stakeholders, resulting in an adverse atmosphere of distrust, disrespect and confrontation (Palewas, 1994).

An approach in which consultation and exchange of views occurs at various stages of the EIA process, through a series of formal and informal meetings between all stakeholders involved, is likely to contribute positively to (after Palewas, 1994, pp. 46-47):

- the comprehensiveness of information relevant to the description of environmental setting
- the exchange of baseline environmental information, and hence avoiding the overlooking or duplication of the baseline study
- the identification of acceptable project alternatives and mitigation measures
- the assessment of significance of effects
- the assessment of cumulative impacts by learning from other projects and programmes which are under consideration by other agencies
- the increase of acceptance of the proposed activity
- the potential co-operation with respect to monitoring and implementation of mitigation measures

Whatever the approach to consultation applied, the EIS review can embrace the following circles (In: Palewas, 1994, pg. 46):

- In-house team review (quality control)
- Competent authority review (guidelines, existing land use plans, policies, regulations)
- Agencies review (existing land use plans, policies, regulations)
- Independent expert review (quality of information)
- Public review (public participation by meetings and hearings)
- Court review (only in case of major conflicts)

One of the difficulties in the review of EIA reports, as in the preparation, is ensuring objectivity since the organisation responsible for formal review (if any) may have a vested interest in the decision about the proposed action (Wood, 1995). Various methods exist to ensure objective, including:

- the use of review criteria
- the accreditation of EIA report review consultants
- the appointment of an independent review body
- the publication of the results of the review
- the involvement of consultees and the public

Generally, review consultants are contracted from the same group, which also prepared the

EIA report, and the need for some form of accreditation applies similarly.

The appointment of an independent commission selected from acknowledged experts in the field to review EIA reports has two advantages (Wood, 1995):

- reducing any bias in the relevant authority's decision on the proposed action.
- improving the quality of EIA, since its opinions, whether positive or adverse, should be both public and influential.

The role of an independent commission EIA (CEIA) will be explained in the next section for the Netherlands, where the CEIA is actively involved in the EIA review (see also http://eia.com.nl).

9.1. Reviewing EIS in the Netherlands

Once the competent authority has accepted the EIS, the EIS is made public together with the draft decision on the proposed action. This public review period last at least five weeks and there are provisions for public hearings. The various statutory consul tees are also asked to comment on the EIS. The results of the consultation process are then passed to the Commission EIA which received the EIS from the competent authority (Wood, 1995). The CEIA checks the EIS against the legislation and regulations and against the specific guidelines issued for each EIS. The CEIA gives no judgement on the acceptability of the proposed activity. In the review of the EIS, only the completeness, substance as well as the correct application of the scientific state of the art are discussed (Holder, V. ten, CEIA, unpublished). When reviewing the EIA the CEIA considers the following ***quality criteria:***

- whether the EIS meets the legal requirements
- whether the EIS meets the guidelines made up in the scoping stage
- whether the EIS provides complete information for sound decision making
- whether the EIS is objective and correct.

Towards the end of the review, the CEIA invites the competent authority and the proponent to discuss a draft of the advice. In this draft the CEIA points out whether the EIS provides sufficient information for the decision or not. If this is considered insufficient, the competent authority will, in most cases, instruct the proponent to supply additional information or to rework the EIS. Ignoring a negative advice of the CEIA and continuing the decision making is seldom done because the advice of the CEIA can be referred to in appeals against the decision.
In the report on the results of the review to the competent authority the CEIA not only gives an opinion on relevant shortcomings and whether these shortcomings are crucial for the decision making, but also gives recommendations on how to overcome the shortcomings, e.g. by way of supplementing the EIA, taking a provisional decision or elaborate a post-project evaluation and correct if necessary. The CEIA may call for the provision of additional information when the additional information is deemed indispensable and therefore crucial for the competent authority to make a sound decision.

The CEIA undertook 68 reviews of EIS's in 1993. In twenty percent of the cases 'substantial deficiencies in the content of the EIS's were found, necessitating the supply of supplementary information to the competent authority (CEIA, 1994, in: Wood, 1995, pg. 172-174). Additional environmental information, mostly of a relatively minor nature, was requested in another thirty percent of the cases. The principal areas of weakness are related to:

- the selection and assessment of alternatives
- miscalculation of extent of impacts
- overlooking of impacts
- use of outdated models
- inadequate baseline information

An overview of shortcomings noted during reviews of the EIS's by the CEIA in the Netherlands is given by Scholten and van Eck, 1994, Annex 2.

10. MONITORING AND AUDITING

Numerous definitions of monitoring and auditing are formulated in the EIA literature (Tomlinson and Atkinson 1987 (a + b), Palewas, 1994, pp. 50-52, Wood, 1995). In the EIA process monitoring and auditing provide a mechanism to ensure that mitigation measures have been carried out and to determine whether predictions were precise.

Environmental monitoring refers to the systematic collection of environmental data through a series of repetitive measurements. A number of different monitoring activities can be distinguished in the EIA process:

- ***Baseline monitoring*** refers to the measurement of environmental parameters during a pre-project period; the main purpose is to determine the nature and ranges of natural variation and to establish, where appropriate, the nature of change.
- ***Effects monitoring*** involves the measurement of environmental parameters during project construction and implementation so as to detect changes in these parameters.
- ***Compliance monitoring*** takes the form of periodic sampling and/or continuous measurement of environmental parameters to ensure that regulatory requirements are observed and standards met.

Inclusion of a framework for environmental monitoring, particularly during project implementation, can significantly improve the effectiveness of the EIA process.
Monitoring is the responsibility of the project proponent and the government institutions responsible for environmental issues.
Unfortunately, monitoring is not a mandatory step in many EIA procedures.

Environmental auditing includes the following objectives:

- The organisation and interpretation of the environmental monitoring data to establish a record of change associated with the implementation of the project;
- The process of verification that all or selected parameters measured by an environmental monitoring programme are in compliance with regulatory requirements, internal policies and standards, and established environmental quality performance limits;
- The comparison of project impact predictions with actual impacts to assess the accuracy of predictions;
- The assessment of the effectiveness of the environmental management systems, practices and procedures;
- The determination of the degree and scope of any necessary remedial or control measures in case of non-compliance or in the event that the organisation's environmental objectives are not achieved.

Audit documents normally include:

- a compliance audit, prepared during the implementation and operation of a project
- a post-project audit, prepared after implementation and commissioning of a project.

Wood (1995) first of all makes a distinction between the monitoring and auditing of individual actions and of the EIA system as a whole. The second distinction he made, is between the three main types of action monitoring and auditing:

- implementation monitoring
- impact monitoring
- impact auditing

Implementation monitoring involves checking that the proposed action has been implemented in accordance with the approval, that mitigation measures correspond with those required and that conditions imposed upon the action have been met. Such checking may involve physical inspection (e.g. building location or waste storage/disposal) or measurement (e.g. noise emissions). This type of monitoring can be carried out either by the decision-making or environmental authorities or by the proponent or, as often the case, may be divided between them. Implementation monitoring frequently is supported by more than one set of legislative instruments (e.g. land use planning or pollution control procedures).

Impact monitoring deals with measurement of the environmental impacts that occur after implementation of the action. This type of monitoring serves two purposes:

- to adapt or change the action design or management measures when unexpected or unacceptable impacts are revealed
- to provide useful feedback for the assessment of other similar actions by helping to ensure that relevant areas of concern are identified.

In most EIA systems impact monitoring is carried out by some combination of the proponent and the environmental authorities, though this is increasingly becoming the responsibility of the proponent.
As with implementation monitoring, impact monitoring may be covered by a variety of legislation.

Impact auditing or post-auditing involves the process of comparing between the forecasts and commitments made earlier in the EIA process (and especially in the EIA report) and the results of implementation and impact monitoring. The main purpose of impact auditing is to enable the effectiveness of particular forecasting techniques to be tested and thus improve future practice, e.g. by reducing the uncertainty in impact prediction. A second purpose is to improve the management of impacts of the actions concerned.
The decision-making or environmental authorities, the proponent or research investigators may carry out auditing. As opposed to implementation or impact monitoring, few EIA systems require impact auditing.

Monitoring of EIA systems

In addition to the monitoring and auditing of impact actions, there is a need for some form of EIA system monitoring. The principal purposes of EIA system monitoring are the diffusion of EIA practice and the amendment of the EIA system to incorporate feedback from experience and remedy any weaknesses identified (Wood, pp. 241). Numerous elements of any EIA system can be monitored to reach these purposes. However, the diffusion of best practice does not depend only on upon EIA system monitoring but also on such matters as the

provision of published guidance and of training and the undertaking of research.

In any EIA system, a definitive record of the number of EIA reports undertaken should be maintained and made public, both for the total number of EIA reports and for EIA reports of different types of actions. Such records are available in many EIA systems. Other evaluation criteria are sometimes less easy obtained. An overview of evaluation criteria for EIA system monitoring is given in Table 10.1 below.

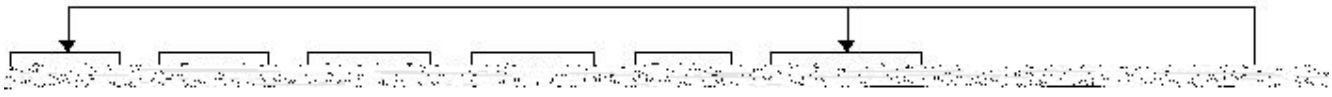
Table 10.1 Evaluation criteria for EIA system monitoring (Wood, 1995, pg. 243)

• Is a record of EIA reports for various types of actions kept and made public?
• Are records of other EIA documents kept and made public?
• Are EIA reports and other EIA documents publicly available at one or more locations?
• Are records of the financial costs of EIA kept and made public?
• Is information of the time required for EIA collected and made public?
• Are the lessons from specific EIA's fed back into the system?
• Have reviews of the EIA system been carried out and changes made?
• Is consultation and participation required in EIA system review?
• Does the monitoring of the EIA system function efficiently and effectively?

In Figure 10.1 the role and position of monitoring and auditing in the EIA process is presented (adapted from Sadler, 1988, in UNEP, 1996, pg. 584).

A major difficulty possibly encountered in developing a broad post-development research might be that the evaluation would be disliked by decision-makers as it could be viewed as a tool for criticising the decision-making process and hence perceived as such. In EIA process evaluation ***it is not the decision to be evaluated, but the process providing information for this decision.***

Figure 10.1 The role and position of monitoring and auditing in the EIA process.



and economic/fiscal impacts.

11.3. Evaluation methods

Preparing an Environmental Impact Statement (EIS) involves the comparison of alternatives based on a number of assessment criteria.
For many development projects subjected to EIA a broad scalar of different environmental effects have to be taken into account in the assessment. Those effects may differ in measurement unit, time span and aggregation level. Not all effects can be expressed quantitatively or in terms of money. Most environmental effects have a spatial component and are often long-term.
In every EIS alternatives are compared by presenting their impacts in an ***overview***.
In such an impact overview the relevant information is summarised and can be presented to decision-makers and other interested parties. Every EIS should present an impact overview. And if the issues involved are not too complex, this overview will be enough for decision-making.
In most cases, however, there will be a need to further structure and aggregate the information in order to enhance differences between alternatives. Any method able to do this is a method of comparison.

The choice of an evaluation method depends on the number of alternatives under consideration, the level of aggregation of information, and the number and type of parties involved. Evaluation methods can formal or informal, quantitative and/or qualitative, aggregated or disaggregated. The most formal one is the comparison of likely impacts against legal requirements and standards, for example air quality standards, building regulations).

Two main evaluation methods can be distinguished:

- Cost-benefit analysis (CBA). A single evaluation criterion is considered: money.
- Multiple criteria decision-making analysis methods.

Cost-benefit analysis

In cost-benefit analysis (CBA) the nature of expenses and benefits for a proposed action are expressed in monetary terms. The most difficult part of CBA in EIA is the expression or conversion of natural resource values into monetary units.
The ***extended cost-benefit analysis*** method is one of the later orientations of EIA in developing countries. In this case an assessment is made of the use of natural and human resources that are invested or affected (extended cost) or are produced or are of benefit (extended benefit) as a result of a (development) project. Three extended cost-benefit techniques have been developed:

- UNEP Test Model of extended cost-benefit analysis
- The cost-benefit analysis of natural system assessment
- The extended cost-benefit analysis graph (appendix F)

More details on economic assessment methods are given during the module 'Economic appraisal and valuation of environmental quality' as part of the Common Base Module of the ESM2 course.

Multiple Criteria Decision-Making methods

Multiple Criteria Evaluation (MCE) methods offer the analytical and statistical modelling facilities to deal with multiple (and often conflicting) choice objectives and multiple criteria, as is the case in EIA.
The basic aim of MCDM is to assist the decision maker in selecting the 'best' alternative from a number of feasible choice alternatives under the presence of multiple choice criteria and diverse criterion priorities (Jankowski, 1995). The problem of multiple objective choice in decision making has two challenges:

1. How to identify choice alternatives satisfying the objectives of all the parties involved
2. How to reduce/order the set of feasible choice alternatives to identify the most preferred one.

Multiple Criteria Evaluation (MCE), or sometimes also called Multiple Criteria Analysis (MCA), is a Multiple Criteria Decision Support (MCDS) technique, in which ***weights are allocated to assessment criteria in order to rank alternatives***.

The basic starting point of any MCDM technique is the generation of the discrete set of alternatives, the formulation of the set of criteria, and the evaluation of the impact of each alternative on every criterion. The estimated impacts of alternatives on every criterion, called criterion scores, are organised into an ***evaluation (***or ***decision) matrix***, or sometimes also called ***effect table***.

11. 4. Communication methods

Communication in EIA means informing all relevant stakeholders about the project an the assessment of process and to obtain the views and concern from the public.
A systematic and transparent format should be used to present information about all impacts identified, predicted and assessed. This can be done in the form of an impact characteristic summary table, an interaction matrix, using maps, or evaluation tables for the comparison of alternatives.
Of recent, new communication tools like *interactive multimedia GIS techniques* are used in public EIA hearings, e.g. the 'high speed train' (HSL-Zuid) in the Netherlands, for which a multimedia package was produced on CD-rom.
The following media can be used to stimulate public participation:

- GIS Maps
- Photographs
- Video information
- Noise simulation
- Air, water or soil pollution simulations
- 3-D graphics
- Text and Sound

Summarising, existing EIA methods and techniques show a great variety in conceptualisation, content-orientation, data processing techniques and evaluation.
In Table 11.2 a generalised overview is given of the most common type of method for each

EIA task.

Table 11.2 Type of method per EIA task.

techniques	identification	prediction	evaluation
checklists	+	+	
impact matrices	+	+	
impact networks	+	+	
modelling/simulation		+	+
overlays			+
cost-benefit analysis			+
multiple criteria analysis	+	+	+
GIS			

11.5. EIA and software support

With a growing need for automation of large and multidimensional environmental data sets and the advent of computer power, more sophisticated software packages became available.
In EIA three main phases and corresponding software tools can be distinguished (after Beinat, 1993):

Phase	Steps	Tools
1. Planning and Identification	formulation objectives; alternatives; indicators/criteria	Expert systems Data bases GIS
2. Inventory, Prediction and Measurement	data structuring; estimation and quantification of impacts	Spread sheets to organise data, e.g. GAIA Models to predict impacts GIS
3. Interpretation and Evaluation	normalisation data; assigning weights; rankings and ratings; sensitivity analysis	MCDM/MCA, e.g. VISPA, EXPERT CHOICE or DEFINITE GIS/MCA, e.g. ARCMER

In fact, as can be seen from this diagram, GIS can be used in all phases of EIA. Numerous GIS packages are used or specifically developed or adapted for EIA studies or elements of it, but the most common GIS software systems used at ITC are ILWIS, ArcInfo, ArcView and IDRISI.

GAIA

The software package GAIA (Guida all'Analisi di Impatto Ambientale) was developed in Italy to perform the following tasks:

1. One of the first steps to be taken in an EIA is the **formulation of alternatives** on the basis of (after Beinat, 1993):
   - the project
   - the environment
   - the actors of the process
   - the scenario

2. The **problem structuring** and **organisation of information** is based on **ONE** matrix for **EACH** alternative. The fundamental operations are:

   ⇒ dis-aggregation (to indicate elementary causes of impacts and elementary impacts)
   ⇒ estimation and prediction of impacts
   ⇒ aggregation (to reduce the amount of data to a reasonable amount for decision making).

3. For the comparison of the proposed alternatives a **synthetic impact matrix** is constructed, which contains all the alternatives. This synthetic impact matrix can be used as input for
   further analysis with the software programmes VISPA or DEFINITE.

In Appendix G an example is given of the different phases of GAIA, based on a simulated project for a new highway. GAIA has the following features:

- it works with components
- it combines components into alternatives
- it offers the possibility of adding information to any items
- it includes a vocabulary manager for the translation of qualitative data into numbers
- it includes an aggregation manager with several aggregation rules (average, weighted average, sum, linear function, qualitative, analytic, etc)
- it prepares a report - on file or printer - of all parts of the study.

The sequence for each component is schematically presented as:

1. BASIC MATRIX (indication of impacts)
   ↓ DISAGGREGATION
2. ANALYSIS MATRIX (estimation of impacts)
   ↓ CONVERSION QUALITY --> QUANTITY
3. QUANTITATIVE MATRIX (vocabularies)
   ↓ AGGREGATION
4. SYNTHETIC MATRIX (impact matrix for all alternatives)

EXPERT CHOICE

Expert choice is s system for the analysis, synthesis and justification of complex decisions and evaluations. It is based on the Analytic Hierarchy Process (AHP), in which data, thoughts and views can be organised in logical, hierarchical structure. The relative importance, preference or likelihood of all the factors can be assessed using pairwise comparisons. AHP accommodates uncertainty and allows for revision so that the individuals or groups van grapple with all their concerns. The results of an AHP evaluation can easily be tested for sensitivities to changes in assumptions and judgements.

The model structure is based on nodes, starting from the objectives nodes below the goal, and alternative nodes below each objective node. More complex models may have additional nodes to represent further breakdowns of the main objectives into sub-objectives. Each node can branch to as many as seven nodes in the next lower level. Each of these nodes can have seven branch nodes, and so on. In this way, Expert Choice is capable of modelling large problems (thousands of nodes).

VISPA

The software package VISPA (Valutazione Integrata per la Scelta tra Progetti Alternativi) was also developed in Italy to perform multiple criteria analysis. VISPA is much simpler than GAIA. Its structure is based on a main menu from which all the operations start:

1. Data input (impact matrix)
2. Normalisation (standardisation of impact scores)
3. Utility functions (standardisation of impact scores)
4. Aggregation
5. Dominated alternatives
6. Weight assessment (direct or pairwise comparison)
7. Sensitivity analysis
8. Concordance and discordance (other ranking methods)
9. Weak dominance (outranking)
10. Ranking (overview of all ranking methods used)
11. Discharging
12. Quit (return to DOS)

DEFINITE

DEFINITE is a Dutch software package designed to support DEcisions on a FINITE set of alternatives in relation to a finite set of criteria. The system can be used to support a variety of environmental planning problems as well as to support the whole decision process: from problem definition to report generation (Janssen & Herwijnen, 1992). In DEFINITE the focus is on methods to support the choice phase.
The system performs the following functions:

1. Problem definition (structure the problem and generate alternatives)
2. Problem presentation (compare alternatives)

3. Problem evaluation (rank and/or value alternatives)
4. Sensitivity analysis (support interpretation of results)
5. Report generation (present results)

In Appendix H1-10 a description of the different modules of the DEFINITE programme is given.

The major difference between VISPA and DEFINITE is that VISPA offers the possibility of using utility functions to perform the normalisation, while DEFINITE allows for the comparison of various multiple criteria analysis methods and for a quite extensive sensitivity analysis.

ARCMER

ARCMER is a software package developed in the Netherlands in 1992 by a privet consultant, the Grontmij, as a kind of macro of ArcInfo. Unfortunately there is only a Dutch version of the software available.
ARCMER offers the opportunity to assess in a standardised way the relative suitability of an area for a spatial function (e.g. housing, gravel extraction). The assessment may take place considering different environmental aspects (themes), like physical environment, economy, and quality of life. By assigning different criteria scores and weights to the different environmental effects, different spatial scenarios can be formulated, analysed and presented. Besides, ARCMER is able to assess and present differences in suitability of alternative solutions. All the results are presented graphically with maps.
The first EIA application with ARCMER was the EIA for new housing sites in Twente (Twente Conurbation). More details about the ARCMER procedure are given during the case study Twente Conurbation that is a simulation of this EIA project.

12. COMPARATIVE REVIEW OF EIA SYSTEMS

Wood (1995, pg. 289) summarised several developments in EIA that have taken place as experience with the use of EIA increased:

- increasing emphasis on the relationship of EIA to its broader decision-making and environmental management context
- increasing codification of EIA requirements
- increasing adoption of additional EIA requirements
- increasing emphasis on maximising the benefits and minimising the costs of EIA
- increasing recognition that some form of strategic assessment is necessary.

By comparing the performance of the EIA systems in seven different countries using a wide range of evaluation criteria, the overall performance of those seven systems could be defined and shortcomings identified. In Table 12.1 the overall performance of the seven EIA systems is summarised.

Table 12.1 The overall performance of seven EIA systems (Wood, 1995, pg. 291)

Evaluation criteria	Criterion met within jurisdiction					
	United States	United Kingdom	Holland	Canada	Australia	New Zealand
Legal basis						
Coverage						
Alternatives in design						
Screening						
Scoping						
Content of EIS						
Review EIS						
Decision making						
Monitoring						
Mitigation						
Consultation & participation						
System monitoring						
Costs & benefits						
Strategic EIA						

There are some evident differences in the performance of the seven EIA systems, except for the one based on the criterion legal basis. All the seven countries meet this criterion. The EIA system in the Netherlands meets almost every one of the evaluation criteria. Only the criterion monitoring is partially met, which in this case means the legal provisions are met, but implementation falls short. The performance of the UK EIA system is worst of all the seven systems, followed by that of Australia.

General shortcomings in the current state of EIA practice can be summarised as weaknesses in (Wood, 1995, pg. 298):

- coverage
- integrating EIA in decision making
- impact monitoring and enforcement
- public participation
- system monitoring
- SEA

In addition there are weaknesses in the quality of many EIA reports.

12.1. EIA in developing countries

Some ten years after NEPA, the concept of EIA reached the less developed regions of the world. And just as there exist big differences between EIA systems in the more developed countries - where some countries still have not adopted EIA- so are there large variations between the less developed countries (Wood, 1995).
In the latter, the first EIA's to be carried out were usually demanded by development assistance agencies on a project-by-project basis, not as a response to improve environmental conditions. However, the EIA requirements in countries like Colombia (1974) and the Philippines (1977) pre-date those in many developed countries.
Apart from the continuing international co-operation and technical assistance in the field of EIA, the main bottlenecks that limit the effectiveness of the assessment process are the institutional and political aspects of EIA. Palewas (1994) distinguishes between internal factors and more legitimate reasons limiting a comprehensive EIA development.

Internal factors:

- lack of political will to integrate EIA into planning and decision making
- the authoritarian character of governments contradictory to the democratic process of EIA (availability of environmental information and public participation)
- lack of a broader environmental policy context and deficiencies in the legislative framework
- lack of an integrated environmental legislation
- inconsistency in coverage, responsibility and authority within environmental planning and management.

More legitimate reasons:

- lack of baseline information may cause unacceptable delay of the proposed action
- costs of a full EIA may be too high for weak economies
- external assistance in EIA may have misapplications (e.g. ignorance of social site conditions)
- a comprehensive environmental policy is out of priority in fragile political systems under the pressure of need for economic growth.

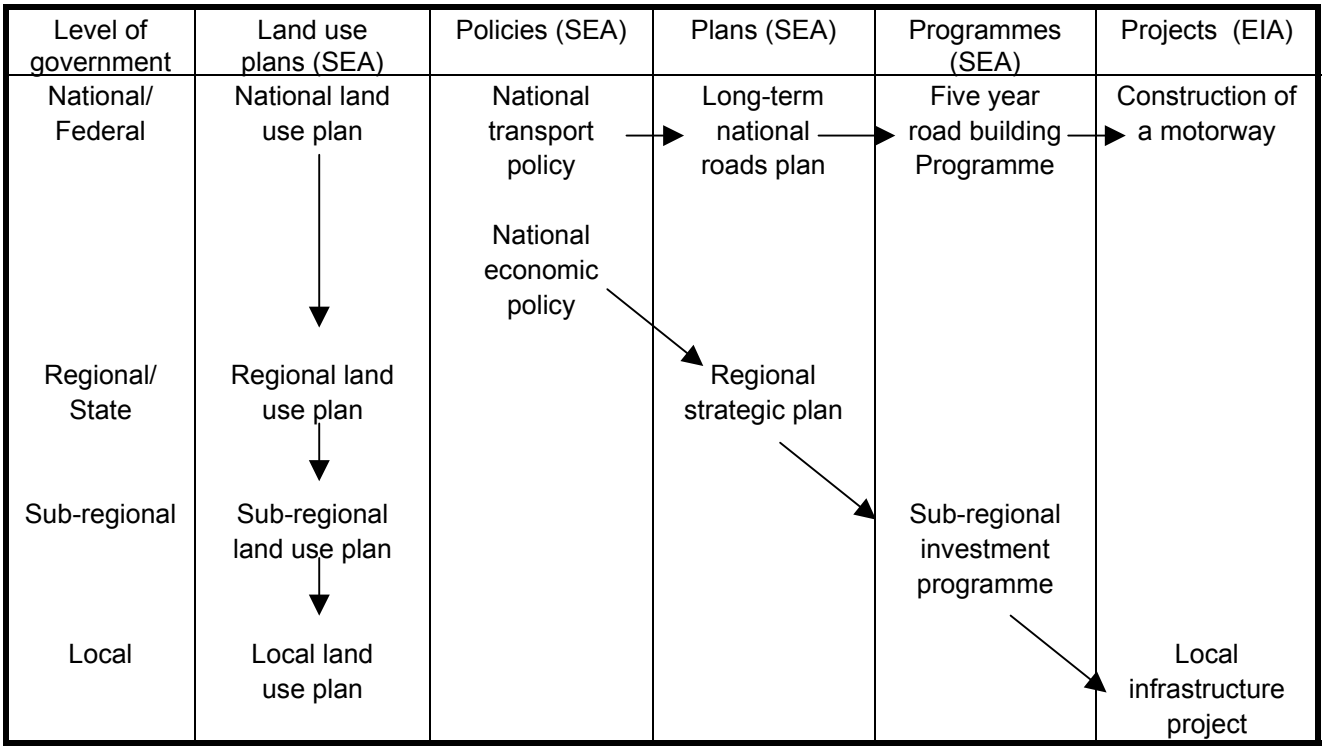
An analysis of the environmental assessment processes of developing countries indicates that the Asian countries have been at the forefront of this type of environmental review. An assessment of the quality of these EIA studies and their overall effectiveness show some very mixed results. There is an urgent need for an objective and reliable review of the current status of the effectiveness, the methodologies used, their relative merits and constraints, the main features of their implementation processes and the institutional arrangements within which such assessments are carried out (Biswas, 1992).

A detailed description of EIA systems in Europe, the Scandinavian countries, North America, and Asia and the Pacific can be found in Gilpin (1995), including the procedural process and a number of case studies.

13. STRATEGIC ENVIRONMENTAL ASSESSMENT (SEA)

The widespread acceptance of the usefulness of EIA in improving the quality of decisions about proposed projects has led to the consideration of, and some practice in, strategic environmental assessment of policies, plans and programmes. This is the consequence of the growing belief that project EIA may occur too late in the planning process to ensure that all the alternatives and impacts are adequately considered (Wood, 1995).
In general there exists a tiered forward planning process, which starts with the formulation of a policy plan, is followed by a plan at the second stage, and by a programme at the end (Figure 13.1, source Wood, 1995).

Figure 13.1 Chronological sequence of actions within a comprehensive EIA system (Source: Wood, 1995).



- Policy: the inspiration and guidance for action
- Plan: a set of co-ordinated and timed objectives for implementing the policy
- Programme: a set of projects in a particular area.

Such a comprehensive EIA system can apply at the national level, and also may apply at regional and local levels. It can apply to all sectoral actions and to physical planning actions. At present there is a general acceptance throughout the world to take the environment into account earlier in the planning process. In table 13.1 the potential benefits of SEA are summarised. The direct and indirect impacts of higher order actions are shown in Figure 13.2.

Table 13.1 Potential benefits of strategic environmental assessment (Wood, 1995)

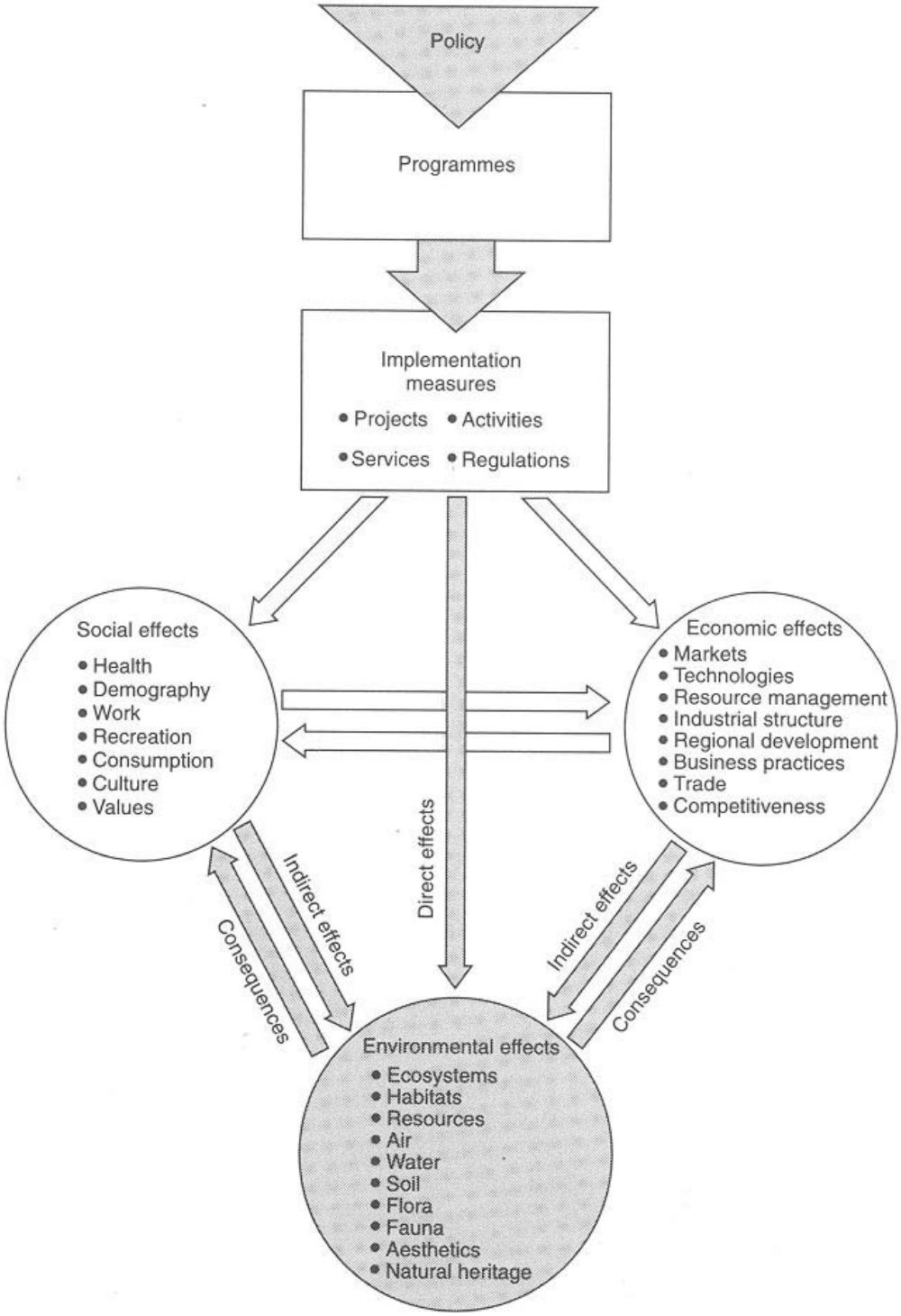
- Encourages the consideration of environmental objectives during policy, plan and programme-making activities within non-environmental organisations.
- Facilitates consultations between authorities on, and enhances public involvement in, evaluation of environmental aspects of policy, plan and programme formulation.
- May render some project EIA's redundant if impacts have been assessed adequately.
- May leave examination of certain impacts to project EIA.
- Allows formulation of standard or generic mitigation measures for later projects.
- Encourages consideration of alternatives often ignored or not feasible in project EIA.
- Can help determine appropriate sites for projects subsequently subject to EIA.
- Allows more effective analysis of cumulative effects of both large and small projects.
- Encourages and facilitates the consideration of synergistic effects.
- Allows more effective consideration of ancillary or secondary effects and activities.
- Facilitates consideration of long range and delayed impacts.
- Allows analysis of the impacts of policies, which may not be implemented through projects.

The main elements of the EIA process and its output, the EIA report, are in principle applicable to all levels of decision-making, including policies, plans and programmes. In practice, it is likely the scope and purpose of the SEA of policies, plans and programmes will be different from that of projects in five main ways:

- The precision with which spatial implications can be defined is less.
- The amount of detail relating to the nature of physical development is less.
- The lead-time is greater.
- The decision-making procedures and the organisations involved may differ, requiring a greater degree of co-ordination.
- The degree of confidentiality may well be greater.

These variations indicate that the nature of SEA will differ in detail from the nature of EIA projects. If alternatives are adequately assessed and if all the significant impacts are examined in project EIA, then there is no need to carry out a SEA. In may countries where there is already a project level EIA system, the most sensible course of action might be to supplement these EIA's with higher tier SEA's largely confined to issues, such as cumulative impacts, which can not be adequately assessed at the project level.

Figure 13.2 Direct and indirect effects of policies and programmes (in Wood, 1995, pg. 269)



14. GLOSSARY OF MAIN TERMS USED IN EIA STUDIES

Abiotic
Non-living

Activity or **action**
An activity or action subject to EIA, may either include a policy (including legislation), a plan (including strategic and local land use plans and programmes) or a proposed project (normally involving construction, engineering or other works) (ERL, 1981).

Alternatives
Alternative means of achieving the objectives of an activity, including alternatives to the proposal and alternative means of achieving this proposal (alternative sites, processes, schedules, etc.) (ERL, 1981).

The ***zero*** or ***no-action*** or ***no-go*** alternative is required to consider the existing trends in impacts and as a reference for other alternatives.
The most environmental friendly alternative is taken to mean not only enhancement of the end-of-pipe technology (e.g. technical measures to treat the residual waste of the activity), but rather the environmental friendly changes in technology, energy and raw material consumption, effective recycling and waste disposal (Cmer, 1994, in: Palewas, 1994, pg. 34)

Biosphere
The area near the earth's surface where all living organisms are found, including portions of the hydrosphere, atmosphere and crust (Anderson, 1993).

Biota
All living organism - plant and animal- in a region (Anderson, 1993).

Cause
The characteristic of an activity that causes an effect in the environment (ERL, 1981).

Community
All populations in a defined area.

Criterion
The environmental characteristic (***parameter***) predicted or measured to indicate the magnitude of the impact (ERL, 1981).

A principle or standard that can be measured and evaluated.

Criterion score
The expression of the magnitude or significance of an impact in numerical units.

Decision
A choice between alternatives. Alternatives may represent different courses of action, different policies, different land allocations (sites), etc. Evaluation of alternatives is based on specific criteria.
Ecology

The study of the relationships of an organism or a group of organism to each other and to its environment.

Ecosystem
Biotic community and its abiotic environment (Krebs, 1978).

The living and non-living components of the environment functioning together (Anderson, 1993).

A structural unity of communities and their living and non-living environment. This may include both the abstract terminology for a tropical rainforest as well as a defined region (CECOS, 1986).

Effect
A change in the environment caused by an activity, which in turn may cause an impact (ERL, 1981).

The measurable changes in the state of the environment resulting from a project or action.

Environment
The whole complex of physical, social, cultural, economic and aesthetic factors which affect individuals and communities and ultimately determine their form, character, relationship and survival (Rau, 1980).

The total of all those physical, chemical, biological and social economic factors that impinge on an individual, a community or a population (Biswas and Geping, 1987, pg. 196).

Environmental analysis
The systematic examination of proposed development activities with a view to deciding how to make them environmentally sound and sustainable (EEC,?).

Environmental evaluation
Evaluation involves assigning values to express the significance of potential impacts (ERL, 1981).

Environmental Impact dimensions
The way in which impacts are expressed; the dimension may be a single impact parameter (e.g. SO2 concentration) or a combination of impact parameters grouped into an ***index*** (e.g. an air pollution index based upon SO2, smoke and nitrogen oxides) (ERL, 1981).

Environmental Impact Index (EII)
The integrated results of all impacts of the project (Petry & Boeriu, 1995).

Environmental Impact Assessment (EIA):

An activity designed to identify, predict, interpret and communicate information about the impact of an action on man's health and well being (including the well being of ecosystems on which man's survival depends). Actions (of men) compass legislative proposals, policies, programmemes, projects and operational procedures. (Munn, 1975; SCOPE-5).

A comprehensive evaluation of the effects of human development activities or non-action on the various components of the environment. EIA is also used synonymous for Environmental Assessment (EA) and
Environmental Appraisal (EA) (Biswas and Geping, 1987).

A process whereby an assessment is made of the environmental impact which may be expected to result from the activity alternatives. An EIA will include a pre-study, a study and a post-study period (ERL, 1981).

A formal procedure for identifying and predicting the environmental effects of a proposed activity and assessing the significance of the net impact compared to other options (EEC,?).

An integrated part of the planning process devoted to the identification, quantification and qualification of environmental impacts due to a development action, as well as the definition of policies and strategies required to monitor and control such impacts (Petry & Boeriu, 1995)

Environmental Impact Statement (EIS)
A document or report that contains the results of an EIA study. In the USA it should be written in the format as formulated by NEPA, CEQ guidelines and specific agency guidelines. It should represent a summary of the environmental inventory and the findings of the environmental assessment.
NEPA stands for National Environmental Protection Agency, established in 1970 as the regulatory agency of the USA. It reviews EIS's prepared by others.
EIS is also used synonymous for Environmental Statement (ES), Impact Statement (IS), Environmental Impact Reports (EIR) or 102 Statements (in the USA) (Biswas & Geping, 1987).
In the Netherlands MER (Mlieu Effect Rapport) is the result of an Environmental Impact Assessment process or m.e.r. (milieu effect rapportage).

Environmental inventory (EI)
A complete description of the environment of an area where a particular proposed action is being considered. This serves as a basis for evaluating the potential impacts on the environment (both beneficial and adverse) of a proposed plan of action.
Such an inventory may be compiled from a checklist of descriptions for the physical, biological and cultural environment.
Other terms that are considered similar are: Environmental Baseline Study (EBS), Environmental Identification (EI) and Environmental Setting (ES) (Biswas & Geping, 1987).

Environmental planning:

I. From the politician's point of view:
The process of identifying activities which contain significant threats to environmental quality and taking steps to develop and use appropriate environmental planning instruments to protect or improve environmental quality.

II. From the planner's point of view:
The methodical pre-definition of future actions judged to have preferred consequences. Environmental planning is the process of methodically deciding how a particular environmental control instrument will be used to maintain or improve some community's

environmental quality (Basinski & Cocks, 1984).

All activities involved in regional and national planning for the future (Munn, 1975).

Environmental profile
A document describing the environment of a geographical region.
Such a description is in a pragmatic way, based on ecosystem studies of the concerning area, determined by identification, assembling, correlation and evaluation of relevant environmental factors. The document includes a
description of available ecosystems, of vulnerable environmental situations and environmental risks at certain interventions, of the possibilities and limitations of production functions, of land use and other utilisation of (non-) renewable resources and of the relevant socio-economic factors.
Conclusions and recommendations are presented by indication of vulnerable areas, of risk carrying projects and of environmental saving measurements. If possible, guidelines for environmental policies are formulated (CECOS, 1986).

Guidelines
Guidelines are designed to provide rules or guidance for carrying out EIA's. Governments usually formulate them. They may be general (covering all EIA's for all types of activities) or specific (referring to the EIA for a particular activity). They may be procedural and/or technical (ERL. 1981).

Impact
The consequence of a change in environmental conditions affecting man, man's use of the environment, natural systems or resources (ERL, 1981).

The net change (good or bad) in man's health and well-being (including the well-being of the ecosystems on which man's survival depends) that results from an environmental effect and is related to the difference between the quality of the environment as it would exist "with" and "without" the same action (Munn, 1975).

Any alteration of environmental conditions or creation of a new set of environmental conditions, adverse or beneficial, caused or induced by the action or set of actions under consideration (Rau, 1980).

The total effect of an environmental change, either natural or man-made, on the ecology of the area (World Bank, 1992).

Impact parameter
The environmental characteristic (***criterion***) predicted or measured to indicate the magnitude of an impact (ERL, 1981).

Initial Environmental Examination (IEE)
A preliminary attempt to evaluate environmental impacts to determine whether a full-scale environmental impact assessment is needed. Also called: Initial Environmental Investigation (IEI), Partial EIA or Preliminary EIA (Biswas & Geping, 1987).

Preliminary (environmental) assessment (PA) which is called IEE in Canada and EA (Environmental Assessment) in the USA, and which is the most sophisticated form of

screening (Palewas, 1994).

Magnitude
The size of an environmental impact (ERL, 1981).

Mitigation
A measure taken to control adverse impacts (intensity, area or influence). Measures may be preventive, corrective and compensatory (Petry & Boeriu, 1995).

Multiple criteria evaluation (MCE)
The procedure in which several criteria are evaluated to meet a specific objective.
Two most common MCE methods are:

- Weighted summation; each factor is multiplied by a weight and then summed to arrive at a final suitability index.
- Concordance-discordance analysis; each pair of alternatives is analysed for the degree to which one outranks the other on the specified criteria.

Proponent
The individual or group proposing the activity (ERL, 1981). Synonymous with initiator.

Ranking:
The simple ordering (1st, 2nd, 3rd, etc.) of alternatives according to significance of impact (ERL, 1981).

Rating:
The verbal or numerical description of alternatives according to the significance of impact (see verbal scales and scoring) (ERL, 1981).

Scope
The requirements for an EIA, which may concern the alternatives or issues to be examined, the content format and timing for the EIS, methods to be used, etc. for a particular activity (ERL, 1981).

Scoping
The process whereby the **EIA scope** is established. Scoping is also a term used to describe the formal procedures adopted during the pre-study period with particular reference to identification and selection of alternatives and agreement on terms of reference for the EIS (ERL, 1981).

Screening
A procedure to select if a proposed activity requires EIA, before a full and detailed assessment process starts. Screening has two main objectives within the EIA process:

- clear identification of projects requiring EIA
- quick and easy operation in order to avoid unnecessary delay in the process (Tomlinson, 1984).

Secondary effects
Secondary effects derive from activities that arise as a consequence of the original activity (ERL, 1981).

Significance
The importance of an effect, impact or other factor in the assessment. Significance may be evaluated during the study or determined prior to the study (e.g. by standards, or other environmental constraints) (ERL, 1981).

The importance (interest, value or concern) of an impact to humans (Palewas, 1994, pg. 12).

Verbal scales:
The verbal description of alternatives according to the significance of impacts (e.g. no impact, slight impact, moderate impact, and severe impact). This may be done using verbal terms or these terms may be translated into letters, numerals or symbols to represent the verbal scale (ERL, 1981).

Weighting
The assessment of the relative significance of different impacts to enable the amalgamation of impacts. In explicit weighting, numerical weights are assigned to each impact dimension to allow weighting and summation of scored impacts. In implicit weighting the process occurs informally within the responsible group (ERL, 1981).

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16. APPENDICES A-H