STELLINGEN

1 Om het streven naar duurzame ontwikkeling op projectniveau vorm te kunnen geven, is het noodzakelijk naast doelmatigheid en (intratemporele) verdeling, ecologische duurzaamheid als (hoofd)toetsingscriterium te beschouwen.

2 Het sterk toegenomen belang dat beleidsmakers aan milieuaspecten van ontwikkelingsprojecten toekennen, moet leiden tot aanpassingen in de keuze van beoordelingstechnieken. De nu beschikbare handboeken op dit terrein zijn toe aan een grondige herziening omdat zij het gebruik van kosten-baten analyse (KBA) centraal stellen, terwijl een gecombineerde toepassing van KBA en multi-criteria analyse (MCA) de richtlijn zou moeten zijn.

3 De vraag of toepassing van KBA een nuttige bijdrage kan leveren aan de besluitvorming over een ontwikkelingsproject, hangt in sterke mate af van de doelstellingen van beleidsmakers, het belang van een project voor andere groepen in de maatschappij, en de beschikbare informatie over criteriascores in fysieke en monetaire termen.

4 De samenstelling van een multi-disciplinair onderzoeksteam is een noodzakelijke maar onvoldoende voorwaarde voor toepassing van het systeem van op duurzaamheid gerichte projectbeoordeling. Een tweede, in de praktijk vaak onvervulde voorwaarde is de beschikbaarheid van een methodologisch raamwerk waarbinnen de verschillende specialisten kunnen en willen samenwerken.

5 Een zinvolle vorm van ontwikkelingssamenwerking bestaat uit de verstrekking van fondsen voor op korte termijn financieel onrendabele, maar economisch en ecologisch wenselijke activiteiten.

6 Zowel economische als ecologische argumenten pleiten tegen de aanleg van een spaarbekken in het huidige Lake Burullus (Egypte).

7 De vraag of het "bilaterale ontwikkelingscontract" een haalbare en wenselijke constructie vormt, zal slechts in beperkte mate beantwoord worden via de door het Directoraat-Generaal Internationale Samenwerking (DGIS) opgezette experimenten met de in geografisch en economisch opzicht kleine landen Benin, Costa Rica en Bhutan. Landen als Nigeria, Brazilië en India zouden in dat opzicht aanzienlijk interessanter zijn geweest.

8 Het wegen van diverse welzijnsaspecten voor een land door middel van een multi-dimensionele maatstaf, zoals de door het UNDP ontwikkelde Human Development Indicator, verdient de voorkeur boven het herleiden van alle aspecten op één noemer, namelijk geld.

9 Bij een correcte toepassing staat de zogeheten O-toets van het DGIS op gespannen voet met de wens het jaarlijkse budget voor het eind van het jaar volledig te besteden.

10 Zonder onderzoek naar "fungibiliteit" is het onmogelijk de effectiviteit en doelmatigheid van ontwikkelingshulp te bepalen.

11 Naast AIO's en OIO's zouden Docenten In Opleiding (DIO's) geïntroduceerd moeten worden ter onderstreping van het belang van kwaliteitsverhoging van het universitaire onderwijs.

12 De financiële draagkracht van een organisatie die zich met een vraag tot een Wetenschapswinkel wendt, zou een criterium moeten zijn voor de bepaling van de bijdrage van die organisatie aan de onderzoekskosten, in plaats van een toetssteen voor de beslissing de vraag al dan niet in behandeling te nemen.

13 Waar boetes onvoldoende helpen, is de al dan niet tijdelijke montage van een snelheidsbeperker in de auto een doelgerichte en doeltreffende sanctie voor automobilisten die regelmatig betrapt worden op snelheidsovertredingen.

14 Mensen die zich bij hun buren beklagen over geluidsoverlast wordt vaak verweten dat zij overgevoelig voor geluid zijn, terwijl met even veel recht gesteld kan worden dat de veroorzakers van geluid bang voor stilte zijn.

15 Omdat buitenlandse reizen sterk bijdragen aan vergroting van zelfkennis en kennis van de eigen cultuur, zijn recente pleidooien om het vliegen terug te dringen te betreuren.

16 Omdat veel luchtvaartmaatschappijen vegetarisch als veganistisch interpreteren, blijven veel lacto-vegetarische reizigers tot hun ongenoegen verstoken van hoofdelementen in hun menu als boter, kaas en eieren.

Michiel J.F. van Pelt
Stellingen bij het proefschrift
Sustainability-oriented project appraisal for developing countries
Wageningen, 9 juni 1993

MICHIEL J.F. VAN PELT

SUSTAINABILITY-ORIENTED PROJECT APPRAISAL FOR DEVELOPING COUNTRIES

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MICHIEL J.F. VAN PELT

SUSTAINABILITY-ORIENTED PROJECT APPRAISAL FOR DEVELOPING COUNTRIES

PROEFSCHRIFT

ter verkrijging van de graad van
doctor in de landbouw- en milieuwetenschappen
op gezag van de rector magnificus,
dr H.C. van der Plas,
in het openbaar te verdedigen
op woensdag 9 juni 1993
des namiddags te half twee in de Aula
van de Landbouwuniversiteit te Wageningen

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CONTENTS

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This study was not the only factor that caused turbulency in my life during the last four years. I am grateful for the warmth and support relatives and friends have given me in that period.

Rotterdam, April 1992

1. SCOPE AND AIM OF THE STUDY

1.1. Sustainable development, project appraisal and developing countries

This study revolves around three issues: ecologically sustainable development, developing countries and project appraisal. The objective is to arrive at an outline of sustainability-oriented project appraisal for developing countries, encompassing these issues simultaneously. In this introductory chapter, they will be reviewed pair-wise, in terms of both main topics and their treatment in the economic literature.

Sustainable development and developing countries

While several decades passed between the introduction of the concepts of "spaceship earth" and "global sustainability", they both express the idea that mankind should respect environmental boundaries in order to survive[1]. Particularly over the last decade, a worrying number of environmental problems have aggravated, strongly suggesting that increasingly such boundaries have been exceeded.

Environmental decay is not exclusively a problem of the present days. In ancient times the Greek philosopher Plato complained already about human interventions that had turned the landscape of Attica into a skeleton. Also in the medieval period we find many examples of environmental externalities, e.g. in cities where horse-driven carriages were forbidden during parts of the night. A well-known example is also the prohibition on burning certain types of smoky coal in London.

The scene of the past has changed, however (see for instance, World Resources Institute, 1991). This concerns both the nature of environmental problems, as well as the scale at which they occur. The intensity and threats of environmental pollution have dramatically increased, especially because of the emission of non-bio-degradable pollution (e.g. toxic substances, persistent micro-pollutants such as pesticides and herbicides, etc.); these pollutants may also endanger human health. There is also the awareness of global environmental changes (e.g. desertification, acidification, deforestation, climate change, ozonization). These changes will have a long-term impact on environmental conditions on earth over a time span which goes far beyond traditional time horizons.

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1 In this study "environment" refers to the bio-physical environment.

These problems would probably not have received the present international attention if not for the fact that environmental degradation increasingly erodes income opportunities and human welfare in more general terms. The name given to the United Nations Conference on Environment and Development (UNCED), held in 1992 in Brazil, provides an excellent illustration. Problems particularly appear in low-income countries, where large parts of the population still depend on the natural resource base. The concept of sustainable development represents the challenge to reconcile the objectives of maintenance of the long-term ecological resource base and short-term economic development. Sustainable development is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". This definition is taken from the report *Our common future*, prepared by the Brundtland Commission (WCED, 1987). "Needs" may be interpreted in terms of social welfare levels; "ability", among other things, refers to the availability of ecological resources. *Ecologically* sustainable development, on which this study focuses, would require that the present generation puts limits on its use of such resources.

The Brundtland report has played a catalytic role in the dissemination of the concept of sustainable development both in the developed and the developing world. It has contributed greatly to putting the relation between economics and environment -once more- at the top of the political agenda (witness UNCED). Many governments have made sustainable development a key policy goal, and are now trying to incorporate "new" sustainability concerns in socio-economic policies.

Poor countries face the most daunting challenge in this respect. Within countries, the poor often are the greatest victims of environmental degradation. At the same time they have few resources available to invest in ecologically sound development strategies. Especially in developing countries, the sustainability concept provides a linkage between poverty, distribution and environment.

In the economic literature environmental deterioration has long been regarded as a peculiarity, which did not belong to the heart of economics. With the exception of Marx (who recognized the poor quality of life conditions of the working class), environmental externalities were mainly treated as an interesting example of social costs (Marshall, Pigou). Only in the post-war period - and in particular since the 1970s - the environment has become a focal point of economic research. This new interest concentrated the attention on both the (individual and social) welfare aspects of environmental decay and the empirical-analytical assessment of social costs involved (e.g. via extended input-output analysis, material-balance models, etc.).

Until recently, the relation between environment and economics did not receive much attention in the literature on developing countries. There was little cross-fertilization between, on the one hand, environmental and natural resource economics, and, on the other hand, development economics[2].When Dasgupta and Mäler (1991) reviewed a number of well-known textbooks (late 1980s editions), they hardly found any reference to the issue of natural resources. Like in other disciplines, however, "sustainable development" has rapidly become a catchword in research programmes, not excluding those for development economics. Since the late 1980s and early 1990s, many important contributions have been made[3].

Sustainable development and project appraisal

The WCED definition of sustainable development is fairly clear and conceivably appeals to many. At the same time, its limitations in practical decision-making should be acknowledged. It does not satisfactorily answer the questions of how to define sustainability in practice, and of how to treat trade-offs with other objectives. An important new element in recent research in environmental economics -in comparison to the literature published particularly in the 1970s and 1980s- refers to the operationalization of the notion of sustainable development, and its incorporation in economic models and theories. The overwhelming number of definitions (for an excellent overview, see Pezzey, 1989) clearly shows that defining sustainable levels of resource use is a normative affair (Opschoor and Reijnders, 1991).

Sustainability can be expected to become an increasingly important criterion in policy-making at all levels between the global and the local level. Until now, research has emphasized sustainability at the global and national level. Much less attention has been given to the question of how to operationalize the sustainability notion at the levels of sectors and regions (meso level) and of projects (micro level), at which many and perhaps most policies and investment decisions are directed. Some attempts have been made to incorporate sustainability concerns in regional or spatial economics theories (Nijkamp, Van

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2 Textbooks on environmental and resource economics include Nijkamp (1977), Hueting (1980), Seneca and Taussig (1984), Kneese and Sweeney (1985), Pearce, Barbier and Markandya (1991), Cropper and Oates (1992) and Pearce, Turner and Bateman (1992). Development economics textbooks include Chenery and Srinivasan (1988), Gilles et al. (1992), and Todaro (1989).

3 Including Warford, (1986, 1987), Schramm and Warford (1989), Archibugi and Nijkamp (1989), Daly (1989), Pearce, Barbier and Markandya (1990), Goodland, Daly and El Sarafy (1991), Dasgupta and Mäler (1991), and World Bank (1992).

den Bergh and Soeteman, 1991; Rees, 1988). The present study is concerned with the question of how the sustainability concept may affect the economic appraisal of activities at the *project* level.

The greatest part of the literature on environment and project appraisal has been concerned with the valuation of economic effects in cost-benefit analysis (CBA)[4]. It will be argued in this study that, while the valuation of environmental impacts in a CBA framework is important, several other sustainability-related issues need to be addressed. First, the sustainability concept may drastically alter the *format* of project appraisal studies, i.e. new types of questions may need to be addressed. Second, as a result, the applicability of CBA to this new type of appraisal needs to be investigated, and other *methods* may be analyzed regarding their potential to complement CBA. In this study CBA will be compared with multi-criteria analysis (MCA)[5]. Both methods aim at facilitating the selection of projects, but they differ in terms of methodology, data requirements and valuation mechanisms. Differences in applicability of CBA and MCA depend to a great extent on case-specific features in terms of preferences of decision-makers and available information about project impacts.

Project appraisal and developing countries

The appraisal of projects in developing countries has received much attention in the 1970s and 1980s, strongly stimulated by the emphasis on projects in aid programmes of multilateral and bilateral donor agencies. Economic appraisal of projects has focused on allocative efficiency: how to maximize aggregate welfare, given available resources. CBA has been routinely been applied by many aid agencies and governments of developing countries. They tend to use a special CBA version that differs in several respects from traditional CBA, as applied in the developed world. To account for the specific characteristics of economies and societies of developing countries, several features of the former version deserve attention[6]:

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4 For instance Hufschmidt et al. (1983), Dixon et al. (1989); Bojö, Mäler and Unemo (1990), Mikesell (1991); Munasinghe (1992); Hanley (1992); Barbier et al. (1991).

5 For overviews, see Voogd (1983); Nijkamp, Rietveld and Voogd (1990); Janssen (1992).

6 The traditional approach is represented by among others Mishan (1988) and Drèze and Stern (1987). The CBA version for developing countries was primarily developed by Little and Mirrlees (1974); Squire and Van der Tak (1975); and Dasgupta, Marglin and Sen (1972). For more recent treatments, see, for instance, Ray (1984); Kuyvenhoven and Mennes (1985); Sang (1988); Squire (1989), Brent (1990); Little and Mirrlees (1991); Van Pelt and Timmer (1992).

- World market prices are commonly recommended as a valuation basis, rather than domestic prices. This is a response to serious market distortions in many developing countries.
- In many developing countries (and regions), the existing distribution of income is relatively unequal. Economic CBA ignores distributive aspects, as it only allows an assessment of efficiency. Therefore social CBA has been developed, whereby outcomes of economic CBA are adjusted to account for ethical views on a fair distribution of income (equity). Experience shows, however, a large gap between the theoretical potentialities of social CBA and the actual use of this tool. In practice, this sophisticated approach has nowhere been applied on a large scale. Both economists, faced with enormous data requirements, and policy-makers, who need to make their value judgements explicit in the framework of a rather inaccessible technique, have been reluctant to embark on such an exercise.
- Whereas the theoretical principles for treating externalities, particularly in the field of the environment, were identical to those in traditional CBA, they were to a great extent neglected in standard textbooks for CBA for developing countries. Moreover, applications in developing countries have suffered much more from insufficient data about environmental impacts and their value. Faced with, on the one hand, CBA's requirement to monetize all relevant effects, and on the other hand, the severe difficulties in collecting data on several types of effects, economists have frequently failed to incorporate all costs and benefits of development projects. Particularly environmental effects have often been included as a "p.m." (pro memoria) item.

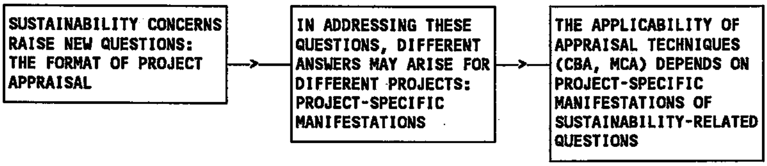
MCA has mainly been applied in the developed world, and experiences with this approach in developing countries are modest. In this study, the applicability of MCA will hence be analyzed from two perspectives simultaneously: the treatment of sustainability-related issues and the special features of developing countries regarding particularly distributive aspects, environmental and socio-economic systems, institutional structures and statistical base.

1.2. Subject and approach

This study is concerned with the question of how to account for objectives in the field of ecologically sustainable development in all phases of (ex ante) project appraisal, with special reference to developing countries. Our aim is to develop a *framework* for what will be termed *sustainability-oriented project appraisal,* which is characterized by a systematic coverage of sustainability issues in all phases. The framework will be particularly focused on characteristics of developing countries[7].

In the development of the framework for sustainability-oriented project appraisal, three questions will be treated in succession: a) which new, sustainability-related issues need to be addressed in each appraisal phase (the *format* of appraisal)?, b) what may be project-specific *manifestations* of these new issues in practice?, and c) to what extent are *appraisal techniques* (CBA and MCA) able to deal with the new format and possible manifestations of sustainability-related issues? Diagram 1.1. summarizes these questions, which are elaborated below.

Diagram 1.1. Major steps in the development of a framework for sustainability-oriented project appraisal



Format of appraisal studies

The format of an appraisal study refers to the set of questions to be covered in subsequent appraisal phases. They are particularly expressed in: the choice of alternatives, the choice of appraisal criteria and the choice of weights (showing the relative priority of criteria). Choices in these fields then guide the structure of remaining issues in appraisal, including impact assessment, and the application of methods such as CBA and MCA.

One of the most important characteristics of sustainability-oriented project appraisal, which affects all appraisal stages, is the explicit role of environmental objectives in decision-making. In a basic criteria set, a sustainability criterion, as a reflection of these objectives, would need to be included in addition to the traditional criteria of allocative efficiency and a fair distribution (intratemporal equity). In contrast to what Little and Mirrlees (1991) seem to suggest,

[7] Despite the emphasis on circumstances typical to developing countries, we feel that much of the analysis may have relevance to project appraisal in developed countries as well. Differences are generally of a gradual, rather than a structural nature.

sustainability is a strongly normative concept[8]. Consequently, in the determination of criteria weights, policy-makers (and other agents in society that may be affected by a project) will often face new types of sensitive trade-offs between the traditional objectives of efficiency and equity and new sustainability concerns. In this study the types of value judgements to be addressed are identified[9]. In the impact assessment phase, the estimation of environmental effects is critical, as it affects the scores on all three key criteria.

Possible manifestations of sustainability-related issues

In addressing key issues, such as criteria, weights and impacts, evaluators may obtain different responses, which are strongly project-specific. The exploration of the ranges of possible responses to each question is an important subject of this study. Some examples are:

- How do policy-makers define the sustainability criterion? What is considered a sustainable level of resource use? At which spatial level is the sustainability criterion applied (global, national or project)? The basic parameters as well as a number of interpretations will be reviewed.
- How do decision-makers (or others in society) judge the relative priority of sustainability versus efficiency and equity? To what extent are they willing to sacrifice short-term financial benefits to achieve long-run ecological sustainability? Basic weighting patterns will be outlined.
- Which difficulties may be encountered in the measurement and valuation of environmental impacts? Under what circumstances is quantification and valuation feasible?

This study emphasizes the applicability of the appraisal framework to developing countries. The institutional context as well as the economic circumstances will often lead to different interpretations of criteria and different weighting schemes in developing and developed countries. Similarly, all other things being equal, the estimation of environmental impacts will more frequently

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8 The authors state that: "'Sustainability' is more of a buzz-word, probably derived from the environment lobby, than a genuine concept. It has no merit. Whether a project is sustainable has nothing to do with whether it is desirable" (page 365).

9 In the literature, the issue of value judgements is often somewhat obscured. Value judgements are sometimes treated implicitly. Or rather than the judgements of policy-makers, those of individual scientists are applied. Scientists should, however, only assist in identification and proper treatment of value judgements, and in showing the results in terms of social welfare changes over time.

result in a set of incomplete, uncertain and qualitative data in many developing countries, because of weaker base-line statistics and less developed models for ecological-economic interaction.

Applicability of appraisal techniques

Appraisal methods are used to obtain the score on a particular criterion (like CBA for efficiency) or to compare the alternatives in terms of their overall performance (for which MCA may be particularly useful). The issues raised by the sustainability concept, as well as the range of their possible manifestations in practice, call for a review of the applicability of project appraisal methods. The key question is: to what extent can a method address the full range of sustainability-related issues, as well as accommodate different, project-specific types of information about these issues. As will be shown, CBA nor MCA performs unequivocally well under all circumstances. Whereas CBA has been applied most often in the past, and for good reasons, it has some important limitations under the new circumstances. MCA methods, being more flexible both with regard to policy variables (criteria and their weights) and impact measurement requirements, would offer better opportunities in these respects, but may suffer from methodological and institutional problems. Therefore, there is a need for problem-specific method selection. A system will be developed that links possible characteristics of sustainability-oriented appraisal studies to corresponding attributes of appraisal methods.

CBA and MCA differ considerably in technical terms, but they address the same substantive question: how, given a set of development objectives, to choose between several (discrete) alternatives? In that sense, CBA and MCA belong to the same family of economic methods, which explains why they are the subject of this study. The reason why this study is confined to CBA and MCA is the lack of other techniques serving the same purpose. For instance:

- Logical framework analysis and related approaches are not economic methods to select projects; they basically prescribe to define a project in terms of objectives, means and results, and to investigate whether these are consistent. No technique as such is incorporated.
- Multi-objective decision-making techniques. These are related to MCA, but are focused on continuous choice problems (i.e. the number of alternatives is infinite). Such techniques hence address a different choice problem than CBA and MCA.

- General-equilibrium models. Such models are usually applied to economic problems at the national level, and not to projects (inter alia because of the immense modelling and data requirements)[10].

It should be noted that a number of techniques may be applied to obtain information that will subsequently be used in CBA or MCA studies. For example, input-output analysis may be used to investigate pollution caused by alternative industrial complexes. The results may consequently be an input into CBA or MCA. If useful, the role of such "support methods" will be indicated in this study.

Differences between developing and developed countries in terms of possible manifestations of sustainability-related issues will translate into different recommendations regarding method selection. For instance, if in developing countries impact assessment will more frequently result in soft information, methods suited to process such data would be recommendable in this respect.

1.3. New elements and limitations of the study

This study aims at integrating presently fragmented knowledge gained in a number of fields, including development economics (key environmental, institutional and economic problems in developing countries), project appraisal for developing countries (CBA), decision-support methods (MCA), environmental economics (valuation of ecological impacts) and ecological economics (interactions between ecosystems and socio-economic systems). Through this integrated approach to the question of how to account for conceptual and empirical problems in the incorporation of sustainability concerns in project appraisal, this study hopes to fill a gap in scientific knowledge. More specifically, the approach has several key elements that clearly distinguishes it from recent work of some scientists, while it may be considered a response to recommendations for further research by others:

- The study responds to the international trend that appraisal of development projects increasingly involves the use of a separate appraisal criterion reflecting environmental concern. In other words, even if environmental impacts are satisfactorily accounted for in a CBA study, decision-making may not be based on its outcome alone. This principle is advocated by many authors in the field of sustainable development, including for instance Pearce, Barbier and Markandya (1990) and Goodland, Daly and El Sarafy (1991). At

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10 The use of general-equilibrium models may be considered in the case of very large projects with significant impacts at the national level.

to prepare a manual for sustainability-oriented appraisal. It is hoped that two important steps are made towards such a manual: a) an exploration of the theoretical basis for sustainability-oriented project appraisal, and b) the development of a system, linking policy issues, possible empirical circumstances, and the applicability of methods. The preparation of a manual would comprise a third and final step.

By definition, this study's relevance is confined to issues at the project level. There may be strong linkages, however, with the problem of how to incorporate sustainability concerns in development programmes at the sectoral or regional level. Our study is complementary to efforts to add the sustainability dimension to, for instance, global environmental management, macro-economics, trade policies and instruments of environmental policy[11].

1.4. Structure and outline

This study consists of a *theoretical and conceptual part* (A) and a part which is devoted to *application* (B). Part A is concerned with developing a framework for sustainability-oriented project appraisal from a theoretical perspective. This implies that a) scientific knowledge gained in the past is used, commented upon and -where feasible- integrated, and b) theoretical justification, comprehensiveness and methodological consistency are more important driving forces than applicability. Part B builds upon part A, in the sense that the theoretical framework is adjusted to account for practical constraints (expertise, time, money, etc.) imposed upon the average appraisal study in a developing country. To achieve this, the practice-oriented framework does not refer to several issues that, although of theoretical interest, are unlikely to come up in the majority of actual appraisal studies. Nor does it elaborate on proposals that, although they make theoretically sense, will not be generally incorporated in actual studies in view of their tremendous requirements in terms of resources. In the process of adjusting the theoretical framework to the reality of actual appraisal studies, an important role is played by lessons from two cases for which the applicability of the theoretical framework was investigated. Part B contains detailed descriptions of these cases, involving environmentally-sensitive projects in Colombia and Egypt.

11 See for instance: Warford (1986, 1987), Repetto (1987, 1988), Collard et al. (1988), Jagannathan (1989), Binswanger (1989), Kanbur (1990), Anderson (1990), Helm and Pearce (1990) and World Bank (1992).

Below a brief outline of each chapter is provided.

Part A: theory and concepts

Ch. 2. *Sustainable development: basic concepts and the position of developing countries*

The main purpose of chapter 2 is to define key concepts in sustainable development, and to outline interrelationships between these concepts. Subsequent chapters will show that these notions comprise the basis for the key decision-making variables in project appraisal studies. Specific features of developing countries regarding linkages between environment and economy, and hence prospects for sustainable development, are sketched.

Chapter 2 defines the main elements in a social welfare function, and shows the dependency of welfare on economic and environmental systems. Development occurs if aggregate welfare increases, which is determined by both man-made goods and services and access to natural resources. Ecologically sustainable development refers to the situation whereby the present generation limits its use of natural resources with the aim of offering future generations the opportunity of achieving morally acceptable welfare levels. The sustainable development concept is hence strongly related to intergenerational equity: how to weigh the interests of present and future generations? Besides intergenerational equity, views on sustainable development are shown to depend on policy issues such as a) trade-offs between elements of the social welfare function, b) the possibility of substituting man-made capital for natural capital in the production of goods and services, and c) the possibility of compensating the loss of one environmental function by enhancing the quality or quantity of another environmental function. Views on such issues strongly determine the question of whether short-term economic and long-term environmental objectives may be reconciled in policies for sustainable development.

It will be shown that developing countries and developed countries face different kinds of problems in terms of causes of non-sustainable development patterns, and the prospects for transforming them into sustainable ones. Basic differences refer to income levels and ecosystems. An analysis of various forms of interaction between economic and ecological systems, however, gives a more thorough understanding of problems in the field of sustainable development: a) environmental problems differ due to differences in socio-economic systems, b) environmental problems have different economic consequences, and c) economic opportunities to combat environmental problems differ.

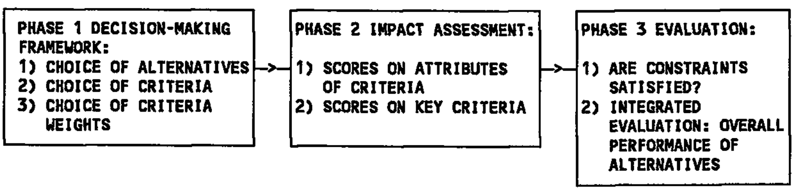
Finally, chapter 2 makes a step towards project appraisal by introducing the spatial dimension of sustainable development. Policy-makers need to decide at which level sustainable development should be achieved, starting with the local/project level.

Ch. 3. *Project appraisal phases and methods: an overview*

Chapter 3 specifies a) main phases in project appraisal, and b) main features of the two appraisal methods dealt with in this study, viz. CBA and MCA. Together, the conceptual chapter 2 and the analytical chapter 3 provide the foundation for following chapters, dealing with the incorporation of sustainability concerns in each appraisal phase, and the applicability of CBA and MCA to sustainability-oriented project appraisal.

The main phases of project appraisal are summarized in diagram 1.2.

Diagram 1.2. Main phases in project appraisal



In the first phase in project appraisal the decision-making framework is defined, comprising alternatives, criteria (reflecting objectives) and weights (the relative priority of criteria). An important question is whether through the use of extreme weights (0 and 1), constraints are imposed on one or more criteria. If so, the scope for trade-offs between criteria is reduced.

In a second phase impacts of alternatives on criteria are assessed. If a certain criterion has several attributes (sub-criteria), scores on these attributes should be estimated first, and be subsequently weighted to arrive at an overall score on the criterion concerned.

The third phase, viz. evaluation, addresses two questions. First, evaluators control whether all constraints (see above) are complied with. If not, the design of the project may be adjusted or additional activities may be undertaken to ensure that the constraint is satisfied in the second round. Here we will use the notion of constraint-satisfying activities. Second, a comprehensive assessment is made of the scores of the (possibly adjusted) alternatives on the complete set of criteria.

Ignoring all other differences, MCA differs from CBA in three respects:
- Type of criteria. In contrast to CBA (focused on efficiency, possibly adjusted for income distribution objectives), MCA does not impose any limits on the number and nature of criteria.
- Effect measurement. To allow the application of prices (see below), CBA requires that effects on efficiency attributes are measured in quantitative terms. There are three groups of MCA techniques with respect to effects: one that requires quantitative data, a second that processes only qualitative data, whereas a third can deal with both types of effects simultaneously.
- Weighting of sub-criteria and main criteria. CBA uses prices to make efficiency attributes compatible, possibly adjusted for distribution weights. Generally, MCA is characterized by a weighting system implicitly or explicitly involving relative priorities of policy-makers or any other group possibly affected by a development project.

The chapter concludes with a decision-tree for method-selection, taking account of a) general methodological pros and cons of MCA and CBA, and b) problem-specific information about criteria and impacts.

Ch. 4. Sustainability issues in the decision-making framework

Chapters 4-7 are devoted to the incorporation of sustainability issues, as defined in chapter 2, in main phases of project appraisal, as addressed in chapter 3.

The incorporation of sustainability issues in the first phase, viz. the definition of the decision-making framework, is the subject of chapter 4. Particular attention is paid to the choice and possible interpretations of the main appraisal criteria. It is proposed to apply three key criteria, viz. efficiency, (intratemporal) equity and sustainability. First, the traditional criteria of efficiency and equity are reviewed, assuming a welfare function that includes environmental amenities. Second, basic elements in the definition of the sustainability criterion are explained. Key parameters are: a) the ecological variables determining sustainability, b) the level of resource use at which sustainability is achieved, c) the moment this level needs to be achieved, d) the spatial level at which sustainability is defined, and e) the treatment of risk and uncertainty. A number of selected, fairly representative approaches to the concept of sustainability, proposed by economists and ecologists and all based on the Brundtland definition, are reviewed.

Once the three key criteria have been defined, their relative priority needs to be assessed. What kind of (short- and long-term) conflicts and trade-offs between sustainability and the other criteria may arise in the appraisal of projects in developing countries? What positions may policy-makers take in this respect?

Ch. 5. Impact assessment: environment and sustainability

This is the first chapter to focus on the second appraisal phase, i.e. impact assessment. It deals with the estimation of environmental effects (environmental impact assessment, EIA) and the related score on the sustainability criterion. It is argued that a precondition for EIA is the development of a) environmental and economic profiles for the project setting (i.e. areas that may be affected by the project), and b) a model showing how ecosystems and socio-economic systems in the same area interact. The profiles summarize basic data about the present state of the systems, and changes in parameters in the past. The model is required to understand interrelationships between man and environment, as regards the dependency of people on natural resources, the impacts of production and consumption on the environment, and the scope for sustainable development patterns (whereby critical resource use levels are respected). In combination with the sustainability policies that apply, the model will also provide the "environmental utilisation space" (Opschoor, 1987), indicating the scope for resource use by new activities.

On the basis of the profiles and the model, environmental impacts of project alternatives can be estimated. An overview is presented of specific difficulties that may be encountered, in terms of the need for a long-term perspective, the limits to scientific knowledge about ecosystems and the consequences of human interventions, the possibly high degrees of uncertainty, and the distributive dimension.

EIA results directly determine the score on the sustainability criterion. The sustainability score can be assessed by comparing a) threshold levels for resource use (i.e. the environmental utilisation space), and b) estimated environmental effects. Sustainability may be measured on several scales, including a binary scale (a project either is or is not sustainable) and a continuous scale (showing the degree of (non)sustainability). More sophisticated approaches distinguish between sustainability objectives for specific groups of environmental attributes, as well as for different spatial levels.

The chapter elaborates on the possible role of MCA in the calculation of a sustainability indicator for the project setting, as well as for sustainability scores of projects. The chapter concludes with a discussion of constraint-satisfying activities aimed at adjusting projects to ensure that they comply with sustainability thresholds.

Ch. 6. Impact assessment: efficiency and equity

This second chapter on impact assessment focuses on the traditional criteria of efficiency and equity, and in particular on the question of how to account for environmental effects, as estimated in EIA. The greatest part is devoted to economic CBA, aimed at measuring contributions to real welfare, ignoring distribution effects. A first step is to determine the value of environmental effects. A number of potentially useful valuation methods will critically be reviewed. The second step is to discount long-run environmental effects. Special attention will be paid to the many solutions provided for the problem of "too high" discount rates. Finally, ecological risk and uncertainty should be accounted for.

The chapter outlines various types of limits to the applicability of economic CBA in these fields. It will be shown that MCA may be a useful complementary approach, and in some cases even a substitute. It offers the opportunity to weigh a) efficiency attributes in a monetary dimension, and b) intangibles, particularly long-run environmental effects.

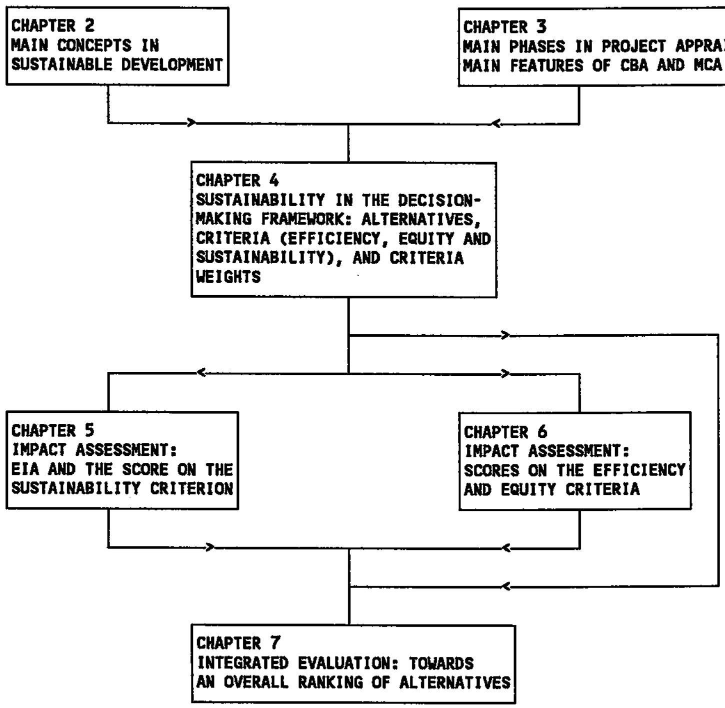
MCA might also be used to assess the score on the equity criterion. It can account for two aspects: a) the distribution of income vis-a-vis accessibility of natural resources, and b) distribution among various population groups or regions.

Ch. 7. Integrated evaluation

Integrated evaluation, the final appraisal phase, involves a comprehensive comparison of the scores of all alternatives on the key criteria of efficiency, equity and sustainability, and is aimed at arriving at conclusions regarding the relative attractiveness of these alternatives. Two basic approaches are discussed, viz. a single-indicator, CBA approach versus the weighted multiple-indicator, MCA approach. In the former case, outcomes of economic CBA would be adjusted for sustainability performance of alternatives. In an even more sophisticated approach, efforts might be devoted to the incorporation of sustainability performance in social CBA. Next, the basis structure of the MCA approach is outlined, involving the weighting of the separate scores on the three key criteria. It is argued that the second approach is more attractive in developing countries both from a theoretical and a practical point of view. Hence, our proposal is to use economic CBA to assess efficiency, provided it can cover the greatest part of its attributes, and to include this outcome in a comprehensive MCA framework. Social CBA would not be recommended.

The structure of part A of the study is reflected in diagram 1.3.

Diagram 1.3. Structure of Part A



Part B: towards application

Ch. 8. Introduction to part B: towards application

This chapter explains the aim of and topics that will be addressed in part B. Therefore, the explanation of the contents of part B will be kept brief here. As indicated above, the theoretical framework developed in part A will be adjusted to account for objectives of and constraints faced by average teams of experts responsible for appraising environmentally-sensitive projects in developing countries.

Ch. 9. Case study: Forestry and environmental protection programme, Colombia

In 1992, this multiple component programme aimed at enhancing the management of natural forests in Colombia was studied by a team of an international agency. Chapter 9 provides an overview of and explanations for the many difficulties that were encountered in the application of the theoretical framework, including a lack of environmental data required for a CBA study and institutional constraints to the use of MCA.

Ch. 10. Case study: scenarios for Lake Burullus, Egypt

In the same year, a comprehensive study was made about Lake Burullus, an ecologically valuable wetland of international importance in Egypt. A number of options for the use of this coastal lake were analyzed. In this case, the circumstances were much more favourable to application of the theoretical framework for sustainability-oriented project appraisal. Because of both the multi-disciplinary composition of the appraisal team and the support of decision-makers, maximum use could be made of CBA and MCA techniques in the treatment of sustainability-related issues.

Ch. 11. A practical framework for appraisal studies

The theoretical framework developed in part A is adjusted to arrive at a system that provides guidelines for multi-disciplinary teams responsible for the appraisal of projects with significant environmental consequences. The basic structure of the part A framework in terms of appraisal phases is maintained, but guidelines are more detailed and reflect a concern for actual conditions surrounding appraisal studies. This inter alia implies that the practical framework is brief regarding questions that rarely are addressed in actual appraisal studies, and acknowledges constraints in terms of time, funds and base-line data many evaluators are confronted with. Practical guidelines are also presented for the choice of appraisal methods: which case-specific factors determine whether CBA and MCA are applicable, useful and appropriate, and provide reliable outcomes?

Ch. 12. Retrospect and prospects

This final chapter summarizes lessons learned about project appraisal, elaborates on the validity and limitations of the practical framework, and defines an agenda for further research.

This study incorporates several chapters that -sometimes edited- have been published integrally or partly in journals, books and reports. A first attempt to tackle the question of how to incorporate sustainability concerns in project appraisal, and the applicability of CBA and MCA in this respect, was made in Van Pelt, Kuyvenhoven and Nijkamp (1990). This article has had a strong impact on chapter 2 of the study. Furthermore, the study builds upon:
Van Pelt (1991) for chapter 3;
Van Pelt (1993-a), Van Pelt, Kuyvenhoven and Nijkamp (1992-a,b) for chapter 4;
Van Pelt (1993-b), Van Pelt, Kuyvenhoven and Nijkamp (1992-a,b) for chapter 5;
Van Pelt (1993-a,b), Van Pelt and Timmer (1992) for chapter 6;
Van Pelt (1993-a,b) for chapter 7; and
Van Pelt, Molemaker et al. (1992) for chapter 10.

PART A

THEORETICAL AND CONCEPTUAL FRAMEWORK

2. SUSTAINABLE DEVELOPMENT: BASIC CONCEPTS AND THE POSITION OF DEVELOPING COUNTRIES

2.1. Introduction

Literature shows a sometimes confusing gamut of sustainable development definitions, goals, conditions and criteria. Lélé (1991) refers to the "semantics" of sustainable development, whereas Pezzey (1989) uses a neo-classical economics model to explain basic approaches. There appears to be a consensus, however, that the sustainability concept emphasizes a) a long-term perspective, particularly a concern for future generations, and b) two-way interrelationships between socio-economic and environmental variables, which leads to c) the view that limits should be imposed on the use of natural resources in production and consumption processes. Dissimilarities refer to the definition of development, of sustainability and -consequently- of (conditions for) sustainable development. Problems in defining and operationalizing sustainability form a main reason why some economists, including Little and Mirrlees (1991) and Beckerman (1992), consider sustainability a meaningless notion.

This chapter aims at clarifying main factors associated with the concept of sustainable development, and at outlining its specific features in developing countries. As a first step, section 2.2 is devoted to the meaning of welfare and development, and to relations between development and environment. A formal welfare function will be proposed that has two constituents, viz. man-made goods and services, and environmental amenities. An elementary two-system model will be discussed, that contains major relationships between a) welfare, b) production and consumption processes, and c) natural resources.

In section 2.3 the concept of sustainable development is shown to be built upon a social welfare function as well as on ethical views on intergenerational equity, i.e. the responsibilities of the present generation to future generations in terms of the transfer of assets. In this study, sustainable development refers to ecologically sustainable development, which stresses the long-term availability of environmental resources, sufficiently large to allow successive generations an acceptable level of welfare.

Whereas sustainable development has a universal meaning, a range of specific issues presents itself if the concept is applied to problems in developing countries (section 2.4). The two-system model developed in section 2.2 is used to illustrate particular features of developing countries in terms of problems in and interaction between ecosystems and socio-economic systems. A basic characteristic is the strong linkage between poverty, inequality and environmental problems. The section concludes with a brief discussion on challenges to designers of policies for sustainable development in low-income countries and regions.

As a step towards incorporating sustainability concerns in project appraisal, we will show the spatial dimension of sustainable development (section 2.5). Prospects for sustainable development patterns in a country may be strongly determined by ecological and economic activities and policies elsewhere. Policy-makers should prescribe whether sustainability is to be achieved at each spatial level (global, national, regional, local) or that non-sustainability at a low level is permitted provided that sustainability is achieved at higher levels.

Final section 2.6 contains some concluding remarks.

2.2. Environment and development

2.2.1. Social welfare and development

Development is a dynamic concept, which is closely related to social welfare, a static notion. Defining development and social welfare is a normative affair, because the choice of the constituents (or attributes) lacks an objective, scientific foundation. In general, development occurs if certain objectives regarding the well-being of people are achieved over time. The economic literature suggests that development would require[1]:

- increasing per capita aggregate social welfare;
- a "fair" distribution of social welfare among contemporaries, particularly among low- and high-income groups (*intratemporal equity*); and
- a "fair" distribution among the present and future generations (*intertemporal, or intergenerational equity*).

Traditionally, the economic interpretation of development was confined to aggregate social welfare. Intratemporal and intertemporal equity were added in the 1960s and 1970s. The reference to "fair" in relation to equity objectives unequivocally indicates the normative nature of views on how aggregate welfare should be distributed. A second ethical question concerns the choice of the constituents of social welfare. As this choice is important to our discussion on sustainable development, it will be treated below.

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1 Structural changes in societies are also widely considered an attribute of development. Gilles et al. (1992), for instance, refer to a declining share of agriculture in national income, and urbanization.

Theoretically, there are no restrictions to the number and the nature of welfare arguments. Literature on sustainable development shows that many authors prefer broad interpretations. The Brundtland Commission (WCED, 1987) refers to "meeting essential needs" of men, covering economic, social, environmental, and other dimensions. Pearce et al. (1990) propose a vector of six social objectives, including "increases in real income per capita" and "increases in basic freedoms". An important question is how (changes in) constituents of well-being should be weighed to arrive at (changes in) aggregate well-being. Other things being equal, weighting becomes more complex if the number of attributes increases. As this study is concerned with application of techniques in practical studies and moreover focuses particularly on environmental issues, we will start from a welfare definition that includes a limited number of arguments[2].

The welfare concept used in this study comprises two constituents. The first, following the most traditional interpretation of (neo-classical) economic theory, is "man-made goods and services". This element will be interpreted in terms of consumption or income, although it may also cover basic needs aspects. The second attribute, which is at the core of environmental economics theory and elaborated by for instance Hueting (1980), Pezzey (1989) and Dasgupta and Mäler (1991), comprises "environmental amenities". Clean air, clean water, and an undepleted ozone layer, increasingly scarce and hence economically relevant, are just a few examples of how the environment directly affects the well-being of man. Moreover, the existence of a rich biodiversity and of specific ecosystems may affect people's well-being, although they are not (yet) used in any way. It could also be argued that a contribution to welfare might be achieved by minimizing ecological risks that directly affect survival of man. The two-attribute welfare concept adopted here is narrower than, for instance, the WCED definition, but it is broader than the traditional (neo-classical) economic interpretation.

We already referred to the need for a weighting mechanism to derive aggregate welfare levels from the various constituents of well-being. In dynamic terms, such a mechanism is required to determine whether development has taken place (equity considerations apart). Pearce et al. (1990) argue that development occurs if the proposed vector of six attributes (see discussion above) increases, but they do not specify a weighting mechanism. Two possible options may be distinguished:

- Development may be said to require a simultaneous improvement in all well-being attributes, i.e. a non-negativity constraint is imposed on each welfare attribute. The welfare vector of Pearce et al. would then imply, for instance,

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2 If operationalization of the sustainability concept on the basis of such a welfare concept proves to be feasible, the analysis may be broadened in a later stage.

that a country only achieves development if at the same time people become richer, obtain more basic freedoms and experience various other types of improvements. Not many countries would seem to fulfil such requirements[3].
- If trade-offs between welfare arguments are tolerated, the analytical and empirical problem arises of how to compare attributes in very different dimensions. For instance: to what extent may a higher income level compensate for deteriorating basic freedoms?

Despite the incorporation of just two attributes, the welfare definition adopted here raises weighting problems. Two extreme cases provide exceptions: a) only consumption of man-made goods and services matters (a narrow economic interpretation), and b) only the state of the environment determines social welfare (purely ecological). In all other cases, aggregation is problematic because of the lack of a numéraire, i.e. a common valuation basis for the two constituents of well-being. As man-made goods and services are traded at markets, prices may be used as a valuation base. There is, however, no satisfactory valuation system and in some cases not even a market for environmental amenities.

Development unequivocally occurs if over time social welfare attributes improve simultaneously or if one of the two improves and the other remains unaffected. But what are attitudes towards compensating a decline in one argument by an improvement in the other? Is it conceivable that the well-being of a country increases if its environment becomes cleaner but its people poorer? Or: what are the views on the possibility to compensate a loss of wetlands for by a greater consumption of food and health services? Processes of changing social preferences and deteriorating environmental conditions in many parts of the world suggest a declining willingness to sacrifice environmental amenities to the advantage of consumption goods. A safer prediction says that technical facilities will never be able to satisfy our need for clean air.

These questions, which above are touched upon in a general and loose way, are important to this study. In project appraisal, a key question will appear to be the comparison of changes in income and environment (see sections 4.3 and 6.2).

2.2.2. *Environmental and socio-economic systems*

In the previous section it was argued that through, for instance, drinking water and air quality, the environment affects welfare *directly*. There are other

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3 Witness also the ranking of developing countries in the annual Human Development Report prepared by UNDP (1992).

linkages between the environment and welfare. Well-being *indirectly* depends on the environment through the use of natural resources as productive inputs in the economy. Moreover, production and consumption patterns affect the environment, for instance if a factory causes air pollution. To explain the total set of linkages between welfare, economy and ecology, a simple systems model will be used (see figure 2.1).

Figure 2.1. An economic-ecological interaction systems model

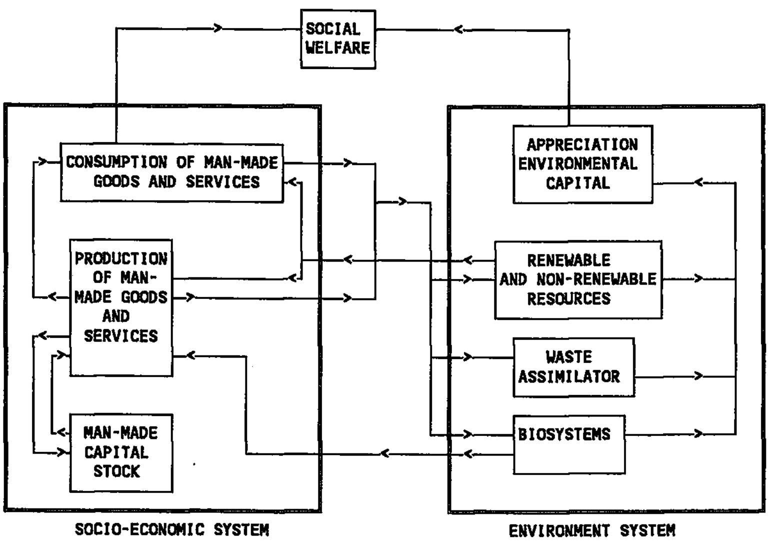

Figure 2.1 recapitulates that welfare has (at least) two constituents, viz. the consumption of products and services produced by man, and the utility derived from environmental services. With respect to environmental amenities, people's well-being may increase, for instance, by visiting a natural park, as well as by esteeming their existence as such. The "appreciation" of environmental capital comprises both aspects.

Man-made goods and services are produced in a *socio-economic system*. This system describes how a society has organized its production and consumption processes. Growth of material production requires investment in man-made capital (and/or technological progress and skill formation). The quantity and quality of environmental utilities are the "output" of an *environment system*. This system contains all natural resources, whether or not they are bought and sold in markets and hence irrespective of the existence of a price. This implies that fossil fuels in the earth crusts are included, as well as the possibility of generating new living conditions (Opschoor and Van der Straaten, 1991). Within the environment system no relations are indicated, which of course is a simplification in view of linkages between environmental variables and stresses[4].

Finally, the model summarizes the main categories of *interrelations* between ecological and economic factors. The production of goods in the socio-economic system not only requires man-made capital, but environmental inputs as well ("environmental productivity"; Pezzey, 1989). In this interpretation, the environment is a *potential source of welfare*. Whereas environmental amenities are a constituent of welfare, productive environmental resources are a determinant of welfare (Dasgupta and Mäler, 1991). Following Barbier (1989), the model distinguishes between three types of economic functions of scarce environmental capital: material and energy inputs (including renewable, non-renewable and semi-renewable resources), assimilation of waste products, and a stream of natural services the quality of which is essential for supporting economic production. The latter element, referred to as "biosystems", includes maintenance of essential climatic and ecological cycles and functions. How much environmental inputs are needed for the production of one unit of man-made products, depends among other things on technology[5].

Production and consumption processes within the socio-economic system affect the environment system. By definition, the impact of socio-economic processes on the environment system depends on the magnitude of production and consumption (which are closely related to income levels). Other factors, which are implicitly included in the model, are: technology, composition of production and consumption packages, and size of the population. The environment system has the capability to overcome a certain degree of stress, but there are limits beyond which it deteriorates in a quantitative and/or qualitative way. Neo-classical economics assumes that increasing scarcity of natural resources will be reflected in higher prices, but, as will be argued in chapter 6, that does not always happen. Hall and Hall (1984) and Barbier (1989) distinguish between two types of physical scarcity, viz. relative scarcity (cf. Ricardo) and absolute scarcity (cf. Malthus). The former is associated with a deteriorating

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4 The model presented here is compatible with several more comprehensive models for interaction between environmental and socio-economic systems. Examples are: Soeteman (1988), who makes a useful distinction between structure, process and foundation variables; Pezzey (1989); and Van der Straaten (1990), who differentiates between several types of waste generation, as well as between stock and flow environmental parameters.

5 For a more refined model of the environment as a productive input, see Mäler (1985).

quality and hence productivity of natural resources, whereas the latter corresponds with the disappearance of such resources[6].

The model illustrates that an overuse of scarce environmental resources and services in production and consumption will negatively affect long-run social welfare opportunities both through lower-quality environmental amenities and decreased environmental productivity. In this way the environment sets *constraints on development*. This observation lies at the root of the concept of sustainable development (see section 2.3).

The two-system model provides a foundation for several other discussions in this study:

- the important differences between developed and developing countries in terms of explanations for and consequences of environmental problems, the availability of resources required to solve these problems, and the prospects for sustainable development (section 2.4);
- the role of government interventions, whether environmental policies or economic policies with (possibly unintended) ecological consequences, in project appraisal (sections 4.4 and 5.5.2);
- the assessment of environmental impacts of development projects, which requires a comparable ecological-economic interaction model for the project setting (sections 5.5.2, 9.4 and 10.4).

2.3. Ecologically sustainable development

Having identified main issues in development, how to define sustainable development? According to the Brundtland Commission, development is sustainable if the present generation meets *its needs*, without compromising the *ability* of future generations to meet *their own needs*. The notions in italics show that there are two main issues in the sustainability concept: needs of successive generations, and ability to create welfare.

Needs is another word for welfare objectives. As shown above, views on the constituents of welfare and the scope for trade-offs between them are ethically determined. Judgements on what should be welfare levels now and in the future, i.e. intergenerational equity, are also in the field of moral questions. We do not know the preferences of future generations, but it is often assumed that their views on needs and trade-offs would be similar to ours. In reality, differences are likely to occur. Environmental amenities, for instance, may be assigned a greater

6 Hall and Hall (1984) develop separate versions of Malthusian and Ricardian scarcity for renewable and non-renewable resources.

priority in the future if scarcity continues to increase. For the project level, we will discuss possible solutions to these problems in section 4.4.

Ability refers to the availability of scarce resources or assets (i.e. the determinants of well-being). Sustainable development requires that the present generation limits its use of such resources in order to hand over sufficient resources to following generations to enable them the achievement of welfare objectives. Similar questions arise: what types of resources should be safeguarded, and what should be the size of stocks of particular assets? (in other words, to what extent are trade-offs between different resources tolerated?) The former question will be treated below, whereas the options to address the latter question at the project level are reviewed in section 4.4.

What kind of resources should be considered the bench mark for sustainability? Consider the following proposals (see also Lélé, 1991):

- The OECD (1989; see also Eggers, 1992), focusing on development aid, considers development sustainable when a recipient country is willing and able to provide sufficient means and resources (financial, managerial, ecological, etc.) required for an aid activity after the donor has phased out his assistance. Hence, sustainability refers to all possible means, including but not confined to environmental ones.
- According to Sachs (1989) sustainability has five dimensions: social, economic, ecological, geographical and cultural sustainability, all having different resources as a point of reference.
- The WCED (1987) argues that sustainable development requires consistency with social values and institutions, encouragement of grassroot participation, etc.

In this study, sustainability is defined in terms of environmental resources. Development is *ecologically* sustainable provided successive generations have sufficient environmental goods and services at their disposal to meet their needs. More precise, achieving their (per capita) social welfare objectives should not be impeded by environmental deterioration, either directly (appreciation of environmental capital) or indirectly (the environment as a productive input), or through a combination of the two.

To achieve long-term social welfare objectives, however, non-ecological resources should be at the disposal of future generations as well. Within the socio-economic system sufficient man-made capital should be available, and related factors are mobilisation of savings, human capital, technology development and entrepreneurial skills[7]. An analysis may focus on requirements regarding long-term availability of man-made capital, in the context of what may be termed *economic* (in a narrow interpretation) sustainability. *Overall* sustainable development requires that sufficient stocks of both ecological and man-made resources are available to successive generations. When we use the notion of sustainable development, we mean ecologically sustainable development, unless stated otherwise.

Empirical analysis of sustainable development patterns and underlying cause-effect patterns is seriously hampered by uncertainty and risk. Little is known about (changes in) the size of natural resources stocks and about the behaviour of essential environmental systems (for instance with respect to synergic processes), particularly in relation to human activities and welfare of future generations (e.g. damage functions). This will be an important theme in our discussions on environmental impact assessment for development projects (section 5.3).

Apart from the numerous questions regarding the definition of sustainable development, many have addressed the related problem of how policy intervention may promote sustainable development. Pezzey (1989) uses a mathematical model to show that free-market forces will not achieve sustainability and that various types of policy interventions may help or hinder sustainability. Opschoor (1992) lists a wide range of government and market failures that underlie non-sustainable development patterns. A key question appears to be whether economic growth can be commensurate with, or is even required for sustainability. Beckerman (1992) says that becoming rich is the surest way to improve the environment. Many share his feeling that economic growth is required to achieve sustainable development, but stress the need for policy interventions: the Brundtland Commission (WCED, 1987), the World Bank (1992) and an academic economist like Heijman (1991). Others feel that economic growth harms prospects for sustainable development (see some contributions to Goodland, Daly and El Sarafy, 1991).

At a more general level, the question arises whether the achievement of sustainable development is possible without basic changes in economic, social and cultural systems and values in society. Many economists and politicians appear to hold the view that such possibilities indeed exist, which implies that necessary changes only refer to variables within existing systems. Others argue that the objective of sustainable development requires drastic modifications of the systems themselves, affecting our lifestyle, mobility, cultural values and so on.

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7 In traditional economic theory, increasing the stock of man-made capital was long considered the key to economic growth.

For examples of advocates who consider sustainable development a process of social change, see Lélé (1991) and Rees (1990).

This section shows that the concept of sustainable development a) involves a wide range of moral issues, and b) points at complex linkages between economy and ecology. In the discussion on project appraisal, these issues will be elaborated in chapters 4 and 5, respectively.

2.4. Sustainable development in developing countries

The objective of sustainable development raises specific problems in developing countries because of particular features of ecosystems, socio-economic systems and their interrelations. The two-system model developed in section 2.2 will be used to illustrate these issues. Frequently, differences with circumstances in developed countries are mentioned. The idea is to present a broad picture: the rough classification between developed and developing countries obscures the heterogeneous composition of both groups and the fact that circumstances often differ more in degree than in nature. The following topics will be discussed:
- specific features of environment and socio-economic systems, and welfare levels;
- socio-economic explanations for environmental problems;
- socio-economic consequences of environmental problems;
- economic opportunities to combat environmental problems.

Finally, some conclusions regarding the scope for sustainable development in developing countries will be drawn.

Systems and welfare

In general, developing countries have other *environmental systems* than developed countries. Climatic circumstances and geographic locations have a distinct impact on features of ecosystems. Many developing countries have highly diversified but fragile ecosystems or equally fragile monoculture lands in rural areas. Whereas rich countries generally are faced with a growing relative scarcity of natural resources, many -regions in- developing countries experience environmental problems that tend to be irreversible (i.e. absolute natural resource scarcity). Although developing countries are still predominantly rural, urban growth now far exceeds levels experienced by developed countries. Particularly in large cities, water, ground and air pollution have reached unprecedented levels (Hardoy and Satterthwaite, 1991). Such problems have been strongly reduced in many developed countries.

As regards *socio-economic systems*, the following factors tend to characterize developing countries: high population growth rates; biased distribution of income and ownership of production factors; strong dependency on agriculture and other natural-resource-based sectors; use of outdated and inefficient production techniques; large subsistence sector; large non-market sector; often weak definition of property rights of land and other resources; economically distorted markets for goods, services and finance; strong government interference in many markets for man-made goods and services[8]. Socio-economic systems in many developing countries are highly influenced by consumption and production patterns, as well as debt, trade and aid policies of the developed world, and by multilateral development and finance institutions.

Traditionally, differences in *social welfare* between developed and developing countries were expressed in much lower per capita income and consumption levels in developing countries. Increasingly, concerns have been expressed regarding the low and deteriorating levels of environmental amenities, as a part of basic needs, in many developing countries. In fact, an interesting debate has evolved regarding the classes of environmental problems that have the greatest (direct) impact on welfare levels in developing countries, at which development policies should hence be directed. Beckerman (1992) argues that the often cited problems of exhaustion of minerals and other natural resources and of global pollution problems (like climate change) are not critical to developing countries. Local problems of access to safe and sufficient drinking water, sanitation facilities, air pollution and urban degradation would be more serious and relevant. The World Bank (1992) also favours greater attention for such local problems.

Socio-economic explanations for environmental problems

Developed countries mainly face environmental problems resulting from affluence, such as pollution generated by high levels of input use, energy consumption, mobility and waste generation. Except in agriculture, rich countries mainly experience output-related problems.

Particularly in rural areas, poor countries generally experience environmental problems that are related to poverty and inequality. The need to earn a minimum income or to obtain essential fuelwood, may bring about overexploitation of land, aquatic systems and forests. Because economic production in many developing countries is largely dependent on agriculture, fishery and forestry, they tend to have input-related environmental problems (i.e. natural-resource depletion;

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[8] Many developing countries have embarked upon structural adjustment programmes, aimed at combating several of these problems.

Breman, 1990). High population growth rates, unequal distribution of land (forcing the poor to occupy fragile lands), low productivity and absolute constraints on land development tend to reinforce each other.

Government policies often (unintentionally) offer incentives to embark on or continue ecologically harmful activities (Warford, 1987; Jagannathan, 1989; World Bank, 1992). Well-known examples include: subsidization of agricultural inputs, subsidization of energy, low cost-recovery in irrigation, negligible logging fees in natural forests, opening of fragile areas through the construction of roads and other infrastructure, and low interest rates. Such policies encourage exploitation of natural resources, because their prices fail to reflect the full costs. At the same time policies aimed at environmental protection are often at the infant stage and enforcement of regulations is generally weak. Administrative, legal, managerial and technical expertise are yet to be developed.

In developing countries information flows in general and regarding the environment in particular are often highly imperfect, which tends to lead to sub-optimal investment patterns from a national point of view. Positive and negative external, particularly environmental effects are usually not recognized by investors. The government often fails to compensate either by providing the information or through providing the investment itself (Cook and Mosley, 1989).

Developed countries increasingly contribute to environmental problems experienced by the developing world. The former group often imports inputs from developing countries without having to face environmental problems associated with their exploitation. Global environmental problems are to a great extent caused by consumption and production processes in rich countries. Foreign debt service obligations may encourage the rapid exploitation of exportable natural resources.

Economic consequences of environmental problems

Many developing countries are extremely sensitive to environmental problems because their income strongly depends on the exploitation of natural resources, whereas several basic needs (water, energy) are also satisfied through local natural resources. If natural resource degradation (desertification, deforestation, land degradation) leads to reduced environmental productivity, income and consumption growth suffer immediately. Developed countries are generally less dependent on natural resource exploitation in the country itself, as opportunities to import from elsewhere or develop alternatives are greater.

Income consequences will be further aggravated if, as in many developing countries, alternative employment opportunities are scarce, or if people lack funds or time to invest in other economic sectors (Tisdell, 1988). This also explains that particularly the poorest groups are hurt by environmental problems.

At a global scale, environmental problems are likely to have different consequences, although data remain disputed. Research suggests that the greenhouse effect might particularly hurt poor (tropical) countries, and benefit several rich countries.

Economic opportunities to combat environmental problems

At high income levels and in conditions of relative natural resource scarcity, the scope for measures to combat environmental problems is fairly wide. First, more resources are available to tackle the effects of existing environmental problems (defensive expenditures). The burden of such approaches is carried primarily by the government and ultimately by tax-payers. Second, source-oriented measures, aimed at preventing future problems, may involve lower consumption or adjustments to production and consumption patterns, but need not affect investment levels. Through the market mechanism, production costs of natural-resource intensive products and consequently consumer prices will increase. Third, reducing output in environmentally harmful economic sectors may often be compensated by increasing output in other sectors. The greater emphasis on both effect- and source-oriented environmental technology may even provide a strong stimulus to sectors that produce it.

Such opportunities are often lacking in developing countries faced with absolute natural resource scarcity. At extremely low income levels, reduction of consumption is not a feasible option. Because people tend to have extremely high rates of discount, investment in environmental protection measures suffer (Dorfman, 1988). Environmentally harmful practices may continue until productivity of natural resources has vanished, and ultimately force people to migrate to other areas (ecological fugitives). Moreover, environmentally sound alternatives are often lacking. Finally, economic adjustment programmes tend to put great strain on government budgets, leaving little scope for defensive expenditures.

Some concluding remarks

Focusing on developing countries, the Brundtland Commission calls the relation between poverty, inequality and environmental degradation a major theme in its analysis. In their strive for sustainable development, poor countries need to overcome great problems with modest means at their disposal. Maintaining, let alone restoring, certain stocks of environmental capital is particularly difficult for somebody who is poor and dependent on the use of natural resources. At the same time, from a long-term point of view, natural-resource based developing countries have a special interest in achieving sustainable development patterns[9].

Recently some important sets of potential conflicts between development objectives have emerged. Although poverty and environment are interrelated, serious problems may occur in achieving equity and sustainability objectives simultaneously. Beckerman (1992) and Summers (1992) pose the question of what should deserve priority: helping the present poor or safeguarding the (uncertain) prospects of future generations. Trade-offs between the removal of poverty (the traditional objective of intratemporal equity) and sustainability (expressing a concern for intertemporal equity) obviously cannot be ignored. Another lesson is that policies that set sustainability *objectives* for poor countries or poor population groups are of little use if they fail to address man-made and natural *resources* available to them. In our discussion on project appraisal, the possibly conflicting nature of development objectives is addressed in terms of the weighting of appraisal criteria focused on immediate concerns (intratemporal equity) and long-term concerns (sustainability).

2.5. Sustainability and space: towards the project level

The Brundtland Commission makes some reference to the need to differentiate between spatial levels in policies for sustainable development. Unfortunately, it does not provide much detailed information, which in a way underestimates the significance of the issue. In any case, it is particularly relevant from the perspective of project appraisal (see, for instance, section 4.4.3).

In more elaborated versions of the two-system model for environmental-economic interaction the spatial dimension would need to be incorporated[10]. Prospects for a particular country to increase well-being and achieve sustainability are not only determined by developments in its own environmental and socio-economic systems, but also by what happens in corresponding systems in other countries. Natural resources may be imported rather than harvested domestically,

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[9] See for instance Tisdell (1988) on the importance of sustainable agriculture in developing countries compared to developed countries.

[10] For a detailed discussion on spatially disaggregated ecological systems and their impacts on economic variables, see Siebert (1985).

chemical waste may be exported rather than deposited in ones own country, pollution may cross administrative boundaries, environmental refugees may cross borders as well, debt obligations may encourage natural resource exploitation, and so on.

The crucial role of space can be illustrated by referring to some of the most important classes of environmental problems. As mentioned above, Beckerman (1992) and the World Bank (1992) argue that local-level problems, including inadequate supply of drinking water and sanitation, air pollution and land degradation, still deserve the highest priority in development policies for low-income countries. In the 1980s, however, international attention has shifted to cross-border (regional, national, global) environmental problems[11].

The spatial dimension should also be accounted for in the design of policy interventions. Whereas a more detailed discussion will follow in chapter 4, a key question is worth mentioning here: should it be our aim to achieve sustainability at all spatial levels separately, or would it be tolerable to achieve sustainability at level A, while non-sustainability occurs at a lower level B? In the former case, production and consumption patterns should respect normatively defined thresholds for natural resource use at the project, the regional, the national and the global level. In the latter, more flexible approach, sustainability at, say, the regional level might be sacrificed as long as national or global sustainability would be assured. Reality shows that governments are often willing to sacrifice sustainability at specific locations in order to attain national economic goals (income, employment). A fine example is provided by a plan of a Dutch power company, involving reforestation in Latin America to compensate for the negative environmental effects of a new power plant in the Netherlands. The assumption is that new forests will absorb as much greenhouse gases as emitted by the Dutch power station. If this is true, and ecologists may not agree, the project would not harm the global environment. The local environment near the power plant, however, would of course be negatively affected.

One of the few scientific attempts to give sustainability policies a spatial dimension was developed in Van den Bergh and Soeteman (1990) and Nijkamp, Van den Bergh and Soeteman (1991). They set out to determine the nature of sustainable development at the *regional level*. Their definition of regional sustainable development is "a development which ensures that the regional population can attain an acceptable level of welfare -both at present and in the future- and that this regional development is compatible with ecological circumstances in the long run while at the same time it tries to accomplish a

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11 See Cox (1991) and Arrhenius and Waltz (1990) for scientific progress in understanding problems such as global warming and their possible economic consequences.

globally sustainable development". In other words, two conditions are formulated for regional sustainable development. First, activities at the regional level should remain within ecological boundaries to ensure that future generations in the region will have acceptable social welfare opportunities. Second, these activities should be commensurate with global sustainable development. The authors do not rule out, however, the possibility that global sustainable development occurs while this objective is not achieved in all regions. It is emphasized that sustainable development paths of regions will show different characteristics because of specific regional circumstances. Sustainability analysis at the *project level*, the subject of following chapters, will share several features with regional sustainable development analysis.

2.6. Conclusions

Operationalizing the concept of sustainable development starts with outlining the objectives of development itself, and the relations between environment and welfare. Equity considerations apart, this study focuses on two constituents of welfare, viz. the availability of man-made goods and services, and the appreciation of environmental amenities. Welfare, socio-economic factors and the environment are linked in numerous ways, as shown by a simple two-system model. The concept of ecologically sustainable development integrates objectives regarding welfare and intergenerational equity, and knowledge about the role of the environment in creating welfare. Natural resources should be considered both a source of and a constraint on development. Whatever the precise definition of sustainability, a guideline for policy is that limits should be imposed on the use of natural resources.

In the context of developing countries, several issues will hamper efforts to achieve sustainable development. It would be fruitless to develop sustainability policies without accounting for the intractable linkages between poverty, inequality and environment.

A further complication in the formulation of sustainability policies is the need to take the spatial dimension into account. It makes a tremendous difference whether sustainability should be achieved at all levels or at higher (say, global) levels only.

This chapter has provided the stage for our discussion in chapter 4 on how to incorporate the sustainability concept in a decision-making framework for project appraisal. It has become clear that this discussion cannot be confined to a definition of sustainability itself, including a spatial point of reference. Because of the normative issues involved in sustainability, appraisal frameworks should build in options to treat trade-offs between various development objectives, and ways to account for possibly different weighting schemes.

Finally, the two-system model developed in this chapter will be the starting point for the treatment of EIA, involving the estimation of environmental impacts of human interventions at the project level.

3. PROJECT APPRAISAL PHASES AND METHODS: AN OVERVIEW

3.1. Introduction

This chapter provides the analytical foundation for subsequent chapters in two respects:

- It describes the successive *phases* in an appraisal study, and particularly the questions that each of these stages addresses (the format of a study, see section 1.2). The subject of chapters 4-7 is how the sustainability concept (see chapter 2) may affect these stages.
- A comparison is made of the theoretical principles of the appraisal *methods* MCA and CBA. These principles are illustrated for each of the appraisal phases distinguished earlier. On that basis, chapters 4-7 will treat the applicability of both families of methods to sustainability-oriented appraisal studies.

A satisfactory definition of a *project* does not exist. Baum and Tolbert (1985, p8), in their review of several decades of World Bank experience, define a project as "a discrete package of investments, policy measures, and institutional and other actions designed to achieve a specific development objective (or set of objectives) within a designated period". Such a definition is sufficient for our purpose, although it may be useful to emphasize that projects usually refer to packages of activities that are implemented at the micro level, as opposed to the sector, regional or national level.

In the economic literature on developing countries, *project appraisal* is often regarded as synonymous with cost-benefit analysis (see Brent, 1990, p3). In the present study project appraisal has a wider meaning. It involves a systematic analysis of the extent to which a project contributes to a set of development objectives, taking account of different priorities that may be assigned to these objectives as well as the scarcity of resources that would be used in the implementation of the project. This study focuses on *ex ante* project appraisal, i.e. an analysis of activities that have not yet been implemented.

Numerous ways to classify *phases* in project appraisal have been presented in the literature, but most of them strongly overlap. The system adopted in this study, which corresponds to mainstream interpretation (see for instance Voogd, 1983, p221; and diagram 1.2 in chapter 1), includes the following phases:

- The definition of the *decision-making framework* (section 3.2). Such a framework provides the point of reference for appraisal studies by outlining a) project alternatives under consideration, b) criteria, and c) criteria weights. With respect to alternatives a distinction is made between the "without-case" and the "with-case". The former comprises measures that would be implemented anyway, also in the absence of a new project. The latter refers to options to undertake new activities (there may be several "with"-cases). Criteria are a reflection of objectives policy-makers (or any other group in society) want to achieve. Weights express the relative priority of criteria. If an appraisal involves more parties, several weight sets may exist.

- The estimation of the *impacts* (or effects) of alternatives (section 3.3). Impact assessment is concerned with expected (positive or negative) contributions of project alternatives to development objectives. In other words, impacts are scores on the selected criteria. Impacts may refer to a criterion that has a single attribute, e.g. recurrent costs, and a criterion with several attributes, e.g. efficiency. A prerequisite for impact assessment is knowledge about the *project setting*, i.e. the institutional, economic, ecological and social environment the project will be influenced by or will affect itself.
- *Evaluation* (section 3.4). Two evaluation steps will be distinguished. First, it is assessed whether alternatives satisfy all *constraints*. Alternatives failing to comply with such constraints may be adjusted to ensure compliance. Second, alternatives that satisfy all constraints are compared in terms of their performance regarding the comprehensive set of (remaining) criteria (*integrated evaluation*).

In this chapter little attention is paid to several institutional dimensions of an appraisal study. A first question is whether a particular study would involve all phases outlined above. This depends on the information the decision-maker requires. For instance, the aim may be to obtain an overview of expected impacts of alternatives, perhaps as a basis to decide on further studies. The evaluation phase would then be redundant, as would methods like CBA and MCA. Our discussion focuses on choice problems which cover all phases. Even if the full procedure is adhered to, however, information requirements may differ. For instance, the aim may be to obtain the best alternative, or to reduce the set of alternatives by eliminating some clearly inferior alternatives.

A second question concerns the study procedure, and particularly the interaction between the analyst, the decision-maker(s) and possibly other parties (Voogd, 1983). At one side of the spectrum of options is the situation whereby the analyst's work ends by presenting his or her conclusions to the decision-maker. At the other side interactive approaches are located. The most complex form would be a study in which a continuous interaction exists between the analyst, the decision-maker, and other actors involved in the project. In the course of the process, feed-back of results leads to adjustments of the project and possibly identification of areas that require further study. In this study none of the possible procedures is chosen a priori.

CBA and MCA principles will be illustrated phase by phase. The methods set certain requirements regarding the decision-making framework and information about impacts, whereas their results appear in the assessment of scores on multi-attribute criteria or in the integrated evaluation phase. The discussion is kept brief, emphasizing main differences and similarities in fields relevant to subsequent chapters.

In the course of time several variants of *CBA* have been developed. The most important distinction is between traditional CBA, applied in the developed world, and CBA focused on particular features of socio-economic systems in developing countries. A classic example of traditional CBA is Mishan (1988), whereas other treatments are provided by Smith (1986) and Drèze and Stern (1987). This study is concerned with CBA for developing countries, as developed by the OECD (Little and Mirrlees, 1974), the World Bank (Squire and Van der Tak, 1975), and UNIDO (Dasgupta, Marglin and Sen, 1972)[1]. The discussion will be confined to basic, partial-equilibrium versions. This implies that no reference will be made to more sophisticated approaches, involving for instance the general-equilibrium derivation of shadow prices (Squire, 1989) and macro-economic cost-benefit analysis (Nentjes, 1989). Such approaches require much more data than the large majority of project appraisal studies will ever produce, and -irrespective of theoretical merits- hence are of little practical value in developing countries. A frequently applied, limited variant of CBA is cost-effectiveness analysis (CEA), which will be referred to in cases where its applicability differs from that of CBA.

We will not treat some other CBA variants and related approaches:

- Financial CBA is concerned with an assessment of the profitability of a project from a private point of view. Together with an analysis of liquidity and finance, the outcomes provide decision-makers with information regarding questions such as: will the private sector invest in a project? Can a cost-recovery scheme be designed for a drinking water project? Will sufficient money be available to cover expenses at any moment in time? This study assumes that such an analysis has been conducted and that financial issues would not obstruct implementation of the project.
- In French-speaking countries the "Effects method" is the dominant appraisal tool. As Balassa (1976) shows, however, there is little difference with the OECD-World Bank-UNIDO methodology.
- No attention will be paid to other, rarely practised variants such as risk-benefit analysis (Smith, 1986).

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1 Non-technical explanations of CBA for developing countries are Irvin (1978), Kuyvenhoven and Mennes (1985), Sang (1988), ODA (1988), and Van Pelt and Timmer (1992). Ray (1984), Squire (1989), and Brent (1990) contain mathematical treatments.

- Several aid donors use "Logical framework analysis" (Cracknell, 1989) in the preparation of projects, or derivations like "Integrated approach" or "Project planning by objectives" (Eggers, 1992). Such approaches are not appraisal techniques and should hence not be considered alternatives for CBA. They may be complementary, however, and be used to investigate the intrinsic logic of a project in terms of consistency between the hierarchy of objectives, inputs, assumptions, and expected outputs. Moreover, they may be useful in the monitoring of on-going projects.

Rather than a specific appraisal method, *MCA* is an umbrella for a multidimensional evaluation of a limited number of alternatives. It comprises nowadays a collection of close to one hundred techniques that share some basic substantive principles, but differ in other, mainly technical respects. In this study only the general characteristics of (main groups of) MCA-methods are outlined[2].

MCA techniques can be classified in several ways. Some of them will be treated in this chapter, including data and weighting requirements. An important classification is between continuous and discrete methods (Nijkamp, Rietveld and Voogd, 1990). The former group is applicable if the number of alternatives is infinite. For instance, how much to spend next year on education? Alternatives can take any value between zero and the total government budget. Continuous MCA techniques include multi-attribute utility functions methods, multiple-criteria linear programming, and multiple-goal programming techniques. Many of such approaches give rise to rather complex algorithms. If the number of alternatives is limited, discrete methods can be applied. This study concentrates on discrete methods, because in appraisal studies for development projects the number of alternatives is usually limited.

While this chapter aims at identifying the main strengths and weaknesses of CBA and MCA, no effort is made to contribute to improvements in their methodologies. This study explores the applicability of state-of-the-art versions of CBA and MCA, as explained and discussed in the relevant scientific fora, to new types of questions in project appraisal. Some issues in various appraisal stages and corresponding features of CBA and MCA are illustrated by a simple, hypothetical example of the construction of dams.

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2 For detailed treatments, reference is made to Thiriez and Zionts (1976), Zeleny (1982), Voogd (1983), Schärlig (1985), Ministry of Finance (1986), Seo and Sakawa (1988), Massam (1988), Nijkamp, Rietveld and Voogd (1990), and Janssen (1992). Romero and Rehman (1989), Pétry (1990), and Van Pelt (1991) focus on MCA's applicability in developing countries.

On the basis of the information gathered in sections 3.2-3.4, this chapter concludes with a tentative decision-tree for the selection of appraisal methods, particularly CBA, CEA and MCA, considering a) methodological pros and cons, and b) problem-specific information about criteria and impacts. This decision-tree underlies our discussion on the use of CBA and MCA in the theoretical chapters 4-7 and the cases in chapters 9 and 10, and will be elaborated in chapter 11.

3.2. The decision-making framework

3.2.1. Alternatives

The idea of a project usually arises if policy-makers or other agents in society observe a certain problem, i.e. actual circumstances are not commensurate with development objectives (see section 3.2.2). Through a screening and scoping process, a number of possible options to solve that problem may be identified and -in a later stage- designed. In many cases project appraisal aims at selecting between available options. If not, which usually occurs if few data are available, policy-makers usually aim at reducing the number of alternatives, to facilitate decision-making. Alternatives may differ in terms of sector, technical design, organisation, location, timing, technology, etc. Usually, different options for a given type of activity are compared, for instance, a low-tech versus a high-tech solution for pumping of ground water. In such cases alternatives are mutually exclusive, which implies that implementing one alternative rules out the possibility of implementing the other. In other cases it may be possible to implement several alternatives at the same time.

Theoretically, no restrictions need to be imposed on the number of alternatives. At least two alternatives exist: the continuation of present activities without introduction of new actions (without-case, base-case, zero-case), and the introduction of new activities (with-case). Unfortunately, decision-makers are often presented just a single "with-case", without even making reference to the "without-case". To minimize the risk of ignoring feasible opportunities, several "with" alternatives are explored.

Both MCA and CBA aim at assisting policy-makers in selecting one (or more) out of a set of alternatives. As indicated above, the scope of this study is restricted to MCA techniques for discrete choice problems[3]. CBA is only used for such problems.

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3 Although some MCA techniques can address both continuous and discrete problems, most are developed to deal with just one class.

A large number of alternatives would often lead to cumbersome empirical problems in CBA applications, but does not raise methodological issues. In the case of MCA, however, the problem of "method uncertainty" deserves specific attention. As will be explained in section 3.4, this refers to the possibility that applying several MCA techniques to a particular choice problem need not result in the same outcome. Voogd (1983) recommends to limit the number of alternatives to about seven to eight, because the problem of method uncertainty aggravates for higher numbers. At the same time, the stability of MCA outcomes is also relatively low in the case of only one or two alternatives. MCA computer software may impose practical limits on how many alternatives can be compared.

In the example developed in this chapter, three alternatives for a dam project will be compared, viz. the construction of one large dam, two intermediate dams, and several smaller dams. A fourth alternative, i.e. the "zero-case", will implicitly be accounted for by defining effects of alternatives as the difference between "with" and "without" conditions.

Box 3.1. Alternatives for a dam project

3.2.2. *Criteria*

The basis for selecting between alternatives is an assessment of how well they contribute to the achievement of policy objectives, as described in a social welfare function. Because objectives are often of a general nature, criteria are derived which are in more operational terms. The "scores" of alternatives on criteria are a proxy for the contribution to policy objectives.

Many development problems are perceived differently depending on the point of view of various agents in society. If a project appears to affect or involve groups with possibly conflicting interests, it may be necessary to take this into account in the choice of criteria.

Outcomes of appraisal studies are extremely sensitive to the choice of criteria. Whatever appraisal method is applied, some of the most important guidelines for criteria selection are the following[4]:

- The set of criteria should be comprehensive, i.e. should cover the full spectrum of objectives. For instance, it should be avoided that only criteria are selected for which information about effects is easily available or which reflect the priorities of a single group.

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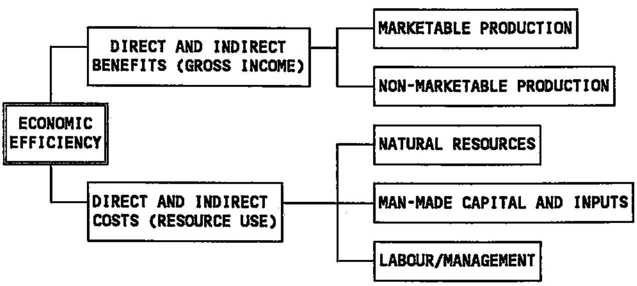
4 For more elaborate treatment, see Voogd (1983).

- Criteria should show a minimal interdependency. This is to avoid a situation of double-counting, whereby a positive score on criterion A by definition implies a positive score on criterion B. An example is to include both "employment" and "labour income" in a criteria set.
- The number of criteria should be limited, as research has shown that people can assign meaningful weights to not more than about eight criteria. Furthermore, most computer software sets limits to the number of criteria. To meet such requirements, a hierarchy of criteria may need to be established. Starting from a limited set of main criteria, each would be divided in several sub-criteria (or constituents or attributes; see Nijkamp, Rietveld and Voogd, 1990; Massam, 1988).

Within an overall theoretical framework, *CBA* starts from a social welfare function, specifying objectives and a mechanism for weighting the contributions to these objectives. A distinction will be made between two variants of CBA, viz. economic CBA and social CBA.

Economic CBA is a tool to assess a single criterion, viz. *economic (allocative) efficiency*, which has several potential attributes (see diagram 3.1).

Diagram 3.1. Efficiency attributes



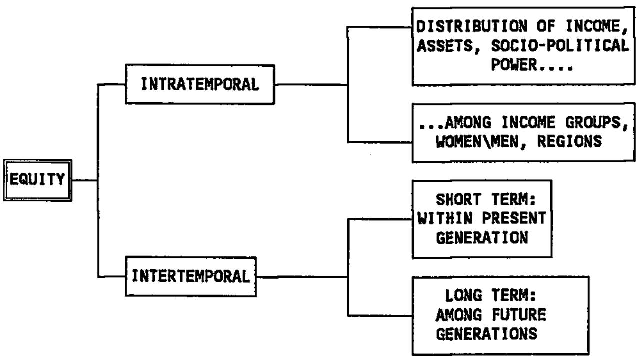
Economic CBA compares costs and benefits to a country, including external effects[5]. External effects occur when the welfare of a country changes without a corresponding monetary transaction. Benefits comprise all positive contributions to real income, whether or not traded in a market (compare agricultural crops and health services). Costs reflect the use of scarce resources, whether man-made capital or natural resources. An essential feature is that CBA recommends to

5 All transfers, such as direct taxes and subsidies, are ignored as they do not affect a country's welfare.

approve a project if aggregate costs could *potentially* be compensated by aggregate benefits. Whether actual compensation is paid is irrelevant in economic CBA[6].

Economic CBA assumes that, at the project level, decision-makers are indifferent as to who benefits from an activity, and who faces the costs, both among contemporaries and over time. The technique to adjust outcomes of economic CBA for some types of *equity* objectives is known as social CBA. Possible equity attributes are summarized in diagram 3.2.

Diagram 3.2. Equity attributes



Intratemporal equity may refer to the distribution of income, but also of productive assets (for instance land) and (informal or formal) social and political power. A distinction has been made between three types of target groups. Intertemporal equity refers to objectives regarding the distribution of costs and benefits over time, either in the short-run or the long-run (generations).

Social CBA cannot cover all equity attributes shown in diagram 3.2. It may only account for objectives regarding:

- the distribution of *income* among target groups. Basically, the marginal utility of dollars accruing to the poor and the rich is given a different value;
- the use of *income* generated by a project for either consumption or savings. Income saved enables investment and hence leads to future consumption and economic growth. To account for economic growth objectives, savings are

6 Whereas this statement is commensurate with traditional welfare theory, public finance economists will point at crowding-out effects in a general-equilibrium system (Musgrave, 1964).

valued higher than consumption through a savings premium. Due to application of the discounting technique in CBA, however, the effective time horizon is limited to two or three decades, viz. one generation.

Because CBA gives concrete directives for (sub-)criteria selection, a *correct* application of the method by definition implies that all guidelines for criteria selection (outlined earlier) are complied with. At the same time, if policy-makers have multiple objectives, CBA's potential applicability is confined to a systematic analysis of efficiency and income distribution.

In principle, *MCA* can process any criterion, including efficiency, a policy-maker or another party considers important. This is a practical advantage of MCA over CBA, especially if efficiency is not among the criteria, or if several other criteria apply besides efficiency. MCA's flexibility, however, also implies that more attention should be paid to the methodological soundness of criteria selection (see the guidelines presented above). Moreover, experience has shown that people can assign consistent weights to not more than about seven to eight criteria.

Assume that in the appraisal of the dam project the following criteria are considered important:
- agricultural production;
- electricity generation;
- discounted investment and recurrent costs;
- environmental damage;
- distribution of income among contemporaries (equity);
- acceptability to local government.

Measurement problems apart, economic CBA covers the first four criteria. Social CBA might be used to incorporate equity concerns as well. Acceptability to government agencies is beyond the scope of CBA. MCA allows treatment of all criteria.

Box 3.2. Criteria for a dam project

3.2.3. *Weights*

Weights may be required for two *purposes*. First, if a criterion has several attributes, the score on that criterion depends on how scores on attributes are aggregated. Second, if several criteria are applied to a choice problem, an assessment of the overall performance of alternatives involves weighting.

Usually, one weight set represents the relative priority of (sub-)criteria according to a *policy-maker*. If, however, a project would involve or affect several other social groups in society and if their interests would be conflicting, additional weight sets may be developed for one or more of these groups. Whether a study actually contains such an analysis to a great extent depends on the attitude of the commissioner of the study, frequently a government agency.

Weights can be in various *dimensions* and measured on different *scales*. In general, weights show the priority of one factor expressed in the priority assigned to another. This implies that weights represent the scope for trade-offs (or substitution): the willingness to give up one unit of a particular factor to obtain more of another factor. Frequently, through standardization, dimensionless weights are used. Quantitative weights are often expressed on a scale with 0 and 1 as extremes (i.e. additive weights). If a criterion is assigned a weight of 0, it does not play a role in decision-making. Similarly, a weight of 1 implies that only the criterion concerned affects decision-making. Qualitative (ordinal) weights often refer to ranking: for a particular choice problem "criterion A is more important than criterion B" (see below).

A key question is whether criterion weights are *linear* or *non-linear* (Voogd, 1983). In the first case, the weight is independent from the value of the criterion score. Consequently, no limits are imposed on the possibility to substitute benefits related to a particular criterion by benefits on another. For example: the criterion "employment" is assigned a weight of 0.3, whatever employment is created by a project. In this case a criterion will be termed an *objective*: something to pursue to its fullest (Zionts, 1989). If weights are non-linear, various types of functions between weights and criterion scores may be considered. One of the most common approaches is to vary weights below (w_b) and above (w_a) certain threshold values. Assuming that additive weights apply, and that a preference exists for avoiding scores above the threshold, a criterion may be converted into [7]:

- *Goal*: $0 < w_b < w_a < 1$. Like objectives, goals permit trade-offs with other criteria, but the "price" of goals in terms of other criteria is higher if thresholds have not been satisfied than if they have.
- *Constraint*: $w_b = 0$ and $w_a = 1$. An alternative failing to comply with such a precondition is either rejected whatever the scores on other criteria (which hence have a weight of 0), or is adjusted to satisfy the constraint (see section 3.4). If constraints are complied with, the criterion concerned does not play a further role in the appraisal (i.e. has a weight of 0), which continues on the basis of all remaining criteria (i.e. goals and objectives). Constraints hence do not permit any trade-offs: they overrule all other criteria if threshold values

7 The terminology is a mixture of approaches of Zionts (1989) and Voogd (1983).

are not satisfied, whereas only the remaining criteria affect further decision-making if they do[8].

- *Mixed goal-constraint*: $0 < w_b < 1$ and $w_a = 1$. A mixed goal-constraint has the features of a constraint if thresholds are not satisfied, and of a goal if they are. Assume, for instance, that economic efficiency is a criterion. Policy-makers may demand that in any case the net present value (NPV) is positive (efficiency is a constraint), and, moreover, prefer high NPVs over low NPVs (efficiency is a goal). As long as the NPV is negative, this criterion overrules all other criteria, but otherwise trade-offs with other criteria are allowed.

Economic CBA addresses a single criterion, viz. efficiency. In other words, CBA assumes that all other possible criteria have a weight of zero. In economic CBA, the efficiency score is determined by a weighting process involving the use of prices to aggregate scores on efficiency attributes (see diagram 3.1). If policy-makers agree with this form of weighting, they need not express their value judgements in any other way.

If market prices are considered to be distorted, economic CBA replaces them by shadow prices. Such prices reflect the "opportunity costs", i.e. the real value of goods, services and factors of production to a country. In traditional CBA, consumer's willingness-to-pay is the basis for the determination of shadow prices, as an application of the consumer sovereignty principle. The aggregated willingness-to-pay across all consumers gives social welfare, provided certain conditions are met: full information, perfect competition, absence of external effects, the existing distribution of wealth and income are considered acceptable, etc. In economic CBA for developing countries consumer sovereignty has at least partly ceased to be the valuation basis. Instead, attention has shifted towards the relation between domestic prices and world market prices. Adjustments are made to the ratio between prices of tradables and non-tradables. In the UNIDO approach, which takes domestic prices expressed in private consumption units as the denominator (the "numéraire") this involves the use of a "shadow exchange rate" to determine the value of traded goods in domestic currency. The OECD-World Bank approach shows the opposite pattern: world market prices constitute the numéraire, and prices of non-traded goods and services are corrected through a "standard conversion factor". The existence of two approaches is somewhat unfortunate, as it can be shown that they are methodologically similar, leading to identical recommendations whether or not to accept a particular project (Irvin, 1978)[9].

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8 Massam (1988) uses the notion of non-compensatory evaluation problems. Nijkamp, Rietveld and Voogd (1990) note that in mathematical programming dual variables related to constraints can be interpreted as weights attached to the various criteria.

9 A condition is that methods are applied at the same level of aggregation.

In economic CBA, costs and benefits occurring at different moments in time are discounted. Through the economic or accounting rate of discount[10], a dollar accruing to a project now is assigned a higher value than a dollar expected to accrue to the project in the future. This is a direct application of the opportunity cost principle (in the without-case funds would also generate net benefits), and does not involve judgementes on a "fair" distribution of income over time.

In *social CBA*, which addresses equity in addition to efficiency, policy-makers are required to express income distribution objectives in quantitative weights[11]. This may refer to intratemporal equity: how to compare a dollar accruing to a landless labourer and one accruing to a rich farmer? Or to intertemporal equity: how to compare a dollar consumed now, benefiting those who are living now, and a dollar invested, leading to higher future consumption? In some cases, the use of income distribution weights may affect shadow prices, leading to the necessity to replace economic by social prices. The reluctance of policy-makers to explicitly elaborate on equity objectives, particularly in the form of quantitative weights, and the technical complexities in re-estimating shadow prices, comprise major reasons why social CBA has rarely been applied.

MCA allows for several criteria, which implies that weighting mechanisms are indispensable. Rather than on prices, the emphasis is on policy weights provided by decision-makers or other parties. If efficiency is among the appraisal criteria, an MCA study would require that its priority vis-a-vis all other criteria is expressed in weights.

The determination of weights is a sensitive affair. Instead of making preferences explicit, policy-makers may feel it is politically more rational to keep some information in hand. Preferably, political priorities are assessed by direct questioning of policy-makers and other parties involved. An iterative process may be followed, whereby the interviewee is offered the opportunity to reconsider weights in view of newly obtained information, for instance about the consequences of particular weight sets for project selection. Another approach involves estimation of weights by investigating the actual behaviour of parties in the past, i.e. weights are derived from revealed preferences. Finally, hypothetical weights may be applied, which means that the analyst himself prepares a weight set that he considers to be representative for a specific agent, or a general

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10 Showing the opportunity cost of capital to a country.

11 Unlike in MCA, no criteria weights are used, just income weights. Decision-makers are hence not asked to assign weights to efficiency and equity as such.

perspective (the "economic" perspective, the "social" perspective, and so on). Policy-makers may comment on hypothetical weights, without having to be (more) explicit about their priorities.

Nijkamp, Rietveld and Voogd (1990) list several techniques that offer interviewees the possibility to express their priorities[12]. Examples are:

- *Trade-off method*: quantitative weights are obtained by asking the respondent to indicate the value of an improvement of one unit of one criterion in terms of the value of an improvement of one unit in another criterion;.
- *Rating method*: the respondent is asked to distribute a constant number of points (for instance 100) among the criteria, whereby the most important criterion is assigned the highest number of points, and the least important the lowest number of points;
- *Ranking method*: the interviewee should rank criteria in order of importance, while having the opportunity to assign the same rank to sets of criteria;
- the *Seven- (or five-)points scale*: criteria should be assigned a value between 1 and 7 (or 5), representing verbal statements such as: "very important, slightly important.... slightly unimportant, very unimportant";
- *Paired comparison*: criteria are compared pair-wise, whereby the respondent should indicate whether criterion A -in comparison with criterion B- "is equally important, slightly more (less) important, very much more (less) important, etc."

Each of these approaches has pros and cons in terms of accuracy, time required for an interview, transparency to the respondent, degree of refinement, and so on. Which is the most appropriate one depends strongly on the attitude of a respondent, and on the time available for the study. To assess the stability of criteria weights, it is recommended to apply several techniques. If they lead to approximately the same relative weights, a greater confidence in ultimate MCA outcomes is justified than if outcomes diverge considerably.

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[12] If a weight determination technique does not directly lead to quantitative priorities, MCA will usually require the transformation of qualitative information into quantitative weights (Janssen, 1992).

Assume that central government policy-makers are asked to rank criteria from most to least important, and that the result is as follows*:
agricultural production > environmental damage = income distribution > costs > electricity production = acceptability to local government.

*> : more important than
= : equally important as

Box 3.3. Weights for a dam project

3.3 Impact assessment

3.3.1. General

Impact assessment involves the estimation of scores (or effects) of alternatives on the selected criteria. If criterion A depends on subcriteria $A_1,\ldots,A_5$, a weighting mechanism is required to calculate the score on criterion A from the scores on these attributes. In section 3.3.2 this will be illustrated by the estimation of the efficiency score.

Impacts may be defined as changes from present levels of a variable, or, as is required by CBA, as differences between levels that are expected to occur with and without the project. To enable an estimation of impacts, information about the economic, ecological, social and institutional context of the project should be available. This can be shown in a *project setting profile* (Nijkamp, 1979). Such a profile gives base-line data on key variables and insight in the linkages between these variables. The project setting profile may play a role in several feed-back processes in project appraisal:

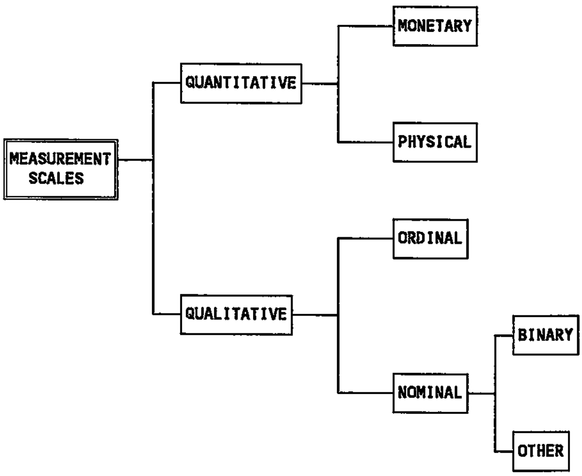
- it may stimulate a search for project alternatives;
- main criteria may be adjusted or specified in more detail after an analysis of the project setting;
- the project setting profile provides the basis for an analysis of risk and uncertainty (see below).

Information may be gathered in a two-dimensional *impact matrix* with alternatives and criteria at the sides. CBA, involving discounting, requires that the temporal pattern of effects, and particularly annual scores can be assessed (the impact matrix then becomes three-dimensional). Although MCA may also incorporate the time dimension, in practice it is addressed less systematically than in CBA. Few attempts have been made to incorporate the time dimension structurally in MCA (Nijkamp, Schaffers and Spronk, 1989; Nijkamp and Van Pelt, 1989).

Outcomes of an appraisal depend critically on impacts and hence assumptions regarding the project setting. Risk and uncertainty are key notions to account for this. Traditionally, risk refers to a situation in which an analyst has knowledge about both possible outcomes and their probability. Uncertainty or ambiguity (Quiggin and Anderson, 1991) covers cases where probabilities cannot be assessed. The impact assessment phase should include justifications for assumptions and on possible risks and uncertainty involved.

The applicability of appraisal methods is strongly dependent on the *measurement scale* for impacts, which are inputs to these methods. Different scales are shown in diagram 3.3.

Diagram 3.3. Measurement scales



A quantitative (or cardinal) scale allows measurement in monetary terms (dollars, rupiahs) or physical terms (kwh, litres, kilograms, etc). A qualitative scale may be:

- Ordinal. A ranking of alternatives according to the magnitude of scores. Possible formats of ordinal ranking are: "1, 2, 3,..." or "+++, +, ..., 0 ..., -, --".
- Nominal. Characteristics of alternatives are indicated. The criterion "colour" would have the following "scores": red, blue, white, etc. On such a scale ranking is impossible.
- Binary. This is a special case of nominal scales, in which an alternative either has or does not have a certain characteristic. Possible formats of "scores" are: "0, 1" or "yes, no".

Whereas quantitative information is often termed "hard", qualitative data are referred to as "soft".

Assume that as a first step the impact matrix below is determined for the dam project. Some scores are in quantitative terms, others are more "soft".

Impact matrix

Criteria (scale)	Alternatives		
	One large dam	Two intermediate dams	Several small dams
Agricultural production (tons)	100,000	80,000	60,000
Electricity (m kH)	500	250	100
Costs (PV m US$)*	2	1	0,5
Environmental damage (ordinal)	(most)3	2	(least)1
Equity (ordinal)	(worst)3	1	(best)1
Acceptability to local government (ordinal)	(lowest)3	1	(highest)1

*PV = present value. Through discounting time is only incorporated in the "costs" criterion.

Box 3.4. Impact matrix dam project

Economic CBA is a monetary approach, which means that scores on efficiency attributes should be valued in terms of money (the numéraire). The determination of a monetized impact matrix supposes: a) impacts on attributes can be measured on a quantitative, physical scale, and b) (shadow) prices are available to assess the value of the (physical) impact. If these conditions cannot be fulfilled, a *partial* CBA may be conducted, whereby only those sub-criteria are taken into account that can be monetized. The remaining attributes are included as a "p.m." item. Obviously, the more significant "p.m." items are, the less relevant a CBA study is.

Social CBA requires additional information about the use of income generated by a project. With respect to intratemporal equity, the distribution of income among contemporaries should be estimated. Intertemporal equity objectives require a distinction between income flows that will be allocated to consumption, and flows that will lead to savings, investment and future consumption. Hence, rather than a three-dimensional impact matrix, social CBA requires a five-dimensional matrix, because of the disaggregation in terms of recipients and uses of income. This is another explanation for the rare use of social CBA.

In an economic CBA study, the impact matrix in box 3.4. would first be reduced by omitting "equity" and "acceptability". As only costs are known in monetary terms, the reduced matrix would still not allow application of CBA. Assume that through further study prices might be determined for the impacts on agriculture and electricity. By multiplying quantities by prices the monetary impact matrix below can be determined. "Environmental damage" is included as a "p.m." item. Therefore only a partial CBA can be conducted.

Monetary impact matrix

Criteria	Alternatives		
	One dam	Two intermediate dams	Several small dams
Agricultural production (PV m US$)	2	1.6	1.2
Electricity (PV m US$)	0.5	0.25	0.1
Costs (PV m US$)	2	1	0.5
Environmental damage	p.m.	p.m.	p.m.

Box 3.5. Monetary impact matrix dam project

CEA is more flexible than CBA with respect to impact measurement and valuation. Generally, the treatment of costs is similar, and differences refer to the benefit side. There are two possibilities:

- if the benefits of alternatives are considered fully compatible, CEA only requires calculation of (discounted) costs. The efficiency criterion is hence reduced to a cost criterion;
- if benefits are qualitatively similar, but vary in quantitative terms, CEA compares discounted physical benefits and discounted monetary costs[13] [14].

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13 This ratio is known as the average incremental cost.

14 If alternatives show important qualitative differences, CEA cannot be applied.

The main classification basis for *MCA*-techniques concerns the type of effects that they can process. Nijkamp, Rietveld and Voogd (1990) give the following classes of MCA-techniques:

quantitative data

- Weighted summation. This is perhaps the most widely practised MCA technique, probably because it is simple. For each alternative, a utility score is determined, being the average of criteria scores weighted by quantitative weights.
- Concordance analysis. Alternatives are compared pair-wise. For each pair a concordance index is prepared, indicating the sum of the weights corresponding with the set of criteria for which a particular criterion A performs better than another criterion B, as well as a disconcordance index, based on the maximum difference of (standardized) scores on the criteria where B performs better than A. In more sophisticated versions of concordance analysis (Electre), a ranking of alternatives is obtained.

qualitative data

- Expected value method. First, qualitative scores are converted into quantitative scores using a transformation technique. Second, the weighted summation technique is applied to these quantitative scores.
- Frequency method. This method is related to concordance analysis, but is particularly applicable if a small number of qualitative scores is distinguished for both impacts and weights.
- Permutation analysis (Qualiflex). This is a rather complex technique, particularly applicable if both impacts and weights are known qualitatively. For each criterion, rank correlations are determined, comparing actual and possible rankings of alternatives. The consequences of weight sets are explored by focusing on the extreme quantitative weights that are commensurate with the qualitative ranking of weights provided by respondents.
- Regime analysis. This technique can be interpreted as an ordinal generalization of pair-wise comparison methods such concordance analysis.

mixed (quantitative-qualitative) data

- Evamix. Two measures are constructed, one for the ordinal criteria, and the other for the quantitative criteria. After standardization, an overall score is determined.

Quantitative and mixed data MCA-techniques often include a preparatory step known as standardization of effects. Several standardization techniques are available to convert scores in different quantitative dimensions ($, kwh, etc.) to scores on a single, dimensionless scale (with, for instance, 0 and 1 as extremes; see Massam, 1988). The choice of a standardization technique generally affects the ultimate outcome of an MCA application.

3.3.2. *Assessing the efficiency score*

If a monetary impact matrix has been determined, the final step in ***economic CBA*** involves the discounting of costs and benefits over time. The outcome of a CBA is an internal rate of return (IRR), a net present value (NPV) or a related indicator. If a budget constraint applies, the NPV may be used to rank alternatives. Ceteris paribus, a higher NPV is more attractive than a lower NPV. More important, CBA outcomes directly indicate which alternative(s) are beneficial to the country and should hence be approved. Approval is justified if a) the economic IRR exceeds the economic rate of discount, or b) the NPV - calculated on the basis of the same rate of discount- is positive. The discount rate is defined at the level of countries (and in special cases of sectors). As a consequence, outcomes of CBA studies of different projects in a country are directly comparable, and have the same "rationing device". Moreover, CBA can fairly easily be applied if only a single project is presented to a decision-maker.

In ***social CBA*** an additional step is made to account for equity objectives. The disaggregated net income streams in terms of recipients and use are multiplied by relevant income distribution weights. The equity-adjusted income flows are discounted, and a social NPV or social IRR results.

If instead of economic CBA, ***CEA*** is applied, the result is the discounted value of total costs (if benefits are fully compatible), or discounted costs per unit of discounted benefit (if they are not). In both cases only a ranking of alternatives results. Unlike CBA, CEA lacks a rationing device.

In the monetary impact matrix for the dam project it was already assumed that costs and benefits had been discounted. The environmental effect apart, the outcome of the (partial) economic CBA would be:

Efficiency measure	Alternatives		
	One large dam	Two intermediate dams	Several small dams
NPV (m US$)	0.5	0.85	0.8

From an efficiency point of view, both these NPVs and ordinal scores on the environment sub-criterion (see box 3.4.) should be taken into account. In any case, the "Large dam" option should be rejected, because it has the worst performance in both fields. But whereas the "Intermediate dams" alternative has the highest NPV, it ranks lower than the "Small dams" alternative on environment.

Box 3.6. Economic CBA for a dam project

In CBA studies, uncertainty and risk are usually accounted for through sensitivity analysis[15]. It shows the dependency of the IRR (or NPV) on assumptions. In general, uncertainty analysis should focus on the following issues:

- the size of benefits, dependent on both the measurement in physical terms and the (shadow) price;
- the size of costs, including investment and recurrent costs, dependent on both an assessment of physical resource use and their valuation;
- the expected development of benefits and costs over time (for instance, how much time is required in the build-up phase?);
- the rate of discount;
- in social CBA the impact of changes in income weights on the overall result may also be investigated.

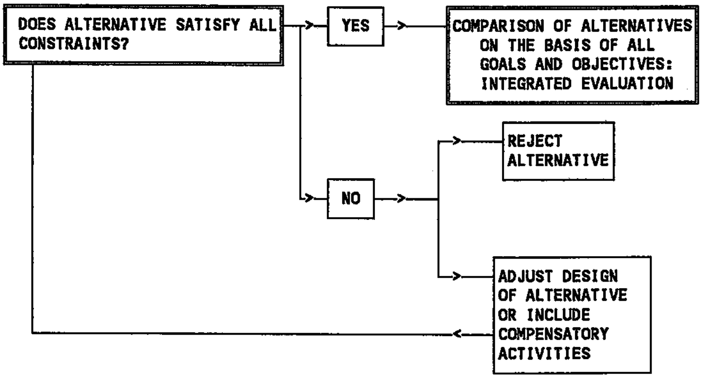
In many CBA studies too little attention is being paid to the soundness of assumptions regarding shadow prices, the magnitude ofcosts and benefits and the built-up phase. This has led to a tendency to overestimate rates of return on development projects, as found, for instance, in World Bank projects. Sensitivity analysis is a tool of limited value if the base-line assumptions lack a sound basis.

15 An interesting approach is to express uncertainty in several "event" scenarios, and to calculate CBA or CEA measures for each combination of alternatives and "event" scenarios (Nijkamp, 1991).

3.4. Evaluation

The evaluation phase has two parts (see diagram 3.4).

Diagram 3.4. Two evaluation phases



The first phase focuses on *constraints* only. When an alternative fails to comply with a constraint, it may immediately be rejected, whatever the scores on other criteria. Instead, it may be investigated whether a project might be adjusted or extended in such a way that its new design would satisfy that constraint. Such measures will be called *constraint-satisfying activities*, of which there are three types. First, the design of the project itself may be adjusted. If a capital-intensive technology would be unacceptable from a social viewpoint, a project might be changed into a labour-intensive activity. Second, instead of adjusting the design of the project, to avoid specific negative effects, additional activities could be developed to compensate for these effects. For instance, to compensate for unacceptable environmental effects of the construction of a dam, reforestation and soil improvement could be undertaken in the project area. Third, compensation might be achieved by assuring that similar negative effects will be avoided elsewhere in society. For instance: it may be decided to accept deforestation in region A provided that it is reversed in region B.

All effects of a project should be re-estimated after constraint-satisfying activities have been incorporated. This includes the extra costs for these activities themselves, and other intended and unintended effects they might have. The costs and benefits should preferably be attributed to the original project.

The second phase, *integrated evaluation*, compares (remaining) alternatives on the basis of a) all objectives, goals and mixed goal-constraints, b) the (standardized) impact matrix, and c) the weight set. Although *MCA* might be applied to obtain the score on multi-attribute criteria, the integrated evaluation phase will usually be the most appropriate moment to utilize this method. As explained above, the most important MCA techniques show considerable differences in the way impact matrices and weights are processed. Some approaches are very simple and can be applied by hand. Generally, techniques are more sophisticated, and require complicated computer software.

Assume that MCA was applied in an early stage, i.e. when the mixed data impact matrix shown in box 3.4 was available. Together with the ordinal ranking of alternatives (box 3.3), these are the inputs into MCA. Two MCA-techniques have been applied, viz. Regime and Expected value method. Using the DEFINITE software (Janssen, 1992), it appears that both techniques rank the "One dam" alternative as least attractive. The ranking of the other alternatives appears to be equivocal: Regime puts "Several small dams" first, whereas the Expected value method ranks "Two dams" first.

Box 3.7. MCA applied to mixed data impact matrix

Some methods, like Weighted summation, result in a quantitative indicator, which can be used to rank alternatives but does not have an intrinsic meaning. Many other MCA-techniques, particularly those using qualitative data, produce just a ranking of alternatives, without an indication of relative performance[16]. Methods such as Regime, Evamix and Qualiflex rank alternatives on a metric scale. In all cases, MCA lacks a general, nation- or sector-wide rationing device, which, like the rate of discount in CBA, indicates which alternatives are desirable and which should be rejected.

MCA results should be subjected to several tests on uncertainty. The scope of sensitivity analysis for MCA and CBA differs considerably. The fields of analysis overlap in the attention for the quantitative (physical) dimension of scores on criteria. If an MCA study involves monetary criteria, prices should be investigated as well, but in general this will be much less important than in a CBA study. Typical elements in uncertainty analysis in the framework of an MCA study include:

- the derivation and possibly cardinalization of weights (see section 3.2.3);
- the choice of impact standardization technique (see section 3.3.1);

16 The traditional form of Concordance analysis, for instance, may even produce a less robust outcome. An example would be that one set of alternatives is found to be superior to another, without further specification.

- the choice of MCA-technique ("method uncertainty": arithmetical operations of different techniques do not necessarily result in the same ranking of alternatives[17] [18]).

Tests should preferably involve the application of different standardization and weight determination techniques as well as several MCA-techniques. Whereas the general methodological problem of transforming a complex reality into a model is not solved in this way, the sensitivity of outcomes to methodological assumptions can be assessed. The smaller the distance between results of various techniques, the more confidence can be placed on MCA calculations. In general, outcomes will be most reliable if a) the number of alternatives lies between three and seven to eight, b) the number of criteria does not exceed seven to eight, c) impacts are known in quantitative terms, and d) different standardization, weighting and overall MCA techniques give comparable outcomes.

3.5. Selecting a method

Project evaluators tend to be rather conservative in their choice of appraisal method. Often they rely on just a single method. There may be sound reasons for this strategy, such as confidence in methods, the desire to enhance comparability of results of various studies, acceptability of methods, etc. A potential drawback of this approach is that methods tend to be used irrespective of the nature and specific characteristics of the appraisal problem concerned. If several appraisal methods are available, it is rational to select that method which is most appropriate to deal with the specific features of a project and its institutional context. Nijkamp (1989) distinguishes between a traditional method selection approach and a new, problem-oriented approach. They are summarized below:

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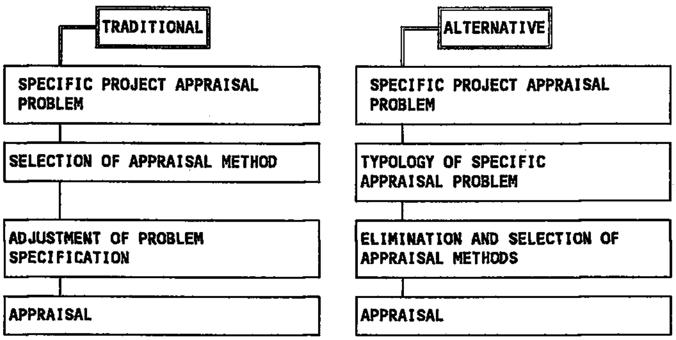
[17] By definition this drawback of MCA does not apply if one specific MCA-technique is considered inherently superior to all other MCA techniques and hence should exclusively be used. There is no consensus on this issue, however, in the academic world. It has as yet been impossible to agree on the question which assumptions, on which MCA-techniques depend, give the best correspondence with the basic structure of discrete choice problems with multiple criteria. Whereas the notion of method uncertainty is widely used, "method sensitivity" would be a more appropriate term. "Uncertainty" refers to probabilities, whereas no technique has a stochastical basis.

[18] For an application of several MCA-techniques to a given choice problem, see Hartog, Hinloopen and Nijkamp (1989).



The problem-specific method-selection approach requires that a system is developed which links attributes of the evaluation problem concerned to attributes of potentially applicable methods. In this chapter we will confine ourselves to methodological and empirical method-selection criteria[19].

From a purely *methodological* viewpoint we consider CBA a more attractive approach than MCA. CBA, which is based in economic theory, uses an explicit objective function and as a result gives unequivocal guidelines for the choice of (sub-)criteria and valuation (weighting). In addition, CBA encourages users to obtain the "hardest" information. Moreover, the problem of method uncertainty is of less importance. Finally, a CBA outcome (IRR, NPV) internationally has an easy appeal.

Some methodological problems associated with MCA are (see for instance, Klaassen and Wijnmalen, 1988):

- the great number of MCA-techniques and the technical jargon often associated with them, may confuse a decision-maker whose background does not cover quantitative approaches;
- due to their complicated structure, the internal logic of several MCA-techniques is not always easily comprehensible by people with a non-technical background;
- decision-makers may be reluctant to make value judgements explicit (the fact that MCA gives policy problems a greater transparency, however, may also be considered an advantage);

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19 Another factor is the decision environment: who are decision-makers? what are their information requirements? what are their attitudes towards appraisal techniques? can new methods easily be incorporated in existing planning mechanisms? how much time and means are available for appraisals? See Massam (1988); Pétry (1990); Janssen (1992).

- policy problems often involve only one choice possibility whereas the benefits of MCA are most clear when more alternatives are compared;
- through arbitrary choices of criteria and weights, MCA offers more opportunities to effectuate an outcome which corresponds with ex ante preferences regarding alternatives;
- MCA may provide an incentive to collect only "soft" information, also when increased efforts might result in more robust (and hence more useful) data;
- MCA-techniques and support techniques may result in different outcomes for a given choice problem ("method uncertainty").

From an *empirical* point of view, MCA's much greater flexibility with respect to criteria and data requirements compares favourably with the rigid CBA methodology. CBA requires that all effects are expressed in money, and particularly that complex shadow prices can be determined. This often raises problems in developing countries. MCA can encompass any policy-makers' objectives, and account for conflicting interests in society. Some methods can deal with any type of information about effects, others require either quantitative or qualitative data, but none demands to value all effects in terms of money. These advantages particularly apply in appraisal studies where non-efficiency objectives dominate efficiency objectives and where "hard" information may not be obtained at reasonable costs.

Acknowledging methodological and practical pros and cons of the two methods, we feel that no unequivocal choice between CBA and MCA can be made. There exists a certain trade-off between theoretical robustness and practical applicability. Preferably CBA and MCA are treated as complementary tools, also because of their different focus (CBA being an efficiency tool).

Below a simple decision-tree is developed for the choice between CBA (including CEA) and MCA. Critical variables for the selection of methods in a particular case are:
- the nature of criteria; and
- information about effects.

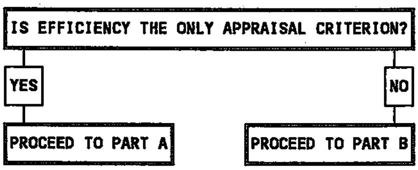
The guidelines will refer to the following types of criteria:
- efficiency;
- income distribution objectives;
- other criteria, including non-income distribution objectives (productive assets, socio-political power, etc.).

With respect to information about effects, a distinction will be made between:
- monetary effects;
- quantitative effects (in physical terms);
- qualitative effects.

At a general level the guidelines for the choice between (economic) CBA[20] and MCA can be summarized as follows:
1. If efficiency is the only criterion and all relevant effects can be measured and valued, economic CBA should be applied. If costs can be valued in monetary terms whereas benefits can only be measured in physical terms (or vice versa), CEA is applicable.
2. If there are more criteria, and/or if not all efficiency attributes can properly be measured and valued, MCA should be applied. If efficiency is one of the criteria, (partial or comprehensive) CBA outcomes should be among the MCA criteria.

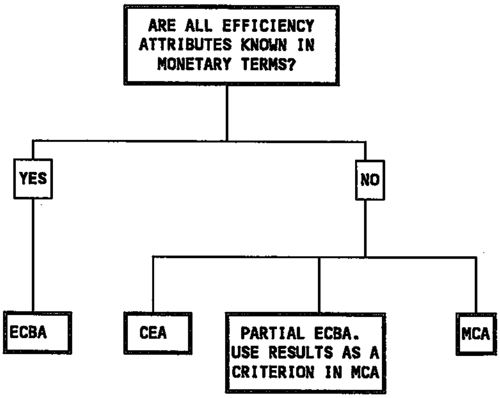
More detailed guidelines are explained by means of three decision-trees. Depending on the question whether or not efficiency is the only criterion (diagram 3.5), users should proceed to part A (diagram 3.6) or part B (diagram 3.7).

Diagram 3.5. The choice of method - Introduction



[20] The treatment of social CBA is only addressed in the more detailed guidelines below.

Diagram 3.6. The choice of method - Part A: Efficiency is the only criterion

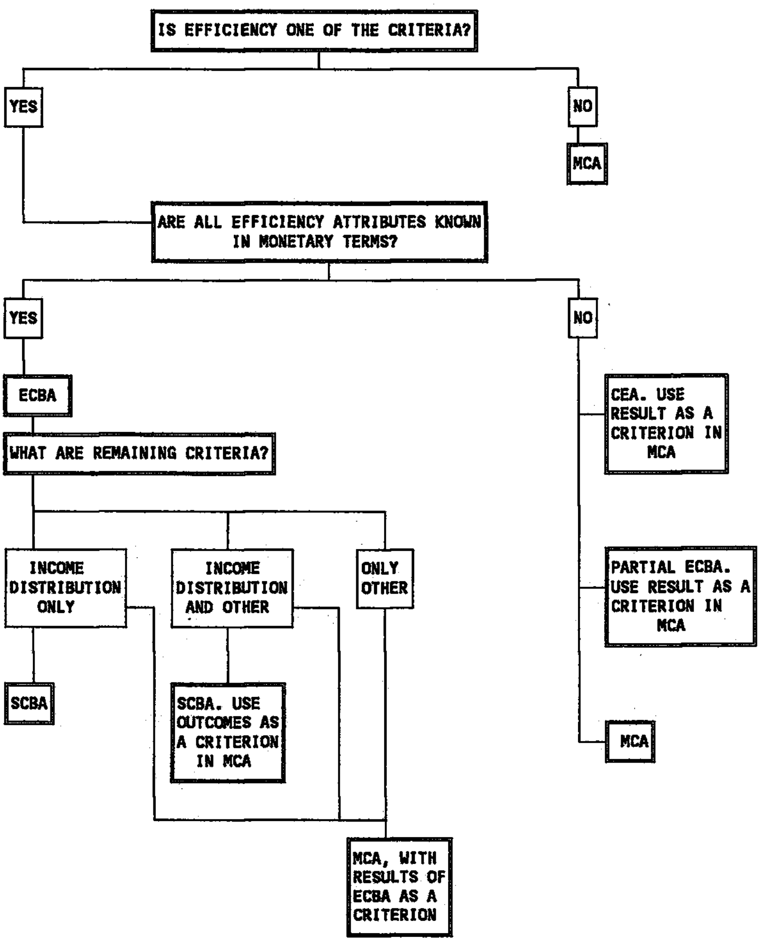


Explanation part A

If efficiency is the only criterion and all efficiency attributes can be measured in monetary terms, economic CBA (ECBA) should be conducted. If efficiency is the only criterion but not all effects on its attributes (income increases, resource use) can be assessed on a monetary scale, three strategies may be followed:

- If either costs (or benefits) are known in physical terms and benefits (or costs) in monetary terms, a comprehensive CEA may be applied.
- MCA may be conducted, covering two groups of criteria: those efficiency attributes for which monetary scores are known and those for which only physical or qualitative scores are known. A partial CBA supplies the score on the first group. The smaller this group, the lower the weight to be assigned to the CBA outcome.
- MCA may be conducted, covering the complete set of efficiency attributes. This strategy would be most appropriate if many efficiency attributes cannot be monetized. Weights should be assigned to all efficiency attributes separately: the use of environmental resources, for instance, would thus be explicitly traded-off against higher income in agriculture.

Diagram 3.7. The choice of method - Part B: Efficiency is not the only criterion



Explanation part B

If efficiency is not among the appraisal criteria in a particular choice problem, MCA is recommendable. If efficiency is among the criteria, the question is first raised, like in part A, whether all efficiency attributes are available in monetary terms.

- If this is the case, a comprehensive economic CBA should first be conducted to determine the efficiency score. Furthermore:
  - if in addition only income distribution objectives exist, there is a choice between conducting a social CBA (SCBA) or conducting an MCA with the outcome of the economic CBA and the distribution score (for instance measured on a qualitative scale) as criteria. The former approach requires the availability of disaggregated income flows and quantitative income distribution weights, the latter approach weights showing the relative priority of income and its distribution;
  - if in addition to efficiency and income distribution other criteria prevail (for instance human rights or position of women), an MCA should be conducted, on the basis of a criteria set including outcomes of either economic or social CBA;
  - if besides efficiency only other types of criteria are to be taken into account, an MCA may be conducted with the outcome of the comprehensive economic CBA as one of the criteria.
- If not all efficiency attributes can be valued properly, there are three possibilities. First, if cost and benefit data permit CEA, its outcome might be included in an MCA criteria set. Second, a partial CBA may be undertaken, the outcome of which may be used in a comprehensive MCA. Third, only MCA is applied.

The conclusion is that application of MCA is generally recommended for choice problems in which efficiency is not the only criterion. The only exception is the use of social CBA when efficiency and income distribution are the only two criteria. In many cases it is recommended to conduct economic CBA or CEA first, and subsequently to apply MCA, including CBA/CEA outcomes in the comprehensive criteria set. The weight for CBA/CEA outcomes should bear some relation to what can be incorporated by CBA/CEA and what is beyond the scope of these methods. Assume, for instance, that a comprehensive CBA is conducted, the weight assigned to this outcome should reflect the priority of the efficiency criterion vis-a-vis other criteria. The weight for an outcome of a partial CBA should in addition be related to the efficiency attributes that could not be incorporated due to valuation problems.

The decision-trees for the choice of method (a multi-criteria problem by itself!) will guide the analysis of the applicability of MCA and CBA to sustainability-oriented project appraisal in the remainder of this study.

[illegible]

[illegible]

[illegible]

[illegible]

4. SUSTAINABILITY ISSUES IN THE DECISION-MAKING FRAMEWORK

4.1. Introduction

This first chapter directly devoted to sustainability-oriented project appraisal is founded on the treatment of two subjects in earlier sections (see also diagram 1.3 in section 1.4):

- the meaning of the concept of sustainable development and relations with traditional development objectives (chapter 2, particularly sections 2.3-2.5); and
- the main elements in the first phase in project appraisal, viz. the development of the decision-making framework (alternatives, criteria, weights; section 3.2).

The present chapter aims at showing how the introduction of the sustainability concept may affect the decision-making framework in an appraisal study regarding a development project.

Linkages between environmental concerns and the design of *alternatives* are explored in section 4.2. Alternatives may be given a particular design to account for specific sustainability policies, environmental standards, or expectations regarding the future development of ecosystems in the absence of new interventions. These examples show that the search for alternatives may involve feedbacks to several other stages in project appraisal (which will be discussed in subsequent sections and chapters).

Environmental concerns may drastically affect the choice and definition of appraisal *criteria*. With respect to the interpretation of the traditional criteria of efficiency and equity, the main problem appears to be the gap between theory and practice (section 4.3). In many appraisal studies most attention is devoted to allocative efficiency. In practice, the scope of efficiency analysis has often been confined to a single welfare attribute, viz. (monetary) income. In sustainability-oriented appraisal, the impact of environmental amenities on well-being should also be addressed. Similarly, experience has shown how difficult it is to systematically account for the objective to achieve a "fair" distribution of income generated by development projects. Sustainability-oriented appraisal would add another complexity, viz. how to process (the desirability of) changes in patterns of ownership of or access to natural resources.

Even a comprehensive coverage of environmental issues in efficiency and equity would be insufficient to account for the objective of sustainable development (section 4.4). If this objective is supported, a third project appraisal criterion, viz. sustainability, should be incorporated in decision-making frameworks in project appraisal. Important elements in the operationalization of the sustainability criterion are explained, as well as underlying normative factors. In section 4.5, a number of well-known interpretations of the sustainability criterion, including weak and strong sustainability, are critically reviewed.

Section 4.6 is devoted to the possibly conflicting nature of the key appraisal criteria of allocative efficiency, a fair distribution and sustainability, and hence the need to determine *weights* at the project level. Particularly interesting are conflicts between the "traditional" criteria of efficiency and (intratemporal) equity and the "new" sustainability criterion, and weighting mechanisms that may be chosen to address such conflicts.

The main conclusions of this chapter are presented in section 4.7.

4.2. Environment and the choice of alternatives

In the choice and basic design of alternatives for a project, environmental aspects may serve as an important point of reference. Some examples, involving feedback of information gathered in other appraisal stages, are presented below:

- Environmental policies may include specific standards or objectives for natural resource use and emission of pollution. For instance, a government may prescribe that all waste generated in a production process should be treated or recycled. Designers of a factory will then include technical facilities in the project to comply with regulations. If possible, alternatives for such facilities will be compared, to arrive at the most cost-effective solution or to determine the best available technology.
- If environmental policies have not yet been decided upon, for instance because policy-makers prefer to first obtain information about their impacts on society, alternatives may be developed that reflect different policy options (for an application, see section 10.2). For example, alternative strategies to control reservoir sedimentation may include a) a source-oriented approach aimed at avoiding further sedimentation, like upstream soil conservation, and b) an effect-oriented option, such as dredging, which may raise waste deposit problems (RDC, 1991). In agriculture, alternative projects may be based on approaches such as "high external input agriculture", "low external input agriculture" and "integrated agriculture" (Breman, 1990). Dutch procedures for environmental impact analysis (EIA) demand that the environmentally most attractive option for projects is included.

- Alternatives may reflect the varying perspectives of social groups in society (section 4.6). For instance, alternative strategies to achieve reforestation may include a) support to community-based replanting activities, and b) support to commercial plantations.
- Analysis of the project setting may show that if no new projects are implemented, ecosystems in an area will deteriorate fastly (section 5.2; for an application: section 10.4). Project alternatives may comprise different types of measures, aimed at avoiding this development. Similarly: an careful analysis of the causes of land degradation (nutrients, water, social inequality, ignorance, etc.) should be the basis for the choice of policy intervention (Breman, 1990). If experts, government agencies and the local population appear to hold different views on these causes, a range of project alternatives may need to be developed.

Whereas above it was assumed that the design of alternatives was influenced by information collected in other appraisal stages, the opposite situation may also occur. For instance, features of project alternatives may serve as a guideline for the need for further study. Many international and bilateral development agencies have developed checklists for environmental screening, showing the required studies regarding environmental effects for several classes of development projects (see for instance, World Bank, 1991).

4.3. The scope of efficiency and equity

The general notion of aggregate welfare (section 2.2.1) corresponds directly to the *efficiency* criterion in project appraisal. Efficiency is perhaps the most widely addressed appraisal criterion in project appraisal for developing countries. It constitutes the difference between gross aggregate welfare changes (benefits) and total use of scarce resources (costs)(section 3.2.2). In economic theory, but particularly in economic appraisal studies, a strong tendency has existed to equate welfare *benefits* with the consumption of goods and services produced in the socio-economic system. As we argued in section 2.2, however, environmental amenities should be considered a second welfare attribute. Consequently, in project appraisal, the analysis of efficiency benefits should include such amenities.

On the *cost* side, all use of scarce natural resources should be accounted for in efficiency analysis. This includes inputs (such as renewable and non-renewable resources) and the by-products of outputs (for instance pollution or material waste generation), and any other type of alterations to ecosystems. As will be elaborated in section 6.2.1, many appraisal studies have failed to completely account for the use of natural resources, particularly in the case of externalities.

In the 1950s and early 1960s, benefits of economic growth were widely assumed to trickle down to the poorest groups. Consequently, no particular need was felt to integrate the distributional impact of development activities (***intratemporal equity***) in project appraisal. In reality, however, it was observed that welfare benefits often did not equitably accrue to all population groups and that central governments were unable or unwilling to redistribute income. The combination of high levels of poverty, biased income distribution patterns, and ineffective (or absent) income redistribution policies led to the growing importance of intratemporal equity as an appraisal criterion for development projects[1]. Initially, the emphasis was on redistribution of income to the benefit of low-income groups. Later it was recognized that equity could have other dimensions. Especially aid donors, who often consider the combat of poverty as the overriding objective, have been particularly concerned with improving living conditions, socio-political power and "autonomy" of target groups such as the poor and women. Increasingly it is recognized that development projects may drastically change the position of target groups in terms of access to or ownership of productive natural resources such as land, forests and wetlands. As Dasgupta and Mäler (1991) explain, there is a close link between environmental preservation and the well-being of the poor, particularly the most vulnerable among the poor. In sustainability-oriented appraisal, such changes should be taken into account. Moreover, they should be related to ethical views of policy-makers on a "fair" distribution.

Intratemporal equity has another dimension. In the past, project appraisal usually had a national focus. Supra-national effects were implicitly, though incorrectly, assigned a weight of zero. In sustainability-oriented project appraisal views on trade-offs between welfare, and the environmental resources that determine it, at the project level, the national level and the supra-national (continental, global) level may need to be addressed.

In our view, efficiency and intratemporal equity should remain key appraisal criteria. Their choice is appropriate because: a) basic problems in developing countries continue to be low aggregate welfare and a biased distribution (see section 2.4), b) they constitute basic elements in (development) economics theory, and c) all international and national agencies involved in development projects have incorporated them in appraisal procedures. However, in sustainability-oriented project appraisal the following requirements should be met[2]:

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1 For a clear discussion on the incorporation of equity in welfare functions, see Dasgupta and Pearce (1978).

2 In chapter 6, weighting mechanisms required to arrive at multi-dimensional efficiency and equity scores provided by CBA and MCA will be reviewed.

- measurement of efficiency should account for a) the direct impact of environmental amenities on well-being, and b) all intended and unintended use of environmental resources in production processes;
- intratemporal equity should be addressed by: a) indicating distributive patterns regarding changes in access to or ownership of natural resources, and b) assessing the ethical appreciation of this pattern by incorporating preferences of decision-makers or other parties.

In section 2.2.1, ***intertemporal (and intergenerational) equity,*** was referred to as the third constituent of welfare. Value judgements on the fairness of the distribution of net income flows within a generation, let alone between generations, have played a modest role in appraisal studies (see discussion on social CBA in section 3.2.2). As will be shown below, views on intergenerational equity are decisive in the formulation of a sustainability criterion.

4.4. Theoretical aspects of the sustainability criterion

4.4.1. The need for a separate criterion

Apart from empirical problems, the efficiency criterion provides the basis for an assessment of welfare consequences of development projects related to changes in environmental amenities and productive natural resources. The equity criterion would cover the distributive aspects of such welfare changes. This raises the question whether the introduction of a separate sustainability criterion is justified. The following considerations demonstrate that it is:

- If a government (or an aid agency) indicates that (ecologically) sustainable development is an important development objective, it implicitly or explicitly acknowledges that, in principle, the availability of environmental resources may pose constraints on long-term development policies. Consequently, the acceptability of environmental resource use should explicitly be accounted for in decision-making at all levels, including the project level[3] [4].

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[3] Similarly, Daly (1990, 1992) argues that macro-economics should be concerned with three objectives: optimal allocation (efficiency), a fair distribution (justice or equity), and scale (ecological sustainability). The Netherlands policy for development co-operation follows a comparable path. Since the early 1980s the overall objective has been "structural combat of poverty", constituting the objectives of increases in production and income (efficiency) and a fair distribution (intratemporal equity). Recently, without altering the overall objective, ecological sustainability was added as a third attribute (Ministry of Foreign Affairs, 1990).

[4] In section 4.4.2 it will be explained that there may be circumstances in which a sustainability criterion at the project level is redundant because policies succeed in achieving sustainability at higher spatial levels.

- Whereas aggregate social welfare and intergenerational equity are two independent, and possibly conflicting dimensions of welfare, allocative efficiency and sustainability are two ethical, independent and possibly conflicting aspects of projects. In other words, policy-makers may not be satisfied with a project that involves a loss of environmental resources, even if this loss could potentially be compensated for by benefits in the form of man-made goods and services. Instead they may want to explicitly deal with trade-offs between efficiency and sustainability. This approach is commensurate with the treatment of conflicts between efficiency and equity: the latter criterion was introduced precisely in response to efficient projects involving undesirable distributive patterns. As Daly (1992) puts it, it is impossible to solve the problem of sustainability through the fields of allocation and intratemporal distribution[5].
- Neo-classical economics, in which allocative efficiency plays a central role, is based on assumptions that are noncommensurable with the sustainability concept. Opschoor and Van der Straaten (1991) give several examples, of which two may be mentioned here. First, the state or functioning of the natural environment is assumed to be static or "given". This is at odds with rapidly changing environmental conditions and their consequences for human welfare in reality. Second, well-being is measured by aggregating individual welfare, using money as a single denominator. The debate on sustainable development shows that people and governments increasingly apply alternative, hierarchical value systems. The incorporation of the sustainability criterion is a step towards such partly non-monetary weighting mechanisms.
- The use of environmental resources is only partly reflected in market prices (market failure), and environmental policies are not (fully) effective in redressing this situation (policy failure) (see section 6.2.1; and Pezzey, 1989). A separate sustainability criterion offers the opportunity to evaluate actual resource use patterns.

In the remainder of this study sustainability will be considered a third key project appraisal criterion, in addition to efficiency and equity. "Key" here means that several other possible appraisal criteria a) can be derived from or associated with efficiency, equity and sustainability, or b) will be of secondary importance in a representative appraisal study.

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5 Daly refers to Tinbergen (1952), who showed that the number of policy instruments should at least equal the number of independent policy objectives.

4.4.2. *Normative issues underlying a sustainability criterion*

Before discussing elements of a sustainability criterion itself, this section reviews moral issues on which it depends[6]. Two of these factors can be derived from section 2.2.1, viz. attributes of a social welfare function, and weights assigned to present and future generations' social welfare. Implicitly a third one was addressed in the two-system model presented in section 2.2.2, viz. judgements on substitution possibilities within production functions.

Attributes of a social welfare function

Whereas incorporation of environmental amenities in a welfare function by itself is an important step, sustainability concerns may further contribute to a more dominating role of environmental issues in economic development. In particular, limits may be imposed on the possibility to substitute man-made goods and services for deteriorating environmental amenities. In other words, if further degradation of the environment is considered morally unacceptable, production and consumption processes may need to be adjusted accordingly[7].

Weighting of social welfare of present and future generations

Judgements on a just distribution of welfare among successive generations strongly affect the definition of a sustainability criterion (see for instance Collard et al., 1988; Pearce and Turner, 1991; Norgaard and Howard, 1991; Toman and Crosson, 1991). How important is welfare of the present generation compared to welfare of future generations? How much welfare are those who are living now willing to sacrifice in order to safeguard the interests of future generations? What are views on the possibility to compensate future generations for a lower level of environmental amenities by higher material welfare levels? To what extent is the present generation willing to take certain risks in this respect, expressing confidence in man's capability to respond to ecological problems? In general, the larger the priority assigned to safeguarding the interests of future generations, the more resources should be at their avail and the more stringent constraints would be imposed on the present generations' resource use in projects.

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6 These factors show that Little and Mirrlees (1991) are wrong to suggest (see section 1.2) that the question whether a project is sustainable has nothing to do with its desirability.

7 The treatment of environmental resources as direct welfare determinants should be distinguished from views on the substitutability between man-made and environmental capital in production processes (see below).

Substitution and compensation in production functions

Finally, the choice of a sustainability criterion critically depends on views on how unique and indispensable natural resources are. Besides being a direct determinant of social welfare, environmental capital is an input into the production of man-made goods and services (cf. the two-system model). Two production functions should be distinguished:

- an "environment production function": the extent to which the environment can provide services to mankind depends on the state of and relationships between specific ecosystems; and
- an "economic production function": the availability of man-made goods and services depends (inter alia) on the availability of man-made capital and natural capital, and how they can be used in combination.

With respect to the environment production function, the discussion centres on questions such as the extent to which ecosystems are unique, ecological changes are irreversible and mankind can "create" environmental systems themselves to compensate for degraded "natural" ecosystems. An extreme position would be to rule out any trade-offs: all ecosystems and their individual manifestations are unique, changes in ecosystems are irreversible and mankind is unable to create nature itself. It has also been argued, however, that over time ecosystems tend to recuperate, and that, perhaps at high costs, environmental damage can be restored. The former view necessarily leads to much stronger constraints on the natural resource use of projects.

Similarly, the extent to which man-made capital can substitute for natural capital in the economic production function needs to be treated. One extreme position emphasizes that they are complements, which rules out substitution. On the other hand, it has been argued that a growing capital stock, technological progress and the development of know-how may offer opportunities to replace natural capital inputs by man-made inputs[8]. Neo-classical economists would argue that the market mechanism will reflect changing scarcities of production factors in relative price adjustments. Such views stress substitution opportunities at the production side, which would ensure a stable quantity of consumption goods even if the stock of environmental capital would decline. If production factors are considered complements, sustainability constraints will be much more severe than if substitutability is stressed, as will be illustrated in section 4.5.

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8 For some examples of technically feasible substitutes for environmental attributes (watersheds, topsoil), and the limits to substitutability, see Goodland (1989).

Views on substitutability of elements in production functions are to a certain extent of a different nature than judgements on the optimal mix of attributes in welfare functions. By definition, the choice of a welfare function is a moral affair. Views on trade-offs within production functions, however, may reflect findings of empirical research. Nevertheless, there are serious shortcomings in our knowledge about ecosystems and their interaction with economic systems. And this scientific uncertainty (how significant are ecological risks?) will inevitably evoke an ethical question (what should be our attitude regarding ecological risks and uncertainty?). Risk attitudes are therefore an important issue to be addressed in the determination of sustainability criteria in project appraisal.

4.4.3. *Elements in a sustainability criterion*

In project appraisal, decision-makers will need to operationalize a sustainability criterion. To understand the complex nature of this process, consider the following five dimensions:
- it is expressed in one or more parameters,
- for which target (sustainability) levels are defined,
- as well as acceptable corresponding risks,
- and a time path for achieving those levels,
- at specific spatial levels.

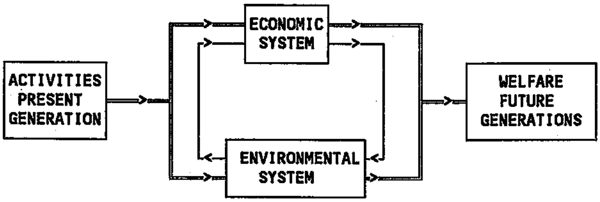
For each aspect, options available to policy-makers are reviewed below.

Sustainability parameter

To ensure ecologically sustainable development, the present generation should limit its use of scarce environmental services. Consequently, operationalization of the sustainability concept at the project level requires the selection of one or more essential environmental parameters. Without any disaggregation, the total environmental stock will be the natural sustainability parameter. Otherwise, sustainability targets may be formulated for any number of environmental groups. The higher the level of aggregation, the more complex weighting systems for sustainability sub-criteria will be (how to compare the quality of the ozone layer with the productivity of land, in the determination of changes in the total environmental stock?).

It may be desirable to translate the ecological parameter(s) into a directly related parameter derived from the economic system. This can be understood from diagram 4.1.

Diagram 4.1. Converting ecological into production/consumption parameters



Constraints on the use of environmental resources may be transformed in corresponding constraints on economic processes. It may be estimated how many economic activities and of what kind would be commensurate with the ecological limits referred to above. This might refer to constraints regarding production processes, volumes of end products, etc[9]. For an example involving constraints on fishing efforts, see section 10.2.

Threshold level

In traditional project appraisal, generally no constraints are imposed on the use of environmental resources. Implicitly, any use of natural resources is permitted provided compensation is offered in the form of a larger production of man-made goods and services. In sustainability-oriented project appraisal, efficiency remains one of the appraisal criteria, which means that this way of processing information about environmental resources will be maintained. Through the sustainability criterion, however, "environment" is given a second essential function. For each sustainability parameter, as chosen above, a threshold, target or satisfying level (both in quantitative and qualitative terms) is defined. Such a level is a normative expression for a desired state of the environment. Resource use in excess of threshold levels implies non-sustainability.

What may be the threshold level for resource use, on the basis of which an activity would be classified as sustainable or non-sustainable? Various choices may be made, such as:
- present levels;
- historical, "natural" levels;

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9 Economic constraints as a translation of ecological limits should not be confused with production and income targets derived from economic policies.

- levels at which irreversible environmental decay occurs;
- levels which are considered necessary from the view point of, for instance, human health;
- extremely strict levels, reflecting a purely ecological point of view;
- more specific interpretations, including critical levels, quality standards, maximum sustainable yield or carrying capacity, resilience, vulnerability, fragility, etc.

The normative nature of the sustainability criterion and the broad spectrum of options imply that decision-makers and other parties in society may have different views on desirable thresholds for resource use.

Risk and uncertainty

Often it will be impossible to know with certainty whether policy actions will involve sustainable or non-sustainable levels of resource use (Quiggin and Anderson, 1991). "Surprises" may occur, i.e. events that cannot be predicted, and particularly unpleasant surprises with potentially disastrous effects for future generations. Often, probabilities associated with various possible events cannot be estimated. A risk strategy should therefore be a part of a sustainability policy, describing subjective attitudes towards risk and associated extreme events. Risk-aversive strategies imply a larger willingness-to-sacrifice present welfare than optimistic views on future possibilities to respond to eventual harmful events, for instance through technological progress. One approach is to follow the maximin strategy, whereby the alternative is preferred of which the worst possible outcome is better than the worst possible outcomes of other alternatives. "No-regret" strategies aim at avoiding highly uncertain but potentially disastrous events and surprises by embarking on measures that also can be justified on the basis of their impact on related, but more predictable fields.

Time path

Assuming that non-sustainable development patterns exist, should sustainability be demanded immediately or would a transition period of shorter or longer duration be preferable? From a purely ecological view, any delay in the implementation of sustainable policies may be unacceptable because it only causes further irreversible environmental degradation. Reasons for a gradual approach may be political, for instance to avoid resistance of affected parties, or economic. A short transition period sets more severe constraints on resource use by new projects than a longer time interval.

Spatial level

At which spatial level should thresholds for environmental resource use be set? The least strict approach would aim at global sustainability. Development would be sustainable if the world uses less resources than the threshold level. There exists, however, a considerable scope for trade-offs at lower levels: project A's non-sustainable resource use would be acceptable if project B would provide compensation by "creating" natural capital. In section 2.5 we referred to the proposal to contribute to reforestation in Brazil to compensate for emissions of greenhouse gases by a new Dutch power station. The aim is to achieve global environmental stabilization, which would be commensurate with non-sustainable development at the local level.

At the other end of the spectrum of policy options, sustainability would need to be achieved at the lowest level, say the project level. In this case, there is no scope whatsoever for substitution: no individual project may use environmental resources in excess of what are considered sustainable levels.

A policy that under certain conditions permits non-sustainable resource use by individual projects would lead to very different project selection outcomes than the strict project-level approach. In the latter case, sustainability tests would lead to lower levels of resource use. At the same time, it will generally become more difficult to find sufficient feasible projects to exhaust available budgets.

Preliminary conclusion

A sustainability criterion will play a dominant role in project appraisal if a) strict limits are imposed on natural resource use, b) limits apply to specific environmental groups without the possibility of substitution, c) all ecological risks should be avoided, d) sustainability should be achieved in the short-run, and e) all these requirements are to be met at the lowest spatial level, i.e. the project level. Such a strict sustainability criterion corresponds with:

- a risk aversive attitude;
- the formulation of a separate objective for environmental amenities as a social welfare attribute;
- a strong concern with future generations;
- a lack of confidence in possibilities for substitution within economic and environmental production functions.

4.5. Fundamental interpretations of sustainability

4.5.1. Weak and strong sustainability

A lively debate has been conducted in the recent literature about the preferable interpretation of the sustainability concept. Sofar no comprehensive concept seems to have been proposed, simultaneously covering all elements treated in the previous section. Most attention has been paid to the choice of a threshold level for sustainability. This section reviews two fundamental options in this field as elaborated by different groups of economists, viz. *weak sustainability* and *strong sustainability*[10]. They will be associated with ideas regarding the spatial level at which they may be applied and other elements in a sustainability criterion. Moreover, underlying value judgements are investigated.

Sustainability parameters and threshold levels

The two sustainability interpretations can be summarized as follows:

- *Weak sustainability* (wS): this approach requires that the total capital stock, comprising the man-made capital stock and the natural capital stock, does not decline. No limits are imposed on the possibility to substitute man-made capital for natural capital. Consequently, natural resources constitute only a relative constraint on development. This concept is favoured by many neo-classical economists, including Solow (1988) and Bojö, Mäler and Unemo (1990)[11].
- *Strong sustainability* (sS): according to this interpretation, the natural capital stock nor the man-made capital stock should decline. The two capital stocks are considered as complementary, and natural resources impose an absolute constraint on development patterns. Klaassen and Botterweg (1976) seem to be the first economists who have proposed to impose non-negativity constraints on environmental capital. Goodland and Ledec (1987), Barbier (1989), Pearce et al. (1990), and Opschoor (1992) are among the authors, often specialized in environmental economics, who have more recently advocated this approach.

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10 The notions of weak and strong sustainability have been proposed by Foy and Daly (1990).

11 Bojö et al. argue that human capital and other forms of capital may also be covered by the sustainability condition.

The sS and wS approaches correspond in two respects. First, both are anthropocentric concepts, aimed at giving future generations access to a certain level of social welfare. Second, both concepts aim at (at least) maintaining *present* welfare levels over time. Consequently, *existing* levels of stocks of production factors are therefore taken as a point of reference for sustainability. This involves an arbitrary element: what is special or desirable about present levels? Sustainability defined in 1993 applies to a different social welfare level and corresponding environmental stocks compared to sustainability defined in 1983.

The wS and sS concepts differ in terms of the scope for possibilities to substitute a unit of the natural capital stock for a unit of the man-made capital stock. The conditions for sustainability are summarized below:

dN	dM	
	<0	≥0
<0		wS*
≥0	wS*	wS, sS

dN :changes in the stock of natural capital
dM :changes in the stock of man-made capital
<0, ≥0 :new levels are lower than; equal to or higher than; existing levels
* :provided positive change outweighs negative change

The following problems can be observed:

- In the case of sS: where to draw the line between man-made and natural capital? Consider, for instance, the mixture of numerous inputs in land development (use of chemicals, terracing, irrigation canals).
- In the case of both sS and wS: how to aggregate the numerous elements in the natural capital stock? How can we tell whether the natural capital stock declines or grows if the ozone layer becomes thinner, while acidification is reduced? Which weighting scheme should be applied to the various elements? Weights should represent the relative importance of the main classes of environmental problems. Market prices are unlikely to provide an option for standardization because so many natural resources and services are unpriced; shadow prices might be estimated in some cases. The alternative is to use other willingness-to-pay indicators or policy weights. Policy-makers may be asked to express their preferences, or their implicit preferences may be derived from past policies. Through questionnaires representative samples of people might be asked to rank environmental problems (Opschoor and Reijnders, 1991).
- In the case of wS: what would be the common valuation basis for man-made and natural capital, required to assess changes in the total capital stock?

A way to solve the second problem is to reduce the scope for substitution within the natural capital stock. This can be achieved by disaggregating this stock, and to formulate non-negativity constraints for groups of environmental resources. Compensation within a particular group would be permitted: deforestation at site A may be compensated for by reforestation at site B. No substitution would be allowed between groups. Consider the following guidelines proposed by Opschoor and Reijnders (1991) and Opschoor (1992)[12]:

- the use of renewable resources (fish, forests, groundwater) should not exceed the formation of new stocks;
- the use of non-renewable resources (metals, fossil carbon) is permitted only if an equivalent amount of renewable resources is generated or if other substitutes become available;
- pollution should be such that no further accumulation of pollutants occurs;
- the rate of extinction of species should not exceed the rate of origin.

In principle, further disaggregation can be considered. De Groot (1992) proposes to distinguish between 37 functions of the environment in the framework of environmental impact assessment (section 5.2). In principle, conditions for sustainability could be specified for each function, but this approach is time-consuming and would apply to large projects only.

In conclusion, the choice between wS and sS, as well as the view on possibilities to substitute within capital stocks are normative questions. Policy-makers are primarily responsible for giving the answers, but views of other parties may also be gathered. The lower the level of disaggregation of the natural capital stock, the more meaningful and operational the sustainability criterion becomes. At the same time, required efforts to investigate sustainability threshold levels increase rapidly.

Risk, time path and spatial level

The basic formulations of wS and sS do not define a strategy for the treatment of ecological *risk and uncertainty*. In other words, in their original form it is assumed possible to assess with certainty whether non-negativity constraints are complied with. Indirectly, however, the issue of risk does play an important role. The attitude towards risk and uncertainty appears to strongly affect the view on the acceptability of substitution between natural and man-made resources. Many advocates of the sS concept acknowledge that it may frequently be possible to maintain welfare levels if a particular environmental loss is compensated for by

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12 An alternative is the following classification: biological/ecological factors, geological factors and recycling systems (Friend and Rapport, 1991).

a gain in terms of man-made resources. Nevertheless, they prefer to impose a non-negativity constraint on environmental capital because of the fear that through cumulative and synergic environmental processes, about which we know little, environmental degradation may ultimately be much more serious than by themselves small interventions would suggest.

With respect to the *time path* towards sS, Pearce et al. (1990) distinguish between two strategies. If the goal is to realize a generally positive trend of welfare development over some selected time horizon, the approach the authors themselves favour, short term constraints on resource use would be less stringent than if welfare is to increase every year. Other authors have given little attention to the time path.

Any sustainability concept, whether wS or sS, needs to be specified at a certain *spatial level*. Several advocates of the sS approach have elaborated proposals in this field:

- Klaassen and Botterweg (1976) recommend to apply the sustainability constraint at the project level. Hence, no individual project should negatively affect the size of the stock of environmental resources[13]. The Dutch development cooperation policy is based on the same principle. The drawback of this, most strict, approach is that few activities would pass the sustainability test, particularly if non-negativity constraints were imposed on particular groups of natural resources.
- Pearce et al. (1990) and Barbier et al. (1991) favour application of a sustainability criterion at the "programme level", i.e. across a set or portfolio of projects. In this case, individual projects may use environmental resources as long as this is compensated elsewhere in the programme.
- Sustainability policies may be formulated at the level of ecosystems or sectors. Tisdell (1988) reviews several proposals to specify conditions for sustainability for agricultural systems. Van Duivenbooden et al. (1991) do the same for arable crop systems (nutrient balances should be in equilibrium), livestock systems (stable herds), and fishery (quota at the level of maximum sustainable yield). Vasavada's (1991) criterion for land use is that the rate of soil depletion should be less than the rate of soil generation.
- Regions may be taken as the starting point for sustainability policies (see Rees, 1988; Nijkamp et al., 1991; IOV, 1992). In a way, this involves a combination of the ecosystem and portfolio approaches. Sustainability targets will be formulated at the level of regions, and cumulative impacts of individual projects should remain below the threshold levels.

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13 Consequently, if each activity in society would be controlled, sustainability would also be achieved at higher levels.

- As said earlier, sustainability thresholds may also refer to countries, continents or the world. The higher the spatial level, the greater the scope for trade-offs.

The project-level approach is most straightforward, as the scope for resource use by each independent project is known and controlable. The choice to define sustainability at higher levels may have two very different reasons. First, it may be considered morally *acceptable* to have non-sustainable development patterns at lower levels as long as it is assured at higher levels. Second, it may be judged *unnecessary* to take measures at the project level, because effective measures can be implemented at a higher level. Such a position might be commensurate with the neo-classical viewpoint that the price mechanism will ultimately assure that ecological constraints will be complied with. In section 6.2.1. we will argue that this view is incorrect (see also Daly, 1992). Project level sustainability instruments may also be considered unnecessary if an effective sustainability-oriented instrument exists at a higher level. An example is Pearce et al. (1990) who advocate to design "compensating projects" at the programme level (see section 5.5). Similarly, if a system for tradable permits for pollution exists, there is no need to investigate the emissions of individual factories. In reality, such instruments are still rare, and where they exist implementation is problematic. In such cases, a project level approach is not obsolete.

View on environmental amenities as a welfare attribute

A review of the sustainable development literature shows that not much attention has been devoted to the direct impact of environmental amenities on well-being. Conditions for sustainability are formulated in terms of aggregate natural capital stocks, covering both amenities and productive environmental goods and services. If a strategy appears to be successful in maintaining welfare levels over time, this may correspond with the combination of an increased availability of man-made goods and services and deteriorated environmental amenities. This aspect should especially be taken into account if present levels of environmental amenities are critical (unsafe drinking water, air pollution, etc). Consequently, in the formulation of sustainability conditions, seperate thresholds may be formulated for environmental components with a direct and an indirect impact on well-being.

Of course, this problem applies much more to the wS strategy than to the sS approach. WS allows for two forms of substitution: man-made capital for natural capital, and man-made goods and services for environmental amenities. In the case of sS, the former form of compensation is excluded. Substitution within the social welfare composition would only occur if, within a constant overall environmental stock, particularly environmental amenities would suffer from negative trends (which would be compensated for by progress in other environmental components). This is rather unlikely.

View on intergenerational equity

With respect to intergenerational equity, both wS and sS aim at allowing future generations access to the same resource base as the present generation. Assuming constant productivity of resource stocks, social welfare levels would at least remain at present levels. Pearce et al. (1990) argue that such an approach can be justified by Rawls' theory of intergenerational equity (Rawls, 1972). As Goodland and Ledec (1987) put it, it is prudent to assume that future generations will have about the same interests in natural resources as the present generation.

Nevertheless, both sustainability approaches raise some questions. The choice of present welfare levels as a bench mark, besides being arbitrary, may be unacceptable if present levels are extremely low, as they are in many developing countries. In other words, accepting continuation of present welfare levels is easiest for the better-off.

A major problem associated with both sS and wS is that without further assumptions, these approaches will not necessarily maintain *per capita* welfare levels over time. Assuming a) a given level of technology, b) a given carrying capacity of the environment, c) a given level of resource use per capita, and d) a growing population, a strategy of keeping capital stocks intact over time results in decreasing capital per capita, and consequently decreasing welfare per capita. Only if productivity increases, if resource use per capita declines or if ecosystems become more robust, this situation need not occur.

In general, the views on intergenerational equity underlying wS and sS correspond. There exists a difference, however, but it is somewhat hidden. Advocates of wS tend to be more optimistic about technological progress, and hence the possibility to compensate future environmental losses by a greater production of man-made goods and services. Similarly, it is often argued that as long as our knowledge about environmental changes and dangers is limited, we should hesitate to embark on programmes aimed at avoiding these problems if they have significant short-term economic costs (see for instance Beckerman, 1992). Supporters of sS strategy usually are in favour of a much more prudent attitude, and warn against the long-term dangers of ecologically risky activities (Opschoor, 1992). This risk attitude shows particularly in the recommended scope for substitution, as will be explained below.

View on substitutability of factors of production

With respect to the *economic production function*, advocates of sS stress the complementary nature of man-made and natural capital, whereas wS is justified by reference to substitution possibilities. The justifications for these positions are a combination of scientific findings and moral judgements.

Pearce et al. (1990) argue that especially in countries at an early stage of development, natural and man-made capital are likely to be complements. In more developed countries substitution might be feasible on a wider scale. Nevertheless, according to the authors, policies should be based on the assumption that the two stocks are complementary. The main motive for this choice is a risk-aversive attitude. Man's knowledge of ecosystems is limited, and natural capital can be decreased but often not increased (lack of replicability). Other environmental functions are replicable only at unacceptably high costs, whereas degradation of parts of a resource system might lead to a breakdown of the integrity of a whole system (Barbier, 1989). Dasgupta and Mäler (1991) add that complementarity of environmental and man-made goods and services especially applies to the poorest groups in developing countries. Bojö et al. (1990), however, emphasize that empirical information on substitution possibilities is insufficient, and argue, like Beckerman (1992), that most economists share the view that there are no economic signs of increased resource scarcity.

When ecological damage occurs, the sS approach can only be complied with by creation of an equal quantity of environmental capital of similar quality. Pearce et al. (1990) do not elaborate on substitution opportunities within *environmental production functions*. At the same time they devote much attention to the notion of environmentally compensating projects (see section 5.5). Such projects involve the creation or improvement of natural capital to compensate for unacceptable resource use elsewhere. Given their cautious approach to substitutability between man-made and natural capital and ecological risks, a similar approach would have been expected with respect to environmentally compensating projects.

The issue of substitutability in production functions may be illustrated by various theories of agricultural development, summarized in Hayami and Ruttan (1985). Such theories express different views on possibilities to substitute capital and labour for land. Technology plays a pivotal role in this respect. Hayami and Ruttan distinguish between mechanical technology, implying substitution of capital and land for labour, and biological technology, involving the substitution of labour and/or industrial inputs for land. The latter is most interesting from a sustainability point of view and may refer to labour-intensive conservation strategies, use of chemical fertilizers, and use of pesticides.

The "conservation model" of agricultural development stresses that the organic (and in a later version also the mineral) content of soil should be maintained at a definite level, usually the level natural to the particular soil. Such constraints play a minor role in theories with an emphasis on technological progress. The "diffusion model" rests on the view that effective dissemination of technical knowledge is a critical factor to growth. Advocates of the "high-payoff input model" argue that agricultural development requires investments in a) agricultural experiment stations producing new technological knowledge, b) the development and production of technical inputs, and c) the capacity of farmers to use modern inputs effectively. Conservation of soils at "natural levels" does not play a role in these approaches.

This section shows that project appraisal outcomes would strongly differ in the case of wS and sS policies. A wS approach permits natural resource degradation by projects provided compensation is offered in the form of an increasing stock of man-made resources. At a given spatial level, a sS approach rules out such an outcome, because the environment should not (further) degrade. From an environmental viewpoint project selection outcomes would undoubtedly be more attractive under a sS policy than a wS policy. In the former case, however, less projects will be available that satisfy the sustainability condition. Moreover, serious conflicts with other criteria are to be expected. Project evaluators should therefore investigate whether decision-makers, and possibly other parties, favour either the wS or sS policy.

4.5.2. *An ecocentric interpretation*

The wS and sS concepts are, as indicated above, anthropocentric, focusing on moral judgements about the well-being of people. Moreover, they are founded on economic concepts, such as welfare and capital stocks. Alternatively, sustainability proposals have been developed from a purely ecological perspective. Such "ecocentric" (Opschoor, 1992) concepts place ecosystems, rather than mankind, at the centre of analysis[14]. Generally, this position imposes the most strict limits on resource use, although advocates may have different views on thresholds for particular environmental resources. A well-known example is provided by the IUCN, which has developed the World Conservation Strategy (described by Adams, 1990; Lélé, 1991). Similar views are discussed in Rees (1988) and Tisdell (1988).

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14 An anthropocentric and an ecocentric approach may lead to similar recommendations, for instance as regards environmental attributes with a direct impact on human health.

To better highlight the particular focus of wS and sS concepts, an ecocentric approach is briefly described. A suitable example is Reijnders (1990)[15]:

- He sets out to argue that policies should follow the steady-state principle, viz. concentrations of environmental pollutants should not increase (in other words, present levels are marginally acceptable).
- This strategy may be inadequate, however, when stabilization of concentrations does not immediately lead to stabilization of environmental effects. Reijnders refers to time lags involved in adjustments of global temperature to changes in emissions of greenhouse gases. To avoid further temperature rises (and their consequences for mankind), concentrations should decrease, which calls for more drastic reductions of emissions than would be commensurate with a policy of stabilizing concentrations.
- Ultimately, effects stabilization may cease to be the guiding principle. Reijnders argues that the present hole in the ozone layer is generally considered unacceptable and should therefore disappear completely. Apparently, in such cases policies should comply with constraints derived from what are considered ecologically acceptable standards. And such standards may imply that specific types of environmental problems are not acceptable at all.

Reijnders' three-step approach may hence be reduced to a one-step approach: long-run environmental problems should be reduced to environmentally acceptable levels. Probably it may be added that these levels should be achieved as soon as possible. Whereas wS and sS approaches take present stocks as satisfying levels, Reijnders aims at restoring or enhancing the environment system. His analysis is confined to ecological welfare attributes: future generations should be safeguarded against any long-term environmental risk and long-term negative environmental effects. Effects on welfare in general are not a part of his considerations.

An ecocentric approach would raise several problems. For instance: who will choose environmental thresholds and on what grounds? Society may not be willing to give ecologists a decisive influence on development policies. It may be preferred to base development patterns on an integrated evaluation of present and future needs and of trade-offs between ecological and socio-economic objectives. In this respect, an ecocentric approach would probably be rather inappropriate in developing countries.

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15 Reijnders focuses on pollution problems, but his approach could easily be generalized to cover all classes of environmental problems.

4.5.3. *Towards project-specific interpretations of sustainability*

The overall conclusion is that significant steps towards operational sustainability concepts have been made, but that present approaches have three, related drawbacks.

- The sustainability interpretations presented here are often a reflection of value judgements of individual authors. The greater the rigidity of terms incorporated by a sustainability condition, the more important this aspect becomes. Normative views of individual scientists need not coincide with views and policies of governments or other parties. In project appraisal there is a need for sustainability frameworks which allow for different views of policy-makers and other groups affected by or involved in a project.
- An important assumption refers to the substitutability of man-made and natural resources. Whereas an element of value judgement is involved, science can help in analyzing the actual situation in an area that would be affected by a project. Instead of basing a sustainability policy on the general assumption that resources are complementary, it would be recommendable to take actual conditions into account.
- Until now it has been implicitly assumed that sustainability policies would be defined in isolation from other policies. In reality, policy-makers as well as many private sector agents will take all consequences of available options into account. In other words, sustainability may be defined acknowledging trade-offs with efficiency and equity criteria.

The WCED (1987) emphasizes that sustainable development should be considered a global objective and that "no blueprint of sustainability will be found as economic and social systems and ecological conditions differ widely among countries". Conditions for sustainable development are not uniform, but eco-system-, culture- and even site-specific (see Sachs, 1989). Moreover, conditions are likely to change over time. We doubt whether governments in developing countries should make an a priori choice between one of the normative approaches outlined above. Preferably, sustainability concepts should be both comprehensive, i.e. allowing for a coverage of all relevant issues discussed above, and flexible, i.e. allowing for different appreciations of these issues in varying contexts. On the basis of a project-specific analysis it may be decided which threshold levels will be chosen for which particular group of environmental attributes, at which spatial level this policy will refer, and what risk may be acceptable.

4.6. Weighting efficiency, equity and sustainability

4.6.1. Possible conflicts

In chapter 2 the possibly conflicting nature of development objectives such as economic growth, an equitable distribution and ecologically sustainable development was referred to. At the project level, the relative priorities of the key criteria of sustainability, efficiency and equity are of no interest if a single alternative would outmatch the other alternatives in every field. In reality, however, there are strong reasons to at least prepare for the possibility that may arise. Conflicts between allocative efficiency and (intratemporal) equity, or between aggregate and local level concerns, have proven so widespread that a specific economic method (social CBA) was developed to account for them. It can safely be predicted that the question of how much efficiency benefits (and funds) to sacrifice for the benefit of relieving poverty among target groups will continue to occur in project appraisal. In addition, new types of conflicts may emerge in relation to the sustainability criterion, which are summarized below.

Efficiency and sustainability

The debate about the Brundtland report appears to lend little support for the assumption that trade-offs between efficiency and sustainability can be ruled out at the project level. There are examples of projects, for instance in the field of financially feasible measures to save energy, in which they comprise compatible objectives. If it is possible to save money by using less resources, there is no conflict. Frequently, conflicts will arise, particularly in terms of short-term economic costs vis-a-vis long-term environmental benefits (Batie, 1989). If resource use is to be reduced, people may face a choice between reducing production, investing in new technology, or searching for (scarce) alternative employment. One of the main explanations is the fact that market prices of outputs and inputs rarely account for ecological costs in their production and use[16]. Expensive investments in environmentally sound technology may therefore not be financially rewarding. Farmers will not see their income increase just because they have switched to the use of less chemical inputs or new management practices. If environmentally sound activities are financially unattractive, outside financing may be required.

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[16] Price mechanisms explain part of our scepticism regarding optimistic views that the "old" conflicts between short-term economic and long-term environmental objectives have been "resolved". See, for instance, ECLAC (1991).

Intratemporal equity and sustainability

To what extent is a sustainability policy commensurate with the objective of combat of poverty among target groups? Pearce et al. (1990) claim that especially in low-income countries a sS policy is "likely to serve the goal of intragenerational fairness-i.e. justice to the socially disadvantaged both within one country and between countries at a given point in time". The argument is unconvincing in the light of practical experiences. For instance, a detailed ex post evaluation of the Dutch aid programme (IOV, 1992) concluded that in many cases projects involved conflicts between poverty and environment objectives, particularly in the short-run. In general, problems underlying efficiency-sustainability conflicts, apply to poverty-sustainability conflicts as well, and probably in an even more serious way. In developing countries, the poorest groups are the most vulnerable to environmental problems. At the same time they have the least resources at their avail to invest in ecologically sound production and consumption patterns. In the absence of market prices that have internalized environmental costs and benefits, once more the key question is who will pay for the transition from non-sustainable to sustainable practices.

By definition, these conflicts will be more pronounced in the case of the most strict interpretations of sustainability, e.g. a disaggregated sS policy, which is applied at the project level. A wS approach, to be applied at the national level, will cause much less havoc.

Until now, the emphasis was on the possibility of conflicting criteria. In addition, environmentally sensitive projects may raise conflicting interests of various groups in society. The government, concerned with sustaining the resource base, may be opposed to the poor local population, who in the past had free access to firewood. If overfishing occurs, the question is which groups of fishermen will need to curtail their fishing efforts. Project appraisal studies will need to address this additional dimension in terms of different weight sets (for an application, see section 10.7.1).

4.6.2. *Specific forms of weighting*

If the three key criteria are conflicting, their relative priority becomes of the utmost importance. A choice problem emerges which is comparable to, for instance, Weber's industrial location triangle[17], or a Möbius triangle (Nijkamp,

[17] Starting from the objective of minimizing total costs, this triangle showed possible locations of industries (i.e. alternatives) and the main "criteria": locations of the market and of two raw materials.

van den Bergh and Soeteman, 1991)[18]. Decision-makers will be required to formulate a weighting mechanism for the three key criteria. To demand that each development project makes a non-negative contribution to combat of poverty, improvement of the position of women (another manifestation of equity), and to ecological sustainability, as the Dutch development aid policy does, is at least rather irrealistic. Weighting will take place, whether implicit or explicit.

Through weighting, the three key criteria can be given specific roles, in terms of objectives, goals, constraints and mixed goals-constraints[19] .

Often, the *efficiency* criterion will be converted into a constraint. For instance, a project is efficient (inefficient) if its NPV is positive (negative). In other words, the achievement of (additional) equity and sustainability benefits is acceptable only if the efficiency constraint is complied with. Efficiency may also be treated as a goal: a strong preference exists to avoid inefficient alternatives (i.e. a high weight applies in the range of negative NPVs), but the option of compensating non-efficiency by positive scores on the other criteria is not ruled out. Finally, efficiency may be converted into a mixed goal-constraint.

No straightforward threshold level can be defined for *(intratemporal) equity*. This is a reflection of the fact that a pure value judgement is involved. In theory, equity may be considered an objective, which corresponds to a constant equity weight. This approach would imply that an unlimited redistribution of income towards low-income groups is aimed at, which seems unlikely. It makes more sense to define relative or absolute thresholds. The former would refer to a minimal part of net benefits that should accrue to specified target groups. In the latter case, thresholds may refer to changes in the part of the population below the poverty line[20]. In both cases, intratemporal equity may be treated as a constraint (a project that fails to satisfy minimum requirements is unacceptable), a goal (the weight of equity is relatively high as long as thresholds are not complied with), or a mixed goal-constraint.

Because threshold levels for resource use are essential to the *sustainability* criterion, to assign it a constant weight may seem strange at first sight. Nevertheless, there may be reasons for treating sustainability as an objective. This occurs if policy-makers prefer an explicit treatment of trade-offs between efficiency and environment, without imposing a constraint on resource use (for

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18 Such a triangle shows the relative share of objectives, and feasible areas if constraints apply.

19 See section 3.2.3 for different approaches to the derivation of criteria weights.

20 For a more elaborate treatment of possible thresholds and related measurement scales for intratemporal equity, see section 6.5.

an illustration, see section 9.3). In this way, environmental issues are given a more prominent role in an appraisal than in the past, but are not considered important enough to overrule all other criteria in the case of non-sustainability. If sustainability is converted into a goal, non-sustainability may still be compensated for by efficiency or equity benefits, but the price is higher than if it is an objective. This type of interpretation of sustainability seems to reflect many experiences from reality.

Finally, sustainability may be converted into either a constraint or a mixed goal-constraint. In both cases a positive score on the sustainability criterion is a precondition for further consideration of a project, irrespective of its efficiency or equity benefits. If it is a constraint, the sustainability criterion does not play a role in project appraisal if environmental resource use remains within specified levels. If turned into a mixed goal-constraint, the aim is to maximize the difference between actual and normative resource use, even if the constraint level has already been satisfied. In this case, the sustainability criterion has a much larger impact on project selection outcomes than if it is treated as an objective or a goal. It will especially dominate appraisals if *furthermore* "strong", risk-adversive, project-level versions of sustainability are applied.

Defining a clear policy framework, including a specification of a sustainability criterion and criteria weights, is a sensitive affair. In some cases the appraisal of a project may be conducted against the background of a well-developed policy framework. In the ideal case, such a framework has been elaborated at the level of a region or a sector. Evaluators of projects will then face an easier task than if the policy context is more fuzzy, with criteria and criteria weights yet to be determined. Sometimes, decision-makers may want to consider possible consequences of available options for sustainability policies and criteria weights before making a choice. An interactive approach is than required, involving feedbacks throughout the appraisal proces. In this case, emphasis will be put on location-specific conditions, i.e. information about the project setting (see section 5.2.1). If, for instance, in a particular area substitution possibilities within production functions are considered feasible, a weaker sustainability condition may be formulated than when such opportunities are ruled out a priori. Possibly, MCA can be used to assist policy-makers in choosing critical parameters. Probably at the level of a region or a sector, MCA techniques may play a supporting role in a learning process of clarifying efficiency and equity effects of varying sustainability and trade-off (weighting) policies. These effects may take views of experts into account through so-called Delphi techniques (Hacker, 1988) and be explored through simple models for scenario analysis or regional development. In general qualitative information will be the result, which calls for MCA techniques that can treat "soft" data.

4.7. Conclusions

The incorporation of sustainability concerns in decision-making frameworks in project appraisal starts with the definition of alternatives. Probably the most efficient way to arrive at ecologically sound project selection is to design alternatives that clearly reflect environmental objectives, and to compare them with alternatives that are more oriented towards efficiency and equity. Project appraisal results will then immediately show trade-offs.

With respect to project appraisal criteria, two important changes are required. First, practices regarding the treatment of the traditional criteria of allocative efficiency and (intratemporal) equity need to be reviewed. The direct impact of environmental amenities on human welfare should be acknowledged, besides the availability of man-made goods and services. And particularly in developing countries, the special position of poor groups in terms of access to natural resources should be addressed in the framework of the analysis of intratemporal equity. The desire to monetize project impacts should not impede a comprehensive treatment of environmental amenities.

Second, sustainability should be considered the third, independent key appraisal criterion in project appraisal. Sustainability is a strongly normative concept, as can be seen from the issues on which it depends: definition of welfare, intergenerational equity objectives, risk and uncertainty regarding environmental resources, and possibilities to substitute man-made for natural resources. A disadvantage of specific interpretations of sustainability, like strong and weak sustainability, is that the scope for individual choices of policy-makers responsible for a project is considerably reduced. Moreover, there is little reference to site-specific conditions in the project setting. A flexible approach is therefore proposed, in which a sustainability criterion may be developed that is appropriate in view of local circumstances. A consequence of the flexible approach is that policy-makers, possibly assisted by appraisal experts, need to define a sustainability criterion themselves. In such a process, they would need to address the following dimensions:

- in which environmental parameters is it expressed?
- what is the level of environmental resource use that distinguishes non-sustainability from sustainability?
- what risks are policy-makers willing to take in achieving sustainability objectives?
- what is the desired time path towards sustainable development patterns?
- at which spatial levels are sustainability thresholds set, and consequently how are welfare trade-offs at lower and higher spatial levels accounted for?

Flexibility in defining the sustainability criterion is also required in the view of the observation that sustainability and the other two criteria may be of a conflicting nature. In contrast to optimistic views on possibilities to achieve long-term sustainability objectives and short-term poverty and equity objectives simultaneously, many appraisals will call for a solution for trade-offs between criteria. Through particular forms of weighting, policy-makers have the option of assigning the sustainability criterion a more or less prominent role in an appraisal.

The conclusions of this chapter are well illustrated by the Colombia case (chapter 9) and the Egypt case (chapter 10). Because of different attitudes of policy-makers regarding the treatment of sustainability concerns in the choice of alternatives, criteria and weights, appraisal studies as a whole obtained a very different scope.

5. IMPACT ASSESSMENT: ENVIRONMENT AND SUSTAINABILITY

5.1. Introduction

After the development of the decision-making framework (alternatives, criteria, weights), the next phase in project appraisal is concerned with the estimation of impacts of alternatives (diagram 1.3; section 1.4). A main finding of chapter 4 is that in sustainability-oriented project appraisal environmental effects play a pivotal role:

- they directly determine the score on the sustainability criterion; and
- they should properly be accounted for in the determination of the scores on the key criteria of efficiency and equity.

A first aim of this chapter is to outline the various steps in the estimation of environmental effects of development projects, and to discuss main problems involved. Moreover, a methodology to assess the score of project alternatives on the sustainability criterion is elaborated. The treatment of environmental effects in efficiency and equity impact assessment is the subject of chapter 6.

Estimating environmental effects of development projects is impossible without knowledge about the *project setting*. Section 5.2 discusses the main components of the analysis of the project setting. Two closely related activities are the preparation of project profiles and a model for ecological-economic interaction. Together they provide insight in present levels of economic and ecological parameters, as well as in the two-way relationships between ecological and economic systems. Moreover, the analysis of the project setting should include the calculation of sustainable levels of exploitation of natural resources. By comparing these levels with actual levels of resource use, the degree of sustainability of production and consumption processes in the setting may be assessed. Finally, it is shown that the scope for future resource use by new projects may be formalized in terms of an environmental utilisation space.

The general approach to *environmental impact assessment* is summarized in section 5.3. In addition, it elaborates on measurement problems often encountered in reality.

How the score of project alternatives on the *sustainability criterion* might be assessed is analyzed in section 5.4. First, the general case is developed, involving the question whether a project's estimated use of natural resources is acceptable, or -more precisely- whether it is commensurate with the environmental utilisation space. Second, complexities are outlined that arise when sustainability objectives are disaggregated in terms of different environmental attributes and spatial levels. MCA is shown to be a potentially useful analytical tool in this field.

If sustainability is treated as a constraint (or a mixed goal-constraint), projects that fail to fulfil sustainability requirements should either be rejected or adjusted through the incorporation of *constraint-satisfying activities*. Problems involved are outlined in section 5.5.

The final section 5.6 contains the main findings of this chapter.

5.2. Economy and ecology in a project setting

5.2.1. Profiles and interaction models

A prerequisite for environmental impact assessment (EIA), i.e. the estimation of environmental effects of project alternatives, is an understanding of the project setting. If not available at the start of an appraisal study, evaluators themselves need to develop two appraisal tools, viz. project setting profiles and a model for ecological-economic interaction. Both should focus on the project area in a narrow sense, as well as at systems at higher spatial levels as far as they are expected to affect the project, or vice versa. Frequently, profiles and models may best be developed at the level of a region (IOV, 1992).

Conceptually, the development of both profiles and models may be based on the (simplified) model developed in section 2.2.2, linking welfare, an environmental system and a socio-economic system. Whereas profiles gather information about the state of environmental and economic variables contained in the scheme, the interaction model explains relationships between such variables. In any case, project setting profiles should present today's values of variables. Preferably past trends are also assessed, because they may be an appropriate or even a necessary basis for estimating future developments.

Project setting profiles will differ from project to project. Generally, however, issues in three fields will usually be treated (see section 2.2.2):

- The analysis starts with a description of *aggregate welfare* levels. What are income and consumption levels? What is the extent of poverty? How is income distributed? In what way does the environment directly affect the well-being of people?
- The description of the *socio-economic system* should provide insight in the economic structure and production and consumption processes. What is the state of man-made capital? How is it distributed? What is the level of economic efficiency? Which part of the output is marketed?

- With respect to the *environmental system* an environmental profile is prepared which informs about the natural resource base, i.e. types of ecosystems prevailing and on the problems in these systems. Environmental characteristics may be classified, for instance, in terms of a) bedrock characteristics and geological processes, b) atmospheric properties and climatological processes, c) geomorphological processes and properties, d) hydrological processes and properties, e) soil processes and properties, f) vegetation and habitat characteristics, g) species-properties and population dynamics, h) life-communities properties and food chain interactions, and i) integrated ecosystem characteristics (De Groot, 1992). A distinction should be made between various sensitive areas, such as: soils and soil conservation areas, areas subject to desertification, arid and semi-arid zones, tropical forests and vegetation cover, water sources, etc. (OECD, 1990)[1]. With respect to environmental problems, the analysis may focus on, for instance (Myers, 1989): the extent to which, scale at which and type of environmental degradation that is taking place; extent to which and over what time horizon environmental thresholds or critical levels are being approached; occurrence of absolute and relative natural resource scarcity; uncertainties and possibilities of surprises with regard to future developments. The distributional dimension is important: where do problems occur, who are affected and at what pace?

Environmental profiles provide important information about major environmental problems, but they are of little value to policy and project development without a complementary interaction model. In general, *interaction models* should address the following linkages (see sections 2.2.2 and 2.4):
- The dependency of production and consumption (differentiated by social groups) on the environment: use of renewable and non-renewable resources, waste disposal levels, etc. To what extent is substitution within economic and ecological production functions feasible? What is the share of natural resources, directly and indirectly, in imports and exports?
- What are economic explanations (poverty, distribution of resources, population growth, etc.) for environmental problems? To what extent do market prices reflect ecological costs?
- What are economic consequences (for specific groups and levels) of environmental problems? How do population groups respond to environmental decay? What is the impact on income-generating activities?

By addressing these questions an ecological-economic interaction model provides the user with an understanding of how the environment affects people

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1 Bie (1990) describes several dryland degradation measurement techniques.

and vice versa. The appraisal of environmentally-sensitive projects is impossible without it[2]. The model may (or should) be expanded in a variety of ways.

In sustainability-oriented project appraisal, models should generally allow for an assessment of the *carrying capacity* of ecosystems, and corresponding sustainable levels of exploitation. In other words, what is the maximum level of pressure and shocks an ecosystem can endure before deterioration sets in? In section 4.5.1 some guidelines for sustainable exploitation were provided for specific ecological resources. For instance, for a wetland, the model may elaborate on the maximum sustainable fish catch; for a forest, the maximum sustainable timber yield; for a region, the maximum capacity to deposit waste. It should be noted that the assessment of the carrying capacity and related indicators is a cumbersome affair, especially if base-line data are scarce.

Government policies should be included in the model if they strongly affect resource use patterns. Binswanger (1989) and Mahar (1988) have highlighted the crucial role of government interventions in the massive deforestation in the Brazilian Amazon. This ecologically disastrous development can largely be attributed to policies in the field of infrastructure (opening of new lands through road construction), finance (low real interest rates) and agriculture (affecting the relative priority of agriculture in different parts of the country). It may be useful to distinguish between direct and indirect environmental policies. Direct environmental policies refer to all measures that have environmental protection as the single or overriding objective. Examples of instruments are price incentives, such as taxes and subsidies, aimed at bringing the price of environmental resource use at the level of the value to society. Other instruments include direct regulation, tradable permits, and the establishment of property rights for natural resources. Binswanger and Mahar have particularly investigated indirect environmental policies. Such (macro-economic, trade, fiscal, monetary) policies constitute all measures that do not primarily aim at achieving environmental objectives, but do have significant environmental effects[3].

Interaction models may also be helpful in outlining *perspectives for sustainable development* in the project setting, as well as in the *identification of project alternatives*. Breman (1990) grounds his recommendations for agricultural systems in Sub-Saharan African countries on an agro-ecological model. He subsequently addresses a number of questions for different areas. What is the carrying

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[2] See chapters 9 and 10 for illustrations of this statement. In the first case no model was available, in the second case serious efforts were devoted to its development.

[3] For overviews of instruments of direct environmental policies, see Helm and Pearce (1990), SER (1991) and World Bank (1992). The last reference also provides a good overview of indirect environmental policies.

capacity, and which are the limiting factors determining productivity (nutrients, water, light, temperature)? What is the actual level of exploitation in comparison with the carrying capacity (underexploitation, optimal exploitation, overexploitation)? What are the causes for this situation and hence constraints to be addressed in projects and policies (demographical, social, economic, technical, ecological)? Breman shows that because the nature of ecological problems differs considerably between areas, solutions for these problems will vary in space. Whereas in one situation the use of external inputs may be too high, in another an increased use would be recommendable. Similarly, whereas providing more water may be critical in one area, it may be an ineffective approach in another where land distribution should be tackled first.

Nijkamp et al. (1991) elaborate a similar approach to sustainable development policies for regions (section 2.5). "Critical success factors" should be identified, which simultaneously provide insight into the environment as a potential means for development and as a set of constraints on human activities. Such factors determine the boundaries of feasible projects in the project area.

The interaction model shows how the environment affects human well-being, and how production and consumption patterns affect ecosystems. As these linkages are complex and wide-ranging, there is a need for a systematic and comprehensive approach. De Groot (1992) provides a useful starting point for such an approach by defining and elaborating 37 *environmental functions* of nature. They are divided over four main classes, viz. regulation functions, carrier functions, production functions and information functions. These functions cover all possible relationships between man and nature, whether at a local or a global level, whether directly or indirectly affecting human well-being, whether affecting income-generating activities or spiritual well-being. Interaction models may be based on De Groot's classification, and elaborate on the functions that are particularly important in the project setting. For examples of studies that involve a function-like approach, see Gottfried (1990) and chapter 10 (Egypt-case) in the present study.

Until now, "models" have not been specified. In principle, in this study a model refers to any systematic attempt to structure ecological-economic processes in the project setting. De Groot's approach is hence a form of a model, just like Dasgupta and Mäler's (1991) mathematical model. In general, much progress has been made in this field in the past decades, but particularly for developing countries modelling is still in an infant phase (Braat and Van Lierop, 1987; Van den Bergh, 1991). Nijkamp et al. (1990) distinguish between two classes of potentially useful models:

- *Ad hoc models*. Such approaches do not start from a formal operational model, but are either based on informal expert views or on a comparative (cross-regional or cross-national) analysis. Simple qualitative impact-, simulation- or scenario- models might be included[4]. They are relatively low-cost and easy-to-use approaches.

- *Structured models*. At the micro-level these include controlled experiments, quasi-experiments (surveys) and non-experiments[5]. Macro-approaches include numerical statistical bases, partial modelling and integrated simultaneous equation models. Examples are: material-balance models, (semi-) input-output analysis, linear programming, dynamic simulation and quantitative scenario analysis. Whereas the quality of forecasting may be higher than for ad hoc models, data requirements, costs and technical expertise requirements are significant.

A main reason why ecological-economic modelling, particularly in the form of structured models, in developing countries is relatively difficult is the paucity of data. The development of "state of the environment" reporting and "resource accounting" (even in purely physical terms) has only just begun at the level of countries (Friend and Rapport, 1991), whereas project appraisal would greatly benefit from spatially disaggregated accounts. One of the means to collect necessary data may be Geographical Information Systems (GIS, see Jagannathan et al., 1990; Fresco et al., 1989, and Despotakis, 1991). Further development of environmental data bases would greatly support experiments with ecological-economic modelling. In the course of time, the availability of such models, probably on a regional basis, will enhance. This will ultimately be reflected in more robust EIA studies for projects.

5.2.2. *Present sustainability*

On the basis of project setting profiles and the interaction model (section 5.2.1) and the chosen sustainability policy (sections 4.4 and 4.5), the question may be addressed whether in the present circumstances development can be considered sustainable. An assessment should be made of differences between *actual resource use* and *normative*, sustainable levels of resource use[6]. Preferably, past trends in differences between these figures should be analyzed.

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4 For an example in India of qualitative modelling, see Nijkamp and Van Pelt (1987, 1989, 1991). The systems model used in that study was the basis for a conceptually similar but more comprehensive (including a natural resource sub-system) model linked to Geographical Information Systems (Jagannathan et al., 1990).

5 In this case no attempt is made to control the effects of policy variables.

6 Whereas defining sustainability is a normative affair, measuring sustainability is not.

In the following discussion on the approach to assess sustainability in the setting, initially the spatial dimension of sustainability and the possibility of defining sustainability objectives for separate environmental attributes will be ignored. Moreover, by emphasizing differences between actual and normative levels of natural resource use, it is implicity assumed that sustainability concepts are applied which involve only environmental parameters (such as strong sustainability). In the course of this section these assumptions will be relaxed.

Present sustainability may be measured on several scales[7]. A distinction will be made between discrete and continuous scales. The former class involves a limited number of intervals of sustainability scores, whereas the latter shows an infinite number of sustainability scores.

In the most simple approach, sustainability will be measured on a *discrete, binary* scale. Such a scale allows just two possible outcomes: "the sustainability condition is complied with" (S+) and " the sustainability condition is not complied with" (S-)[8]. In the literature this binary interpretation of sustainability is given most attention.

A drawback of binary measurement is that development cannot be "more sustainable" or "less sustainable". A somewhat more data-demanding approach is sustainability measurement on a *discrete, ordinal scale*. Possible outcomes would be: "actual resource use /far exceeds/slightly exceeds/is slightly below/is far below/ sustainable levels".

The most sophisticated form of sustainability measurement involves the determination of the *degree* of sustainability on a *continuous, quantitative* scale. Opschoor and Reijnders (1991) have elaborated on how such a quantitative sustainability indicator may be developed for a country like the Netherlands. Their analysis is taken as a starting point for the development of an approach to measure sustainability in the project setting.

According to Opschoor and Reijnders a sustainability indicator shows the degree to which the actual use of environmental resources deviates from sustainable levels, as elaborated above. The greater the distance between sustainable and actual levels is, the lower the degree of sustainability. The value of the indicator is zero when actual and target levels overlap. It is positive if

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7 See section 3.3.1 for a general classification of measurement scales.

8 Risk and uncertainty can be incorporated, however: "the probability of S+ is..", "S+ is likely but the possibility of a S- score cannot be ruled out".

actual resource use lies below the threshold level (=sustainable), and it is negative, if actual resource use exceeds the target level (=non-sustainable).

A formal expression of a (dimensionless) sustainability indicator for actual conditions in the project setting (SI_a) would be:

$$SI_a = (R_s - R_a) / R_s$$
$$= 1 - R_a / R_s$$

(R_s=sustainable level of resource use; R_a= actual level of resource use)

If over a number of years the SI_a has been positive, development can be considered sustainable, whereas non-sustainable development occurs if it has been negative[9].

This approach, whereby the sustainability indicator is expressed in terms of the relative distance between actual and sustainable levels of resource use, bears a close resemblance to the Goals achievement method (Hill, 1973). For a particular variable, this approach requires the definition of a quantitative objective, e.g. a sustainable level of resource use, and the assessment of the degree to which actual performance (e.g. actual resource use) achieves this objective. Alternatively, penalty models, originally developed by Theil (1964), may be taken as a starting point. Any discrepancy between actual and normative resource use would be penalized by means of a penalty function. Higher deviations can be penalized more heavily by including a quadratic specification (Nijkamp, 1979).

Continuous sustainability indicators provide much more information than binary sustainability indicators. Consequently, development policies and projects can be better targeted, particularly because the degree of natural resource scarcity is addressed rather than the question whether present conditions correspond with either sustainability or non-sustainability. Of course, data requirements for a continuous indicator are more demanding.

The determination of sustainability indicators becomes more complex if sustainability thresholds are specified for groups of ecological attributes and for

9 Opschoor and Reijnders indicate that a separate indicator may be developed, showing the speed at which the distance between target and actual levels changes over time. The following formula is proposed:
$dSI_t = (SI_t - SI_{t-1}) / SI_t$
If $dSI > 0$, development is becoming more sustainable; if $dSI < 0$, the direction is unfavourable.

different spatial levels. Table 5.1 provides the basic structure for an analysis of sustainability in the project setting, assuming four categories of environmental attributes and three spatial levels, viz. local/project, regional, and national/global (see section 4.5.1).

Table 5.1. Resource use matrix for analysis of sustainability in the project setting

Environmental attribute	State	Spatial level		
		Local/ project	Regional	National/ global
Pollution	s			
	a			
	d			
Non-renewable resources	s			
	a			
	d			
Renewable resources	s			
	a			
	d			
Biodiversity	s			
	a			
	d			

s: normative, sustainable level
a: actual level
d: changes in levels over time

If sufficient data can be collected, such a matrix provides the foundation for the calculation of three types of indicators[10]:

- Single-attribute, single-level sustainability indicators: sustainability is assessed for each environmental attribute at each spatial level. For instance, separate indicators can be developed for pollution at the regional level, use of renewable resources at the national level, etc.
- Multi-attribute, single-level sustainability indicators: for a specific spatial level, the sustainability indicators for the four environmental attributes are weighted.

10 A distinction should be made between sustainability indicators for the present situation (i.e. the relative distance between s and a), and changes in this factor over time. For reasons of simplicity, these are not separately treated here.

- Multi-attribute, multi-level sustainability indicators: the integration of both spatial levels and environmental attributes.

In the calculation of such indicators, weighting problems would arise[11]. In principle, the first type of indicator, involving a single environmental parameter at a given spatial level, can be determined according to the principles outlined above (relative distance, penalty functions, etc.). In practice, calculations may involve a weighting procedure. For instance, sustainability in the field of renewable resources may encompass the use of land as well as water resources. The sustainability condition for such resources might be that utilization should be less than natural regeneration. To assess sustainability in the field of renewable resources, results for land use and water use need to be weighted.

Weights are by definition required for the multi-attribute, single-level sustainability indicator[12]. How to compare the sustainability scores for environmental attributes which are in different physical dimensions? A function is required to minimize the weighted differences between thresholds and actual performance. In principle, the Goals achievement method is applicable again, involving the multiplication of sustainability scores by attribute and the weights of attributes, to arrive at an overall indicator. Through the use of penalty functions, non-linear relations may be incorporated[13]. Finally, calculation of multi-attribute, multi-level indicators would require weights representing the importance of achieving sustainability at various spatial levels.

It should be acknowledged that calculation of a weighted sustainability indicator only for the present situation and without comparison with values elsewhere is of limited value. For instance, the outcome of the Goal achievement method is a dimensionless, and by itself meaningless indicator. By calculating such indicators over time, however, trends in environmental resource use can be analyzed. Moreover, comparisons with developments in other areas can be made.

Sophisticated indicators would be desirable if the decision-making framework shows that policy-makers are willing to discuss trade-offs between environmental attributes and spatial levels[14]. Whether it is possible to develop disaggregated

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11 The weights referred to in this section need to be assessed in the development of the decision-making framework (see section 4.5).

12 The AMOEBA approach developed by Ten Brink (1991) uses graphics to show differences between actual and sustainable resource levels for numerous environmental attributes. Scores on attributes are not weighted.

13 Multiple-goal programming might be a more sophisticated approach (Nijkamp et al., 1990).

14 If non-negativity constraints are imposed on attributes and spatial levels, there is no need for the calculation of such indicators.

sustainability indicators to a great extent depends on data availability. If environmental monitoring has been practised in sufficient detail over the years, indicators can in principle be determined. In many developing countries, however, this is not yet the case.

In the case of sustainability concepts that are expressed in a combination of environmental and non-environmental parameters, like weak sustainability, sustainability indicators should cover both aspects simultaneously. In the SI formula, R_a and R_s then refer to the total of man-made and natural resources, rather than to natural resources alone.

5.2.3. *The environmental utilisation space*

Following Siebert (1982), Opschoor (1987, 1992) has elaborated the concept of the environmental utilisation space (EUS). The EUS shows the scope for resource use by new activities with sustainable levels of resource use in the project setting as the bench mark. Under a strong sustainability policy, the assessment of the sustainability scores of project alternatives will have the EUS as the point of reference (see section 5.4). In the case of a weak sustainability policy the EUS is less relevant as any environmental loss may be compensated for by an increase in the man-made capital stock[15].

The sustainability indicator for present conditions in the project setting (SI_a) was defined above as the relative distance between actual and normative resource use ($(R_s - R_a)/R_s$). If it is assumed that in the future R_s and R_a will remain constant, the "without"-alternative corresponds with the present situation. The EUS is then defined as the maximum amount of resources available to new activities ($r_u = R_s - R_a$), if the objective for the setting would be to just achieve sustainability in the future (i.e. the sustainability indicator should then just equal zero: $SI_p = 0$).

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15 For the weak sustainability policy a total resource utilisation space would need to be developed.

If r_p is expected resource use by the project[16], the future, "with-the-project" sustainability indicator for the project setting is:

$$SI_p = (R_s - R_a - r_p) / R_s$$
$$= (r_u - r_p) / R_s$$

If $r_p = r_u$, $SI_p = 0$[17].

The following situations may be distinguished:

- If at present resource use is below sustainable levels, the corresponding sustainability indicator is positive ($SI_a > 0$). Then the EUS available to additional projects is positive ($r_u > 0$). In other words the actual resource use of projects (r_p) may involve a limited net negative environmental effect ($r_p > 0$, but $r_p < r_u$). This implies that without additional constraints, it is acceptable that the sustainability indicator may deteriorate, as long as it remains positive ($SI_p < SI_a$, $SI_p > 0$). If, however, expected resource use by the project exceeds the EUS ($r_p > r_u$), sustainability turns into non-sustainability ($SI_a > 0$, $SI_p < 0$).
- If at present non-sustainability occurs, additional projects have a negative EUS available ($SI_a < 0$; $r_u < 0$). This implies that their environmental effects should on balance be positive ($r_p < 0$). A negative environmental effect would cause a further deterioration in the sustainability indicator for the setting ($SI_p < SI_a < 0$). From a sustainability point of view a project would be acceptable in two cases. First, a project involves a positive environmental effect, which is, however, insufficient to achieve sustainability ($r_p > r_u$; r_p, $r_u < 0$). In other words, the setting sustainability indicator improves but remains negative ($SI_a < SI_p < 0$)[18]. Second, non-sustainability is turned into sustainability ($SI_a < 0 < SI_p$), which demands that the net contribution of a project to the natural capital stock is sufficiently large ($r_p < r_u$; r_p, $r_u < 0$).
- Consequently, if at present sustainability is marginally achieved ($SI_a = 0$), net resource use of additional activities should be neutral ($r_u = 0$). If $r_p > 0$, $SI_p < 0$; if $r_p < 0$, $SI_p > 0$. This situation corresponds with a strong sustainability policy, which takes the present situation as the bench mark for the sustainability threshold.

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16 If $r_p>0$, the environmental effect is negative, if $r_p<0$, a project "creates" environmental capital.

17 This implies that a project will improve sustainability conditions in the project setting ($SI_p>SI_a$), if a project "creates" environmental capital ($r_p<0$), and vice versa.

18 Such a policy is commensurate with the view that a transition period to sustainability is acceptable.

Starting from this basic structure, several types of complexities may arise. First, above it was assumed that resources comprised a uniform entity. In reality, different thresholds may exist for environmental attributes. This was shown in table 5.1, which distinguished between pollution, renewable and non-renewable resources and biodiversity. In such cases the EUS should be differentiated by attribute as well. Depending on the existing state of the environment, the EUS for pollution, for example, might be much larger than the EUS for biodiversity.

Second, at which spatial level should the EUS be defined? In principle, any level between the global and the project level may be chosen. The EUS may comprise specific targets at various levels simultaneously. For instance, a biodiversity EUS is formulated at the local level, whereas a non-renewable resource EUS is defined at the national level. Particular interpretations of the sustainability criterion, however, may require a specific choice. In section 4.5.1 reference was made to proposals by Klaassen and Botterweg (sustainability required at the project level), Pearce et al. (programme level) and Nijkamp et al. (regional level). In these circumstances the EUS should be defined at the corresponding level. Some types of environmental problems may then call for a translation of a supra-project level EUS to a lower level EUS. For instance, focusing on climate changes, global agreements on emissions of greenhouse gasses may be translated in national ceilings (Winpenny, 1990). A further scaling-down may be required. A focus on local-level emissions (flow parameters) may be more feasible than a EUS reflecting targets for supra-project level, cumulative environmental problems (stock parameters).

Third, in contrast to the assumption above, resource use without new projects, and consequently the EUS, may change over time. This problem should be addressed by investigating resource use associated with expected autonomous developments in the project setting. In this dynamic approach the EUS should be reduced if autonomous developments would use environmental capital, and expanded if they would involve a creation of natural resources.

Fourth, fixed quantities of permitted resource use are assumed to be allocated to a project. In the debate on environmental policies, particularly in the field of pollution, several economists favour the allocation of pollution rights to polluters while leaving them the opportunity to buy (or sell) such rights from (or to) others (Helm and Pearce, 1991). In the context of project appraisal such a flexible approach might also be incorporated. A project might buy pollution permits to increase its EUS.

In summary, the determination of the EUS is a complex affair, inter alia due to severe data requirements (what are sustainable and actual levels of use of specific resources?) and the spatial dimension. In reality, a full application of EUS principles in project appraisal will often be too ambitious. Nevertheless, the idea that existing ecological conditions will set limits to resource use by projects is essential in sustainability-oriented project appraisal. At least in a rudimentary form, the EUS notion should therefore be adhered to.

5.3. Environmental impact assessment

EIA is concerned with the measurement of environmental effects of project alternatives, based on the project setting profiles and the ecological-economic interaction model (section 5.2). Combined with the analysis of sustainability in the project setting (section 5.2), EIA results determine the sustainability score of project alternatives (section 5.4).

Several detailed manuals for EIA in developing countries have been developed in recent years, including Biswas and Geping (1987), World Bank (1991) and ADB (1991). Therefore, rather than presenting specific guidelines, this chapter addresses only some general methodological aspects that are relevant to subsequent sections and chapters. Frequently, a distinction will be made between the "traditional" and an "ideal" approach to EIA. Consequently, practical bottlenecks will be reviewed, that explain part of the shortcomings of the traditional approach and constitute main challenges to implementation of the ideal approach[19].

Projects may *affect the environment in different ways*. Hufschmidt et al. (1983) distinguish between:
- projects involving management of natural systems to produce certain outputs;
- projects that affect natural systems off-site;
- projects that eliminate a natural system and replace it with an alternative human-built system, which possibly has important off-site effects; and
- projects that modify or replace the on-site ecosystem with a more or less artificial system on the site through alteration of the existing natural system.

For instance, major adverse environmental effects of agricultural projects can be classified as follows (Winpenny, 1991):
- natural vegetation: changes in land use (including deforestation, bush clearance, shorter fallowing and so on), soil erosion, siltation and deposition, loss of soil fertility;
- hydrological: irrigation impact on the ground water table, river flows, changes in watershed run-off, salinisation, contamination;

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[19] For a critical review of EIA practices in developing countries, see Adams (1990).

- public health: water contamination and eutrophication, aquatic diseases, agro-chemicals entering food chains and body systems;
- biodiversity and wildlife: loss of habitats, interruptions to trails, extinction of exotic species, hunting and collecting.

In the ideal case, all environmental effects would be accounted for, whether in the construction phase or during normal operation, whether direct or indirect, whether on-site or off-site, whether intended or unintended. Chains of effects should be assessed, and possible time-lags identified[20]. The analysis should show whether ecological effects occur immediately or contribute to long-term, cumulative classes of environmental problems. It should also provide insight into the possibility that effects will (ultimately) be irreversible, or only reversible at extremely high (opportunity) costs[21].

With respect to past practices, many appraisal studies have had CBA as a main element. In practice, measurement and valuation problems have often impeded a comprehensive treatment of environmental effects[22]. It has been argued (Summers, 1992) that this problem can be solved by merely paying more attention to EIA. Whereas increased efforts to estimate ecological consequences of projects are a prerequisite for sustainability-oriented project appraisal, this view underestimates some significant problems.

Estimation of environmental effects may be highly problematic for the following reasons (Hufschmidt et al., 1983): a) discharges of material and energy residuals into air, water and land are of many different types; b) a wide range exists for both the rate of change in environmental quality and for the geographical area of influence of residual discharges on environmental quality; c) there is a wide range in the time rates of effects on receptors from changes in environmental quality; d) a large element of randomness exists in the levels of environmental quality over time because of differences in the time pattern of discharges and of the assimilative capacity of the environment; e) residuals discharged from human activities are not the only factors affecting the quality of the environment. Pearce et al. (1990) emphasize problems in estimating effects on

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20 In general the focus will be on "forward linkages", i.e. effects which result from the decision to start an activity. Environmental effects associated with the production of goods and services that are *consumed* by the projects will usually not be considered, if only for the severe measurement problems involved.

21 Both Hedman (1990) and Toman and Crosson (1991) propose to consider size of the impact and irreversibility as the two main attributes of environmental effects. In our view, the temporal pattern of effects is an essential third attribute.

22 In addition, environmental effects have often been ignored because they were not considered "project-specific" (see section 6.2).

life support systems, such as contributions to geochemical cycles. Nijkamp et al. (1991) stress the existence of synergetic environmental impacts, whereby numerous, negligible changes in ecosystems together may have significant environmental effects. Whereas direct environmental impacts may sometimes be reasonably accurately estimated, an analysis of indirect impacts, involving interaction between ecological and socio-economic systems, is much more difficult. Similarly, while a quantitative estimate of localized environmental effects may already be difficult, it will often be impossible to attribute changes in the environment at supra-project levels to individual projects[23] [24].

These issues show that the prediction of environmental impacts is hampered by ecosystem complexity, and particularly by shortcomings in our knowledge about this complexity (Hanley, 1992). The scarcity of environmental profiles and ecological-economic interaction models especially accounts for this.

As far as they paid attention to environmental effects, many appraisal studies in the past assumed that they could be assessed with certainty (Squire, 1989). Quiggin and Anderson (1991) argue that analysts generally have been satisfied with best-estimate or even best-case (most favourable) outcomes. Projections appear to be "surprise-free", assuming that nothing unexpected will happen. Expected values are generally calculated on the basis of unskewed, especially normal distributions. The ideal EIA would pay serious attention to risk and uncertainty. From the start, EIA should preferably be in terms of effect-risk combinations. Particular attention should be given to "worst-case" outcomes, their probability and their consequences. The possibility of unfavourable surprises should also be acknowledged. Instead of presenting a single "best-case" impact matrix, other matrices may be developed to show outcomes under more or less extreme scenarios (see for instance Nijkamp, 1991). Probabilities may not be known at all or only be available in the form of beliefs people have on ranges or intervals of probabilities for an event. If probabilities can be assessed quantitatively, their distributions may often be skewed to the left (Quiggin and Anderson, 1991). Sustainability-oriented project appraisal would need to focus on decision-making under risk, and integrate strategies for decision-making under uncertainty (Chankong and Haimes, 1983).

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23 Winpenny (1990) explains difficulties in attributing contributions to global warming to individual projects: great uncertainty regarding causes and trends in these problems, the problem of disentangling incremental contributions to the existing problem, and the fact that global problems may geographically have very different types of impacts, and even benefit some countries and groups.

24 For a discussion on this issue from the perspective from a country, see Opschoor and Reijnders (1991).

Finally, to enable an analysis of intratemporal equity, the ideal EIA should involve the question of which population groups are "losers" and "winners" (section 6.6). This calls for the development of comprehensive impact tables, comparable with those used in planning balance sheet approaches and community impact assessment (Lichfield, 1988-a, 1988-b, 1992).

5.4. The sustainability score of project alternatives

5.4.1. General

All building-stones for the estimation of the sustainability score of a project have now been gathered:
- on the basis of a) the normative sustainability policy and b) environmental project setting profiles, the EUS (r_u) available to the project can be determined[25];
- the ecological-economic interaction model and the features of the project alternatives are inputs into EIA, which results in an estimation of actual resource use (r_p) of the project. Usually resource use by project alternatives (A, B, ...) will differ, which implies a set of r_{pA}, r_{pB}, ...[26]

By comparing EUS and impacts, the sustainability score of project alternatives can directly be assessed. Ignoring for the moment complexities associated with multiple environmental levels and spatial attributes, sustainability scores may involve three ***measurement scales***.

The sustainability score may be expressed on a *binary* scale: for each project an assessment is made whether estimated resource use is commensurate with the EUS (r_p > or < r_u?).

If measured on an *ordinal* scale, positive notations (+, ++, +++) may be used to indicate that the EUS is not exceeded ($r_p < r_u$), and negative notations (---, --, -) if thresholds have been crossed ($r_p > r_u$). It should be noted that it is insufficient to know, for instance, that project A uses more environmental

[25] If the EUS cannot be assumed to remain at present levels in the future due to autonomous developments, this should be accounted for in terms of a without-alternative.

[26] Here a strong sustainability policy was assumed. Under a weak sustainability policy, only the results of EIA are relevant. They should be aggregated, and consequently added to the change in the man-made capital stock to determine the sustainability score. MCA might be used to weigh the changes in the stocks with different dimensions.

resources than project B ($r_{pA} > r_{pB}$). Reference should be made to the sustainability threshold level. Hence, further information is required, for instance:
- $r_{pA} > r_{pB} > r_u$; projects A and B both exceed the EUS (or create insufficient resources);
- $r_{pA} > r_u > r_{pB}$; only project A exceeds the EUS;
- $r_u > r_{pA} > r_{pB}$; both projects use less resources than permitted.

Finally, the most data-demanding as well as informative sustainability score of a project uses a *continuous, quantitative* scale. Provided that environmental effects can be estimated in quantitative terms, the absolute or relative distance between a project's resource use and the EUS can be determined. In the latter case the result is a sustainability indicator for each project alternative (si; to be distinguished from SI, which focuses on the setting):

$$si = (r_u - r_p) / r_u$$

A project's score on the sustainability criterion is negative (si<0), if $r_p > r_u$, and vice versa.

Measurement on a binary scale is sufficient if the sustainability criterion is treated as a constraint: if resource use remains within acceptable limits, the sustainability score is "yes", or "positive", whereas in the other case the score is "no" or "negative". If sustainability is interpreted as a goal criterion, which means that the degree of sustainability matters, measurement on an qualitative or quantitative scale is required.

The discussion above centred on the main attribute of a sustainability criterion, viz. the threshold level for natural resource use. A second main attribute is ***risk*** associated with the environmental effects and hence the sustainability of development projects. A binary approach might be followed, leading to a statement whether environmental risks are acceptable from a sustainability point of view. More informative would be to rank risks of project alternatives on an ordinal scale. An interesting question is whether trade-offs are allowed between the si and the risk score: may a relatively high risk be compensated for by an attractive expected performance in terms of resource use?

5.4.2. *Multi-attribute, multi-level scores*

The assessment of sustainability scores becomes more complex if separate resource use thresholds have been formulated for classes of *environmental attributes*. In the framework of the analysis of existing degrees of sustainability in the project setting, table 5.1. was developed, showing four classes of such attributes. Starting from these four classes, table 5.2 shows the basic ingredients of quantitative, disaggregated sustainability scores of project alternatives.

Table 5.2. Sustainability scores for project A (to be prepared for all project alternatives)

Environmental attribute	Environmental utilisation space (r_u)	Estimated resource use (r_{pA})	Sustainability score ($si_A = (r_u - r_{pA}) / r_u$)
Pollution			
Non-renewable resources			
Renewable resources			
Biodiversity			

For instance, the sustainability score of a project with respect to renewable resources may be determined by taking the relative distance between the EUS for such resources (which is similar for all alternatives) and the estimated use of renewable resources. If non-negativity constraints are imposed on each environmental attribute, there is no need to determine overall sustainability scores of alternatives. A weighting scheme is only required if trade-offs are permitted (see below)[27].

If sustainability indicators for the project cannot be quantified, qualitative information may be presented. Hence, whereas the quantitative si for pollution might be calculated as 1.2 for project A and -0.2 for project B, a qualitative expression would be A: + +, B:-[28].

Incorporating multiple *spatial levels* may further complicate the assessment of sustainability scores. If the EUS sets constraints on resource use for individual environmental attributes at various spatial levels, it is theoretically possible to expand table 5.2 by introducing spatial levels. Project sustainability indicators would be specified by environmental attribute and spatial level. Obviously, such a comprehensive approach raises tremendous data requirements. Moreover, it is not necessary anyway if the EUS is defined at a particular level (as recommended in section 5.2.3).

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27 The Ministry of Housing (1992) provides an overview of weighting mechanisms in EIA.

28 To account for the temporal dimension of environmental and hence sustainability effects, si's may need to be calculated for various moments in time (short- as well as long-run).

Assuming that no non-negativity constraints apply, *MCA* may be used twice to determine sustainability scores for project alternatives[29]. First, if the four main environmental attributes themselves have various attributes, a weighting system is required for deriving the score on, for instance, pollution, from the scores on the various pollution attributes (for instance, emissions of specific greenhouse gasses). Second, to arrive at an si for each alternative (or a ranking of alternatives regarding the sustainability score), the scores on the four main environmental categories should be weighted. Weights should reflect the degree of priority environmental (sub-) attributes are assigned.

If quantitative sustainability scores on attributes are available, the Goal achievement method or a comparable MCA technique may be applied to obtain the overall sustainability score. The outcome is a quantitative indicator for each alternative, which allows a ranking of alternatives. It may be expected, however, that scores on environmental attributes show a combination of quantitative and qualitative data. For instance, "hard" information may be more likely regarding the use of non-renewable resources than for biodiversity. This implies that ordinal and mixed data MCA techniques might also be useful, such as the Regime method (Hinloopen, Nijkamp and Rietveld, 1987) and Qualiflex (Ancot and Paelinck, 1982 and 1990). The outcome would again be a ranking of alternatives on the sustainability criterion, but without corresponding quantitative indicators.

In conclusion, section 5.4 is instrumental in showing that an in-depth determination of sustainability scores of projects involves a number of steps, requires considerable data, and may even involve weighting mechanisms such as MCA. In reality, only a more modest approach will often be feasible. In any case, key questions to be tackled are: a) what is the scope for resource use, considering present conditions (EUS)?; b) what are environmental impacts of alternatives (EIA)?; and c) are impacts acceptable in view of the chosen sustainability policy?

5.5. Constraint-satisfying activities: sustainability

If the sustainability criterion is treated as an objective or a goal, non-sustainability can be compensated for by a positive score on other criteria. If it is converted into a constraint (or a mixed goal-constraint), non-sustainability is unacceptable. The scores on the sustainability criterion hence provide the means to divide the initial set of alternatives in two groups: non-sustainable projects ($si < 0$) and sustainable projects ($si \geq 0$). A non-sustainable project might involve

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[29] Theoretically, a third field for MCA application exists, viz. to derive overall sustainability scores in the case of an spatially differentiated EUS.

the construction of a dam aimed at electricity generation and irrigation improvement, with unacceptable long-term consequences for ground and surface water availability, water quality and sedimentation. Such a project may immediately be rejected, but a more constructive approach would involve *constraint-satisfying activities* (see sections 3.4 and 4.5.1). Constraint-satisfying activities as far as sustainability is concerned may be classified as follows[30]:

- The design (timing, site or technology) of the project itself may be adjusted. Measures may be included to prevent or mitigate negative environmental effects (defensive expenditures). The dam could be made lower, special filters could be installed or reforestation activities could be conducted to avoid sedimentation.
- Through "compensating projects" (Pearce et al., 1990) or "shadow projects" (Klaassen and Botterweg, 1976) as much environment (in physical terms) should be "created" by additional activities as will be lost due to the original project. As argued in section 4.5.1, this approach may imply a too optimistic view on man's capability to "build" natural capital. Take for instance the compensating project of replanting trees to compensate for deforestation. There may be a time gap of several years before newly planted trees have the same characteristics as the original trees. Moreover, trees are part of ecosystems, which are extremely difficult to create. Irreversible environmental and synergic effects by definition cannot be compensated.
- Other activities should reduce their use of natural resources (Winpenny, 1990). In this way the negative sustainability impact of the proposed project is compensated for externally. Obviously, this arrangement would create considerable implementation and institutional problems.

Whether it is feasible to assign costs of additional activities to a project depends to a great extent on the level at which the sustainability constraint is defined. Following Klaassen and Botterweg's (1976) project-level approach, the costs of shadow projects can be attributed to and directly affect the feasibility of resource-using projects. Projects that are economically feasible without the shadow project might turn out to be non-feasible once the costs of shadow projects are included. Such a linkage cannot unequivocally be established if the sustainability constraint is defined at the programme level, as proposed by Pearce et al. (1990), or at even higher levels. There is no straightforward way to assign individual projects the full costs of environmental resource use. As a consequence, the appraisal mechanism does not provide an incentive to prevent

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30 The examples below assume that the strong sustainability approach applies. Constraint-satisfying activities then by definition involve saving or building natural resources. In the case of the weak sustainability approach, such activities could aim at creating man-made capital as well.

or mitigate environmental damage. Pezzey (1989) poses the question of who will pay for the economically unattractive constraint-satisfying activity. An attempt might be made, however, to attribute costs of programme-level constraint-satisficing activities to individual projects in proportion to environmental damage caused by projects.

Besides costs, all other impacts of constraint-satisfying activities should be reassessed. This includes environmental effects: constraint-satisfying activities themselves may need resource inputs, which would affect sustainability.

Distributive aspects should also be reconsidered. If compensating projects are implemented at another site as the resource-using project, a transfer in space of environmental capital takes place. Similarly, social groups benefiting from a shadow project need not be the same as those that take the burden of the resource-using project. Compensating an increase in emissions of greenhouse gases by a new Dutch power station by contributing to reforestation in Brazil, will be of little comfort to people living close to the power station (see section 2.5). Similarly, constraint-satisfying activities may raise questions of intertemporal equity. Preservation or rebuilding of natural capital can have significant short-term opportunity costs, whereas the benefits (actual compensation) often occur after several years. The present generation might thus be affected negatively in two ways: they experience the environmental burden (which will in effect be compensated only after some time), whereas they also may face the bulk of the constraint-satisfying project costs.

In conclusion, in principle the notion of ecologically compensating projects may be considered a useful tool to assure that projects satisfy sustainability constraints. Even if a strong sustainability policy applies, a certain flexibility in natural resource use by projects is permitted. There are some caveats, however, which appear to receive too little attention by those who regard compensating projects as a main solution to address sustainability constraints (see for instance Barbier et al., 1991). The main problem is that where natural resource degradation occurs, man may encounter serious problems in creating in the short-run new environmental capital of a similar quality. Satisfying sustainability constraints by incorporating measures in project design aimed at *avoiding* environmental damage do not have this drawback (see for instance section 10.2 for an application).

5.6. Conclusions

This chapter shows the steps in the assessment of the scores of alternatives on the sustainability criterion. In a first step, a thorough analysis should be made of the project setting, particularly in terms of the collection of values of environmental parameters (profiles) and the modelling of the interaction between ecology and economy. Moreover, sustainable levels of resource use should be estimated, and consequently the EUS.

In a second step, EIA is conducted. Much more experience needs to be gathered with the systematic estimation of environmental effects of development projects, for instance on the basis of an analysis of various ecological functions. A considerable degree of uncertainty, however, is likely to remain in view of the complexity of ecosystems. This conclusion not only concerns the sustainability criterion, but efficiency and equity criteria as well, as will be discussed in the next chapter.

In a third step, the assessment of the sustainability scores of projects may involve binary, ordinal and quantitative scales. Binary measurement requires the least data, but also is least informative. Preferably more experience is gained with measurement of sustainability on qualitative and quantitative scales. MCA might be considered to determine overall sustainability scores if the EUS distinguishes between several classes of environmental attributes.

If sustainability is treated as a constraint, a negative sustainability score might lead to a fourth and final step, viz. the development of constraint-satisfying activities. In view of the complexity of ecosystems, the possibility to "create" environmental resources should not be overestimated.

A lack of hard data will often set limits on the depth of the analysis in these four steps. The Egypt case (chapter 10), however, shows that even a less detailed treatment of each step will strongly enhance the quality and usefulness of appraisal studies. On the other hand, the Colombia case (chapter 9) illustrates the severe consequences for an appraisal if these steps are largely ignored.

[illegible]

[illegible]

[illegible]

[illegible]

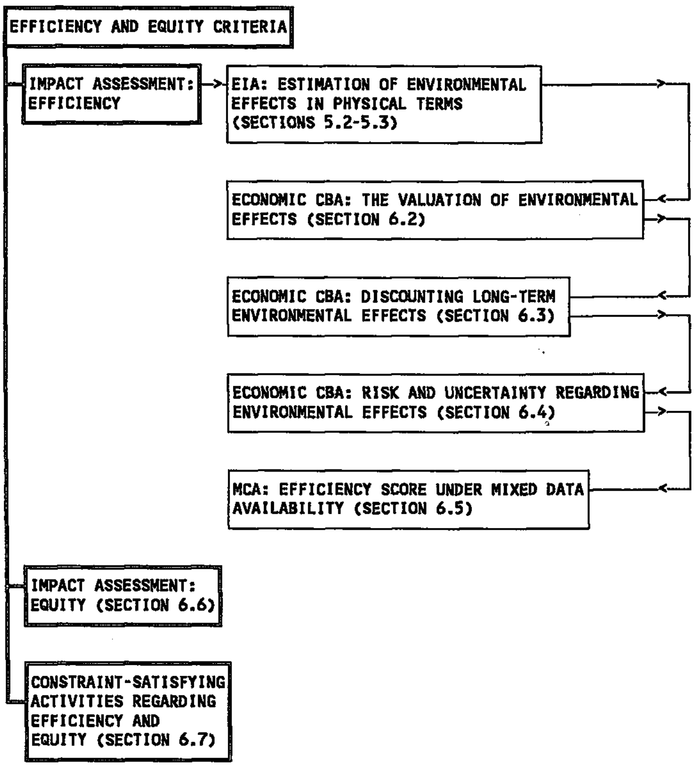
[illegible]

6. IMPACT ASSESSMENT: EFFICIENCY AND EQUITY

6.1. Introduction

In the previous chapter the discussion on EIA was particularly related to the scores of project alternatives on the sustainability criterion. The present chapter is concerned with the treatment of EIA outcomes in the estimation of the scores on the remaining key appraisal criteria, viz. efficiency and equity[1]. The main topics are shown in diagram 6.1.

Diagram 6.1. Incorporation of environmental effects in efficiency and equity impact assessment



[1] Chapter 7 discusses the possibility to adjust efficiency outcomes for equity or sustainability concerns, as well as to arrive at an overall score covering the three criteria simultaneously.

Most of this chapter is devoted to efficiency impact assessment and hence to economic CBA, which according to the decision-tree for method-selection (section 3.5) is the first-best choice to address this criterion. Efficiency is a multi-attribute criterion, and the use of natural resources is among the elements that should be accounted for (see sections 3.2.2 and 4.3). Confusion exists regarding methodological and empirical problems in CBA's treatment of environmental effects. Cooper (1981, p38) argues that "conceptually, cost-benefit analysis of environmental impacts is a straightforward business, which does not require any considerable extension of the principles of project evaluation set out in the standard 'manuals'". Little and Mirrlees (1991, p364) agree, but add an empirical concern: "all effects of a project -including on ... the environment- that might seriously affect its value should always be considered and quantified *if possible*"[2]. Barbier et al. (1991), however, distinguish between a "traditional" and an "extended" CBA, of which the latter would include environmental costs. De Groot (1992, p250) argues that "a major shortcoming of (traditional) cost-benefit analysis is that it is often limited to economic (financial) trade-offs", and consequently that CBA should be "adjusted" to account for environmental effects. Our investigation of the difficulties CBA may have in accounting for the environment covers both conceptual and empirical dimensions.

The treatment of environmental effects in economic CBA is the subject of three sections. Assuming that biologists, ecologists and other physical scientists are able to quantify ecological effects in the framework of EIA (section 5.3), CBA economists should subsequently set out to determine the *value* of these effects to society. Section 6.2 explains why many types of environmental resources are not properly priced. A number of valuation techniques for environmental effects are outlined, in terms of both potential fields of application and limitations. If evaluators succeed in assigning a value to environmental effects, the next phase in CBA is to *discount* all costs and benefits, including impacts on the environment. Section 6.3 reviews various suggestions put forward in the literature to adjust discounting practices for environmental concerns. Finally, section 6.4 briefly surveys CBA strategies to account for *risk and uncertainty* associated with environmental impacts.

A number of conditions have been formulated for a comprehensive coverage of environmental effects by CBA, including quantification and monetization of such effects. If these conditions are not fulfilled in reality, it is impossible to conduct a comprehensive CBA. Section 6.5 addresses efficiency measurement under mixed-data availability. One option in such cases is to conduct a partial CBA and use the results together with environmental intangibles as inputs into an MCA.

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2 Italics indication is ours.

Section 6.6 is concerned with the assessment of equity scores when distributive aspects of natural resource use patterns of projects are to be addressed. Several indicators and techniques to calculate equity scores are reviewed.

If non-negativity constraints are imposed on efficiency or equity, and a project fails to comply, constraint-satisfying activities may be considered (section 6.7). In the former case, such activities should succeed in bringing efficiency at an acceptable level, in the latter case the aim would be to achieve an acceptable distribution of project costs and benefits.

Section 6.8 contains the main findings of this chapter.

6.2. Economic CBA: the valuation of environmental effects

6.2.1. Market failures and the environment

One of CBA's principles says that prices are the means to aggregate individual preferences. All gains and losses should hence be valued in terms of money. From an environmental perspective, this means that all environmental damage and amelioration should be included and valued at economic (shadow) prices. In this sense, it is incorrect to state that the incorporation of environmental effects requires a conceptual adjustment to the CBA methodology (see section 6.1).

This section focuses on particular problems that may arise in the determination of the value to society of environmental costs and benefits of projects. This subject has received ample attention by environmental economists[3]. It has been of minor importance in textbooks on CBA for developing countries, which are mainly devoted to shadow-pricing to account for a variety of market distortions.

Two types of market failures are typically associated with environmental effects and explain the difficulties in their monetization in project appraisal. The first is that environmental effects are often external effects or *externalities*. Such effects are not recorded in any market system. For this to happen, two conditions should be met (Dasgupta and Pearce, 1978): a) an activity at a particular site affects welfare elsewhere in society (the interdependence condition), and b) no financial compensation is provided by (negative externality) or to (positive externality) the activity concerned (the non-price condition). Environmental

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3 See for instance Nijkamp (1979), Freeman (1979), Seneca and Taussig (1984) and Mäler (1985).

effects are often externalities because no property rights exist for many environmental goods and services, or because such rights are not enforced. Opschoor and Van der Straaten (1991) use the notion of cost-shifting: pushing the adverse consequences of activities to others in society. Examples of externalities are: pollution of rivers where the polluter does not pay, uncontrolled emissions of greenhouse gases, depletion of the ozone layer, etc. Helm and Pearce (1991) argue that many of the most important current environmental problems show a combination of many generators and many recipients.

The second type of market failure in relation to environmental effects is the existence of *collective goods or bads*. Dasgupta and Pearce (1978) give two characteristics: non-excludability and non-rivalry in consumption. The first says that provision of a public good to one person implies that it is also provided to others. The second implies that consumption by one person does not affect the availability to others. Collective goods (environmental improvement) and bads (environmental degradation) do not have a market price, and if they do, it can seldom be construed as a proper indicator of social value.

James et al. (1987) summarize the deficiencies of the market system in handling environmental problems as follows:
- for many environmental services there is no market;
- for some environmental problems not all parties interested can effectively enter into market relations;
- environmental services do take on aspects of indivisibility;
- there are external effects on other people's welfare; and
- little is known about the effects of environmental deterioration.

If a natural resource is not marketed, the effective market price is zero and the temptation exists to consider it for "free". Consequently, an environmental resource like air is overused and degraded as demand grows (Pearse, 1991). The price of natural resources that are marketed often is a fraction of the value to society. For instance, irrigation water is heavily subsidized or even provided free of charge in many developing countries. This encourages overuse and wastage, which in combination with poor maintenance has led to lower ground water tables, siltation and erosion. The market price of timber usually covers only costs of extraction and transport, ignoring all present and future externalities.

Low prices for natural resources find expression in prices of man-made goods and services. The costs of natural resources used in production, or the ecological costs of consuming these goods are generally not or only partly reflected in their market prices. This in its turn encourages production and consumption of such products. As Chapman and Barker (1991) explain, pricing policies for agricultural inputs and outputs have often encouraged environmental resource use and discouraged investments in environmental protection in agriculture in developing countries. Whereas structural adjustment programmes, adopted by a great number of low-income countries, centre on the message of "getting prices right", so far this credo has rarely been applied to environmental goods and services.

These issues cast a particular light on traditional shadow-pricing practices for man-made goods and services, particularly for marketed resource-based products. Often, such shadow prices are market prices adjusted for distortions due to economic policies only: import tariffs, overvaluation of the domestic currency, subsidies, and so on. World market prices are applied to tradables directly and to non-tradables indirectly. These prices are considered the best guide to the real value of goods and services, which otherwise would result under competitive, long-term market conditions[4]. Characteristic features of many environmentally-sensitive production processes, however, are that a) factors other than supply and demand determine price levels and b) prices generally only reflect -part of- direct production costs and fail to incorporate direct and indirect environmental costs. A strategy to internalize all environmental costs in supply prices would therefore call for adjustments to world market prices of many goods and services, and hence to CBA shadow-pricing practices.

Valuation of environmental effects of projects should cover all relevant dimensions. As a guide to the total economic value of natural resources, Munasinghe (1992) gives the following possible constituents:

- *use values*: a) direct use values (outputs that can be consumed directly, like food), b) indirect use values (functional benefits, like flood control), and c) option values (future direct or indirect use benefits of preserving an asset now, for instance conserved habitats);
- *non-use values*: a) bequest values (the satisfaction derived from knowing that others will be able to benefit from a resource in the future, often related to irreversibilities in ecosystems), and b) existence values (the satisfaction derived from knowledge of continued existence of natural assets unrelated to use, for instance regarding endangered species).

Techniques available to estimate use- and non-use values are treated in the next section. Experiences in the 1980s strongly suggest that evaluators of development projects should pay them much more attention. Despite the still growing number of case studies (Dixon and Hufschmidt, 1986; Dixon et al., 1989; Bojö et al., 1990; Barbier et al., 1991; Munasinghe, 1992), environmental effects have generally insufficiently been taken into account. Often, CBA studies have simply overlooked such external effects. Barnes and Olivares (1988, p15),

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4 In some fields, for instance agriculture, this assumption is obviously unrealistic, but then one could always say that these are the prices developing countries face anyway.

summarizing practices of World Bank appraisal teams, found that "documentation of potential externalities is haphazard and generally inadequate". CBA calculations generally failed to incorporate positive and negative environmental externalities. This particularly refers to projects that are not specifically aimed at environmental protection. The guideline provided by CBA textbooks to take only "project-specific" effects into account has been the justification for many evaluators to ignore externalities, often on doubtful grounds (Cook and Mosley, 1989). Another reason for the inadequate coverage of environmental effects concerns problems in the measurement and valuation of environmental effects. Barbier et al. (1991), for instance, argue that although the attention for environmental effects has increased, rarely an attempt is made to value them in monetary terms. Munasinghe (1992, p14) notes a "discrepancy between what ought to or could be done and what is actually being done in practice".

The modest performance of evaluators can to a certain extent be attributed to their own attitudes and those of the agencies they work for. Even if evaluators would endeavour to narrow the discrepancy Munasinghe refers to, methodological and particularly empirical factors may still impede a comprehensive valuation of environmental effects. In subsequent sections, such factors will be identified.

6.2.2. *Overview of valuation techniques*

Although classic CBA textbooks for developing countries rarely mention them, economists are not without tools to value use- and non-use values referred to above. This section contains an overview of valuation methods[5]. Its main purpose is to identify their strengths and weaknesses, as a basis for conclusions regarding CBA's role in sustainability-oriented project appraisal.

Valuation methods can be divided in several, not mutually exclusive categories. In all cases environmental effects that do not have a value in markets or have an artificially low market value, are linked to markets where prices are available. These markets may be classified as follows:

- Conventional markets, i.e. existing markets with a direct linkage to environmental goods and services. Either environment is considered a productive input, the value of which can be derived from the value of final products, or outlays for environmental protection are assessed.

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[5] For detailed discussions see, for instance, Freeman (1979); Hufschmidt et al. (1983), Dixon et al. (1988); Folmer and Van Ierland (1989); Green et al. (1990); Winpenny (1991); Barde and Pearce (1991).

- Surrogate or implicit markets, i.e. existing markets with indirectly linked to environmental goods and services. Environmental quality is often one of the variables determining the value of man-made goods, services and assets, and of factors of production.
- Hypothetical or artificial markets, whereby a "market" is created by asking people to value environmental goods and services.

Whereas this classification is founded on a technical question, viz. markets that evaluators may use as a valuation basis, we will refer to a grouping focused on environmental functions (see the discussion on De Groot, section 5.2.1)[6]. A distinction is made between approaches:
- to assess actual or hypothetical expenditures aimed at influencing environmental quality (*cost* approaches);
- to analyze how changes in environmental quality affect income or wealth (*benefit* approaches).

To understand the principle underlying all valuation methods, consider the question of how to value erosion caused by deforestation. Assume that erosion reduces agricultural output. The value of the ecological damage (viz. increased erosion) might be estimated by investigating the corresponding loss of agricultural production. Similarly, the ecological benefits of an erosion control project (viz. reduced erosion) may be valued with reference to the resulting increase in agricultural output. Hence, the value of ecological costs is equal to the benefits foregone in agriculture; a proxy for the value of ecological benefits are the avoided costs in agriculture. Hence, costs and benefits are two sides of one coin, linked by the notion of opportunity costs (=benefits foregone=costs avoided).

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6 Each group may encompass the three types of markets outlined above.

Cost approaches[7]

Individuals and organizations may invest in facilities aimed at preventing or mitigating environmental problems (*defensive expenditures*) (see box 6.1). Prevention measures are source- or process-oriented, whereas effect-oriented measures combat actually occurring damage. Defensive expenditures may be taken as a minimum value for environmental quality changes.

To prevent damage caused by flooding of rivers, drainage facilities may be constructed.

To reduce noise levels caused by a nearby airport, houses may be insulated by double-gazed windows.

Hydropower development projects may result in increased extreme river flow rates and heavy siltation loads. Preventive expenditures may be included to avoid downstream consequences of deforestation.

Box 6.1. Defensive expenditures

To estimate the value of acidification and the related loss of trees, the costs of reforestation may be taken.

The construction of an oil palm mill may result in the discharge of waste water into a nearby stream. As a consequence, a downstream intake for a domestic water supply should be relocated. The costs of relocation may be a proxy for the environmental costs of water pollution.

Box 6.2. Replacing or relocating costs

Changes in environmental quality may cause damage to physical assets, such as houses, buildings, machines and cars. The value of environmental changes may be estimated by investigating the costs of *replacing* lost assets or *relocating* these assets (see box 6.2).

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7 Unless references are explicitly mentioned, examples presented below are taken from several publications on valuation methods referred in footnote 5.

Flood prevention schemes may destroy environmental services like fish production and a habitat for birds. The costs of the loss of these services may be estimated by calculating the costs of creating an artificial lagoon nearby offering similar environmental services.

Box 6.3. Shadow project

Due to development projects, irreversible damage may be inflicted on environmental goods and services. A *shadow project* may be implemented that would create as much environment as was lost due to the original project (see box 6.3).

These valuation techniques all relate environmental quality changes to existing markets for man-made products. If such markets do not exist, a hypothetical market may be created by asking individuals how they value environmental services (*Contingent valuation method, CVM*).

Through surveys, people may express their willingness-to-pay (WTP) for being protected against environmental degradation. Alternatively, they may express their willingness-to-accept (WTA) financial compensation for being exposed to environmental decay (see box 6.4).

People might be asked to say how much they are prepared to pay for improvements in drinking water quality.

Promoters of airport expansion plans may offer neighbours financial compensation for increased noise nuisance.

Box 6.4. Willingness-to-pay

Benefit approaches

Natural resources are inputs into the production of many marketed goods and services. Consequently, environmental quality changes will directly affect *productivity* in income-generating activities (see box 6.5).

Anderson (1989) conducted a CBA of an afforestation project in Nigeria. In the project area deforestation had taken place for various reasons, such as the demand for firewood, opening of land for agriculture and livestock development. The scale at which trees were felled far exceeded natural growth. Consequently, erosion aggravated, leading to declining yields. Costs being unaffected, farmers income decreased. To enhance soil fertility, two alternatives were compared, viz. shelterbelts (strongly concentrated, with a central role of the government) and planting of trees by farmers near farm dwellings and on farm boundaries. The project benefits were the following:

- improving current levels of soil fertility and stemming future declines in fertility. A key assumption was that without the project fertility would decline by 2% annually, whereas with the project this decline would be stopped after eight years;
- receipts from sales of tree products (firewood, poles and fruit);
- increased availability of fodder.

Considering only fodder benefits, which could be measured and valued relatively easy, the economic IRR amounted to just 5%. Taking also the other benefits into account, it rose to 15%. Acknowledging the highly conservative estimates regarding benefits, the project was economically desirable.

Box 6.5. Productivity

Changes in environmental quality may affect human health and subsequently human productivity. The *loss of earnings* approach (also know as human capital approach) estimates environmental value by calculating the loss of income and costs of medical treatment that are attributable to environmental problems (see box 6.6).

A lack of sewerage facilities may lead to pollution of drinking water. This may negatively affect health conditions, and lead to income losses and higher outlays for doctor visits and medicines.

Box 6.6. Human health and productivity

Usually it is impossible to fully assess the value of natural resources in view of their multiple functions and our limited knowledge about ecosystems. Instead of attempting to assign a value to these functions, an analysis might be made of the costs of preservation of that asset in terms of corresponding income changes elsewhere in society. The focus would hence be on the *opportunity costs* (benefits foregone) of preservation (Fisher et al., 1974; see box 6.7).

In a unique wilderness area a project might be implemented for the generation of hydroelectric power. Not building the dam would have two consequences: the wilderness area would be preserved and additional expenses would have to be made to generate power elsewhere. The opportunity costs of preservation would be the additional costs of the alternative project.

Box 6.7. Opportunity costs of preservation

Several valuation methods focus on markets in which environmental quality is one of a great number of factors affecting price levels (*surrogate markets*). Three approaches in this category are presented below.

Differences in prices of houses, land or other property at sites that only differ in terms of the quality of environmental services may be attributed to the environment factor (*hedonic price method*) (see box 6.8).

All other things assumed equal, a given type of house may cost 40% less in a city with severe air pollution than in an otherwise similar city where citizens enjoy clean air. The price differential might be considered the value of clean air.

Box 6.8. Hedonic price approach

Wage differentials for similar jobs may be explained by differences in working or living conditions associated with environmental quality (see box 6.9).

Employers may have to pay labourers relatively high wages as an incentive to work at polluted sites.

Box 6.9. Wage differential

Where admission fees are lacking or artificially low, the amount people are prepared to pay for transport to the area may be a proxy for the value of a natural park.

Box 6.10. Travel cost approach

The *travel cost* approach may be used to value recreational areas (see box 6.10).

6.2.3. *Limitations of valuation methods*

These (and several other) techniques show that despite the lack of a market for environmental products and services, tools exist to value environmental effects. To enhance the scope and coverage of CBA studies, evaluators should make more and better use of valuation methods[8]. Potential and actual application is illustrated in the Colombia case (chapter 9) and the Egypt case (chapter 10). Textbooks on valuation techniques, however, tend to dismiss the limitations of valuation techniques rather lightly. Some of these are of a practical nature, i.e. they are more or less relevant in a particular case, and may be addressed by intensified study. Other limitations are conceptual, and hence location-independent.

A first limitation concerns *absolute imperfect information*[9]. No valuation method is applicable if environmental effects cannot be assessed in physical terms. Section 5.3 described serious difficulties in measuring environmental effects due to deficiencies in scientific knowledge about ecosystems and the impact of human interventions. General discussions on CBA provide few means to deal with risk and uncertainty associated with the environment (see section 6.4). Studies on valuation techniques for the environment generally devote more attention to the question *how* to value the environment than to what we know about *what* should be valued. To a certain extent the problem of absolute imperfect information may be tackled by devoting more time to impact studies, and improving appraisal skills. Due to the complexity of environmental problems, however, a significant degree of uncertainty is likely to remain in many studies. The problem may be least serious for some types of localized environmental effects, occurring in ecosystems about which much knowledge has been collected and which can

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8 Generally, more time and means should be made available for studies to estimate and value environmental effects.

9 The distinction between absolute and relative imperfect information is taken from Cooper (1981).

directly be related to productivity and income in economic sectors[10]. Moreover, data requirements differ considerably between valuation techniques. Methods based on surrogate markets are more data-demanding than methods that rely on direct observations of market behaviour.

A second limitation refers to the WTP principle that underlies all valuation techniques. *Relative imperfect information* hampers comprehensive valuation by individuals. Due to a lack of awareness, people may appear to be willing to pay relatively little for the environment. Hueting (1980, 1990) argues that valuing the loss (or gain) of environmental functions in most cases is impossible due to a lack of a demand curve for such functions. An important reason is that no method is available to account now for the interests of future generations who may be affected by these losses (or gains). This problem particularly refers to option, bequest and existence values and to a lesser extent to direct and indirect use values. Undervaluation is also due to other factors, including the occurrence of public goods and bads, and free rider and prisoners dilemma problems.

The valuation techniques may involve some particular caveats in developing countries, where the linkage between environmental effects and markets, and hence observable prices, is often weak (Cooper, 1981). In some countries a large part of income is in the form of unmarketed subsistence income. Possibilities of using measures of revealed preferences may be limited where many fixed assets are not marketed.

A third limitation, related to the previous one, is that most valuation techniques are *partial approaches*, focusing on a single aspect of environmental quality. Whereas the travel cost method is especially useful to value recreation areas, the loss-of-earnings technique is applicable if human health is affected. Their specific focus aside, most techniques are likely to result in undervaluation of the environment. Because most techniques focus on environmental effects that can be linked to existing markets, they may fail to incorporate other values. Nevertheless, it may be interesting to compare actual prices and incomplete economic prices for natural resources. If, for example, the actual charge for irrigation water is even below an imperfect shadow price, a higher charge would be recommendable, at least to the level of the latter price. For an example of the simultaneous use of several methods, see box 6.11.

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10 Winpenny (1990) has elaborated some principles for the valuation of emissions of greenhouse gasses by projects, under the assumption that national ceilings would be established. Instead of trying to assess contributions to global environmental problems, Winpenny proposes to focus on national marginal abatement costs. His opportunity-cost approach is commensurate with several traditional valuations techniques.

Winpenny (1991) summarizes the main findings of the Korup Forest project in Cameroon, with the combined objectives of natural conservation and economic development in rain forest areas. The project involved: a) establishment of the Korup National Park, b) resettling of several communities based in the park, and c) development of economic activities in the buffer zone.

Several types of environmental benefits were distinguished:
- "sustained forest use": the benefits to neighbouring residents from the existence of the forest and buffer zone;
- "replaced subsistence production": the benefits from livelihoods recreated outside the main forest for resettled communities;
- "tourism": spending of new visitors to the park;
- "genetic value": the potential usefulness of extractions from the park to industries;
- "watershed protection": protection of the coastal fisheries affected by the watershed in the park;
- others: control of flood risk, soil productivity maintenance, agricultural productivity increase, induced forestry, induced cash crops.

At the cost side, the main elements comprised investments in roads and other infrastructure, and foregone income of commercial logging and of the use of the forest by local residents. The economic NPV was found to be positive at the 13% economic discount rate.

Box 6.11. Valuation of the environmental benefits of a natural park

A fourth limitation may be termed *method uncertainty*. Hanley (1992) gives a considerable list of methodological problems associated with the most widely used valuation techniques, including CVM and travel cost method. Apart from method-specific shortcomings, several studies have shown that if a number of valuation techniques are applied in a certain case, (significantly) different results may be obtained ("convergent validity"). A related, serious problem in the case of CVM is the divergence between WTP and WTA measures of value. One explanation, particularly relevant in developing countries, is that WTP bids are constrained by income, whereas WTA bids are not.

Finally, whereas the above-mentioned arguments all reflected a concern to arrive at proper economic prices for natural resources, the results of methods may raise criticism from an *equity* point of view. As economic CBA is indifferent as regards the existing income distribution, so are WTP-indicators for the environment. Consequently, a millionaire in Bombay will be able to assign a much higher value to cleaning up a slightly polluted stream in the backyard of his house than an extremely poor peasant to curbing desertification nearby. For many people, such an outcome would be morally unacceptable. WTP may also cease to be an appropriate valuation principle in the light of intertemporal equity objectives and related sustainability concerns. The former issue is taken up in section 6.3, the latter in chapter 7.

These and other problems in the valuation of the environment provide sufficient support to Winpenny's conclusion (1991, p72) that "appraisals of environmental effects will inevitably omit a great deal from their attempt to value costs and benefits". This conclusion particularly applies to non-market natural resources and hence to methods to assess non-use values (Munasinghe, 1992; Hanley, 1992). Textbooks, however, either do not draw this conclusion, or do not endeavour to find an analytical response to this important limit to CBA's usefulness. The World Bank economist Summers (1992) ignores several shortcomings in CBA methodology when he argues that problems regarding the incorporation of environmental impacts can be solved by simply doing a better appraisal job.

6.2.4. *Cost-effectiveness analysis*

CEA can be applied instead of CBA when costs can be monetized but benefits cannot. CEA may, for instance, be used to select the alternative with the lowest monetary costs per unit of environmental benefits. A project to combat erosion may follow several strategies, such as afforestation, soil conservation measures, and improved irrigation. Application of CEA requires that expected outlays for each alternative for investment, recurrent costs and any other cost element (including external effects) are available in monetary (shadow-priced) terms. With respect to benefits of reduced erosion three possible outcomes should be distinguished:

- Benefits are known in quantitative, physical terms. For example: hectares of improved soil of a certain quality. In this case the discounted total costs per unit (hectare) of discounted benefits can be calculated (average incremental cost method).
- Benefits are quantitatively and qualitatively similar for all alternatives. In that case CEA is confined to calculating the total discounted costs for each alternative.
- If benefits differ between alternatives but cannot be quantified, application of CEA is impossible.

An example of CEA is presented in box 6.12.

An appraisal of a project aimed at increasing the availability of irrigation water in a region in Yemen illustrates how the cost of water may be estimated in a CEA exercise. Two alternatives were distinguished:
- increasing the use of ground water by investing in pumps;
- increasing the use of surface water by constructing dams.

The price of water (YRial per cubic meter) was determined in the following steps:
- The surface water alternative involved heavy *investments* in the first three years. Initial investments in ground water facilities were about 50% lower, but in view of the limited life time of handpumps components regular reinvestment was required over the 50-year project period.
- *Annual costs* for operation and maintenance were much lower for dams than for pumps.
- *Total costs* were calculated and discounted at a 12% discount rate. The NPV of total costs amounted to YR 103 million for dams against YR 124 million for pumps.
- *Annual benefits* consisted of incremental (i.e. compared to the without-case) irrigation water availability. The NPV of annual incremental water amounted to 122 million cubic meter for dams and 98 million cubic meter for pumps.
- *The price of water per cubic meter* (=NPV costs/NPV benefits) amounted to YR 0.85 for surface water and YR 1.26 for ground water.

The calculated price of water does not incorporate environmental externalities. This factor played a role in the remainder of the evaluation, because in Yemen water is becoming increasingly scarce and ground water tables are decreasing at an alarming pace. Despite this incomplete coverage of economic costs, the calculated price showed that water fees, which were much lower, were inappropriate from an efficiency point of view.

Source: information gathered during advisory work of the author.

Box 6.12. The price of water

6.3. Discounting

6.3.1. The problem

The discounting of future costs and benefits is perhaps the most widely criticised element in CBA's treatment of long-term environmental effects. This concern can be understood from table 6.1. It shows the present value of one unit of costs or benefits occurring 30, 40 or 50 years after the start of the project at various discount rates.

Table 6.1. Present value of one unit of costs or benefits in year n at discount rate i

Year n	Discount rate i			
	5%	10%	15%	20%
30	0.231	0.057	0.015	0.004
40	0.142	0.022	0.004	0.001
50	0.087	0.009	0.001	0

The table shows that at the usual discount rate of 10%, one dollar in year 30 through discounting looses 95% of its value, whereas one dollar in year 50 has a present value of close to zero. Assuming a generation encompasses about 25 years, costs and benefits accruing to the next generation are assigned a very low value, whereas those affecting subsequent generations are not counted at all[11] [12].

Due to discounting, future environmental costs and benefits have a small impact on NPVs. This is advantageous to projects with long-run environmental costs. The construction of large dams, for instance, has often been justified on the basis of, among other things, sufficiently attractive economic rates of return. Benefits, usually consisting of increased agricultural production and hydro-power generation, occur soon after the construction of the dam and reservoir. After two or three decades many dams have started to show adverse ecological effects, including sedimentation, siltation and changes in water regimes. Even if such long-term effects can be estimated in a reasonably accurate way, they affect CBA outcomes much less than the benefit stream starting in the short-run (see box 6.13).

Similarly, discounting is one of the explanations for the problems many "free-standing" environmental projects have in passing economic feasibility tests. The costs of reforestation (i.e. planting trees), for instance, mainly occur in the early years of a project and therefore have a high discounted value. The greater part of ecological benefits, such as protection against the wind, less erosion, and safeguarding of species, start only after trees have grown for several years. Their impact on CBA results is therefore much smaller[13].

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11 The discussion here focuses on long-run environmental effects. Of course, discounting has similar consequences for all other types of long-run effects.

12 If a particular benefit or cost item, worth one dollar now, increases in price over time at the same rate as the rate of discount, it maintains its real value over time.

13 Several other factors may explain low rates of return for environmental projects, such as too little attention for the measurement and valuation of benefits, including avoided further damage in the "without-case".

To illustrate the impact of long-term ecological effects on economic feasibility, take the example of a dam. The time horizon is 40 years. Two cases are distinguished. In case I, assume the following costs and benefits:

Year	Investments	Recurrent costs	Agricultural benefits
1	-4,000		
2	-2,500		
3-40 (annually)		-100	830

The NPV at a 10% discount rate is 2,341, the economic IRR amounts to 14%. In case II it is assumed that in addition to the costs and benefits shown above, environmental damage is expected to occur between years 30 and 40 amounting to -4,000 annually. Although the *annual* environmental damage from year 30 onwards amounts to about two-thirds of the *total* initial investment, the NPV remains positive at 703 (the IRR decreases to just 12%).

Box 6.13. The impact of long-term ecological effects on NPV

Rigid application of CBA discounting techniques may lead to ecologically disastrous activities. Well-known examples refer to renewable natural resources such as forests and whale populations. Such resources have a natural growth capacity, offering people the opportunity to obtain an income over long periods of time. As long as the annual harvest is less than the annual natural increase, a forest is maintained over time, and harvesting can continue over long periods (i.e. is "sustainable"). Under certain assumptions, CBA recommends to annihilate all whales or cut all forests immediately if the rate of discount exceeds the natural growth rate. Given that forests grow at rates between 3 and 10%, discounting at 10% favours rapid timbering. Assumptions underlying such outcomes, however, may be irrealistic. One of them says that real profit margins (selling price minus costs of extraction and distribution, both adjusted for inflation) remain constant over time. The more likely scenario is that growing scarcity of environmental resources will push selling prices upwards and therefore contribute to increasing margins. This will mitigate the impact of discounting.

The examples above illustrate that discounting may be in conflict with intertemporal, and particularly intergenerational distribution objectives. The present generation may feel that CBA recommendations are incompatible with its responsibility to future generations as regards the environment. This problem has led to a lively debate in the literature on whether discounting practices should be adjusted, and if so, how this should be effectuated. For instance, it has been argued that because the rate of discount is "too high", lower rates should be applied. In our view, the discussion has been somewhat confusing because several fundamental elements in the theory of discounting have been disregarded. As application of discounting only makes sense if the underlying theory is adhered to, these elements will be reviewed in two subsequent sections. In section 6.3.2 the question is addressed of how a theoretically sound use of *general* discounting and CBA principles may affect projects with long-term environmental impacts. Section 6.3.3 reviews proposals to adjust discounting principles *specifically* to address the problem of long-term environmental impacts.

6.3.2. General CBA and discounting principles

Principles of CBA give important clues as to how a) to choose a correct rate of discount, irrespective of the consequences for the valuation of long-term environmental impacts , and b) to appreciate discounting results in overall decision-making regarding projects with such impacts.

Discount rates should be based on CBA principles

The discount rate serves as a cut-off rate to assess whether a project should be approved from an efficiency point of view. There are several approaches to the calculation of the economic rate of discount. The *consumption rate of interest* (CRI) has two elements, viz. the pure time preference rate and the expected growth of income per capita multiplied by the marginal utility of consumption. The *accounting rate of interest* (ARI) focuses on the marginal productivity of capital. An estimation may be based on the rate of return on the marginal project in the public sector. An approach which incorporates both demand and supply of investment funds centres on the *capital market*. If domestic capital markets comply with free market conditions, the real domestic interest rate may be used as the rate of discount. If such markets are distorted, for instance due to government interference, the real interest on a foreign loan is an alternative (commensurate with the use of world market prices as the general valuation base in economic CBA). Finally, the discount rate may be interpreted as a *rationing device,* ensuring that available funds for development projects will just be exhausted.

The choice of the discount rate should be based on the alternative use of capital funds available for projects (Lind, 1990). Will development projects be at the expense of consumption (because taxes are raised)? Will private investments be crowded out? Is foreign borrowing required? The appropriate discount rate in these examples would be the CRI, the marginal rate of return in the private sector and the real commercial interest rate abroad, respectively. These factors show that the rate of discount is not a static variable, and that it should not be applied indiscriminately to countries. If countries experience different economic circumstances, one would expect different rates of discount as well. If circumstances change over time, so should discount rates.

In a study (Van Pelt, 1990) we investigated current practices of bilateral and multilateral aid agencies. A tendency was found to apply a uniform rate in the range of 8-15%, with a strong concentration in the range of 10-12%, to all developing countries (see for instance ODA, 1988; and with respect to the World Bank, Munasinghe and Lutz, 1991). Discount rates are reviewed rarely. This confirms the impression of Little and Mirrlees (1991) that since the early 1980s attention for regular updating of shadow prices and other aspects of CBA has seriously slipped.

Given the widely different economic conditions in the rapidly growing countries of South-East Asia and in the poorest countries in Africa and Asia, the use of a uniform rate of 10-12% cannot be justified with reference to CBA principles. Particularly in the poorest countries, the rate should be lower, say between 5 and 8%, given low growth rates and low marginal returns. Brent (1990) even argues that most economists would favour a rate of 4-5%.

In any case, in many countries the 10-15% rate is not "too high" because of its impact on environmentally-sensitive projects, but because it lacks theoretical justification. In a number of countries, there may hence be much better arguments in favour of a lower discount rate than a concern with the environment and future generations. (At the same time, a lower rate of discount need not be environmentally attractive; see section 6.3.3).

A correct application of CBA principles may also affect the rate of discount in a second way. If a discount rate is, for instance, based on the marginal rate of return, the question arises whether in the calculation of the IRR on the marginal project all environmental benefits and costs have properly been accounted for. If not, and previous sections suggest this to be expected, enhanced measurement of ecological costs and benefits may lead to alterations in the rate of discount.

The real problem may be measurement and valuation of environmental impacts

The rate of discount may unjustly be blamed for CBA recommendations to approve (reject) environmentally harmful (sound) projects. The real culprit may be shortcomings in measurement and valuation of environmental effects. In section 6.2 the severe difficulties in this field were outlined. If part of environmental benefits cannot be measured or valued, the *calculated* IRR of an environmentally attractive projects is lower than its *true* IRR. At a 10% discount rate, an environmental project with a calculated IRR of 8% and a true IRR of 13% would be incorrectly rejected. Similarly, environmentally harmful projects have an artificially high IRR if ecological costs are not fully accounted for. At any discount rate, enhanced measurement and valuation would reduce the probability that the former (latter) type of projects is incorrectly rejected (accepted).

Above the somewhat perverse CBA recommendations regarding the exploitation of renewable resources, such as forests and fish, were discussed. Better valuation of ecological costs and benefits may be instrumental in reducing the probability that CBA studies recommend such drastic and irreversible actions.

CBA and discounting are exclusively tools to address efficiency

CBA may recommend to reject (accept) environmentally sound (harmful) projects, even if all ecological impacts of a project have properly been incorporated and a correct rate of discount has been applied. There may be reasons, however, why policy-makers choose not to follow such a recommendation. In other words, in the decision-making process, discounting and CBA may play a limited role. Tinbergen's study of the "Delta Plan", an extremely expensive programme to build dams along the Dutch coast after the 1953 flood, may serve as an example. Short-run construction costs being tremendous, the benefit stream, viz. the protection of the many people living below sea level, starts after the construction process and stretches out over centuries. Tinbergen indicates that CBA is instrumental in showing the financial sacrifices required to achieve the objective of protecting future generations against floods. The decision to implement the Delta Plan, however, was primarily a political one, in which such costs were among the factors taken into account.

Economic CBA is solely concerned with the efficiency objective. Therefore, a single tool like the rate of discount or CBA in general should not be used to address two objectives simultaneously, viz. allocative efficiency and intergenerational equity (Tinbergen, 1952; Daly, 1990)[14]. If projects involve "intergenerational transfers" (Norgaard and Howard, 1991), CBA outcomes just provide information about the efficiency objective, which policy-makers would need to weight against other objectives (see chapter 7)[15]. It is important to recognize that this conclusion is not confined to projects with long-term

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14 The next section reviews a proposal to adjust the discount rate for intergenerational equity objectives.

15 More elaborate justifications for this view can be found in Goodland (1989), who suggests to use discounting for projects with a 1-20 year life span only, and in Lind (1990).

environmental impacts: all types of impacts stretching out over decades may raise moral objections to unlimited intertemporal trade-offs[16].

In conclusion, a sound use of CBA principles will help to solve several problems associated with "high" discount rates. This includes a comprehensive coverage of all categories of costs and benefits of projects, as well as a theoretically correct determination of discount rates. Moreover, limitations of CBA methodology and the role of the discount rate should not be confused.

6.3.3. *Adjusting discounting principles for the environment?*

In the literature numerous solutions have been proposed to address the problem of the consequences of discounting, particularly of "high" discount rates, for ecologically sensitive projects. In our view, the observation that high rates have undesirable consequences for such projects is not an argument to adjust the discount rate. A different situation arises if adjustments are commensurate with CBA principles.

Proposals for adjustments can be classified as follows:

- a general reduction in the rate of discount, in the extreme case giving up discounting (rate is zero);
- multiple discount rates, the lower rates used for environmentally sensitive activities or effects;
- changing the discounting technique.

General reduction

It has been argued that the discounting problem can be tackled by a general reduction in the rate of discount. At a lower discount rate, and assuming that ecological effects would primarily occur in the long-run, environmentally sound (harmful) projects would indeed have a higher (lower) chance of being accepted. From an ecological perspective, the composition of the set of accepted projects will hence enhance. The drawback, as Pearce et al. (1990) note, is that all types of activities, whether or not environmentally friendly, have a higher probability of passing the CBA test. This implies an upward pressure on aggregate resource

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16 Another observation is that the problem of discounting has no relation to the possible non-acceptability of short-term environmental effects. Then the Kaldor-Hicks principle should be referred to, which says that (timing aside) any type of cost may be compensated for by any type of benefit (see section 7.2).

use. It is questionable whether the balance of the two changes, which are in opposite directions, would be beneficial to the environment. In any case, a general reduction in the discount rate would be an ineffective, because non-targeted, solution. Moreover, to which level should the rate of discount be reduced?

An extreme position is to argue that the rate of discount should be zero, which means that discounting should be abandoned. Discounting, however, is an expression of the opportunity cost principle, which is at the core of CBA. Therefore, such an extreme position cannot be accommodated by the CBA framework. The solution would then be to search for other appraisal tools than CBA rather than to adjust CBA elements.

Multiple discount rates

The option to use different discount rates in specific circumstances has been elaborated by, for instance, Gijsbers and Nijkamp (1987). Some of the proposals are the following:

- In the case of sustainable or environmentally sound projects, a rate of discount should be used equal to the return on the marginally sustainable project. Non-sustainable or environmentally harmful projects would face a higher discount rate. This is a second-best solution. The first-best solution would be to devote more attention to a) estimation of the true rate of discount by incorporating all costs and benefits on the marginal project and b) better estimation of all costs and benefits of individual activities (see above).
- Long-term projects should be evaluated using a discount rate that is lower than the discount rate reflecting the (individual) opportunity costs of postponing the consumption of goods or services. The theoretical justification would be that long-term, particularly environmental considerations carry little weight in individual time preferences. A counter-argument would be that a social rate of discount should reflect long-term goals. Apart from this, a number of other issues would also be eligible for a special rate of discount: education, activities with a redistribution impact, etc. Where to draw the line? And what should be the rate in these cases? (see below for Klaassen and Iwema's answer to the second question).
- Adjusting the rate of discount may be a means to account for high uncertainty and risk. This is another non-targeted solution, because the optimal approach would be to develop mechanisms to account for risk and uncertainty (see section 6.4).

- When there are large intangible social costs, the discount rate should be lowered to impose more strict test on such projects. In our view, it is better to use other appraisal tools, like MCA, if CBA cannot be applied due to measurement and valuation problems (see section 6.5).
- Discount rates may also be differentiated in time, a lower rate being applied in the future (Cooper, 1981).

It is more attractive to use a lower rate of discount in specific cases, than to choose for an across-the-board reduction, because in the former case the instrument corresponds to the observed problem. Nevertheless, the drawbacks outlined above warrant a cautious approach. Moreover, the effectiveness of multiple discount rates should not be overestimated. Tinkering with the discount rate will only enhance the *probability* that environmentally sound projects are preferred over ecologically harmful projects. A lower discount rate will not necessarily lead to project selection outcomes that are acceptable from an environmental viewpoint. If sustainability is applied as a constraint on project selection, ecologically harmful projects would need to be banned, not just be subjected to a somewhat stricter evaluation (see sections 4.6.2 and 5.5).

Few theoretical guidelines have been developed regarding the level at which multiple discount rates should be set. One attempt to integrate long-term considerations in the rate of discount in a theoretically defensible way is Klaassen and Iwema (1981). They propose to include a *generation preference factor* in the rate of discount formula. This factor shows the priority the present generation assigns to the well-being of future generations. A strong concern for future generations leads to a high generation preference factor, and consequently to a low rate of discount. A high generation preference factor implies a high weight for long-term, and particularly irreversible costs and benefits. Klaassen and Iwema argue that a high factor is justified for all types of projects with such impacts, including environmentally sensitive activities. In extreme cases the generation preference factor will be so high that the rate of discount becomes zero. Despite the practical problems (how high should the generation preference factor be? for which projects should a high factor be applied?), the Klaassen/Iwema model has the advantage of attempting to contribute to a theoretically well-founded approach towards accounting for intergenerational and efficiency trade-offs.

Adjusting the discounting technique

The few suggestions to change the discounting technique rather than the discount rate include the modified discounting technique (Kula, 1988) and the continuation condition (Cooper, 1981).

Kula focuses on intergenerational aspects of projects, and hence not on environmental issues in particular. He criticises the traditional discounting technique for being based on the idea that society is comparable with an individual with infinite longevity. This, according to Kula, is the basis for discrimination of future generations. In his view mortal individuals, with partly overlapping life periods, should be taken as the point of reference. In the modified discounting method a net present value is determined for each individual affected by a project over time. The year of birth of a particular individual is the bench mark, in contrast to traditional discounting where there is only one base year. The total net present value is the sum of the discounted individual net present values. The fact that the CRI is used as the rate of discount shows that Kula leaves the discount rate itself unaffected.

Kula's proposal has led to a lively debate in subsequent issues of *Project Appraisal*. Part of the criticism did not focus on the new element in his model, but on the choice of a constant CRI. Instead of assuming a constant elasticity of the marginal utility of consumption, increasing income levels would argue for a lower discount rate for future generations. The unweighed aggregation of individual net present values evoked considerable methodological criticism, and also raises great practical problems.

In our view a more attractive approach is Cooper's continuation condition, involving the determination of NPVs with multiple base years. Traditionally, a project is accepted if its NPV is positive, calculated by discounting all future effects to a particular base year (usually year 1). Cooper suggests an additional procedure, involving the calculation of NPVs for base years more distant in time. For instance, a second NPV can be determined by discounting all effects occurring after year 30 with that year as base year (meaning that the present value of 1 dollar in year 30 would be 1 dollar). A project combining a positive NPV from year 0 onwards and a negative NPV from year 30 onwards, would need to be rejected. From the perspective of generations, a project should result in a positive NPV for each single generation. Data requirements (involving the measurement and valuation of long-term environmental effects) become tremendous with long time horizons, but the logic is appealing. For an example, see box 6.14.

The conclusion should be that most of the proposed adjustments to the rate of discount or the discounting technique either lack a theoretical basis or raise significant empirical problems. The guidelines presented in the previous section, emphasizing a correct use of CBA principles, deserve more attention.

Cooper's continuation condition may be illustrated by the dam example of box 6.13. Instead of only calculating an NPV with year 0 as base year, NPVs have also been assessed with year 20 and year 30 as base year. Results are shown below:

NPV from year y onwards discounted at 10%

year	case I	case II
0	2,341	703
20	8,649	-1,368
30	6,495	-19,485

Cooper's approach would not alter the conclusion in case I (no long-run environmental effects) because the NPVs for all base years are positive. In case II (environmental costs from year 30 onwards), however, the project should be rejected because of a negative NPV from year 20 onwards and year 30 onwards.

Box 6.14. Discounting with multiple base years

6.4. Economic CBA: risk and uncertainty

The CBA review article of Squire (1989) starts from the assumption that effects are known with certainty. Most CBA textbooks, including those on valuation techniques, follow a similar approach. Tools that are offered to account for risk and uncertainty may have significant limitations in the case of environmental effects.

The usual recommendation is to apply sensitivity analysis. This approach, though instrumental in showing how close projects are to marginal feasibility levels, is not very useful in accounting for gaps in scientific knowledge about ecosystems. For instance, whereas the impact of a 10% increase in environmental costs on the IRR can be calculated, the important question of the probability of this event is not answered. Another drawback is that sensitivity analysis usually is a partial approach, which fails to address (uncertainty about) linkages between ecological variables. Finally, rarely is sensitivity analysis linked to ecological risk attitudes of decision-makers.

A second mechanism to account for uncertainty involves the calculation of expected values for ecological and other variables, to replace more precise estimates. Two questions arise: a) how may probabilities be assigned to a range of known possible outcomes?, and b) what if all possible outcomes are not known? (Hanley, 1992). In other words, expected value approaches only address the problem of risk (i.e. all possible events are known) and require insight into probability distributions for environmental events, which may frequently be lacking. Risk-benefit analysis also is concerned with the risk factor. Ecological risks would be compared with the monetary benefits of not taking measures to prevent these risks.

In decision analysis, risk attitudes of decision-makers are incorporated. A monetary variant is the proposal to use "certainty equivalents" in CBA calculations (Markandya and Pearce, 1987). Decision-makers should indicate which part of the net benefits of a project they would be willing to sacrifice in order to avoid the risk associated with expected values. For a given degree of risk, a risk-aversive person will be inclined to give up a larger sum then a risk-prone one. Not all decision-makers, however, will be willing or able to assign monetary values to environmental risk and uncertainty.

Ecological risks may also be accounted for by linking CBA and scenario analysis. Nijkamp (1991) provides an example in his evaluation of Dutch defence strategies against the threats of the sealevel rise as a consequence of global climate change. He distinguishes between four "event scenarios", reflecting different assumptions about the impacts of climatic change on the level of oceans. For each event scenario the costs of alternative policy options ("do-nothing", "raise dikes", "ring dike", "retreat") are estimated. This allows a conclusion about the best policy option for each of the event scenarios. Depending on policy-makers' views on how likely event scenarios are, and on their risk strategies, a policy option might be selected.

In all risk and uncertainty approaches, expert opinions may be taken into account through for instance Delphi techniques[17]. Such approaches by definition involve subjective views on risk and uncertainty, but a large judgemental component seems unavoidable in the case of environmental effects (Winpenny, 1991).

6.5. Efficiency scores under mixed data availability

The system for method-selection developed in section 3.5 refers to the possibility that impacts on some efficiency attributes cannot be monetized. Given the wide range of potential problems in EIA, environmental impacts may often be assessed in just physical or qualitative terms. In these circumstances, at best a

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[17] For Delphi techniques, see Hacker (1988).

partial CBA can be conducted. In the worst case, CBA cannot be applied in a meaningful way.

The literature on CBA acknowledges that environmental intangibles may hamper a full assessment of efficiency. Like many other books on valuation techniques, Dixon et al. (1988) and Winpenny (1991) include a section on the limits to economic measurement. Contributions to global environmental problems, like the greenhouse effect, are usually considered beyond the scope of CBA valuation (see for instance Bojö et al., 1990). Munasinghe (1992) argues that a rigorous analysis of non-monetary and irreversible consequences of projects should be conducted to supplement standard CBA. He refers to the possibility to apply MCA to integrate information about intangibles and (partial) CBA outcomes.

Like Munasinghe, we are in favour of considering CBA and MCA as potentially complementary appraisal tools. The basic principle would be to apply MCA to two criteria: the outcomes of a partial CBA, and the non-monetary environmental impacts. The partial economic IRR may exclude, for instance, all intangible externalities, like environmental effects that are diffuse in time and space, synergic or irreversible effects, or impacts on complex ecosystems. MCA can assist in arriving at an overall efficiency score by weighting this partial economic IRR and the intangibles[18]. If CBA would only fail to incorporate some environmental effects of minor importance, the economic IRR should be assigned a higher weight in MCA calculations than if most ecologically significant impacts would be beyond its scope. There is a limit to this approach. If CBA can account for just a minor part of efficiency attributes, it does not make sense to conduct a partial CBA. MCA would then be the only tool available to determine the efficiency score.

The basic format of the approach outlined above can be illustrated by the dam project presented in chapter 3. Box 3.6 showed the outcomes of a partial CBA, covering the three efficiency attributes for which monetary estimates are available. Box 3.4 contained the qualitative information about the remaining efficiency attribute, viz. the environment. The result is a mixed-data efficiency impact matrix, as shown in table 6.2.

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18 In a variant of this approach, CEA outcomes would be used as MCA inputs. CEA would account for a) monetary outlays and b) quantifiable benefits, but not cover ecological intangibles.

Table 6.2. Mixed data efficiency impact matrix dam project

Criteria	Alternatives		
	One large dam	Two intermediate dams	Several small dams
CBA result (NPV in m US$)	0.50	0.85	0.80
Environmental impact (ordinal)	3 (least favourable)	2	1 (most favourable)

Policy-makers or other parties would need to provide weights to the two criteria addressed in the MCA study. Whereas in principle MCA can be applied to table 6.2, outcomes would be unstable because of the small size of the impact matrix. Its usefulness will be much greater if more alternatives and non-quantifiable efficiency attributes are distinguished.

A similar approach might be followed regarding risk and uncertainty. MCA can incorporate risk and uncertainty in the same way as CBA, viz. by effect-specific adaptations of data. Especially if no quantitative probabilities can be assigned to environmental events, risk and uncertainty may also be considered a separate criterion. A positive economic IRR based on most likely effects would then be weighted against high risks or significant uncertainty. Weights would reflect the risk-attitude of the decision-maker.

6.6. Assessing (intratemporal) equity

Whereas in efficiency analysis environmental impacts should fully be accounted for, the distributive dimension of these impacts should be a part of equity analysis. In general, in the analysis of distributive impacts a distinction should be made between:

- An "objective" *description* of these impacts. From a welfare perspective, two aspects should be taken into account, viz. changes in the distribution of income and changes in patterns of ownership of (or access to) natural resources (particularly land and water; see section 2.2.1).
- A "subjective" *evaluation* showing the desirability of these outcomes according to the policy-maker's preferences (see sections 3.2.2 and 4.3). Usually, techniques will be used to arrive at an overall equity score of alternatives, by weighting several types of distributive impacts.

Description

Particularly if data are scarce and limited resources are available for impact assessment studies, changes in ownership of income-generating natural resources may be taken as a proxy for changes in income itself. Generally, it will be easier to estimate the former than the latter.

As an example, consider the dam project in Yemen referred to in chapter 3 and in the previous section. The aim of the project was to increase the supply of irrigation water to farmers. Traditionally, farmers built a system of numerous small, temporary and simple dams in "wadi's", which periodically carry water from the mountains to the sea. In times of low rainfall, (rich) upstream farmers were better-off because the dams provided them with water. Regularly, however, floods were too strong for the dams, which were demolished to the benefit of (poorer) downstream farmers. Initially, consultants proposed to build a single dam in the wadi. They made the crucial assumption that this dam would provide additional water to be used in irrigation; without the project this water would be "lost". Consequently, the argument was that upstream farmers would benefit without hurting downstream farmers. This view raised criticism. Without the project, water would not be lost, but benefit downstream farmers either in the form of surface water as in the past, or in the form of ground water (which may be pumped). In fact, the dam was likely to increase evaporation and reduce the supply of water for downstream farmers. Also considering user charges policies, the project would supply additional irrigation water at low costs to rich farmers and harm income opportunities of poorer families. Even without estimating income impacts, important distributive aspects could be indicated by focusing on changes in access to water.

The Yemen case bears some resemblance to formalized methods aimed at providing insight into distributive impacts of development projects. Lichfield has been a pioneer in this field. He has developed the *Planning balance sheet method* (Lichfield, 1988-a,b) and contributed to efforts to integrate distributive impacts in environmental assessment (Lichfield, 1992; Lichfield and Lichfield 1992). His basic approach involves the construction of a matrix with the various alternatives on the one side and possibly affected population groups on the other side. Within the matrix the impacts on social groups in terms of, for instance income and ownership of production, may be presented for each alternative.

Approaches such as the Planning balance sheet method are primarily meant to systematically present all distributive impacts of a project in various, sometimes complex tables. It may be desirable to derive from such tables concrete indicators for equity performance of alternatives. The least data-intensive, *ordinal* approach is to rank alternatives in terms of their impacts on social groups. It may be particularly helpful in briefly presenting information about changes in ownership of or access to natural resources. An example is provided by appraisals of Early implementation projects (EIP), which are selected every year in various regions in Bangladesh. These are fairly small-scale projects, involving the construction of embankments to protect agricultural land against regular flooding, as well as several other infrastructural and institutional measures. The intratemporal distribution is a key appraisal issue, in view of existing conditions of poverty and strong inequality in land ownership. Table 6.3 gives a hypothetical, though not unrealistic distribution matrix, under the assumption that three sites were selected for appraisal, and that five social groups are distinguished.

Table 6.3. Distribution matrix embankment projects

Social group	Alternatives		
	Site A	Site B	Site C
Landless labourers	1	2	3
Small farmers	2	3	1
Medium-scale farmers	2	2	2
Large farmers	1	2	3
Women	3	2	1

For each row in the matrix, and hence for each social group concerned, "1" indicates the most favourable alternative and "3" the least attractive alternative.

Besides three classes of landowners, who would benefit by increased access to arable land, the matrix includes effects on landless labourers and women. Landless labourers might benefit if embankment projects benefit rich farmers, who need to employ more unskilled labour. Women may benefit more from projects favouring poor farmers. The matrix informs about the distributive pattern, but does not allow a conclusion regarding the ranking of alternatives on the equity criterion. This requires the application of an MCA technique (see under "evaluation" below).

Sometimes it may be possible to develop *quantitative* indicators, which usually are based on the same philosophy underlying (in)equality measures for countries, such as the Lorenz curve and the Gini concentration ratio (see Gilles et al., 1992). At the project level less data-demanding indicators are required (see for instance McGaugney, 1980). Focusing on relative income, an indicator may be taken as the ratio of the part of net efficiency benefits that accrue to target groups and the total net efficiency benefits. Alternatively, changes in absolute poverty measures may be used as scores on the equity criterion. This requires the definition of a poverty line, representing minimally acceptable levels of income or certain groups of basic needs (education, nutrition, and so on).

Evaluation

There are two ways to account for equity objectives. The first, to be discussed in secton 7.2, is represented by social CBA, whereby through quantitative weights outcomes of economic CBA are adjusted for income distribution objectives. The second possibility, to be treated below, is to arrive at a separate score on the equity criterion. This is commensurate with current practices. Squire (1989) states that if project appraisals devote any attention to distribution effects at all, results are often separately presented (in qualitative terms).

A simple way to incorporate value judgements in equity scores is to adjust quantitative indicators referred to above. This may require the definition of a threshold, representing the optimal distribution pattern according to policy-makers. Threshold values may indicate, for instance, that a project is considered most attractive from an equity point of view if 60% of efficiency gains accrue to target groups. Consequently, scores on equity indicators may be standardized by converting them to a scale with 60 as the optimal level. Any deviation would be penalized.

More sophisticated approaches would involve explicit weighting. To obtain an equity score for the EIPs in Bangladesh, the appraisal team developed its own methodology (EIP-Cell, 1986). Rather than trying to estimate income changes by social group, the team focused on changes in effective access to arable land, the most crucial natural resource in most of Bangladesh. A *social index* (SIN) was developed, which is the weighted average of the shares of various classes of rural social groups in the newly embanked land. Weights reflect the team's view on the decision-makers' policy regarding the relative priority of these groups (unfortunately, policy-makers were not actually consulted). For example, assume that a piece of land of 200 ha is embanked, of which 100 ha is owned by poor (small-scale) farmers, 50 ha by medium-income farmers and 50 ha by rich (large-scale) farmers. Shares in the embanked area are hence 50%, 25% and 25%, respectively. The mission applied the following weights: landless labourers 3, small farmers 2, medium-income farmers 1 and rich farmers 0. The SIN then equals: $(3*0 + 2*50 + 1*25 + 0*25)/100 = 1.25$. A project at another site with a SIN of .8 would be less attractive from an equity point of view.

The major advantage of the SIN is that the basic data, viz. landownership in the project area, can be collected fairly easily. Its major drawback is that it fails to give a comprehensive picture of distribution, as landless labourers -assigned the highest weight being the primary target group- do not actually enter the SIN as they do not own land. The SIN should hence better be considered a means to evaluate distribution effects within the class of landowners[19].

MCA might be used to obtain a more comprehensive equity score. Starting from the distribution matrix shown in table 6.3, the next step would be to obtain policy-makers' views on the relative priority of the five target groups. Assume that the following ordinal ranking results:

landless labourers > women > small farmers > medium-scale farmers > large farmers

Using the Regime technique, a project at site A appears the most attractive, followed by respectively, site B and site C.

From a theoretical point of view, MCA could account for two kinds of value judgements. The first is the relative importance of income and access to natural resources. Weights may differ between target groups. The second, illustrated above, is the relative priority various populations groups have in the view of their government.

In conclusion, environmentally sensitive projects may have considerable distributive consequences, which should be addressed in the analysis regarding the equity score. Illustrations of this statement can be found in both the Colombia case (section 9.5) and the Egypt case (section 10.5). In general, if serious difficulties are encountered in the estimation of changes in income levels of social groups, it is recommended to focus on changes in effective access to natural resources instead. MCA may be an appropriate tool to systematically account for equity performance.

6.7. Constraint-satisfying activities: efficiency and equity

Like sustainability (section 5.5), efficiency and equity may be converted into constraints. A logical efficiency threshold would be a positive NPV. If a proposed project fails to satisfy this minimally acceptable level, constraint-satisfying activities might be designed to enhance efficiency. Such activities may, for

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19 Another drawback of the approach, i.e. the choice of weights by the team rather than by policy-makers, does not concern the methodological basis of the SIN but its implementation in practice.

instance, aim at reducing costs or at improving the income-generating potential. In sustainability-oriented project appraisal, the environmental consequences of such activities would need to be assessed. A problematic situation arises if as a result of measures to improve efficiency, the project would switch from a positive to a negative sustainability score.

Similarly specific distribution thresholds, referred to above, may be taken as a bench mark if the equity criterion is converted into a constraint. For instance, a project may be unacceptable if less than 60% of the net project benefits accrue to the poor. In such cases constraint-satisfying activities might be designed to increase the share of target groups in total benefits, or to compensate them for the negative impacts of projects. A well-known example of the latter category is to compensate indigenous groups for the catastrophic consequences of the construction of large reservoirs. Increasingly, relocation projects are made part of such projects. Environmental impacts of such components need careful examination, especially if land allocated to affected groups is in environmentally fragile areas (see, for instance, transmigration projects in Indonesia). Such constraint-satisfying activities may also be very costly, possibly casting doubts on the overall feasibility of the project.

6.8. Conclusions

This chapter has explored theoretical and empirical problems in the estimation of scores on the key criteria of efficiency and equity. Most attention has been paid to the treatment of environmental effects in *efficiency*-oriented economic CBA. Considering the most important obstacles to a comprehensive coverage of environmental effects, the following guidelines can be provided:

- Measurement of environmental effects in physical terms is a prerequisite for CBA application. This underscores the importance of sound and timely EIA.
- Economists should devote more efforts to the application of valuation techniques for the environment. In the appreciation of the results, however, their shortcomings should be acknowledged. Some difficulties are of a methodological nature, e.g. certain techniques are likely to underestimate ecological values and the dependency of outcomes on existing income distributionp597Xpatt[illegible]Other problems are empirical, like the large amount of data required for methods like CVM. This class of problems may to a certain extent be addressed through more in-depth, and hence expensive studies.
- All effects should be discounted in CBA, and this includes long-term ecological costs and benefits. Outcomes may be incompatible with intergenerational equity objectives. However, this question may to a certain extent be satisfactorily accounted for by a) acknowledging CBA's limited

purpose, and b) a correct application of CBA principles in the determination of the rate of discount.

- The use of sensitivity analysis, the traditional way to account for risk and uncertainty in CBA studies, may be insufficient if estimates on environmental effects are highly uncertain. More experience should be gained with approaches aimed at linking CBA and decision analysis.

In some cases, data availability and decision-making context may permit a theoretically sound as well as useful application of economic CBA. In other cases the limits to the applicability of CBA may be crossed. Then MCA might be used to complement, and in extreme cases substitute for, CBA in efficiency measurement. Preferably, partial CBA outcomes are used as inputs into MCA, which would in addition address environmental intangibles. In chapter 11 case-specific factors are listed that allow an approprate choice of technique as well as a judgement on the usefulness of the outcomes for decision-making.

In the determination of scores on the *equity* criterion, a distinction should be made between an "objective" description of the distributive patterns of costs and benefits, and a "subjective" evaluation, involving policy weights. A number of techniques may be used, including the Planning balance sheet method (description) and MCA (evaluation). Both techniques are particularly useful to account for changes in ownership of or access to natural resources by social groups.

[illegible]

[illegible]

[illegible]

7. INTEGRATED EVALUATION

7.1. Introduction

The evaluation phase is a two-tier process (see diagram 1.3 in section 1.4; section 3.4). If one or more criteria have been converted into (goal-)constraints, a first step is to check whether expected impacts comply with these constraints. If not, constraint-satisfying activities may be designed regarding sustainability (section 5.5), efficiency and equity (section 6.7). In a second step the (relative) overall performance of alternatives is assessed on the basis of the scores on *all* three key criteria and the priorities of these criteria[1]. This chapter focuses on the applicability of CBA and MCA in this integrated evaluation phase, and hence on their usefulness to inform about the relative attractiveness of alternatives.

The *CBA approach* is to take the score on one particular criterion as a point of reference, and to adjust it for scores on the remaining criteria. The "rod of money" is the numéraire, and results are in terms of indicators such as the IRR or NPV. Section 7.2 first reviews possibilities to accommodate sustainability objectives by adjusting outcomes of efficiency-oriented economic CBA. Next, the question is addressed whether it may be possible to incorporate sustainability concerns in social CBA, which would then cover the three key criteria simultaneously.

The *MCA approach* treats criteria on the same footing, without selecting a single criterion (and hence its measurement scale) as a bench mark. Through arithmetical operations, combinations of criteria scores and criteria weights are used to arrive at a ranking of project alternatives[2]. Theoretical aspects of this approach are discussed, followed by a hypothetical, though realistic case study (section 7.3).

Finally, section 7.4 summarizes the conclusions of this chapter.

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1 It is assumed that no criterion will be interpreted as a pure constraint.

2 Like MCA, CBA would be a "multiple criteria" approach if efficiency as well as equity and sustainability could be satisfactorily processed. The major difference lies in the choice of a numéraire and the corresponding weighting mechanism.

7.2. The CBA approach

7.2.1. Can economic CBA outcomes be adjusted for sustainability concerns?

In its basic form economic CBA is unsuited to account for sustainability concerns. A major reason is the Kaldor-Hicks principle underlying CBA theory, stating that any type of cost to society is acceptable as long as a project generates greater benefits. Whereas benefits may *potentially* compensate for costs, CBA is indifferent as regards the question whether *actual* compensation takes place. Environmental damage is acceptable if benefits, for instance a greater production of man-made consumption goods, are valued higher. No CBA principle prescribes that part of the benefits should actually be invested in measures to avoid or compensate the environmental damage. In other words, substitution between natural and man-made resources is perfect. This is diametrically opposed to the sustainability principle, which says that beyond a certain limit environmental damage is undesirable or even unacceptable, and that dissatisfaction increases with the size of the gap between expected and normative resource use.

This question may also be approached from another angle. In CBA, any future cost may be compensated for by any present benefit. Through discounting, the weight of present benefits becomes more pronounced. In contrast, sustainability concerns are long-term concerns. The present generation expresses its willingness to sacrifice present welfare to avoid unacceptable welfare losses in the future. Again, the sustainability criterion calls for limits to resource use, whereas CBA permits unlimited trade-offs.

Shadow-pricing of environmental resources does not solve these problems. Assume for the moment that it is technically possible to assign a price to all natural resources, covering all their functions and use- and non-use values alike. In this rather utopian situation, CBA outcomes would undoubtedly become more acceptable from a sustainability point of view. However, even then there would be no guarantee that environmental thresholds will satisfied. Pearce (1976), for instance, argues that the applicability of CBA reaches its limits when, as a result of waste emission, the assimilative capacity of ecosystems is exceeded. According to Pearce, CBA will not avoid this to happen, nor the resulting, often irreversible deterioration of ecosystems. He proposes to use biological standards (nowadays interpreted as sustainability thresholds) instead of CBA as guides to acceptable levels of pollution. Cooper (1981) is somewhat more optimistic about CBA's potential and feels that biological standards are only required in the case of relative and absolute imperfect information. Unfortunately, especially in developing countries, information often has these characteristics (section 6.2.3).

Sustainability weights

A new approach would combine monetized environmental effects (sections 5.3 and 6.2) and project setting sustainability indicators (section 5.2.2). In a first step, environmental effects, say emissions of gases, would be measured and valued (possibly by looking at the costs of mitigation measures). Next, sustainability weights would be developed, which reflect the distance between existing and sustainable resource use patterns in the project area. Such a weight should equal one if existing pollution levels are considered just sustainable, and increase with the degree of non-sustainability. This measurement scale explains why these weights are not equal to, but can be derived from the sustainability indicators for the project setting, discussed in section 5.2. In a third and final step, environmental benefits and costs would be multiplied by the sustainability weight. In contrast to the proposal above, this approach does not provide a guarantee that sustainability thresholds are complied with (although the probability that this happens increases).

Multiplication of the economic IRR by a sustainability indicator

The most tentative idea involves the multiplication for each alternative of the economic IRR by a factor derived from the score of a project on the sustainability criterion (section 5.4). This factor should equal one if the project is marginally sustainable, and increase (decrease) in proportion to degree of (non-)sustainability. The higher the resulting score, the more attractive the project. Like in the previous case, non-sustainability may still occur if the economic IRR is sufficiently high. A sound methodology would need to be developed.

7.2.2. *Can social CBA outcomes be adjusted for sustainability concerns?*

Starting from economic CBA results, social CBA offers a framework to account for intratemporal and intertemporal equity judgements[6]. The -still growing- pile of academic books on social CBA contrasts sharply with the virtual neglect of the method by practitioners[7]. Social CBA is rarely applied for a number of reasons, including the severe data requirements, the high degree of

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6 For theory and references, see sections 3.2.2 and 3.3.

7 Brent's (1990) motivation to provide another exposition on the Squire-van der Tak approach to social CBA is that it had been developed at the World Bank, "the chief practitioner of project appraisal". Since the 1980s, however, the Bank has experienced serious difficulties in the application of economic CBA, and even more complex social CBA has not been practised.

technical sophistication, and the reluctancy of policy-makers to define income distribution weights. In general, all limitations of economic CBA apply to social CBA as well, except for the incorporation of income distribution objectives in the latter[8]. Both methods are particularly affected when significant environmental impacts cannot be estimated in quantitative terms, or if so, one is unable to assign a monetary value to such effects. Although the rate of discount will usually differ in economic and social CBA, in both cases discounting results may be morally unacceptable for projects with long-term environmental impacts. The savings premium only mitigates this problem (see table 6.1 for the modest consequences of widely different rates of discount).

Social CBA has appeared to be an inappropriate tool to assess efficiency and equity simultaneously due to conceptual and empirical reasons. Only from a purely theoretical viewpoint it may therefore be of interest to explore possibilities to expand social CBA by incorporating sustainability concerns as well. If poverty is considered an important cause of environmental degradation, project benefits accruing to the poor could be valued even higher than in traditional social CBA. Similarly, investments in environmentally sound practices might be valued higher than investments in unsustainable practices. Consumption patterns could be differentiated in a similar way.

To conduct such an expanded social CBA would be a major undertaking. From a practical perspective, there is little scope for or interest in such a complex technique. This leads us to the conclusion that CBA cannot be considered a tool to address the three criteria of efficiency, equity and sustainability simultaneously.

7.3. The MCA approach

7.3.1. Theory

In the MCA approach the separate scores on the three key criteria would be the starting point for integrated evaluation. The choice of technique would depend on the dimension of the scores on the criteria of efficiency (section 6.5), equity (section 6.6) and sustainability (section 5.4). The main options can be summarized as follows:

- The scores on the *efficiency* criterion may be of three kinds. If a CBA study allows full coverage and monetization of environmental (and other) effects, comprehensive economic IRRs or NPVs results. If all or the greater part of

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8 Social CBA cannot cover changes in ownership of or access to natural resources without information about an eventual corresponding changes in income levels.

ecological costs and benefits cannot be monetized, MCA may be applied. An intermediate solution is to apply MCA to a) the outcome of a partial CBA and b) a group of intangibles, externalities and so on. If MCA is applied, a ranking of alternatives on the efficiency criterion results.

- The (intratemporal) *equity* criterion can take several forms. Quantitative indicators may show, for instance, which part of project benefits accrues to target groups. It may also be possible to obtain quantitative indicators involving a weighting mechanism (for instance on the basis of land distribution). MCA may be applied to rank alternatives regarding their overall equity performance.
- An estimation of the score on the *sustainability* criterion may take the form of quantitative sustainability indicators. Alternatively, alternatives may be ranked with regard to their sustainability.

The final impact matrix will probably incorporate different dimensions. The "hardest" matrix would combine: a) a monetary (NPV) or quantitative, dimensionless (IRR) efficiency measure, b) a quantitative, dimensionless equity indicator, and c) a quantitative, dimensionless sustainability indicator. At the other extreme, a matrix would only contain a ranking of alternatives for each criterion. Depending on the type of information, quantitative, mixed-data or qualitative MCA-techniques could be applied[9].

In three respects MCA is particularly appropriate to be used in the integrated evaluation phase in sustainability-oriented project appraisal. First, unlike CBA, MCA can incorporate the three key criteria. Second, thanks to the existence of a variety of techniques, MCA can process all information about impacts, whether quantitative, qualitative or mixed. Third, as a consequence of criteria and impact flexibility, the MCA approach may be useful in exploring trade-offs between the main appraisal criteria. Foy and Daly (1989) correctly state that sustainability is a benefit, and generally one that is not free. The MCA approach may show the costs of sustainability in terms of possible efficiency and/or equity losses. It may provide a basis for a discussion on desirable compensation mechanisms, and on who would pay for sustainability benefits (see also section 11.8).

Case-studies, however, should learn whether MCA offers better opportunities to overcome two problems that have impeded the use of social CBA, viz. the use of weights and methodological complexity. As regards the first issue, MCA has the advantage that several weight determination techniques exist. Whereas social

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9 If no comprehensive CBA can be conducted, and MCA would be applied to obtain the efficiency score as well as to integrated evaluation, weights would need to be applied to environment at two levels. To avoid this, MCA could only be used in the last phase, covering the partial CBA score, the equity score and the sustainability score.

CBA requires that preferences are expressed in quantitative weights (and more in particular income weights), MCA weights may range from quantitative weights to qualitative rankings. Policy-makers can be expected to be less hesitant if they are asked to rank criteria from least to most important, than if they should indicate the value of a dollar in the hands of a poor man relative to one in the hands of a rich man[10].

In chapter 3 guidelines were presented with respect to methodological issues such as criteria selection and uncertainty regarding standardization technique, weighting technique and MCA technique. Still, just like social CBA has been considered a confusingly complex technique, policy-makers may need at least time to get acquainted with the MCA family of techniques.

7.3.2. *A hypothetical example*

In section 6.5 reference was made to Early implementation projects (EIP) in Bangladesh. The annual mission responsible for the appraisal of a set of possible sites for such projects used a methodology involving a social index (SIN), as well as a simple benefit-cost ratio. No attempt was made to arrive at an integrated evaluation. Below the EIP experiences are used to illustrate the possible use of monetary and non-monetary information in MCA. The structure of the case is commensurate with the actual context of the appraisal studies, but the figures are hypothetical. It is emphasized that the aim of the case is to illustrate some problems MCA could address. This implies that several types of complexities usually associated with this method (like method uncertainty) are ignored.

Annually, a fixed budget is available for EIPs at different sites. Because this budget is insufficient to finance all proposed projects, the appraisal team should arrive at a ranking of alternatives. In a particular year, seven areas are proposed, to be referred to as the *alternatives* sites A,...,G.

The following *criteria* apply:

- Costs. In principle, this covers all (shadow-priced and discounted) investment and recurrent costs, as well as environmental externalities.
- Benefits. Reduced flooding will enhance agricultural production, which comprises the project benefits. Agricultural benefits are shadow-priced and discounted.

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10 The applicability of MCA, and the collection of weights in particular, may have a clear political dimension in developing countries. This will issue will be addressed on several occasions in part B of the study.

- Equity. The projects will, in different degrees, benefit three classes of land owners (large, medium and small (subsistence) farmers) and landless labourers (being employed by landowners).
- Ecological sustainability. The general target for sustainability is to at least maintain the present state of the environment. Hence, worsening of environmental conditions implies non-sustainability, and improvement sustainability.

For the appraisal of the seven proposed projects limited time is available. Consequently, the appraisal team cannot not make firm assessments of all *effects*. With respect to cost measurement, it proves to be impossible to assign a monetary value to environmental effects. Therefore, discounting of costs is confined to the categories of investment and operation and maintenance. Agricultural benefits are also discounted. Results are shown in table 7.1.

Table 7.1. Monetized costs and benefits EIP (present values, '000 US$)

Criterion	Alternatives						
	A	B	C	D	E	F	G
Benefits	700	200	200	75	75	800	200
Costs	-400	-200	-150	-50	-100	-400	-100
Net	300	0	50	25	-25	400	100

The analysis of distributive impacts involves two steps. First, an "objective" equity impact matrix is determined. With respect to landless labourers, alternatives are ranked regarding the additional employment they would create for this group. (If more time had been available, additional man-years of employment or even income might have been estimated.) From the perspective of landless labourers, "1" represents the most attractive alternative, and "7" the least attractive alternative. With respect to each class of landowners, an estimation has been made about the area of land benefiting from the project. The equity impact matrix is shown in table 7.2.

Table 7.2. Equity impact matrix EIP

Group (dimension)	Alternatives						
	A	B	C	D	E	F	G
landless labourers (ordinal)	6	2	3	4	1	5	7
small farmers (ha of land)	600	300	300	400	500	400	400
medium-scale farmers (ha of land)	300	500	300	200	300	200	300
large farmers (ha of land)	100	200	400	100	400	100	50

The second step in equity analysis involves the application of MCA to arrive at an overall equity score, which may be used as an input into integrated evaluation. MCA requires a ranking of the relative priority of the four social groups. The following weight set is applied:

landless labourers > small farmers > medium-scale farmers > large farmers

The Regime technique gives the following ranking of the alternative sites on the equity criterion:

E > B > C > D > A > F > G

The estimation of the score on the sustainability criterion is hampered by a lack of information about ecological impacts. However, it is known that all alternatives would involve negative environmental effects. The degree of environmental damage differs between alternatives due to the different characteristics of ecosystems at the various sites and the size and nature of infrastructure works. On the basis of such factors, the mission provides qualitative information about sustainability. Table 7.3 gives the results, where non-sustainability increases with the number of signs.

Table 7.3. Scores on the sustainability criterion EIP

	Alternatives						
	A	B	C	D	E	F	G
Sustainability	- - -	- -	- -	-	- -	- - -	-

Now the building blocks for the use of MCA in the integrated evaluation phase have been gathered, viz. present values of costs and benefits (together covering the efficiency criterion, excluding environmental impacts), a ranking on the equity criterion, and a ranking on the sustainability criterion. With respect to the weighting of the criteria, two weight sets are applied. The first represents the "social" viewpoint:

sustainability = equity > costs = benefits

The second has been termed the "economic" perspective:

costs = benefits > sustainability = equity

The Regime technique has been applied for both weight sets. Resulting overall rankings of alternatives are shown in table 7.4.

Table 7.4. Overall ranking of EIP alternatives for two weight sets

Weight set	Alternatives						
	A	B	C	D	E	F	G
"Social"	6	3	5	1	2	7	4
"Economic"	6/7[a)]	5	3	1	4	6/7	2

a) 6/7: two alternatives have equal rank

The matrix shows that for both weight sets the Regime method ranks alternative D first, and A and F among the least attractive. Alternatives B, C, and E do not achieve an extremely high or low ranking. The ultimate selection of sites would depend on which weight set would be preferred as well as on the available budget. If the total budget would amount to US 1,400,000, in principle all projects may be financed, if no constraints are applied on, for instance, the difference between benefits and (monetized) costs. If the budget would be lower, and no constraints would be applied, the (expensive and from an overall perspective unattractive) alternatives A and F would be the first projects to be rejected[11].

7.4. Conclusions

In sustainability-oriented project appraisal, integrated evaluation is likely to involve three criteria (efficiency, equity and sustainability) and mixed-data

[11] An efficiency-oriented economist might object: alternatives A and F have the highest NPVs (environmental effects ignored)!

information about impacts. In this last appraisal phase the applicability of CBA is limited. The easiest way to take the sustainability criterion into account in economic CBA is to adjust the net benefits for any resource use in excess of sustainable levels by focusing on the costs of additional contributions to the capital stock. This, however, is not an adjustment to economic CBA methodology as such. Some tentative options to change the methodology itself need further study, including a focus on sustainable income levels and sustainability weights. Due to conceptual and empirical problems social CBA is rarely applied. Consequently, efforts to try to incorporate the three criteria in a CBA framework would not have much practical relevance in developing countries.

The MCA approach offers better prospects for the integrated evaluation phase in view of its flexibility in terms of criteria and impacts. However, the collection of weights, although less problematic than for social CBA, needs careful study and experiments. Furthermore, the methodological complexity of the MCA approach may raise institutional obstacles, which also calls for further study.

In contrast to the Colombia study (chapter 9), CBA and MCA could be used in a complementary way in the Egypt case (chapter 10).

PART B

TOWARDS APPLICATION OF SUSTAINABILITY-ORIENTED PROJECT APPRAISAL

8. INTRODUCTION TO PART B: TOWARDS APPLICATION

Part A of this study has explored the contours of sustainability-oriented project appraisal from a theoretical perspective. It emphasized three, interrelated subjects in appraisal studies: a) a comprehensive review of the numerous ways in which environmental issues may affect the scope and contents of each stage in project appraisal, b) project-specific manifestations of new issues, and c) the potential role of two main groups of appraisal methods, viz. CBA and MCA, in addressing problems encountered in the previous steps. Part A was not primarily concerned with applicability in reality. Sometimes proposals for the treatment of appraisal problems have been formulated that make theoretical sense, but may be of little practical value. In other parts, the analysis in part A was even confined to identifying problems, without offering solutions.

Exploration of the theoretical dimension of sustainability-oriented project appraisal is a prerequisite for the development of a framework that provides guidelines for practical application. Part B of this study is aimed at translating the overall theoretical framework into a structure for sustainability-oriented project appraisal that has a synergy with real-world circumstances. The practical framework differs from the theoretical analysis in three respects:

- It focuses on issues that would be relevant to the majority of project appraisal studies. Problems that may be highly interesting from a theoretical viewpoint, but would occur in a small minority of projects are therefore not included. For example, MCA may play a role in obtaining multi-attribute, multi-level sustainability scores (see section 5.4.2), but application will generally not be essential for the discussion about sustainability issues in a representative appraisal study.
- The practical framework acknowledges that evaluators of projects in developing countries generally need to operate within a set of severe constraints in terms of financial resources, time, expertise and base-line data, to mention some of the major factors. Part B therefore discusses problems that evaluators may reasonably be asked to tackle in the average appraisal study[1]. Hence, issues that affect projects but need to be tackled at supra-project levels, for example, are beyond the scope of the guidelines. This would include the question, for instance, of how to assure that sets of projects comply with nation-wide limits to emissions of greenhouse gases.
- The practical framework deals in more detail with the case-specific manifestations of sustainability-related issues that determine the applicability of CBA and MCA. This is important as the framework is not a set of rigid

[1] Nevertheless, as we will show in chapter 11, the new framework may call for considerable changes in the way appraisal studies are organized.

guidelines leading straightforward to conclusions in each individual case. Instead, a two-tier procedure is developed, comprising general guidelines for the initial phase of analysis and more specific guidelines for further study, allowing for different types of outcomes of the first phase for different kinds of projects.

Besides the theoretical analysis of part A, the practical framework developed in part B has a second corner stone, viz. the review of two recent studies of ecologically-sensitive projects in developing countries. The first concerns the appraisal of a Forestry and Environmental Protection Programme in Colombia, the second is an explorative study on policy scenarios for Lake Burullus, an ecologically rich wetland in Egypt. In both cases, the aim is to investigate the applicability of the theoretical approach developed in part A, and to identify empirical, case-specific factors that either impeded or facilitated application. The analyses of the Colombia (*chapter 9*) and Egypt (*chapter 10*) projects have the same structure. The emphasis is on the treatment of issues in the field of environment and sustainability, and on issues in other, but related fields (for instance income from the exploitation of natural resources). To test the theoretical framework, a number of key questions were derived from it. They are the following (between brackets the number of the chapter or section where the theoretical background is explained):

Objective and organization of the appraisal study
- what was the *objective* of the appraisal study; what role was it expected to fulfil in decision-making regarding the project?
- how has the study been *organized*, particularly in terms of disciplines represented in appraisal teams and the time available for research on especially environmental issues?

Decision-making framework (ch 4)
- which *alternatives* for the project were considered, particularly in terms of options to achieve environmental objectives? (4.2)
- what was the *institutional context* of the project, i.e. to what extent would private and public sector agents in society have different interests regarding the use of natural resources the project would affect? (4.6)
- which appraisal *criteria* have been applied, particularly in the field of ecological sustainability? (4.3-4.5)

Impact assessment (ch 5)
- to what extent has the *project setting* been analysed, particularly in terms of profiles of ecosystems and socio-economic systems affected by the project and models for their interaction? (5.2)
- how have ecological and other types of *impacts* been estimated, and how robust were the results? (5.3-5.5; 6.6)

Efficiency: economic CBA (ch 6)
- to what extent was *economic CBA* applicable, particularly in relation to the possibility to assign monetary values to environmental impacts? How useful were CBA results for evaluating the project's performance? (6.2-6.4)

Integrated evaluation: MCA (ch 7)
- to what extent were policy-makers and other agents affected by the project willing to express their subjective views on the relative priority of environmental and other criteria in terms of explicit *weights*? (4.6)
- was *MCA* considered an appropriate analytical tool, and which problems were encountered during application? (7.3)
- what conclusions were arrived at in the *integrated evaluation* of the performance of project alternatives, particularly in view of trade-offs involving ecological issues? (7.2-7.3)

The Colombia and Egypt cases appear to be highly instrumental in illustrating major issues in sustainability-oriented project appraisal. The treatment of the issues listed above gives rise to distinctly different problems in the two studies, showing clearly the impact of case-specific circumstances on the possible scope of an appraisal, the extent to which problems that evolve can satisfactorily be addressed, and the usefulness of the outcomes of an appraisal study for decision-making. Each case concludes with a summary of lessons for project appraisal in these fields.

In *chapter 11*, which builds on part A and the two cases, a practical framework for sustainability-oriented project appraisal is developed. As much as possible, the findings are translated into concise guidelines for practitioners: what environmental issues should be addressed and in which appraisal stage? what are the requirements for sound environmental impact assessment? what determines the applicability of CBA and the usefulness of its outcomes? in what phase may MCA be applied and what are the factors determining the reliability and usefulness of its results? how should sustainability-oriented appraisal studies be organized?

Finally, *chapter 12* evaluates the main findings of the study by referring to the original objectives as stated in chapter 1. Moreover, the general validity as well as the limitations of the framework are analyzed. On that basis an agenda for further research is developed.

9. CASE STUDY: FORESTRY AND ENVIRONMENTAL PROTECTION PROGRAMME COLOMBIA

9.1. Background and organisation

The Government of Colombia (GOC) applied to an international agency[1] for a loan for a Forestry and Environmental Protection Programme (FEPP). This project aims at enabling the GOC to improve the management of its forest resources and arrest the problems of environmental degradation. The project area comprises natural forests as well as selected watersheds in mountainous regions.

A preparation team visited Colombia, consisting of three economists, a financial expert, two forestry specialists and one anthropologist[2]. Its tasks were to discuss the design of the project; technical, financial, institutional and economic matters; remaining actions; and conditionality. Whereas the preparation team itself spent less than three weeks in Colombia, it benefited from information gathered by a number of other teams. The findings were expected to be a basis for work of eventual additional field exercises, as well as an important input into the GOC and the international agency in final stages of the decision-making process regarding the project.

9.2. Project components and alternatives

The project would include four major components[3], viz:

- *Watersheds*
  This component would address water catchment degradation and related problems in selected mountainous areas. Basic community-based activities would include tree planting and protection of vegetation by the population in exchange for goods and services provided by the executing agency, production of seedlings, and soil conservation measures.
- *Natural Parks*
  The aim of this component is to improve management in nine national parks, to establish two new parks, and create buffer zones in areas adjacent to parks to cater for the indigenous/negro population.

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1 In view of the confidential nature of information presented here, the name of this agency cannot be mentioned. For the same reason no reference will be made to specific areas where the project would be implemented.

2 This chapter is based on the findings of this team (April 1992), in which the author of this study participated.

3 Several other, minor components will not be reviewed here.

- *Forest Management*
  This component would aim at improving the management and control of 5.4 million ha of natural forest.
- *Industrial Plantations Fund (CIF)*
  Through the creation of a temporary fund, subsidies would be provided to improve the profitability of investments in industrial plantations. Planting would need to take place in areas with a forestry vocation in ecologically sensitive mountainous areas. It was hoped that the CIF would also contribute to relieving the pressure on natural forests.

The FEPP was presented as a package of components. The preparation team did not review alternatives for these components. An important explanation is that the project's review process was close to the final stage. Nevertheless, the question remains whether proposed activities are the most (cost-)effective to achieve the project objectives, particularly environmental protection. In general, it should be acknowledged that policy adjustments in the field of agriculture, land reform, and infrastructure may have a greater impact than institutional strengthening of the forestry sector. Where poverty is a cause of environmental degradation, combating poverty through such non-environmental policies might be a more effective tool than environmental projects.

Alternatives might also have been considered regarding the design of the various individual project components. For instance, attention has been paid to the possibility to include activities to enhance farm productivity in the Watershed component. Whereas the activities listed above primarily involve the provision of incentives to the population to plant trees in degraded areas, this activity would aim at relieving the pressure on fragile land by enhancing productivity on less sensitive agricultural land. It was decided not to include this approach in the Watershed component as it would require the involvement of other ministries in the project, besides the Ministry for Environment. From an environmental perspective, however, it remains to be seen which measure would be more effective in avoiding deforestation and land degradation.

Similar questions were raised in connection with the CIF:

- Is the CIF is a cost-effective means to reduce pressure on natural forests? An alternative would be to increase stumpage fees faster, and to spend more on effective control and support to the introduction of sustainable forestry practices. Or instead of subsidizing the domestic forest product industry, imports might be an alternative source of timber.
- Is the CIF the most cost-effective way to achieve reforestation in watershed areas? To answer this question, it should be compared with other approaches (like intensified programmes of interchange of services) in terms of a) financial requirements, and b) size of the planted areas.

9.3. Agents and criteria

The FEPP is concerned with man's exploitation of natural resources, particularly forests and watersheds. The project would seem to be politically highly sensitive, potentially affecting consumers, producers and government institutions in very different ways. As a result, environmental protection and strengthening of the forestry sector, the two main objectives of the project, may not be commensurate in all respects. Consider the following examples:

- Public and private sectors may have different perspectives regarding the Watershed component. The public sector would emphasize environmental protection, reforestation being considered a means to achieve that objective. Local communities, however, may be particularly interested in the project in terms of an opportunity to secure fuelwood availability. Regular felling of trees for that purpose would negatively affect the likelihood that positive ecological externalities will materialize.
- The most important cause of deforestation is clearing of land for agricultural purposes. Firewood is one of the most important sources of energy in the project area, and the timber industry is well developed. At present, individuals and business have easy access to natural forest resources. Wood is either free or very cheap. Under the Forest Management component, natural wood would be priced at an economically justifiable level, and control and management in natural forests would be made more effective. This would obviously hurt vested interests. Social conflicts between the present users of the forest resources, emphasizing income opportunities, and government agencies in charge of realizing environmental objectives, may arise.

The FEPP hence clearly illustrates the importance of two, strongly interrelated issues in natural resource use, viz. the market price of a natural resource (see section 6.2.1) and access of different groups in society to such a resource (section 6.6).

To evaluate the impacts of the project, a set of criteria has been applied that would seem to cover the interests of all groups possibly involved in or affected by the project. Each project component has been evaluated with regard to the following criteria:

- *Environment*, particularly in terms of biodiversity and erosion.
- *Human welfare*, covering the human-environmental linkage, both in terms of the impact of human activities on the environment, and the dependency of human welfare on natural resources. Particular attention is being paid to income levels in forestry and in other sectors.
- *Financial inputs*, in terms of both costs and financial sustainability.
- *Equity*, including potentially conflicting interests of social groups.

- *Institutional feasibility and risks*, particularly dealing with capacities of government agencies.

These criteria cover the three key criteria distinguished in this study. The first four criteria would comprise the efficiency criterion, "Environment" is moreover linked to sustainability (see below), whereas "Equity" is the third key criterion. "Institutional feasibility" may be interpreted as both a factor determining scores on key criteria and a risk factor.

Different agencies would tend to assign a different priority to these criteria. For instance, public sector representatives were not too strongly concerned with financial sustainability. The argument is that once the project has been started and proved to be successful, the government would be willing to provide sufficient funding for long-run recurrent costs. The team of the international agency (TIA), however, considered financial sustainability a precondition for a successful project. Different preferences of various agents are addressed in more detail in section 9.7.

Ecological sustainability has not been explicitly incorporated in the criteria set developed by the TIA. Colombian officials consulted by the preparation team applied the notion of sustainable development to the range of options that would achieve the key objectives of strengthening of the forestry sector and environmental protection simultaneously. As indicated above, however, these objectives may be of a conflicting nature. It is unknown how these objectives should be weighed in such cases. Consequently, ecological sustainability was not used in an operational way. Anyway, the FEPP is not based on the principle of "strong ecological sustainability", which would imply that no further environmental degradation is permitted (section 4.5.1).

The TIA was mainly concerned with economic justification, which means that aggregate costs and benefits should produce a positive net outcome. In other words, environmental effects and effects on human welfare (particularly in the form of production of wood) would need to be aggregated, avoiding double-counting.

9.4. The project setting

Background documents prepared by other teams provided a wealth of information about Colombia's forest industry, market and policies, as well as the public sector institutions responsible for management of natural resources. From the perspective of finance, economics and legislation, information was abundant. Ecological profiles and a model for the interaction between ecosystems (natural forests and parks, watersheds) and socio-economic systems, however, were lacking (see section 5.2). This has hampered the analysis of the "without" case, and consequently caused problems in the measurement of FEPP impacts (see section 9.5).

9.5 Impact assessment

9.5.1. Approach

Impacts were defined as scores on the main criteria in terms of differences in conditions with and without the project (see section 3.3). As stated above, the analysis of the without-case was constrained by available information about the project setting. Therefore, only a tentative impression could be obtained about possible future developments of these systems over time should the FEPP not be implemented. By comparing these developments with tentatively expected changes that would be attributable to the FEPP, the impacts of the project result.

The TIA started from the objective to systematically collect all available information, irrespective of the question whether or not effects could be quantified or even monetarized. To give a fair picture, all uncertainties would be indicated, particularly in relation to possible social issues and institutional capabilities (i.e. the criteria of Equity and Institutional feasibility).

Impacts have been analyzed for each individual component, and the results are shown in sections 9.5.2-9.5.5. Section 9.5.6 summarizes the findings.

9.5.2. *Component 1: Watersheds*

Criterion	Without case	Impacts project
Environment	The project area covers several mountainous regions. The basic ecological problem is deforestation, leading to erosion and siltation. The greatest part of the project area (about 140,000 ha), comprising about 75 watersheds, is not denuded, i.e. there is still grass or other vegetation. In such conditions, human intervention would have the greatest impact and be most cost-effective. However, three severely degraded watersheds have also been included in the project. Intervention there tends to be more costly, as environmental damage is closer to being irreversible.	Direct environmental benefits would consist of a reduction in the rate of deforestation or -less likely- even reforestation (if people plant more trees than they fell). Indirect (on-site and off-site) environmental benefits include avoided or reduced erosion, siltation, sedimentation and flooding (externalities). Little is known about the magnitude of these benefits. One reason to suppose that they might be limited is that the project will lead to reforestation of just a fraction of the total eroded part of the project area. What impedes impact assessment most is the limited knowledge about linkages between forests and erosion/siltation processes, and more so the extent to which expected changes in these processes may be attributed to the project.
Human welfare	The local population is dependent on and exploits natural resources in several respects. Deforestation in the project area is mainly caused by opening of marginal land for agriculture. Furthermore, tree felling is due to demand for fuelwood stakes and posts. Principally, the natural vocation of the mountain areas would be forestry, but actually the main use is for agriculture and livestock, causing overexploitation.	The environmental benefits would translate into the following (on-site and off-site) benefits for the population: - more regular supply and improved quality of drinking water in urban areas; - avoided damage to physical infrastructure; - less damage to irrigation infrastructure, and hence avoided agricultural losses; - more regular supply of drinking water supply to urban areas/longer life of hydropower facilities and hence avoided electricity losses.

Criterion	Without case	Impacts project
Human welfare (continued)	Drinking water supply in several urban areas depends critically on the watersheds. In other areas, hydropower covers all of the regional electricity requirements (and a significant portion of the national consumption).	An assessment of the magnitude of these benefits is impeded by our limited knowledge about environmental effects (see above) and about quantitative and qualitative dimensions of linkages between these effects and human welfare. More easily quantifiable benefits include increased supplies of wood products for fuel and timber consumption. Moreover, farmers' income would increase somewhat from sales of fruit products from trees planted primarily for protection. A final group of benefits may comprise the satisfaction people derive from the feeling that they are contributing to safeguarding the welfare of their children.
Financial inputs		Short-run: project costs US$ 23.10m Long-run: present financing mechanisms will require continuous subsidization. A case can be made for adjustments to cost-sharing mechanisms. Benefits of tree planting involve positive externalities, and local communities and private landowners reap at least a significant part of these benefits. It can be argued that they should pay for these benefits.
Equity	Land in the project area is privately owned. Poor farmers are forced to move to steep, marginal land; the richer farmers have obtained most of the land in ecologically more robust areas.	The project would benefit small private farmers in upstream areas directly, and larger landowners in downstream areas indirectly. Past experiences have shown that local communities are interested in the approach, and social conflicts are therefore unlikely.

Criterion	Without case	Impacts project
Institutional feasibility	Deforestation is mainly the result of autonomous developments, although the government imposes some taxes on natural resource use.	This project component builds upon past activities, and hence does not seem to involve great risks. It is therefore relatively certain that benefits will materialize, although the magnitude is unknown. However, an eventual drastic change in cost-sharing mechanisms might cause resistance among the population.

9.5.3. *Component 2: Natural Parks*

Criterion	Without case	Impacts project
Environment	The total area covered by the national parks in the project would exceed 1 million ha, in addition to about 150,000 ha in buffer zones. As all forests, natural parks have several environmental functions, including: - the parks are among the most biodiverse regions in the world. Estimates on recent changes in biodiversity, however, vary widely, - parks along the coast include brackish water marine areas, which fulfil an important role as nursery and migration area for many species. Along the coast, the migration of whales is particularly important, - potentially, the parks are a rich source of botanical resources (ornamental, medical, etc), - through transpiration, the parks play an essential role in regional rainfall patterns, - through fixation of carbon dioxide, parks possibly contribute to mitigation of the global warming phenomenon.	The project would primarily focus on the development of control and management capacities of local government agencies, and of physical infrastructure. In comparison to the existing budget, the project multiplies available funds. Under effective management the parks would be safeguarded against exploitive use by non-residents, whereas the indigenous/negro population would be trained and assisted in sustainable use of natural resources their welfare strongly depends on. The main result would be that the extremely rich biodiversity would be maintained, as well as the other functions mentioned in the left column.

Criterion	Without case	Impacts project
Environment (continued)	Until now parks have hardly been exploited, in contrast to the buffer zones. The small indigenous/negro population is involved in nonsustainable use of renewable natural resources (see below)(non-sustainable meaning that extraction from the stock of renewable natural resources exceeds the natural regeneration). In the absence of effective government control and with increasing scarcity of natural resources in surrounding areas, the parks themselves are likely to be invaded in the coming years.	
Human welfare	In coastal areas, fishing provides the basic source of proteins for local communities. Other resource-based income-generating activities include the catch of turtles and pianga, and cutting of manglare trees. In the buffer zones palms are cut to obtain palm harts, which are exported. In buffer zones, wood is extracted at a rapid pace. Ecotourism to parks along the coast is still very limited, due to a lack of infrastructure (park stations, for instance), transport (boats), and local services. Parks in the proximity of large urban centres do experience considerable tourism impacts, and moreover are important for educational purposes.	If successful, the project would ensure the long-term income basis for the -relatively small-indigenous/negro population, which is fully dependent on natural resources. Ecotourism may prosper, if infrastructure can be sufficiently be upgraded. The Colombian society would benefit from the continued presence of ecologically unique parks, in the form of educational and scientific values, and the satisfaction derived from the knowledge that future generations will also have access to them (option value). The global community would benefit in view of expressed concerns with maintaining biodiversity, even if people themselves do not have access to the parks (non-use value).
Financial inputs	At present the budget assigned to the management of parks is small, leading to uncontrolled developments.	Short-run: project costs US$ 6.56m. In the long-run the public sector will need to cover recurrent costs. Possibilities to recover costs from the local community are modest, but tourists may be a source of income. There is a case for support by the global community.

Criterion	Without case	Impacts project
Equity	All land in the parks is owned by the government. Often informal landownership arrangements exist, which in relatively densely populated areas have given rise to social conflicts. In the coastal parks, the population is extremely poor. In the parks in the interior, the population is less poor.	Introducing sustainable techniques of natural resource use are in the long-term interest of the poor local population. However, to avoid conflicts between the present users of the parks and government agencies, new types of cooperation models may need to be developed. Colombian scientists and tourists will be other beneficiaries.
Institutional feasibility	The present staff is extremely dedicated to their work, despite the difficult working conditions. Institutional presence, however, is weak.	Institutional risks exist because management and control capacities need to be built up virtually from scratch. The extent to which responsibilities will be decentralized and appropriate means will be provided to responsible government agencies, may strongly affect the scope for effective cooperation between these agencies and local communities.

9.5.4. Component 3: Forest Management

Criterion	Without case	Impacts project
Environment	The project area covers about 5,400,000 ha of natural forests. The principal forest type is coastal tropical high forest and mangrove. The basic environmental problem is degradation of the forest. Present deforestation is estimated at 160,000 ha per annum.	The objective of the project is to achieve -in the long run- an ecologically sustainable level of forest use. The sustainable yield of merchantable roundwood is estimated to be 2.5m m^3/annum. In practice, the sustainable yield might be lower as part of the forest may need to be reserved for protection.

Criterion	Without case	Impacts project
Environment (continued)	Degradation of the forest and deforestation may lead to a loss of environmental functions in the following fields: a) erosion control, b) transpiration mechanisms regulating the rain fall pattern in the Cordilleras, c) biodiversity, d) control of siltation of streams and the marine environment, and e) possibly, a loss of the mitigating impact on the global greenhouse effect.	The environmental benefits would consist of avoided deforestation and consequently avoided losses in environmental functions of the forest. The effectiveness of the project in achieving these ecological benefits primarily depends on the ultimate performance of forest management agencies (see Institutional feasibility).
Human welfare	The main income-generating activities contributing to deforestation in the project area include minerals (gold) mining and logging for industrial (80%) and domestic (20%) consumption. The region accounts for 2.4m m^3 roundwood production per annum or 80% of industrial log output in Colombia. Wood is close to being a free good. It is the primary source of energy for the local population. To a much lesser extent non-wood products (like fruits) provide an income basis. New land development for agriculture and to a lesser extent livestock are other causes of forest degradation. Available data do not distinguish clearly between the factors that in the past have contributed most to environmental problems, and factors which primarily account for present degradation processes. Potential benefits of the forests cover genetic material, medicines, herbs, fruits and fibres.	The impact of the project on income derived from commercial forestry is uncertain. In principle, sustainable forestry need not result in a reduction of the quantity of wood products if enhanced forestry practices are effectuated. However, the increase in stumpage fees combined with effective control will make forestry in natural forests less profitable in general terms as well as vis-a-vis plantations. If the decline in profitability is sufficiently large, timber production and income from natural forests would decrease. As a result, wood prices in Colombia would increase. Total wood availability in the country may decrease, or imports may increase. (Increased supply through plantations may mitigate these developments.) Local communities would reap the -modest- benefits of agroforestry activities around homesteads. The global community has expressed a great interest in maintaining tropical moist forest and would hence benefit from the project, although mainly in the form of non-use values.

Criterion	Without case	Impacts project
Financial inputs		Short-run: project costs US$ 16.50m. In the long-run recurrent costs would be balanced by a more effective collection of higher stumpage fees. As the benefits would be supra-national, support by the international community is justifiable.
Equity	The greatest part of the natural forests are public land. The population living in the forests are poor compared to the Colombian average.	The introduction of new stumpage fee policies will increase government revenues. These policies may cause some social tension. Whereas in the past access to forest products was practically free, government agencies will face the difficult tasks of convincing communities that to pay taxes is in their own long-term interest, and of actually collecting charges. If stumpage fees are effectively implemented, all present users of the forest would be harmed. The poor would be hurt hardest. Such effects could be mitigated through, for instance, special concession policies. If control would not extend to the poorest groups, only the industrial exploiters of the forest would be harmed. If commercial firms would cut back on their activities in natural forests, employment among the local population would negatively be affected. Due to higher prices, wood products consumers would be hurt. Plantation owners would benefit from higher prices. The international community would benefit.

Criterion	Without case	Impacts project
Institutional feasibility	Access to the forest is poorly controlled. At present, natural forest policies are virtually lacking. Local staff is extremely small compared to the area under their command. Moreover, institutional conflicts exist.	The risks are mainly that insufficient technical personnel can be employed and trained, and that communication between implementing government agencies and local communities is not optimal.

9.5.5. Component 4: Industrial Plantations Fund

Criterion	Without case	Impacts project
Environment	The project area comprises eroded watershed areas (see section 9.5.2). Indirectly, the project might affect natural forests (see section 9.5.3).	The basic justification for the project would be in the field of environmental externalities (A) and reduced pressure on forests (B). (A) New plantations (70,000 ha in the project period) would be developed in environmentally fragile areas with a forestry vocation. Plantations would have several positive environmental externalities, viz. avoided erosion (on-site), avoided sedimentation (downstream) and carbon-dioxide fixation (global). These benefits will only materialize if plantations are developed in fragile areas, particularly along steep hills, and if felling of trees is matched by replanting.

Criterion	Without case	Impacts project
Environment (continued)		(B) The CIF may induce a shift from foresting activities from natural forests to plantations by changing the relative prices of the respective products. If successful, the result would be reduced pressure on the natural forests, and hence avoided environmental damage associated with further deforestation in the without-case (see section 9.5.2). According to available estimates, by developing one hectare of plantations, between 2 and 4.5 hectares of natural forests may be saved.
Human welfare	There are around 175,000 ha of plantations in Colombia. High interest rates, long gestation periods, and low wood prices are considered the main explanations for the lack of profitability of plantations.	The types of benefits associated with reduced erosion are similar to those discussed for Watersheds (section 9.5.2). There may be opportunity costs in the form of higher costs of or foregone income from cattle grazing.
	Without the project land may be used for other purposes than plantations, particularly for cattle grazing.	The type of benefits of reduced pressure on natural forests are similar to those of improved forestry management (section 9.5.3). The magnitude depends on the extent to which wood from natural forest and from plantations are considered perfect substitutes. Another condition would be that investments in plantations substitute for activities in natural forests rather than lead to additional timber production in Colombia. This points at the critical role of rapid changes in stumpage fee policies in natural forests.

Criterion	Without case	Impacts project
Financial inputs		Short-run: project costs US$ 36.53m. The financial basis of the programme depends, among other things, on the level of the subsidy. If plantations have become sufficiently profitable for the private sector, the government could reduce the level of and eventually phase out the subsidy. However, the benefits associated with externalities (avoided erosion, carbon-dioxide fixation) would need continued subsidization. If private beneficiaries are willing to pay for (part of) localized avoided externalities, the level of subsidies could be reduced.
Equity		The domestic wood products industry would benefit from artificially cheap wood. The CIF would benefit only landowners and firms with access to formal credits. It can be expected that the greatest benefits will be reaped by commercial, industrial firms. Obviously, there are strong political interests in the CIF. The CIF would be at the expense of tax payers (or external donors), and of the present exploiters of natural forests.
Institutional feasibility		Organizational aspects still needed elaboration at the time of the visit of the preparation team.

9.5.6. *Overview*

The preparation team has devoted most attention to evaluating the institutions responsible for implementation, and hence to the criterion of Institutional feasibility and risks. Moreover, a detailed analysis was made of the costs of the project. In other words, emphasis was put on *inputs* into the project. As previous sections show, much less attention was given to estimation of impacts in other fields, including the effectiveness in terms of realizing environmental benefits. Apart from costs, no quantitative data can be presented on impacts. Even a comparison in qualitative terms of the components is far from easy. For instance, which component would have the most favourable impact on biodiversity, Natural Parks or Forest Management? Acknowledging the significant uncertainty and the subjective nature of part of the estimates the impact matrix in table 9.1 summarizes available information[4].

Table 9.1. Impact matrix

Criteria	Component			
	Watersheds	Natural Parks	Forest Management	CIF
Biodiversity	0	++	+++	+
Erosion	++	+	+	+++
Forestry income	+	0	-	+++
Other income	++	+	0	0
Equity	+	++	-	---
Costs (US$m)	-23	-7	-17	-37
Financial sustainability	-	--	++	---
Institutional risks	-	--	---	-

Besides the special concern with institutional issues, a lack of necessary expertise in the team impeded a good insight in the environmental consequences of the FEPP. Had the team's task been to estimate environmental impacts, ecologists or biologists should have participated. Even then environmental impact assessment for the FEPP would have been more time-consuming than for many other types of projects in view of a) the complex linkages between the project, human activities and ecosystems, b) the varying types of environmental effects involved and c) the geographical division of project components.

The estimation of environmental impacts would have required the development of economic-ecological interaction models (see secton 5.2). For the Watershed component, such models would link factors such as slope, soil, rainfall, vegetation and sedimentation. For the Forest Management component,

[4] It should be acknowledged that the international agency could decide to collect more robust data through additional field investigations.

studies would be required to more obtain more accurate estimates on, among other things, the maximum sustainable yield. Assessing ecological impacts of the Natural Parks and Forest Management components would remain relatively difficult, as these are primarily institution-building components.

Financial and environmental issues have been interrelated in several ways. The financial analysis raised the problem of how to recover the costs of a project the environmental benefits of which are to a great extent externalities. The occurrence of externalities may be a reason to either tax or subsidize activities. The latter option raises the question of who will pay, both in the short term and the long term. Colombia's macro-economic policies put constraints on public spending. Therefore, the preparation team has explored several ways to collect charges from private beneficiaries. Frequently, there are strong arguments in favour of such mechanisms, like in the case of reforestation in watershed areas with localized benefits. In practice, it may still be problematic to have local communities pay for enhancement of public resources, even if they are direct beneficiaries. Other cost-sharing mechanisms are required if the benefits materialize at higher levels: it is not justifiable to tax local communities because a project might have a mitigating impact on the greenhouse phenomenon (see section 4.5.1).

Institutional risks have been a critical issue in FEPP design. They also affect the reliability of expected impacts. Some FEPP components appear more robust than others. The Watershed component, for instance, builds on past experiences and is therefore more predictable than, for instance, the Natural Parks and Forest Management components, which involve more experimental approaches.

9.6. Efficiency: cost-benefit analysis

The basic economic justification for each component and for the overall project would be that environmental (and other) benefits exceed financial (and possibly other) costs. As discussed in section 6.2, CBA requires that all costs and benefits, including environmental impacts, can be assessed in monetary terms. Section 9.5 showed, however, that little information has been collected on environmental impacts. Consequently CBA, which uses money as numéraire, played a minor role in the analysis of the project. It was only applied to the CIF. The calculated IRRs for this component covered the (shadow-priced) benefits of tree planting, but excluded environmental externalities. They are hence partial IRRs only (see section 3.3.2).

A lack of quantitative, let alone monetary data on environmental impacts impeded the application of CBA. More in particular, there was a lack of a) baseline data on environmental systems and processes, b) insight into the linkages between human activities and ecosystems, and -consequently- c) the magnitude of ecological impacts of the project components. In other words, rather than valuation or discounting (typical steps in CBA), a serious lack of information about environmental impacts (an input to CBA) impeded an economic analysis. This is not a conceptual, methodological but a practical problem (see section 6.1 for the distinction between these problems).

If more time and expertise had been available to forecast environmental impacts, economists would have been able to make a more useful contribution to the analysis of the project. CBA would use impacts on Human Welfare to value (at least part of) the environmental impacts. Valuation problems would differ considerably between components, depending on the dominant type of environmental impact. Valuation is much easier if environmental improvement directly affects income-generating activities ("use-values", e.g. timber production), than if such a linkage is indirect or even lacking ("non-use values", e.g. safeguarding biodiversity). Moreover, it is more difficult to estimate the environmental benefits of institutional measures, such as strengthening of natural forest agencies, than those of physical measures, such as planting of trees. Based on sections 6.1 and 6.2, table 9.2 summarizes the difficulties that would be encountered in valuation, the types of values involved and some examples of environmental benefits.

In the absence of a valuation mechanism like prices, the justification of the FEPP could only be based on an assessment of the underlying logic of the project, in terms of a clear definition of objectives and particularly the relation between objectives and means. Obviously, justification of the project is much more difficult than of traditional projects. Assuming a longer study and a multi-disciplinary team, the conventional tool of CBA might have been applied, at least to some components. The question then arises whether the costs of such an exercise would outweigh the benefits, and if so, who should bear the costs. It should be acknowledged that is makes not much sense to embark on such studies if the project preparation cycle is near to the end. For projects like the FEPP, environmental impact and valuation studies would need to be build in feasibility studies from the very start. This would obviously increase the costs of appraisal.

Table 9.2. Valuation of environmental impacts FEPP

Valuation	Component			
	Watersheds	Natural Parks	Forest Management	CIF
Valuation problems	low	high	intermediate	intermediate to high
Type of environmental values	use-values	mainly non-use values	both use values and non-use values	both use values and non-use values
Examples of benefits	avoided maintenance costs of physical infrastructure avoided agricultural losses upstream and downstream the electricity benefits of prolonged life of dams improved drinking water availability, measured by willingness-to-pay by beneficiaries	safeguarding biodiversity contribution to carbon fixation education/ scientific values	avoided deforestation (replacement values) safeguarding ecological functions of the forest sustainable timber production	a mixture of impacts of the Forest Management and Watershed components

9.7. Integrated evaluation: multi-criteria analysis

Considering the mainly qualitative information about impacts, the occurrence of non-efficiency criteria, and the strongly political dimension, MCA would seem to be a promising analytical tool to evaluate the FEPP (see sections 3.5 and 7.3 for method-selection criteria). In reality, MCA was not formally incorporated in the analysis for two reasons. First, government officials nor the international agency showed a strong interest in exploring alternative designs for the FEPP. As argued in section 3.2.1, MCA is particularly useful if several options are to be compared. Second, little time was made available to determine the relative weights of criteria. The availability of at least one weight vector is a prerequisite for MCA application. As the FEPP seems to involve conflicting interests, it would furthermore be very desirable to obtain rankings of criteria according to various agents. Each party involved in or affected by the project should assign weights to environmental protection and other criteria.

Despite these factors, a MCA exercise has been conducted to illustrate the potential utility of this tool. The starting point was the mainly qualitative impact matrix presented in table 9.1. To overcome the problem of alternatives, it was assumed that decision-makers would like to obtain a ranking of the four project components regarding their overall performance. (In reality especially public sector officials preferred to treat the project as an integrated package.) With respect to weights, the TIA itself developed vectors of criteria weights for four parties involved by the FEPP on the basis of available knowledge about their priorities and interests. Such "imputed" weight sets (see section 3.2.3) are hypothetical, as they have not been confirmed at the highest official levels. The simplest weighting scheme has been applied, whereby criteria are ranked from most to least important. They have been developed for Colombia's Public Sector and the TIA itself, as well as for Environmentalists and Business, as a reflection of possibly varying views in the private sector. Table 9.3 shows the imputed criteria rankings.

Table 9.3. Imputed criteria rankings

Criteria	Institution			
	Environ-mentalist	Business	Public Sector	TIA
Biodiversity	1	8	4	6
Erosion	2	5	2	3
Forestry income	5	1	1	3
Other income	5	1	5	3
Equity	3	6	8	7
Costs	8	7	7	8
Financial sustainability	7	3	6	2
Institutional risks	3	3	3	1

"1" indicates the criterion considered the most important, "8" the least important criterion.

On the basis of the above impact and weight matrices, three MCA techniques have been applied, viz. the Regime method, Evamix and the Expected Value method. These are well-known techniques, that can process mixed data[5]. Resulting rankings of the components are shown in tables 9.4-9.6[6].

Table 9.4. Rankings of FEPP components according to Regime

Institution	Component			
	Watersheds	Natural Parks	Forest Management	CIF
Environmentalist	1	2	4	3
Business	1	2	4	3
Public sector	2	3	4	1
TIA	1	2/3	4	2/3

Table 9.5. Rankings of FEPP components according to EVAMIX

Institution	Component			
	Watersheds	Natural Parks	Forest Management	CIF
Environmentalist	3	1/2	4	1/2
Business	1	3	4	2
Public sector	2	3	4	1
TIA	1	3	4	2

Table 9.6. Rankings of FEPP components according to Expected Value Method

Institution	Component			
	Watersheds	Natural Parks	Forest Management	CIF
Environmentalist	2/3	1	4	2/3
Business	1	2	4	3
Public sector	1/2	3	4	1/2
TIA	1	2/3	4	2/3

5 Brief explanations of these techniques are provided in section 3.3.1. For calculations the DEFINITE software programme was used (Janssen, 1992).

6 "1" means preferred component, "4" the least attractive component.

The tables show that the methods do not give unequivocal outcomes, a phenomenon known as method uncertainty (see section 3.4). For the three techniques, the following conclusions can be drawn:

- Irrespective of the MCA technique, the *Business* weight set ranks Watersheds as the most attractive component and Forest Management the least attractive. Depending on the choice of MCA technique, Natural Parks and CIF rank either second or third.
- For the *Public Sector* weight set, all MCA techniques put Natural Parks and Forest Management third and fourth, respectively. MCA techniques show a minor difference regarding the preference for CIF and Watersheds, which are ranked either first and second, respectively, or ranked equally attractive.
- For all MCA techniques, the *TIA* weight set results in Watersheds and Forest Management ranked first and fourth, respectively. The methods show a slight difference regarding the allocation of the second and third rank to CIF and Natural Parks.
- Differences in outcomes of MCA techniques are only significant in the case of the *Environmentalist* weight set. This does not concern Natural Parks, ranked either first or second, and Forest Management, ranked fourth. Watersheds and CIF, however, rank first, second or third, depending on the MCA technique.

Table 9.7 shows the rankings of the components under various weight sets on the basis of the (unweighed) rankings for the three MCA techniques.

Table 9.7. Average of rankings of FEPP components for three MCA techniques

Institution	Component			
	Watersheds	Natural Parks	Forest Management	CIF
Environmentalist	2/3	1	4	2/3
Business	1	2/3	4	2/3
Public Sector	2	3	4	1
TIA	1	2/3	4	2/3

For the selected MCA techniques, calculations show that the Forest Management component is least attractive, irrespective of the weight set, due to its relatively weak performance on all criteria but biodiversity and financial sustainability. There is no unanimity regarding the attractiveness of the other components. The Business and TIA weight sets give similar rankings of FEPP components.

To obtain more robust outcomes of MCA several conditions would need to be fulfilled:

- more attention to impact assessment;
- in the case of a greater willingness to participate in MCA, discussions with all parties involved would have resulted in more realistic weight sets;
- more sophisticated weight procedures could be followed, whereby it would be possible, for instance, to assign a weight of zero to a criterion that is considered irrelevant;
- all parties involved would be willing to discuss the relative attractiveness of alternatives instead of a single package of activities.

9.8 Conclusions

The main conclusions regarding the FEPP case can be summarized as follows:

- In the case of projects that involve issues of natural resource use, it is impossible to estimate the benefits without an in-depth study of the project setting. In this respect special attention should be paid to the development of analytical models providing insight into the two-way relationships between ecosystems and socio-economic systems. These questions would need to be addressed in the earliest feasibility studies.
- A serious estimation and valuation of environmental impacts would have required a different composition of the team, a longer study period, as well as a different terms of reference. If the emphasis is put on project inputs, like financial means and institutions, there is insufficient opportunity to investigate (environmental) benefits. In the actual circumstances, it was impossible to give a sound economic justification.
- Whereas the FEPP has a strong environmental focus, the criterion of ecological sustainability did not play an essential role. No party would seem to be in favour of a strong sustainability policy. Environmental enhancement was aimed at, without imposing constraints on natural resource use.
- CBA was not applicable because of a lack of data about impacts. Even if CBA could have been applied, its results could not have served as the overriding criterion for justification. The FEPP has several non-efficiency dimensions, particularly in terms of social and institutional risks, and trade-offs involved would need an explicit treatment. MCA could have been a useful analytical tool, but application requires a more favourable institutional environment.

[illegible]

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[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

10. CASE STUDY: SCENARIOS FOR LAKE BURULLUS, EGYPT

10.1. Background and organisation

Along the coasts of the Mediterranean Sea numerous lakes and lagoons are situated. In an optimal case, policies simultaneously succeed in maintaining, or even improving, ecological functions of these wetlands, as well in strengthening the long-run income basis of local communities that strongly depend on them. Frequently, such options are not available, trade-offs occur, and difficult choices between conflicting criteria need to be made. Egypt has five coastal lakes and lagoons: Manzala, Bardawil, Idku, Maryut and Burullus. This chapter focuses on Lake Burullus. In the near future, the Government of Egypt (GOE) will decide on policies that may profoundly affect the lake. Trade-offs indicated above undoubtedly apply to Lake Burullus. Lake Burullus has been listed as a Ramsar site. According to the Ramsar convention, such sites are ecologically sensitive and unique areas, and particularly important for water fowl. According to convention, such areas should not be disturbed or otherwise developed (unless an equally valuable alternative is provided). Both as a result of activities of the government and the private sector, however, Lake Burullus is far from being left undisturbed, to the detriment of the ecosystem.

One of the options for future use of Lake Burullus as considered by the GOE would even more drastically change the ecosystem. Under this plan the presently brackish Lake Burullus, or a major part of it, would be converted into an artificial lake for storage of fresh Nile water. By saving Nile water, which otherwise would spill into the sea, additional irrigation water for agriculture would become available. Reducing losses of Nile water is a top priority in Egypt, both for economic and political reasons.

It was decided to prepare an overview of the consequences of the storage plan as well as several alternative policy options (called scenarios[1]) for Lake Burullus. Moreover, an investigation would be made of possibilities to save Nile water in Egypt otherwise than through the construction of a reservoir in the Lake Burullus area. This chapter summarizes the findings of this study, termed *Lake Burullus: ecology, economy and Nile water conservation*[2]. It has been commissioned

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1 Scenarios here refer to policies, i.e. sets of measures. Such policy scenarios should be distinguished from event scenarios, which are developed to account for uncertainty regarding forecasts about, for instance, ecological or economic parameters (Nijkamp, 1991).

2 The study report (Van Pelt, Molemaker et al., 1992) contains three volumes. In this chapter only the main conclusions will be presented. All underlying assumptions, calculations and models are described in the original study report.

by the GOE and the Government of the Netherlands (GON), which provided financial support.

A multi-disciplinary study team of Dutch consultants was formed, with an economist as study leader, and further comprising two hydrologists, an ecologist, an economic geographer and an aquaculture specialist. The team visited Egypt three times for periods of two to three weeks. Moreover, Egyptian consultancy firms and individual experts were responsible for a socio-economic survey in the project area, ecological surveys, and the preliminary design of infrastructural works.

In view of the wide range of issues to be addressed, the scarcity of reliable, quantitative base-line data, and the limited time available for analysis, the study is of an explorative nature. It should hence not be considered a detailed and in-depth EIA or a comprehensive feasibility study. Its main aim is to assist policy-makers in making a first choice between very distinct policy options. In a next phase of decision-making, detailed feasibility studies would focus on one or more selected policies.

10.2. Project components and alternatives

10.2.1. Base-case scenario

The Base-case scenario (LB-1) starts from the assumption that no significant deviations from present policies will occur in the future ("without-case"). Its definition is of the utmost importance, as it serves as a point of reference for a judgement on the attractiveness of alternative policy options ("with-case") (see section 3.2.1). The key assumptions in the Base-case scenario regarding government policies for Lake Burullus are the following:

- *land reclamation*: all ongoing and planned reclamation projects around Lake Burullus will be finalized;
- *agriculture*: in accordance with present GOE policies, it is assumed that the newly reclaimed land around Lake Burullus will be supplied with sufficient irrigation water irrespective of the question whether the storage plan will be implemented;
- *infrastructure*: it is assumed that the project to narrow and deepen the inlet to the Mediterranean Sea will be finalized;
- *fisheries*: continuation of present policies, which seems to involve little effective government involvement, is assumed.

The future development of the Lake Burullus area will also depend on activities of the private sector, particularly the fishery sector. In the Base-case scenario it is assumed that: a) the local communities will continue to try to obtain their income from fisheries (in the absence of alternative income-generating activities), and b) current trends in the fisheries sector made in response to overfishing will continue (e.g. intensified fishing efforts, increased hosha encroachment, growth of fish farms, use of non-selective gear, and so on; see section 10.4.2).

10.2.2. Storage scenario

During the winter (January/February), the irrigation infrastructure in Egypt is closed due to annual maintenance works. This means that the demand for Nile water by the agricultural sector is much lower than in the rest of the year. Ideally, releases of water from the High Aswan Dam would be reduced accordingly. In reality, however, as a result of Nile navigation requirements, releases at the High Aswan Dam can only partly be reduced. Due to the winter closure in irrigation, fresh Nile water, a scarce and hence economically important product in Egypt, is lost to the Mediterranean sea ("excess flow"). The Storage scenario (LB-2) aims at reducing the magnitude of this loss by diverting part of the excess flow to Lake Burullus. Instead of wasting water to the sea, it would be stored in the lake and consequently be used for irrigation. Lake Burullus would be converted from a brackish lake to an artificial fresh water reservoir, with Nile water and drainage water as its main sources. Two variants will be distinguished. Variant LB-2/A assumes that the whole lake is converted into a reservoir. Variant LB-2/B would involve the use of only the Western half of Lake Burullus for storage, whereas the Eastern half would remain a brackish lagoon.

In the framework of the study technical designs have been prepared. The Storage scenario basically consists of a set of infrastructural works. Main elements are the construction of encircling embankments, a feeder canal, outlets, drainage canals, and pumping stations, remodelling of existing irrigation canals. Moreover, to avoid excessive growth of floating vegetation in the lake, the Storage scenario would also include regular mowing by boats (mechanical weed control). The scenario would not call for the establishment of new government agencies.

10.2.3. Environment scenario

The Environment scenario (LB-3) is based on the principle of strong (ecological) sustainability, which implies that its underlying long-term objective is to at least maintain the present ecosystem (see section 4.5.1). The proposed measures are therefore strongly based on the expected ecologically harmful developments under the Base-case scenario (see section 10.5.2). In other words, the measures are aimed at avoiding this deterioration. In fact, the scenario is even aimed at restoring recent damage, where possible at reasonable costs. As will be elaborated below, such a purely ecological objective, aimed at saving an internationally important wetland, would require rather radical measures from a socio-economic point of view.

The key measures in the Environment scenario are summarized below:

- *reduced land reclamation*: this would halt the ongoing reduction in the size of the lake;
- *construction of a second inlet to the sea*: this infrastructural work is essential to restore heterogeneity and biodiversity, to stop reed and weed infestation, and to restore the storage and recycling capacity of the ecosystem;
- *regulation of the fishing effort*: the restoration of the natural species and size composition of the fish population requires a drastic reduction in the fishing effort in the short run. Fishing effort and methods should be commensurate with the "wise use" principle. This ecologically acceptable catch level is estimated at 60% of the present fishing effort and 75% of the maximum sustainable yield (see Fisheries scenario) of Lake Burullus;
- *depopulation of selected ecologically sensitive islands in Lake Burullus*: to restore the foraging and breeding places for birds and foraging and spawning sites for fish, no human activities should take place on such islands;
- *construction of a sewerage system for Baltic village*: this infrastructural work addresses eutrophication and pollution of Lake Burullus;
- *prohibition of aqua/agricultural activities on the littoral bar (east of North Motobis reclamation)*: this area, which is still in a more or less pristine state, should be fully restored and conserved;
- *development and implementation of a water quality legislation and control system*: this measure addresses the problem of increasing loads of nutrients, heavy metals, PCBs[3] and detergents;
- *single clearing of excess aquatic vegetation*: this involves the mechanic removal of existing water plants in the centre of the lake;
- *development and implementation of an ecological monitoring system*: existing organisations should be strengthened to allow for the collection of key ecological data;
- *development and implementation of a management plan and nature conservation legislation*: the above measures require a strong government body to control and enforce regulations. This would call for either considerable strengthening of existing, or the establishment of new agencies.

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3 PCB: polychlorinated biphenyl.

10.2.4. *Fisheries scenario*

In several respects the Fisheries scenario (LB-4) runs parallel to the Environment scenario. Both are based on the strong sustainability principle, but the latter takes an even more cautious approach towards ecological risks. The Fisheries scenario primarily is concerned with maximizing sustainable levels of income in the fisheries sector. It aims at bringing the fishing effort to a level that corresponds with the maximum sustainable yield. In other words, the annual fish catch should not exceed the annual growth of the fish stock (see section 5.2). In the existing conditions of overfishing, this implies that the fishing effort should be reduced, particularly in the short run, to enable the restoration of the ecosystem. In other words, the EUS is negative and new activities should "create" natural capital (see section 5.2.3).

Like the Environment scenario, the measures in the Fisheries scenario primarily reflect the desire to avoid the rather catastrophic expected developments under the Base-case scenario. These measures are divided into four groups:

fisheries management
- improvement of the data collection system;
- in-depth study on the level of the maximum sustainable yield, now tentatively estimated at 80% of the present catch;
- strengthening of the institutional capacity;
- development and implementation of a fisheries management plan, including regulation of the fishing effort and abolishment of indiscriminate fishing practices and equipment;
- development of co-financing and co-management relations between the private and the public sector;

improvement of water quality, heterogeneity and biodiversity
- construction of second inlet to the Mediterranean Sea;
- regular dredging of inlets;
- water quality control;

reduction and control of water weeds
- single clearing of aquatic vegetation;
- introduction and regular restocking of grass carp;
- mechanical control;

aquaculture development
- introduction of appropriate hatchery-cum-nursery systems for selected strains for fast growing tilapia species, mullet and other euryhaline and marine species and grass carp;
- strengthening of training and extension services;
- prolongation of the duration of the concession period for fish farming;

- redistribution of the aquaculture development area;
- introduction of an appropriate credit scheme;
- technical assistance in the field of fry distribution and feed supply.

10.3. Agents and criteria

The institutional context is complex, as shown by the long history of plans for the development of Lake Burullus. The interests of, for instance, local farmers and fishermen may be conflicting if a fresh-water lake would reduce fishery income. Environmentalists might agree with fishermen, but this is far from certain. Moreover, various government agencies have long held different views on the preferable policy for the lake. The performance of scenarios will be assessed with reference to a set of criteria that reflect the main objectives of all parties that may be involved in or affected by policy scenarios. In that way, the risk that important consequences of policies for society remain unaccounted for is minimized. The list of criteria includes:

- investment and recurrent costs of policy measures[4];
- hydrology and ecology;
- income in the fisheries sector;
- income in irrigated agriculture;
- other aspects of human welfare, including health;
- equity, i.e. the consequences for social classes such as low-income groups;
- institutional requirements and risks, i.e. the likelihood that government agencies at all levels, as well as the private sector, will be able and willing to participate in the preparation and implementation of scenarios.

The list of criteria is fairly similar to the criteria applied to the FEPP (see section 9.3).

It was decided not to convert the Ecology criterion into a sustainability criterion for two reasons. First, as shown above, a policy of strong sustainability was a guiding principle for the design of two scenarios. Second, agents involved in the study showed more interest in obtaining information about ecological impacts as such than in obtaining sustainability scores. However, for instance, the use of MCA (section 10.7.1) indicates that the normative nature of ecological issues was acknowledged. In such circumstances there is not much difference between an Ecology or a sustainability criterion.

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4 Beyond the scope of this study is the question of how to finance and recover the costs of scenarios.

10.4. The project setting

10.4.1. The ecosystem Lake Burullus

Lake Burullus is a coastal lagoon situated between the western Rosetta Branch and the eastern Damietta Branch of the River Nile. Before the completion of the High Aswan Dam (1968), Lake Burullus and its surrounding marshes used to be flooded with Nile water towards the end of the summer. The lagoon had a seasonal variation in size, water level and water quality. After 1968 the ecology of the lake has changed drastically. The seasonal flooding ceased and a fairly stable shoreline was gradually established. The surrounding area was brought into cultivation, and six drains were constructed through which slightly saline, nutrient-rich water enters the lake. The main ecological parameters of Lake Burullus are summarized below:

size	At present the size of the wetland is about 595 km^2, of which 370 km^2 of open water area and 225 km^2 of marsh habitat. Since the 1950s these areas have been reduced by an estimated 37% and 85%, respectively. Land reclamation has greatly contributed to this process.
depth	The lake is shallow, its average depth ranging from 0.5 to 2.1 m.
salinity	Near to the only inlet to the Mediterranean Sea in the north-east, the lake is brackish (salinity varies between 3-11‰). In the other parts of the lake salinity is much lower (between 0.7 and 3.0‰) due to the relatively large influx of comparatively fresh drainage water.
nutrients	Before the construction of the High Aswan Dam, the natural productivity of the lake was determined by the relatively poor nutrient load of the Nile water. Nowadays, the lake contains less silicon but, due to the large inflows of drainage water, far higher concentrations of phosphate and to a lesser extent nitrogen compounds.
contamination	Until now pollution by heavy metals and PCBs has remained modest, but contamination levels appear to be rising. The limits to the storage/buffering capacity may be near.
vegetation	Due to the eutrophic fresh water conditions, emergent (reeds), submergent (weeds) and floating (hyacinth) plants are abundant, covering about 40% of the lake. This aquatic vegetation has increased the water purification capacity.

plankton	Following the enrichment of the water by nutrients, the phytoplankton and zooplankton communities have become rich both in terms of density and number of species (124 and 115, respectively).
invertebrate fauna	The biomass of benthic fauna seems to have deteriorated due to decreasing salinity and increasing vegetation. The species living on the progressively extended vegetation area appear to increase at the expense of those living on the uncovered bottoms.
fish fauna	The fish community, initially rich both in numbers and species, has experienced sweeping changes. Numbers of fishes and fish species (tilapia, catfish) that prosper in fresh, eutrophic waters have multiplied and now dominate the fish stock. The decreasing marine influence and migration possibilities have been at the expense of: a) marine "visitors", which visit the lake in search of food, and b) migratory catadromous "transients", i.e. fish species that reproduce at sea and develop in lagoons (nursery function). In summary, the migration and nursery functions of Lake Burullus are deteriorating, thereby negatively affecting biodiversity.
birds	Lake Burullus is placed on the list of Ramsar sites in view of its significance for breeding, migrating and wintering birds. Lake Burullus holds internationally significant populations of breeding birds (12 species), for some the only area within the Western palaearctic region. It is a wintering and migration area of major importance for water birds, and for some species it holds the world's largest concentration. In the recent past the changes in vegetation and benthic/fish fauna have had negative impacts on the habitats frequented by breeding, migration and wintering birds.

The analysis of present ecological conditions and impacts started from the interpretation of Lake Burullus as an ecological system that fulfils a wide range of functions. Following the methodology proposed by De Groot (1992) and also incorporating elements of ADB (1991) and OECD (1992), a distinction was made between 22 ecological functions (see section 5.2 for De Groot's approach). These functions range from water purification via biodiversity to its scientific value.

10.4.2. *Interaction between the ecological and the socio-economic system*

Lake Burullus affects human welfare in various ways. In this section most attention will be given to its importance for local communities, whose welfare and income to a great extent depend on fisheries. To illustrate this relation, and particularly the severe problems that increasingly characterize it, a two-system model has been developed (see section 5.2), addressing three issues:

- the ecosystem Lake Burullus as a "supplier" of a potentially renewable resource, i.e. fish;
- the socio-economic system, consisting of the local fisheries sector and related agents, which determine the level of "exploitation" of this resource;
- the interaction between the two systems, particularly focusing on the question whether an equilibrium exists.

To start with the question of *interaction*, the key problem increasingly appears to be one of overfishing. Overfishing refers to a situation where the annual catch (fishing effort) exceeds the annual regenerating capacity (the maximum sustainable yield) of the ecological system. Hard proof for this statement is scarce, as statistics on all aspects of fisheries at Lake Burullus are extremely weak. Together the indicators below, however, point at the likelihood of (increasing) overfishing:

- Calculations by the study team suggest that, even under the most optimistic assumptions on yields, the actual catch exceeds the annual regeneration[5].
- According to several surveys as well as interviews by the study team, average catches seem to be declining, although fishermen have intensified their fishing effort. The fishermen have turned to fishery techniques and methods that are typical responses to overfishing (see below).
- One particular species, viz tilapia (a prolific breeder), makes up for the greatest and still growing share of the catch. Fish stocks of other species may even be decreasing.
- The average size of the fish caught at Lake Burullus has decreased considerably. In other words, fish are increasingly caught while still small, with detrimental consequences for regenerating capacity and the size of fish stocks.

The phenomenon of overfishing can be understood by investigating particular features of and changes in the ecological and the socio-economic system. With respect to the *ecological system*, important changes have been: the reduced size of the lake, increasing dulcification, eutrophication, strong growth of vegetation (reeds and weeds) and the relative shift in composition from brackish and salt water fish to fresh water fish. From the point of view of the socio-economic system, particularly of fishermen, these are all negative factors. A smaller lake implies that each fishermen has a smaller area available, even if the number of fishermen would not increase (which it does). Dulcification reduces the number

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5 Tentative estimates point at a maximum sustainable yield equal to about 80% of the present catch.

of profitable brackish and salt water fish species, which implies that an increasing fishing effort is required to sustain a certain income level. Growth of reeds further reduces the effective size of the lake. Pollution negatively affects the quality of fish.

The *socio-economic system* involves the fishery sector itself, which is influenced by markets and the government. Markets in Egypt's main urban centres determine fish prices. In real terms, i.e. corrected for inflation, present prices for most species are clearly below the mid-1980s level. Many fishermen consulted through questionnaires and by the study team stated that the prices of boats, nets and other materials have soared. In combination, this has negatively affected profit margins and hence the income position of the Lake Burullus fishery sector. In principle, the local government is responsible for controlling the fisheries sector, mainly through the issue of licences and the registration of fish catch. In practice, control is weak, which has provided incentives to the private sector to embark on activities that have strongly contributed to overfishing.

The fishery sector comprises a highly heterogenous set of increasingly competing sub-sectors. In total, between 31,000 and 46,000 fishermen are estimated to work on and around Lake Burullus. The majority is employed in various types of open-lake fishery. Aquaculture (fish ponds) is becoming more and more important, as well as (often illegal) "hoshas", i.e. enclosures of muddy dikes to catch fish. Estimation of annual net income is highly problematic due to the weak statistical basis and the complex structure of the sector. The study team's best estimate shows a net income figure of about LE 85m, being the middle value in a range of LE 44-120m.

Overfishing has several causes:

- The growing number of fishermen. This growth is due to population growth (2.3% on average in Egypt), and a lack of alternative employment opportunities in the Lake Burullus region. As the size of Lake Burullus has been reduced, a fisherman has much less area available than in the past. Given the desire to at least maintain income levels, fishermen have intensified fishing efforts.
- The growth of the fish ponds and hoshas sub-sector, which collect from the lake particularly fry and fingerlings, i.e. very small fish. This activity requires the use of (illegal) techniques and materials that indiscriminately collect the largest quantity of fish, independent of size.
- Decreasing profit margins and smaller fish stocks provide a strong incentive to use non-selective fish-gear, like fine mesh nets, and methods in order to maintain income levels.
- Ineffective enforcement of legislation aimed at avoiding overfishing.

As can be seen from these issues, a vicious circle has developed whereby increased fishing efforts reduce the regenerating capacity of the lake, which in its turn stimulates fishing efforts, and so on. This development, dominated by short-term interests, may have severe long-term consequences: by overexploiting the natural resource now, coming generations will have less opportunities to obtain an income from Lake Burullus (see section 4.6 on conflicts between short- and long-run interests).

In recent years conflicts between open-lake fishery and aquaculture have intensified due to the developments above. It seems that especially the poorest fishermen, who use small boats, are the victims. The sectors that are growing, viz. relatively capital-intensive fish farms, larger hoshas and dourahs[6], are owned by either the government (fish farms) or relatively wealthy individuals (all sectors).

For local communities the Lake Burullus ecosystem has several other functions, although much less important in terms of income. Besides fish, the lake allows modest income generation from animal husbandry, bird hunting and reed collection. Indirectly, Lake Burullus affects people's welfare because it plays a role in shore protection, is used to leach newly reclaimed land on the sandy littoral bar, and -as a brackish water lake- strongly contributes to the absence of fresh water-born diseases.

The value to mankind of a wetland like Lake Burullus exceeds the level of local communities. Although the GOE has put the lake on the list of Ramsar sites, the study team has the impression that generally little appreciation exists in Egypt for the crucial function the lake has for migrating birds. In other words, the Lake is mainly considered important, especially by local communities, for the income that can be derived from it. The international community, particularly the richer countries, seems to highly value wetlands like Lake Burullus much more for purely ecological characteristics.

10.5. Impact assessment

10.5.1. Approach

Impacts are defined as expected changes over time in a factor with the

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6 Dourahs comprise a fyke system with wings extending over 100 meter.

present state as the bench mark[7]. Preferably, impacts were assessed in physical or monetary terms. This appeared to be frequently impossible due to a combination of three factors. First, several criteria pose measurement problems due to shortcomings in scientific knowledge. Estimating long-run environmental changes, for instance, is notoriously difficult. Second, the great number of scenarios and criteria to be addressed. Third, the limited time and means available for estimation of impacts. In the case that no "hard" data can be collected, qualitative information is provided; see table 10.1:

Table 10.1. Legend for qualitative impacts

Sign	Meaning
-, - -, - - -	starting from the present situation, a deterioration is expected. The higher the number of signs, the greater the magnitude of the impact
0	no changes are expected
+, + +, + + +	starting from the present situation, an improvement is expected. The higher the number of signs, the greater the magnitude of the impact
?	impact cannot be estimated
na	criterion is not applicable

A scenario will be assigned a negative score on, for instance, the environment criterion if it results in a worsening of present environmental condition (- -, -), a positive score if it leads to environmental improvement (+, + +), and a score of 0 if it succeeds in maintaining the present level of environmental services.

10.5.2. Impacts of the Base-case scenario

The main *ecological* impacts of the Base-case scenario are summarized below:

- The reclamation of new land will further reduce the volume and the surface of Lake Burullus, implying a further loss of this wetland and corresponding ecological functions. Reclamation will lead to a loss in marsh habitat and stimulate aquaculture and agriculture, both contributing to an increase in eutrophication. The loss of vegetation and the smaller volume of the lake will

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7 In CBA (see section 10.6) these impacts are transformed into "differential impacts", i.e. the difference between the situation "with" a scenario and "without" a scenario.

temporarily mitigate siltation. In the long run situation will increase as the current speed is reduced after restoration of the vegetation belt.
- The continued inflow of drainage water in a smaller lake induces dulcification. This results in a further loss of heterogeneity and biodiversity. On the longer term the growth of fresh water plants will be stimulated, inducing siltation and evapotranspiration.
- The sustained eutrophication will strain both the nutrient storage and recycling capacity and the biological control mechanisms of the lake.
- Population growth and the expansion of agriculture and industry will contribute to further accumulation of, for instance, heavy metals and PCBs.
- Continued overfishing will (further) reduce fish stocks. This will induce both eutrophication and siltation. Overfishing implies an underutilization of the primary and secondary production function of the lake. This will aggravate eutrophication, aquatic weed infestation and siltation.

In summary, if present patterns of human interventions continue in the future, Lake Burullus will continue to be transformed into a terminal, eutrophic, fresh water ecosystem, and loose much of its present ecological functions.

The consequences of the Base-case scenario for the *fishery sector* are strongly interrelated with the environmental impacts. The main expected consequences over a thirty-year period are given below:
- Stocks of mullet and other marine and brackish water fishes will be reduced, and small tilapia will increasingly dominate the total fish stock.
- A continuation of present trends would not only result in further decreases in the volume of fish catch per unit effort, but increasingly in a decreasing total catch volume. All sectors would be hurt by this development, whether directly (open-lake fishing and hosha) or indirectly (fish-farming) dependent on Lake Burullus. However, through intensified competition, hosha activities may expand at the expense of open-lake fishery. Fish farms will be hurt especially through depletion of the total mullet stock. However, they may find other suppliers of fry and fingerling.
- Assuming constant prices, income derived from exploiting Lake Burullus would decline. Simple computer models developed by the study team indicate that total fisheries income in 2020 would be over 50% lower than at present. If more pessimistic, but perhaps more realistic, assumptions are made, overfishing would result in even more severe income reductions.
- The consequences for employment in the fishery sector to a great extent depend on the question whether alternative economic activities can be found or developed. If it is assumed that these would become available, and that present income levels are close to what the local population considers minimally acceptable levels, the number of fishermen would probably decrease drastically. In the absence of alternative employment opportunities,

which seems to be the case at the moment, employment may decline less fast but poverty would deepen. In that case, migration to other regions might be the only remaining solution for part of the population. In any case, the poorest groups are likely to be hurt hardest.

The Base-case scenario would provide opportunities for *agricultural* expansion at the newly reclaimed lands around the lake. No effort has been made to quantify these net benefits, as they will also occur under alternative scenarios.

The continuation of ecological decay and the decreasing size of Lake Burullus imply that all other positive contributions to *human welfare* will suffer: income gained from the use of other products than fish, the mitigation of health risks, contribution to shore protection, the satisfaction gained from the existence of Lake Burullus as a unique ecological wetland, and so on.

The Base-case scenario is not expected to have important *hydrological* impacts, apart from the reduction of the volume of the lake by 95-125 million m^3 due to land reclamation.

10.5.3. Impacts of alternative scenarios

General

In this section the estimates of the appraisal team regarding the consequences of alternative scenarios are presented. To facilitate a comparison, the impacts of the Base-case scenario are also shown. It is emphasized that many estimates are based on assumptions about factors about which little can be said which certainty. This particularly refers to environmental impacts and impacts on the fisheries sector.

Costs

The Storage scenario would be much more expensive than the Environment and Fisheries scenarios. Whereas the former comprises large-scale infrastructural works, the latter are to a great extent institution building projects. Cost estimates are summarized in table 10.2.

Table 10.2. Estimated costs of scenarios

Scenario	Investment costs (10^6 LE)	Annual recurrent costs (10^6 LE/yr)
Base-case scenario (LB-1)	-	-
Storage scenario LB-2/A (full lake)	600.7	4.77
LB-2/B (half lake)	279.4	2.60
Environment scenario (LB-3)	26.0	1.90
Fisheries scenario (LB-4)	46.8	3.70

Hydrology

Table 10.3 shows the strongly different hydrological impact of the scenarios.

Table 10.3. Hydrological impacts

Scenario	Hydrological impact
Base-case scenario (LB-1)	. the size of the lake is reduced by 45,500 feddan due to land reclamation . water quality will show increasing dulcification, eutrophication, pollution and siltation
Storage scenario LB-2/A (full lake)	. the size of the lake is reduced by 45,500 feddan due to land reclamation . used excess Nile flow: 1.29 billion m^3 . net irrigation water: 0.87 billion m^3 . Lake Burullus is converted from a brackish water,to an artificial fresh water lake
Storage scenario LB-2/B (half lake)	. the size of the lake is reduced by 45,500 feddan due to land reclamation . used excess Nile flow: 0.70 billion m^3 . net irrigation water: 0.68 billion m^3 . half of Lake Burullus remains a brackish water lagoon, whereas the other half is converted into an artificial fresh water lake . the LB-2/B variant is hydrologically more efficient than the LB-2/A variant

Scenario	Hydrological impact
Environment scenario (LB-3)	. the size of the lake is reduced by 45,500 feddan due to land reclamation, or by 29,500 feddan if present reclamation plans are adjusted . the construction of a second outlet will have two impacts, viz.: a) flow patterns will change, due to the creation of a central zone with mainly northward flows, b) salinity will increase in the neighbourhood of the new outlet.
Fisheries scenario (LB-4)	. the size of the lake is reduced by 45,500 feddan due to land reclamation . the construction of a second outlet will have two impacts, viz.: a) flow patterns will change, due to the creation of a central zone with mainly northward flows, b) salinity will increase in the neighbourhood of the new outlet.

Ecology

The comprehensive analysis on (changes in) environmental functions is summarized in qualitative terms in table 10.4.

Table 10.4. Environmental impacts

Scenario	Eutrophi-cation	Sil-tation	Hetero-geneity/ biodiversity	Vegetation/ evapotrans-piration	Pol-lution	An-oxia
Base-case scenario (LB-1)	- -	0	-	-	- -	-
Storage scenario LB-2/A (full lake)	- -	- - -	- - -	- -	- -	- - -
LB-2/B (half lake)	- -	- -	- -	-	- -	- -
Environment scenario (LB-3)	+ + +	+ + +	+ + +	+ +	+ +	+
Fisheries scenario (LB-4)	+ +	+ +	+ +	+	+	+

The table shows that from an ecological viewpoint, the Environment and Fisheries scenarios are preferable. The two Storage scenarios have the worst performance. Implementation of the full-lake variant would mean the loss of the ecosystem. The Base-case scenario has an intermediate position. It is noted that a negative score implies non-sustainability, and a positive score sustainability.

Fisheries sector

To assess the impact of the scenarios on the fishery sector, the study team has developed several computer simulation models. These models distinguish between several sub-sectors, include environmental-economic linkages and produce estimates on several key variables. Outcomes are highly sensitive to assumptions on a wide range of issues, and should therefore be considered as tentative. For all scenarios impacts in terms of *catch volume* and *net income* are shown in figures 10.1 and 10.2, respectively (see next page).

A critical factor in the impact on the fisheries sector is time. In the short term, say until the year 2000, a further gradual decline is expected under the Base-case scenario. The short-term consequences of the other scenarios would be more radical. In the Storage scenario a severe reduction in the catch is expected due to, amongst other things, the time required to obtain (funds for) new equipment for fishing in deeper waters and dying brackish and marine fishes. Both the Environment and the Fisheries scenario include the introduction of fish quotas, which call for immediate sharp reductions in the fishing effort.

The relative performance of scenarios in the long run may be very different from the short-term ranking. For instance, the Fisheries scenario, despite its obvious short-run sacrifices, performs best in all respects in the long run.

Differences between rankings in terms of volume and income should be attributed to changes in catch composition. A lower volume may result in relatively high income if the share of expensive, brackish and marine water fishes increases (as happens in the Fisheries and the Environment scenario). In the Storage scenario, only cheap fresh water fish would be caught in the reservoir.

Although predicting the distribution of the impacts is extremely difficult, particularly the poor, open-lake fishermen are expected to be hurt. A first reason is that they lack the financial resources to invest in new equipment or alternative activities. A second reason is that the wealthier fish-farms are much less dependent on Lake Burullus. They can turn to other suppliers of fingerlings, for instance hatcheries.

Like the FEPP, the Burullus study shows severe distributive impacts of activities aimed at changing access to exploitable natural resources. Whereas the introduction of stumpage fees was essential for the FEPP, Burullus scenarios depend more heavily on management adjustments. In any case, prices and management of natural resources, and equity are closely linked in this type of project.

Figure 2.1. Total catch volume

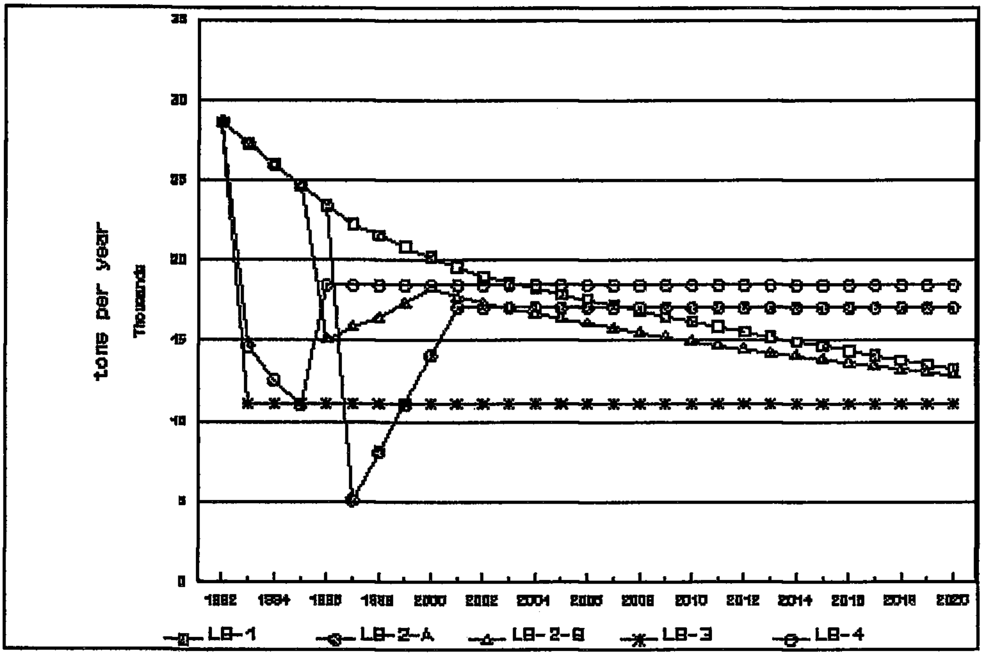
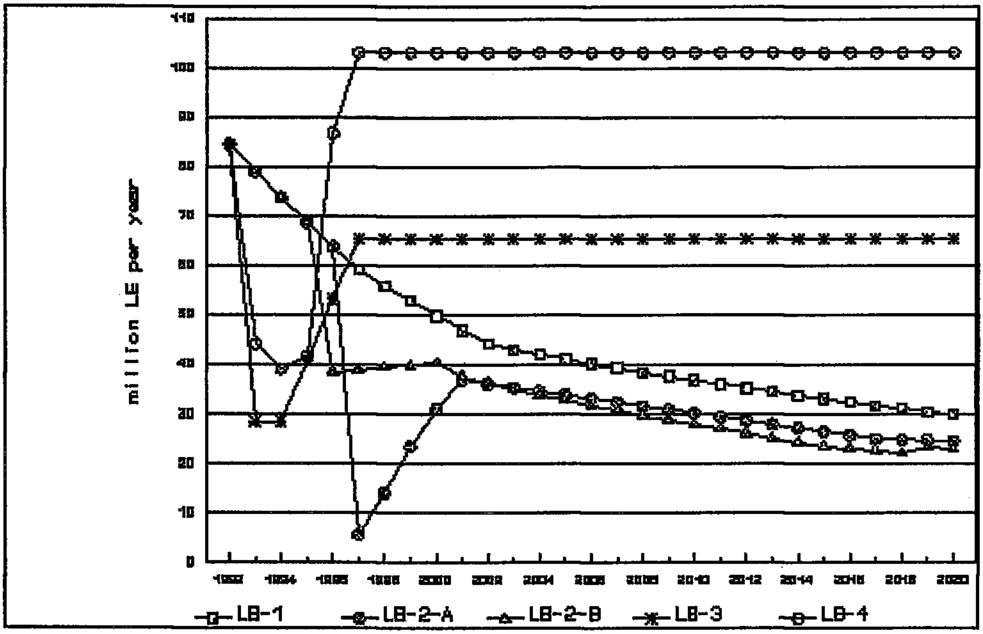


Figure 2.2. Net income



Irrigated agriculture

Only the Storage scenario results in an additional quantity of irrigation water available for agriculture. The value of these benefits depends on the areas in Egypt that would benefit from this effect. These areas are *not* the newly reclaimed areas around Lake Burullus, which will obtain sufficient irrigation water irrespective of the question whether or not the storage project is implemented. Water management policies will determine where the actual beneficiaries live. Rather than to existing land in the Delta, the larger availability of irrigation water will most probably be translated into a greater supply to new lands in either the Western Desert or the Sinai. The ultimate choice significantly affects the value of agricultural benefits but cannot be assessed in the framework of this study. Agriculture in the Sinai tends to be less profitable than in the Western Desert due to much higher water transportation and pumping costs. Such costs need to be taken into account given the assumption that an *incremental* availability of water will benefit *new* land. In view of the uncertainty, net agricultural benefits have been calculated for three cases: a) all benefits accrue to the Sinai, b) all benefits accrue to the Western Desert, and c) the two areas obtain an equal share.

Whereas the location of the beneficiaries is uncertain, the extent to which *land development costs* should be included is also problematic. It can be argued that 100% of land development costs should be attributed to the storage project (in other words, without the storage project the areas concerned would not have water, which implies that no irrigation infrastructure would need to be developed). More likely, however, new lands benefiting from the storage project would at least partly reap the benefits of existing infrastructure, such as main irrigation canals. Therefore, two cases have been developed. In the first case 100% of land development costs are included, in the second -probably more realistic- only 50%.

Table 10.5 gives the outcomes in terms of the present value (PV) of discounted net agricultural benefits over time[8]. "Net" here implies the difference between gross agricultural benefits and the sum of agricultural inputs and land development costs (ldc); the costs of the storage infrastructure are hence not included.

[8] The GOE applies a 12% discount rate to economic appraisal of all infrastructure projects. It could not be assessed whether this is a theoretically justifiable rate.

Table 10.5. Agricultural impacts

Scenario	Net benefits in agriculture (PV million LE, 12% discount rate)					
	100% Western Desert		100% Sinai		50% Western Desert 50% Sinai	
	100 % ldc	50% ldc	100% ldc	50% ldc	100% ldc	50% ldc
Base-case scenario (LB-1)	0	0	0	0	0	0
Storage scenario LB-2/A (full lake)	127	781	-705	24	-289	403
LB-2/B (half lake)	99	610	-551	19	-226	315
Environment scenario (LB-3)	0	0	0	0	0	0
Fisheries scenario (LB-4)	0	0	0	0	0	0

As the central-case (i.e. given available information most reasonable) assumption has been taken the combination of a) 50% of land development costs, and b) an equal share for the two regions. This gives the central-case estimate of LE 403 and 315 million, for the Storage A- and B-variant, respectively.

Other aspects of human welfare

Impacts have been investigated with reference to two other categories of human welfare attributes, viz. (see table 10.6):

- consequences for human health, which are closely related to the salinity of Lake Burullus;
- the appreciation of the international community of the existence of wetlands like Lake Burullus. In the context of the present study it is impossible to monetize the impacts of the various scenarios. Considering, for instance, the UNCED conference, a substantial willingness-to-pay for conservation of Lake Burullus might exist. In any case, this may be an important factor should the GOE decide to apply for assistance from external donors for any of the scenarios (see section 10.7.2).

Table 10.6. Impacts on other aspects of human welfare

Scenario	Public health	Appreciation of the sustained existence of wetlands by the international community
Base-case scenario (LB-1)	-	-
Storage scenario LB-2/A (full lake)	- - -	- - -
Storage scenario LB-2/B (half lake)	- -	- -
Environment scenario (LB-3)	+	+ + +
Fisheries scenario (LB-4)	+	+ +

Institutional risks

The scenarios will involve different types of institutional risks. In table 10.7 a distinction is made between public sector risks and private sector risks. The former refers to the level of technical and managerial capabilities of government agencies that would be involved in the preparation and implementation of Lake Burullus scenarios. Private sector risks reflect the willingness and ability of local communities to act in accordance with public sector plans. If local communities feel projects are not in their own interest, social unrest may arise. Formulated in this way, public and private sector risks are a reflection of the impacts of scenarios on different groups in society.

Table 10.7. Institutional risks

Scenario	Public sector risks	Private sector risks
Base-case scenario (LB-1)	0 The MPWWR has considerable experience with land reclamation The GAFRD does not plan to expand its presently rather weak presence	- In view of the continuously increasing overfishing at an increasingly smaller lake, competition and controversy between various fisheries sub-sectors are likely to be intensified
Storage scenario (LB-2)	- Although Lake Burullus would be the first lake to be used for storage of water, the project is not expected to raise severe technical or managerial problems for the MPWWR	- - Especially the full-lake variant is likely to raise considerable problems at the local level, if communities share the impression of the study team that storage would lead to considerable income losses, particularly in the short run
Environment scenario (LB-3)	- - - Key roles would need to be played by the EEAA and the GAFRD. Without considerable institutional strengthening and/or expansion the benefits of the scenarios will not materialise	- - - In the short run this scenario leads to drastic reductions in the fishing effort, and hence income and employment. Local opposition is therefore likely to be strong. In the longer run, income would be higher than in the Base-case scenario, but fishermen may be tempted to compare it with the present level, which is likely to be higher
Fisheries scenario (LB-4)	- - - To enable the GAFRD to play a central role in this scenario, it would need considerable institutional strengthening. Moreover, the role of the GAFRD should be one of 'enabler', rather than a competitor with much of the private sector	- - Basically the same risks as with the Environment scenario. Opposition, however, is expected to be weaker, as both in the short- and the long-run the scenario provides better perspectives

MPWWR: Ministry of Public Works and Water Resources
GAFRD: General Authority for Fish Resources Development

10.5.4. *Overview*

Table 10.8 summarizes the scores of the scenarios on the criteria addressed above. The fisheries impacts are shown in qualitative terms, which can be predicted with greater certainty than the corresponding quantitative figures presented earlier. In view of the significant uncertainty regarding agricultural benefits, the corresponding but more reliable estimates on the contribution to the reduction of the excess flow have been included.

Table 10.8. Impacts of Lake Burullus scenarios

Types of impacts (criteria)		Scenarios				
		Base-case	Storage 100%	Storage 50%	Environ-ment	Fisheries
Costs	investment (LE million)	0	601	280	26	47
Environment	change from present situation	-	- - -	- -	+ +	+
Fisheries income (long-run)	change from present level	- -	- - -	- - -	-	+
Contribution to Nile water conservation	remaining excess flow (m^3 billion/ year; the present flow amounts to 1.7)	1.7	0.4	1.0	1.7	1.7
Impacts on local communities in the short run (private sector risks)	change from present situation	-	- -	- -	- - -	- -
Institutional requirements (public sector risks)	change from present situation	0	-	-	- - -	- - -

10.6. Efficiency: cost-benefit analysis

To conduct a comprehensive CBA for Lake Burullus scenarios, two requirements would need to be fulfilled (see section 3.1):

- all costs and benefits relevant to the country should be taken into account, including impacts that are not priced at markets (i.e. external effects);
- all estimates on the size of costs and benefits should be available in monetary terms. Economic CBA requires that shadow prices are applied if market prices are considered distorted.

A scenario is efficient if the *comprehensive* Internal Rate of Return (IRR), covering both impacts on markets and external effects, exceeds the cut-off rate (which according to the GOE amounts to 12% in Egypt).

In fact, the study team has not been able to conduct a comprehensive CBA because of a lack of data. Consequently, the analysis of economic efficiency has the following structure:

- All impacts in terms of marketed goods and services are estimated in monetary terms, viz. costs, changes in fishery income, and agricultural benefits due to storage. External effects, all in the field of ecology (otherwise expressed than through the fishery sector), could be assessed only qualitatively. An example is the appreciation that may be assigned to the existence of a wetland like Lake Burullus for purely ecological reasons. It has not been possible to assign a monetary value to changes in this appreciation in the present study (which does not imply that the value is zero). Impacts on human health present a comparable example. In all such cases, valuation is problematic as non-use or existence values, rather than use-values, are involved (see section 6.2).
- With respect to the group of impacts for which monetary estimates have been made, it has been impossible to collect all necessary shadow prices for inputs and outputs. Only the net agricultural benefits are in shadow prices. The remaining categories, i.e. costs and fishery income, are in market prices. In view of a) the scope and contents of present macro-economic programmes in Egypt, b) the marketing system for fish, and c) the type of inputs required for the various scenarios, the study team does not expect that the use of market prices for the categories concerned introduces important errors in the analysis.

In summary, the performance of the scenarios with respect to economic efficiency has two components:

- a *partial* IRR, covering only costs, and fishery and agricultural impacts. Although for some categories market prices have been used, results are probably close to values in economic terms;
- a qualitative evaluation of external effects, particularly environmental impacts.

This implies that unambiguous conclusions regarding efficiency are only possible if:

- the (partial) IRR exceeds 12% *and* environmental impacts are positive; the conclusion is that the scenario is efficient;
- the (partial) IRR lies below 12% *and* environmental impacts are negative: the scenario is inefficient.

In two cases, no unambiguous conclusion can be drawn about economic efficiency:

- the (partial) IRR exceeds 12% *and* environmental impacts are negative;
- the (partial) IRR lies below 12% *and* environmental impacts are positive.

The outcomes of the analysis, which are based on the study team's view on the most reasonable assumptions, are shown in table 10.9[9].

As said earlier, the estimation of impacts of scenarios on the environment, the fishery sector and on agriculture involves significant uncertainty. By definition, the conclusions about economic efficiency should therefore be treated with great care. Table 10.9 is based on "central-case" assumptions, i.e. the value in the middle of the range of more or less likely values. In *sensitivity analysis*, the consequences of changes in these assumptions for the IRR have been explored. The nature of the sensitivity appears to differ between scenarios.

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9 CBA is conducted on the basis of a differential analysis, i.e. impacts have been reformulated in terms of differences between the situation with and without the project. Therefore it is not applicable to the Base-case scenario.

Table 10.9. Economic efficiency

Scenario	Economic efficiency		
	Partial rate of return (IRR)	Non-monetized ecological impacts	Total efficiency
Storage scenario full lake (LB-2/A)	11%	- - -	The IRR excluding environmental impacts already lies below 12%. In combination with negative environmental impacts, total efficiency is even further reduced.
Storage scenario half lake (LB-2/B)	12%	- -	The partial IRR just equals the cut-off rate. Taking environmental impacts into account, the project would be economically inefficient.
Environment scenario (LB-3)	10%	+ +	No conclusion can be drawn: it is unknown whether the positive environmental effects would be sufficient to raise the comprehensive IRR above the cut-off rate.
Fisheries scenario (LB-4)	18%	+	The project is economically efficient, as it combines positive environmental effects and a partial IRR above the cut-off rate.

Sensitivity has been investigated with regard to assumptions in three fields:

- *Agricultural benefits* (Storage scenario only): central case assumptions are that a) the benefits would accrue to both the Sinai and the Western Desert, and only 50% of land development costs need to be taken into account. Sensitivity has been analyzed by assuming a) benefits would fully accrue to the Western Desert, or fully to the Sinai, and b) 100% of land development costs should be attributed to the storage project.
- *Fisheries income*: estimates on impacts on fisheries income critically depend on assumptions regarding yield per feddan. IRRs have been calculated for high, central-case and low assumptions in this field.
- *Costs*: IRRs have been calculated assuming that costs would be 25% higher or lower than in the central-case as shown in table 10.2.

The partial IRR for the Storage scenario critically depends on assumptions regarding agricultural benefits, as shown in table 10.10.

Table 10.10. Sensitivity IRR Storage scenario to agricultural variables

Storage scenario variant	Rate of return (excluding non-monetized ecological impacts)					
	100% Western Desert		100% Sinai		50% Western Desert 50% Sinai	
	100% ldc	50% ldc	100% ldc	50% ldc	100% ldc	50% ldc
LB-2/A (full lake)	10%	*13%*	5%	8%	8%	11%
LB-2/B (half lake)	11%	*15%*	6%	9%	9%	12%

Taking the negative environmental impacts of the Storage scenario into account, it would be inefficient in most cases. In the remaining two cases (indicated in italics), efficiency is unclear (combination of IRR > 12% and negative environmental impacts).

The Storage scenario much less depends on assumptions regarding the fisheries sector and costs (see table 10.11). In all cases but one, the Storage variants would be economically inefficient. In the remaining case, efficiency cannot be assessed, as a 13% partial IRR is combined with negative environmental impacts. The table also shows that the Fisheries scenario would be economically efficient under all assumptions, combining a partial IRR above the cut-off rate and a positive environmental impact. The Environment scenario scores a very low IRR (excluding environmental benefits) under the "low" fisheries assumption. In other words, environmental benefits would need to be valued high to obtain an economically efficient Environment scenario. Under "high" fisheries assumptions, the Environment scenario is efficient as positive environmental impacts should be added to a marginal partial IRR. Sensitivity with respect to costs is weak for both non-storage scenarios.

Table 10.11. Sensitivity IRR scenarios to fisheries and cost variables

Scenario	Rate of return (excluding non-monetized ecological impacts)					
	Fisheries assumptions			Costs assumptions		
	low	central	high	low	central	high
Storage (LB-2/A; full lake)	11%	11%	11%	12%	11%	10%
Storage (LB-2/B; half lake)	12%	12%	12%	13%	12%	12%
Environment (LB-3)	2%	10%	12%	10%	10%	9%
Fisheries (LB-4)	13%	18%	20%	19%	18%	17%

10.7. Integrated evaluation

10.7.1. Multi-criteria analysis

Section 10.6 showed that on economic grounds, only acknowledging uncertainty, and all public and private sector risks apart, the Fisheries scenario would be recommendable. Over the past two decades, however, discussions in Egypt have clearly shown that the development of Lake Burullus is a politically extremely sensitive subject. In such a case, CBA outcomes may not be decisive and the relative priority assigned to criteria becomes extremely important. This section explores the views of a number of agencies that may be involved in or affected by Lake Burullus policies on the relative priority of criteria. These results are used to conduct MCA, leading to rankings of scenarios according to the preferences of various agencies. Another main input into MCA calculations is the mixed-data impact matrix presented in table 10.8.

Several agencies and Egyptian consultants to the study have been asked to rank six criteria that have been applied in previous sections. The criterion considered most important was ranked as "1", the least important criterion as "6"[10]. Criteria could also be assigned equal weights. Unfortunately, it was impossible to obtain the rankings of criteria by agencies within the Ministry of Agriculture, as well as of local fishermen in the Lake Burullus area. For these parties, the study team itself has prepared a ranking on the basis of earlier

10 It should be noted that a ranking of criteria is just one of the options to express the relative priority of criteria (section 3.2.3). The procedure applied here, however, was considered to be the most practical one in view of the limited time available for discussions on criteria.

discussions held with them during visits to Egypt. These "imputed" rankings have not been confirmed by the agencies concerned. Results are shown in table 10.12.

Table 10.12. Criteria rankings according to various agencies

Agency	Criteria					
	Costs	Environment	Fisheries	Nile water conservation	Private sector risks	Public sector risks
MPWWR	5	3	6	1	2	4
EEAA	6	1	2	5	4	3
EWS	4	1	2	3	6	5
MOA-GAFRD (imp)	5	3	1	6	2	4
MOA-LR (imp)	4	5	6	1	2	3
NIOF	6	1/2	1/2	5	3/4	3/4
Gov. Kafr el Sheikh	4	1/2/3	1/2/3	5/6	1/2/3	5/6
Local communities (imp)	6	3	1	4	2	5
GON	5	1	3/4	3/4	2	6

MPWWR: Ministry of Public Works and Water Resources
EEAA: Egyptian Environmental Affairs Agency
EWS: Egyptian Wildlife Service
MOA-GAFRD: imputed by the study team: Ministry of Agriculture, General Authority for Fish Resources Development
MOA-LR: imputed by the study team: Ministry of Agriculture, Land Reclamation Department
NIOF: National Institute for Oceanography and Fisheries
Gov. Kafr el Sheikh: Governor Kafr el Sheikh
Local communities: imputed by the study team
GON: Government of the Netherlands

Some weaknesses appeared from the criteria ranking matrix. For example, most agents ranked the cost criterion low or lowest. In reality, this factor would be important in view of the scarcity of public sector funds in the country. The matrix is therefore particularly useful in showing the varying and highly subjective views of different parties, apart from the question who would bear the costs. This allows a good insight in the probability that scenarios will be acceptable to the private or public sector. The question of costs should then addressed through CBA and supplementary financial analysis.

To arrive at a ranking of scenarios according to the preferences of the various agencies, MCA has been applied. To account for method uncertainty, several techniques have been applied, which all can deal with qualitative information about weights, and mixed information about impacts. These techniques are Evamix, Expected Value Method, and Regime[11]. It appears that the three methods give comparable rankings for a particular institution in the large majority of cases. In the case of slightly different rankings, the unweighed average of the three values has been taken. Outcomes are shown in table 10.13.

Table 10.13. Preferred rankings of scenarios according to various agencies

Agency	Scenario				
	Base-case	Storage, full-lake	Storage, half-lake	Environ-ment	Fisheries
MPWWR	2	1	3	4	5
EEAA	1/2	5	4	1/2	3
EWS	3	5	4	1	2
MOA-GAFRD (imp)	1	5	4	2/3	2/3
MOA-LR (imp)	2/3	1	2/3	4/5	4/5
NIOF	1	5	4	2	3
Gov. Kafr el Sheikh	1	5	4	2/3	2/3
Local communities (imp)	1	5	4	3	2
GON	1	5	4	2	3

The results show that Lake Burullus scenarios are appreciated in very different ways by various groups:

- MPWWR representatives are in favour of the full-lake Storage scenario, followed by respectively the Base-case scenario, the half-lake Storage scenario, the Environment scenario and the Fisheries scenario. The imputed preferences of the Land Reclamation Department give rise to a comparable outcome.

[11] For all calculations, DEFINITE software has been used, developed by Janssen (1992). Short explanations of these techniques are provided in section 3.3.1.

- All other agencies, including the GON, rank the two Storage-variants fourth and fifth. The Base-case scenario, the Fisheries scenario and the Environment scenario rank first, second or third.

MCA outcomes appear to differ in some respects from the CBA results. There are two main explanations:
- most parties assign a low priority to "costs", whereas in CBA costs are valued in the same way as other variables expressed in money, like agricultural benefits (derived from reductions on the excess flow) and fisheries income;
- in MCA, agriculture and fisheries impacts have been weighted by subjective priorities rather than prices, and, moreover, are processed in qualitative terms;
- in CBA public and private sector risks have not been accounted for.

The application of MCA is instrumental in showing the political dimension of the use of Lake Burullus. Particularly by more or less ignoring costs, MCA outcomes clearly reveal the true preferences of various agents in society. Moreover, they strongly indicate that society is divided in two groups, one of which is in favour of a storage project in Lake Burullus, whereas the other opposes it. There seems not much scope for a compromise solution, apart from the Base-case scenario.

10.7.2. The opportunity costs of saving Lake Burullus

The high priority the GOE assigns to saving water strongly suggests that Lake Burullus will be used for storage of Nile water in the absence of other conservation options. Such options, however, do exist and have been investigated in the study. Besides storage in Lake Burullus, technically feasible strategies to reduce this excess flow include:
- *Winter irrigation*: this water management option is aimed at increasing irrigation in the winter, thereby reducing the excess flow (which is due to the closure of irrigation infrastructure in that season);
- *Groundwater recharge*: rather than storing water in surface reservoirs, groundwater stocks may artificially be recharged.

Taking account of these options, the key question confronting policy-makers appears to be the "price" of the existence of the wetland Lake Burullus in terms of the size of the excess Nile flow. If no Storage scenario would be implemented, but the potential for artificial groundwater recharge and winter irrigation utilized, the excess flow could be reduced from the present 1.7 to 1.0 billion m^3/year. If in addition a Burullus reservoir would be constructed, the excess flow would be further reduced to 0 or 0.4 billion m^3, for the full-lake and half-lake variant respectively.

In other words, apart from the financial costs of scenarios, the price to be paid for the reduction of the excess flow to 0 or 0.4 billion m^3 instead of 1.0 billion m^3 would be the loss of the Lake Burullus ecosystem and a corresponding decline in fisheries income. Thus, saving Lake Burullus and achieving sustainable benefits from its resource base would require the willingness to forego the perceived benefits of the corresponding amounts of conserved water (0.6 and 1.0 billion m^3, respectively). Formulated in this way, the choice problem is an illustration of a well-known CBA valuation principle, viz. opportunity costs (see for instance, section 6.2; Fisher, Krutilla and Cichetti, 1972; Hanley and Graig, 1991). Without attempting to monetize the (full) ecological value of the ecosystem Lake Burullus, it shows how much net benefits in the field of water conservation (and hence agriculture) the GOE should be willing to give up in order to preserve an ecologically important natural asset.

The ultimate choice will be made by the GOE. The GOE might request external assistance for the selected scenario(s). From the viewpoint of investment costs, this is most likely to refer to the Storage scenario. However, most donors assign a high value to environmental conservation and the well-being of low-income communities, and their willingness to participate in such a project might therefore be limited. At the same time, donors may be particularly interested in supporting the GOE in paying the "price" for saving Lake Burullus, in terms of technical assistance and financial support to:

- the preparation and implementation of an Environment or Fisheries scenario, including a social programme aimed at compensating local communities for short-run costs;
- research, pilot projects, and implementation of measures in the field of artificial groundwater recharge and water management.

10.8. Conclusions

The Lake Burullus study has several interesting features:

- The study team has been able to present decision-makers a fairly clear picture of the basic choices available to them and the trade-offs involved. This conclusion applies despite the fact that not all impacts could be assessed in physical or monetary terms.

- The willingness of the GOE to consider alternatives for the storage plan, both in the sense of other policies for Lake Burullus and other options to save Nile water, has been a major positive factor for the study. Options as well as trade-offs could be clarified in much more detail than otherwise would have been the case.
- The concept of ecological sustainability played an essential role in the study as two out of four Lake Burullus scenarios have been based on it. This allowed a comparison of the impacts of such policies and those based on other considerations.
- Impact assessment was at the core of the study, but all efforts would have been futile without close co-operation between varying disciplines. The exercise was inter- rather than multi-disciplinary.
- Impact assessment required the development of ecological-economic models. In view of the many uncertainties, however, outcomes should be interpreted with care.
- Environmental protection and fishery promotion appeared to be fairly commensurate objectives, but were at odds with the objective of agricultural development.
- CBA and MCA were both used, providing insight into a range of issues.
- The evaluation of the Lake Burullus scenarios benefited greatly from the additional analysis of options to save Nile water elsewhere in the country (opportunity costs).

11. A PRACTICAL FRAMEWORK FOR APPRAISAL STUDIES

11.1. Introduction

Ecologically-sensitive projects require a different approach to appraisal than most traditional projects. It will be argued that they often will call for multidisciplinary appraisals teams. The greatest danger threatening such teams is that each specialist focuses almost exclusively on his or her own field, following the approach he or she has always applied. An appraisal report may be prepared, containing informative chapters for each separate field, but lacking an umbrella approach that a) identifies essential linkages between these fields, b) assures that a set of common research principles has been applied, and c) allows for consistent overall conclusions. To avoid fragmented studies, all specialists should work within an overall methodological framework. Such a framework defines common appraisal principles and offers the opportunity to bring together information and impressions from the various disciplines to arrive at justifiable conclusions and recommendations.

This chapter sets out to present systematic guidelines for the multidisciplinary appraisal of projects involving environmental issues[1]. Starting from the theoretical work of part A, it acknowledges the practical constraints facing evaluators, as illustrated in the two case-studies. The overall methodological framework, which corresponds with the structure of the present study (see section 1.2), would suggest two main steps:

1 Evaluators should carefully and systematically investigate which types of environmental issues should be addressed in each of the subsequent stages in project appraisal (the "format" of an appraisal study). Moreover, the project-specific manifestations of these issues need to be analyzed. Given its nature, this first step is a matter of applying conceptual principles, rather than using techniques like CBA and MCA. It will be argued, however, that this part of the overall methodological framework would incorporate some basic elements of both MCA and CBA as a *way of thinking*.
2 Next, CBA and MCA as appraisal *techniques* may be applied to address questions that evolve in step 1. The previous chapters show that it would not be realistic to rely solely on either CBA or MCA, both for methodological and

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1 The emphasis in this chapter is on the systematic incorporation of environmental issues in project appraisal. In reality, project appraisals will usually focus on other, traditional issues as well (like shadow-pricing of non-traded commodities). These issues will not be addressed here.

project-specific, empirical reasons. The optimal approach, which will be elaborated in this chapter, involves the selection of one of these methods or a combination of them, depending on the specific features of a particular project, as assessed in step 1. Factors will be listed that determine whether a method can be applied, and affect the reliability and usefulness of the results.

The main issues in sustainability-oriented project appraisal will be discussed starting from the most important stages in project appraisal as defined in chapter 3 and maintained throughout this study, including the case-studies. Table 11.1 shows: a) name and number of each stage, b) the type of issues addressed in each stage, and c) the section in which a particular stage is discussed.

Table 11.1 Framework for sustainability-oriented appraisal by stage

Number and name of stage		Main issues	Section
I	*Decision-making framework*		11.2
I.1	Alternatives	how and how many alternatives are selected, and what role do environmental considerations play in this respect?	11.2.1
I.2	Institutional context: multiple agents	to what extent is a project in the field of natural resources likely to raise conflicts between agents in society, both in the private and public sector?	11.2.2
I.3	Key criteria and constraints	considering the objectives of various parties involved in or affected by the project, which criteria should be selected regarding environmental and other issues? Are constraints imposed on one or more criteria?	11.2.3
II	*Project setting and project impacts*		11.3
II.1	Ecological and socio-economic profiles and interaction models	what are basic features of ecological and socio-economic systems that would affect or be affected by the project? And how do they interact?	11.3.1
II.2	Assessment of ecological and other impacts	how are impacts defined, and what dimensions do these impacts have? How may ecological and related impacts be measured?	11.3.2

This scheme is more flexible than the strict classification of stages might suggest:

- The scheme covers all possible stages in project appraisal. In practice it may not be necessary to complete all stages. This will depend to a great extent on the type of information decision-makers need. For instance, if their aim is to obtain an insight into possible ecological and socio-economic impacts of a particular policy, the analysis could be confined to stage II. Perhaps policy-makers are satisfied with the assistance of experts in designing alternatives for a project that would satisfy ecological objectives; then stage I (or even a part of it) would be sufficient. If alternatives are known and policy-makers are just interested in knowing the IRR, evaluators would need to study only stages II and III[2].
- Stages may need to be conducted simultaneously, or even in a different sequence than presented above. For instance, the determination of alternatives (stage I.1) may only start once environmental profiles (stage II.1) have been prepared. Or, the design of alternatives may be adjusted in the light of additional information about impacts, which would lead to a renewed round of impact assessment, and so on. In fact, if sufficient resources are available, such an interactive approach would be recommendable. There are, however, limits to possibilities to change the sequence of stages. For instance, without data on impacts (stage III.1), MCA cannot be conducted (stage VI.1).
- A distinction should be made between the *analytical* stages presented in table 11.1, and *procedural* stages in the project cycle adhered to by governments and donors. A sequence of procedural stages needs to be completed before it is decided whether or not a project will be approved. These stages may include pre-identification, identification, preparation, preliminary appraisal and final appraisal. In principle, each procedural phase may involve a study encompassing all or several analytical stages. In the course of this process, information and conclusions would become more precise and targeted towards final decision-making.

Section 11.9 contains a discussion on the practical consequences of the presented framework for the organization of appraisal studies, in terms of the composition of appraisal teams, and time and financial means required for studies.

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2 A difference may exist between the stages policy-makers show interest in, and the stages that would be recommendable from the viewpoint of sound evaluation principles.

11.2. Stage I: Decision-making framework

11.2.1. Stage I.1: Alternatives

Environmental considerations may play an important role in the design of alternatives for development projects. The following issues may need to be addressed (see section 4.2):

- CBA principles prescribe a "with"-"without" approach, i.e. an exploration of differences between the situation with and without a project. To understand the environmental impacts of projects (stage III), the definition of the without-case is of the utmost importance. Frequently, this may include a statement on environmental policies: what types of environmental policies and measures are expected to apply in the absence of new policies. This prediction may be particularly problematic in the case of recently established environmental institutions.
- The generally valid, but often ignored arguments in favour of starting from a wide range of alternatives have special relevance for ecologically-sensitive projects[3]. It is extremely important to investigate whether several "with" options may be considered that differ in their potential contribution to environmental objectives (see stages I.2 and II.1). A key question for projects aimed at environmental improvement is whether adjustments to the design of the project might result in even greater environmental gains or in the same environmental benefits at lower cost. Projects that tend to be beneficial to short-term economic interests but raise serious long-run environmental objections should be approached in a comparable way: is it possible to adjust the design to avoid environmental damage without a loss in economic benefits? In other words, it is recommended to test an environmentally-sensitive project on effectiveness and cost-effectiveness, and care should be taken not to approve (or reject) a project because it is in the "right" (or "wrong") sector (see also stage III.1).
- Established environmental policies may be translated into specific measures to be incorporated in project design. Governments may apply fixed standards for natural resource use or pollution. For instance, ceilings may be imposed on emissions of certain gasses. In response to such standards technical facilities aimed at avoiding or mitigating emissions could be incorporated in the project. Generally it will be more efficient to build in such measures in an early appraisal phase, rather than elaborating on constraint-satisfying measures after the impact assessment phase (stage V).
- Sometimes policy-makers may not be able or willing to decide on an environmental policy affecting a project without having insight into the

3 The number of alternatives also affects the applicability of MCA techniques (see stage VI.1).

consequences various options would have in the field of environment, economy, etc. In that case, different project alternatives may be based on different assumptions regarding such policies, as illustrated in the Egypt case. For instance, one alternative may be based on a policy of "strong sustainability", whereas another could assume a "weak sustainability" approach. In this way, socio-economic consequences of different types of environmental policies may be investigated, and ultimately balanced against different impacts on the environment. It should be noted that this would often require that expected impacts under the without-case (stage II.2) are explored first.

- The discussion above focused on alternatives for a particular project, for example the construction of a dam in a rural area. In the evaluation of the project, criteria will be applied that are not particular to that project, such as energy generation. A critical step in the appraisal may be to investigate both alternatives for the dam (small or large, various sites), as well as options to achieve the generic objective of energy generation in other ways, not affecting that particular area. This refers to the CBA notion of opportunity costs: what would be the extra costs of generating energy elsewhere and would these costs justify a decision not to construct the dam in the project area? In this way, CBA principles stimulate a search for options that would achieve socio-economic benefits in other, ecologically less harmful, ways. The scope of a choice problem is widened to encompass aspects surpassing the level of the project or the project area. In the Egypt-case, for instance, possibilities to save Nile water otherwise than through storage in Lake Burullus were investigated.

11.2.2. Stage I.2: The institutional context (multiple agents)

Projects usually involve or affect numerous groups and agents in society. A key element in the MCA way of thinking is to distinguish between multiple agents throughout an appraisal. Three issues would need to be addressed (section 4.6 and the two cases):

- An inventory of all groups and institutions expected to be involved in or affected by the project, particularly through changes in market prices of and access to natural resources. A useful starting point is to distinguish between the public and the private sector, but further subdivision as well as broadening by incorporating foreign donor agencies, may be required.
- The objectives, interests, and -if applicable- policies regarding natural resource use of each possibly relevant agent. With respect to public sector agencies, the description of past and present policies provides an important input into the ecological-economic interaction model (stage II.1) and the estimation of impacts in the without-case (stage II.2).

- The extent to which interests, objectives and policies of various agents may be conflicting.

The third question would deserve special attention, because many ecologically-sensitive projects are politically highly sensitive as well. The following cases of conflicting interests may occur:

- Projects may raise conflicting interests within the *private sector*. In many developing countries, a large part of the population is directly dependent on the use of natural resources. The use of such resources is typically associated with market imperfections, particularly externalities and collective goods or bads. Any change in the prices of, access to or ownership of natural resources is likely to evoke different views in society. Particularly if access to forests, wetlands and other natural areas was previously free, vested interests may be opposed to projects involving a managed development. Appraisal would therefore need to focus on the pre-project situation regarding the questions of: a) who has (and who does not have) access to natural resources, and at which price, and b) what are ecological and socio-economic consequences of this situation? These questions will quickly point at different positions of population groups (consumers) and producers.
- Frequently, *public sector* environmental agencies will be primarily responsible for the implementation of a development project aimed at environmental improvement. Other types of agencies will also directly or indirectly play a role. For projects with primarily non-environmental objectives that will affect ecosystems, the opposite situation occurs. In both cases it should be investigated whether it is appropriate to consider the government as a uniform entity. Often, tension may arise between, for example, existing government institutions in the field of agriculture or industry, and often recently established environmental agencies. In addition, the perspectives of local and central government agencies may not be commensurate.
- A third field of potential conflict would involve both *public and private agents*. Public sector, implementing agencies may be confronted with private sector opposition if changes are made in prices of or access to natural resources. Conflicts may particularly arise between short-term, private sector (income) interests, and long-term, public sector interests in terms of objectives regarding ecological sustainability.
- Finally, *recipient and donor countries* may hold different views on how important environmental conservation and improvement is compared to other dimensions of development.

11.2.3. *Stage I.3: Key criteria and constraints*

The definition of criteria provides the structure for impact assessment (stage II.2). Basically, this study recommends to start from the three key criteria of efficiency, equity and sustainability (sections 4.3 and 4.4). In practice, these criteria may need to be disaggregated and/or be complemented by other criteria. This approach draws on both CBA and MCA guidelines for criteria selection (sections 3.5 and 7.3):

- Focusing on *efficiency*, the CBA philosophy is particularly useful in pressing researchers to clearly define human welfare, and show its dependency on clean drinking water and other environmental amenities. Moreover, it prescribes a clear distinction between aggregate (efficiency) and distributive (equity) aspects.
- With regard to *distributive* consequences, the political dimension of many ecologically-sensitive projects suggests that they may be significant (stage I.2). The MCA approach complements the CBA approach by emphasizing that equity may be concerned with the distribution of both income and (access to) natural assets.
- The MCA approach draws attention to the possibility that besides efficiency and equity *other criteria* may need to be taken into account. There may be two reasons for this. First, decision-makers may want to weigh environmental consequences explicitly against other types of impacts, rather than to apply the CBA principle of potential compensation. Second, if a project is expected to involve conflicting interests between groups in society, it may be insufficient to take only criteria stressed by the government into account. In preparing a criteria list, general methodological principles should be adhered to: double-counting should be avoided, the list should be comprehensive, and so on (see section 3.2.2).

The case for including environment as a separate criterion is strongest if:

- governments do not favour an unlimited trade-off between environment and other welfare constituents or determinants;
- markets do not lead to environmentally acceptable outcomes, and/or environmental policies cannot be implemented effectively. Individual projects may then be considered a tool to achieve environmental objectives[4].

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[4] An analogy with two CBA variants exists. According to economic CBA philosophy it makes sense to select projects on the basis of hypothetical shadow prices that replace actual, distorted prices. Social CBA's rationale is that in the case of lacking or ineffective income redistribution policies at the central level, projects may be an instrument to achieve equity objectives.

An explicit environmental criterion may be formalized in various ways (section 4.6). One possibility is to apply the objective of maximal environmental protection or improvement. Another approach involves the imposition of a constraint on natural resource use. In this case environmental objectives are converted into a sustainability criterion, in the form of a goal, mixed goal-constraint, or a constraint. Besides the definition of the level of resource use that would just be considered sustainable, key parameters in a sustainability criterion include: the spatial level at which it should be applied, the scope for trade-offs between man-made and natural resources (strong versus weak sustainability) and a time path towards sustainability.

Sustainability criteria become more operational if targets are set for specific types of environmental resources. A distinction may be made between non-renewable resources, renewable resources, pollution and ecosystems. If a sustainability criterion is specified in this way, it may lead to the definition of the environmental utilisation space (EUS) available to a particular project (section 5.2).

If decision-makers impose constraints on acceptable values for environmental attributes, they in fact say that the attribute concerned outweighs all other aspects if a certain critical value is exceeded. Such a basic form of weighting may also be applied to other criteria. For instance, policy-makers may require that a project should be efficient, or that projects satisfy budget constraints.

Weighting may also take other forms, all of which allow for some degree of trade-off between two or more criteria. If the technique MCA is applied, such weights should be explicitly addressed (stage VI). If not, it may still make sense to explore in an informal way the extent to which different parties would assign different priorities to criteria, particularly in terms of environmental vis-a-vis other types of criteria (the MCA way of thinking). Such an exercise may be useful, for instance, if in the impact assessment phase (III.2) insight should be gained in the willingness of population groups to cooperate in projects and contribute financially to environmental improvement (see the Colombia and Egypt cases).

11.3. Stage II: Project setting and project impacts

11.3.1. Stage II.1: Ecological and socio-economic profiles and interaction models

A prerequisite for the estimation of impacts (stage II.2) of an environmentally-sensitive development project is a thorough understanding of the ecological and socio-economic systems it would affect. Analysis of the project setting may also be a step preceding the selection of alternatives for projects aimed at environmental improvement or avoiding environmental damage (stage I.1). The collection of base-line data concerning the project setting would cover two fields (section 5.2):

- the preparation of ecological and socio-economic profiles, *describing* each system in sufficient detail, and
- the development of an ecological-economic interaction model, *explaining* the interrelationships between systems.

The *ecological profile* describes the nature of the environmental system under consideration (arid, semi-arid, wetlands, watersheds, natural parks, etc.). It summarizes historical and present data on the state of the ecosystem, in terms of biomass, nutrient balances, biodiversity and so on. Preferably, all ecological functions are systematically addressed, in terms of their relative importance as well as recent changes in the level and the quality of these services. The vulnerability of the ecosystem should be analyzed, leading to an overview of the main problems (pollution, depletion of non-renewable natural resources, overexploitation of potentially renewable resources, etc.). An estimate should be made of the level of environmental services that could be utilized in the long run without threatening the aggregate stock of natural resources. This may be expressed in terms of indicators such as: critical levels, quality standards, maximum sustainable yield, carrying capacity, resilience, vulnerability and fragility.

The *socio-economic profile* outlines the economic structure in the area that might affect or be affected by the project. Key issues to be addressed include: main sectors, per capita income, population and population growth, property right systems for natural resources, and distributive aspects.

An *ecological-economic model* would describe the two-way interaction between the ecosystem and the socio-economic system. Basically the following questions would need to be dealt with: a) the dependency of production and consumption on natural resources and ecosystems, b) economic explanations for environmental problems (both input- and output-related), c) the economic consequences of environmental problems, and d) the prospects for sustainable development. To answer d), a key question would be whether an equilibrium exists or is expected to evolve between "supply" characteristics of the ecosystem and "demand" factors of the socio-economic system. For instance: does the fishing effort by local communities (socio-economic system) exceed the maximum sustainable yield (ecological system), and what are the socio-economic factors that explain this situation? Areas where short-term economic and long-term ecological objectives conflict rather than coincide, should be analyzed. The difference between actual and sustainable use of natural resources provides guidance for the determination of the EUS for new projects (stage I.3).

The ecological-economic interaction model should include environmental (and other) government policies as an exogenous factor. A distinction may be made between policies that have environmental protection (i.e. enhancement of the ecosystem) as the single or overriding objective, and policies that primarily aim at achieving non-environmental objectives (focused on elements in the socio-economic system), but may have significant consequences for the ecosystem. Examples of the former type of policies are interventions in the prices of environmental inputs and outputs, tradable permits and direct regulation of emissions. The latter category includes macro-economic, trade, population control, and regional policies.

The notion of ecological-economic interaction models may refer to any analytical effort to systematically cover ecological-economic relationships. It may vary between a qualitative systems model and a sophisticated, mathematical model. Which type of model is called for, depends on the type of project and on the requirements of the appraisal study.

11.3.2. Stage II.2: Issues in impact measurement

Ecologically-sensitive projects call for a non-traditional attitude towards the measurement of effects. In the CBA approach, money is the single denominator for all impacts. An emphasis on CBA in project appraisal may easily produce misleading "hard" information if actual data availability is weak. In other words, to stress monetization of environmental impacts as a universal principle runs the risk of unreliable outcomes. Whereas a monetary estimate on, for instance, benefits of soil improvement, suggests "hard" information, it may in fact be based on debatable assumptions about poorly understood ecological-economic relationships.

In the MCA way of thinking, impacts are presented as "hard" as possible, but not more robust than assumptions allow. If in-depth investigations are made, an MCA analyst will search for quantitative (physical) or even monetary data. If little time for analysis is available, however, the same analyst will be satisfied with "soft", qualitative information. Rather than to convert unreliable data and possibly arbitrary assumptions underlying the impacts into monetary figures, uncertainty and subjective elements in the assessment of ecological impacts would be shown explicitly. This particularly applies to studies characterized by a) incomplete base-line data, b) complex linkages between ecological and economic systems, and c) little time for EIA (which will often occur in earlier procedural phases of the project cycle).

In general, an impact should preferably be shown in five dimensions (section 3.3.1):
- magnitude;
- temporal pattern;
- level at which effect is expected to occur (local, regional, national, global);
- scale of measurement (monetary/physical-quantitative/qualitative/ranking);
- risk/uncertainty (are all possible events known? do we know the probability of events? what assumptions have been made for the "best-estimate"?).

For a particular variable, impact assessment will be based on information about its present value, and on the historical trends leading to that value, as described in the profiles and explained in the interaction model (stage II.1). Initially, it may be useful to define impacts as expected changes in the present value of a variable. Impacts will then be assessed first for the without-case, and consequently for all alternatives. This allows the preparation of graphs and diagrams showing simultaneously expected impacts with and without the project (see Egypt-case). Such comparative information is often more accessible than overviews of "differential" impacts, i.e. the difference between values of variables under with- and without-assumptions (as required by CBA).

In the appraisal of ecologically-sensitive projects, the assessment of environmental impacts plays a pivotal role (section 5.3). Without information about these impacts, scores on the key criteria of efficiency, equity and sustainability cannot be determined. EIA should not be considered the exclusive domain of ecologists, as forecasts of environmental impacts require an understanding of how the economy affects ecosystems and vice versa. In other words, estimation of impacts on the ecosystem and the socio-economic system are to a great extent two sides of the same coin, requiring multi-disciplinary EIA studies.

11.4. Stage III: Score on efficiency criterion (cost-benefit analysis)

11.4.1. Stage III.1: Basic factors determining the applicability of CBA

In principle, CBA is the preferred tool to assess economic efficiency. A practical argument is that most donors and many developing countries have appraisal procedures that prescribe the determination of economic rates of return. A theoretical justification is the importance of knowing whether a country would be better off, if all costs and benefits of a project are taken into account. In reality, however, there may be absolute or relative limits to CBA's applicability[5]. For a particular case, evaluators need to investigate the extent to which these limits apply. Consequently, it can be decided whether CBA can and should be applied, and what the scope of this exercise should be. The issues of valuation, discounting and uncertainty, which are briefly referred to in the present section, are treated in more detail in section 11.4.2.

Comprehensive CBA, which covers all relevant environmental and other attributes, is *not applicable* if an appraisal study shows any of the following features:

Feature	Explanation
Efficiency is not among the appraisal criteria selected by decision-makers.	CBA is a tool to assess economic efficiency.
Environmental impacts are significant but cannot be quantified.	To allow monetization, ecological impacts need to be known in physical terms.
It is impossible to assign a monetary value to environmental impacts.	CBA has money as the numéraire.

Cases may have specific features that indicate whether a CBA study can be expected to be an important tool for decision-making. In the following conditions, CBA is *most appropriate and/or useful* for the evaluation of a project:

Feature	Explanation
Efficiency is the single criterion or is assigned a high weight compared to other criteria.	Economic CBA focuses exclusively on efficiency and, moreover, is the preferred technique to assess the efficiency score. Its role in decision-making will be more modest if a separate environment/sustainability criterion applies.
Efficiency is converted into a constraint (i.e. the NPV should be positive).	Depending on CBA outcomes, a project is either immediately rejected or considered for further study, irrespective of environmental impacts.

5 An absolute limit indicates that CBA is not applicable, whereas a relative limit implies that certain problems may occur during application (see section 6.1).

Feature	Explanation
Affected parties are willing to consider trade-offs between welfare attributes, particularly natural and man-made consumption and production goods and services.	This is another way of saying that the "potential compensation" principle is applied, thereby limiting the role of environmental objectives. Implicitly, the role of discounting should also be acknowledged.
The project's consequences for access to or pricing of natural resources are unlikely to raise seriously conflicting views in society.	In such cases, an outcome of an analysis in terms of net aggregate benefits will be least controversial.

Application of CBA may be more or less complicated. The following circumstances *facilitate* a CBA study:

Feature	Explanation
Environmental impacts can be measured relatively easily.	Impacts need to be known in quantitative terms to allow monetization. Localized environmental impacts will generally pose less difficulties that contributions to supra-project level environmental problems.
Environmental impacts can be monetized relatively easily.	This occurs if environmental impacts can directly be related to defensive outlays or to productivity in income-generating activities (use-values; fishery, agriculture, forestry). Valuation is most difficult in the case of non-use values (biodiversity).
If a sustainability criterion applies, it is defined at the project level.	Costs and benefits of constraint-satisfying activities can directly be attributed to the project and hence be accounted for in CBA.

These factors suggest that, all other things equal, application of CBA would be easier in the later (procedural) phases of the project appraisal cycle. In early stages (reconnaissance, identification), available data are likely to be more scarce and less reliable, particularly in the complex field of ecological-economic interaction.

Outcomes of CBA are *most reliable* when:

Feature	Explanation
Environmental impacts are known with certainty.	CBA's means to cope with ecological uncertainty and risk are rather limited.
Environmental impacts are uncertain, but events and probability distributions are known.	In these circumstances, a meaningful sensitivity and/or stochastical analysis can be conducted.
Valuation of environmental impacts is determined through appropriate techniques and surveys.	The credibility of valuation exercises is determined by the theoretical soundness of the approach chosen to express environmental changes in terms of willingness-to-pay indicators, as well as by the way practical research is organized.
The discount rate is theoretically justifiable, taking account of all relevant ecological values.	The rate of the discount is a key parameter, which, however, in actual applications has often lacked a sound theoretical basis.

The overviews above focus on CBA application, which requires that both costs and benefits are monetized. Even if efficiency is among the appraisal criteria, however, it may not always be necessary or even desirable to conduct a comprehensive CBA. Less data-demanding CEA may be an appropriate alternative technique if the aim is to find the alternative that:

- achieves a given environmental objective at the lowest cost;
- achieves the greatest contribution to an environmental objective per unit of cost;
- makes the greatest contribution to an environmental objective for a given amount of financial resources;
- achieves the lowest cost per unit of environmental benefit.

In all these cases two issues are simultaneously addressed: a) effectiveness in terms of achieving environmental objectives, and b) minimization of the use of scarce resources. Application of CEA requires that at least two alternatives are selected (stage I.1), which, moreover, should achieve the same qualitative standards of environmental benefits (see section 3.1).

In the case of several appraisal criteria, CBA or CEA results will be incorporated in the integrated evaluation stage (VI), involving MCA.

11.4.2. Stage III.2: Some specific issues

If application of CBA is considered useful, and data availability meets the minimum requirements (including quantitative estimates on environmental impacts), three issues will play a dominant role: valuation, discounting and uncertainty. These issues are discussed below (see sections 6.2-6.4).

Valuation

There are two key questions in valuing environmental impacts:

- To what extent can *all* expected changes in the level and quality of environmental functions be covered? To answer this question, the functions approach should have been applied in the preparation of profiles and models and in impact assessment (stages II.1 and II.2). In the ideal case, changes in each individual function will be assigned a monetary value. As the nature of these functions is likely to differ considerably, a range of valuation techniques may be required. In reality, this may be a too ambitious approach because a) insufficient time is available for valuation studies, and/or b) valuation of particular types of ecological functions appears to be problematic. In such cases, valuation will need to be selective. It should be acknowledged, however, that the usefulness of CBA results depends to a great extent on the degree of coverage of environmental impacts.
- Which valuation *techniques* will be applied? In general, environmental impacts will be linked to markets. A distinction can be made between conventional, surrogate (or implicit) and hypothetical (or artificial) markets. Hence, a key question is the types of markets the expected changes in environmental functions should be associated with. Especially if the existing data base is weak, an emphasis on surrogate and/or hypothetical markets will lead to more time-consuming and less reliable valuation studies.

Of course the issues of comprehensiveness and the choice of valuation techniques are interrelated. In a particular case, it will be justified to devote more efforts (time, money) to valuation of environmental impacts if the a satisfactory degree of coverage can be achieved and if the most reliable techniques can be used.

Discounting

The rate of discount is a key parameter in CBA as it divides a set of alternatives into a group that should be rejected, and a group for which proposals should be approved of (on efficiency grounds). If it is set at a theoretically unjustifiable level, projects will be approved and rejected for incorrect reasons. If the rate is too high, a bias exists against (in favour of) projects with long-term environmental benefits (costs). A too low rate would create the opposite pattern. This might seem attractive from a purely environmental perspective, but it is at odds with CBA principles that stress overall welfare and efficiency. Moreover, aggregate resource use may well increase because each project has a higher chance to pass the discounting test.

In considering a rate of discount, three issues need to be analyzed:

- Is the rate commensurate with general CBA principles? In other words, depending on the alternative use of capital funds, does it reflect the weighted average of the marginal rate of return on public sector projects, the real domestic or foreign interest rate, or the CRI? Environmental considerations as such do not play a role here, but the result of the analysis will affect ecologically-sensitive projects (see above).
- Do prices used in the calculation of the rate of discount properly reflect ecological costs and benefits? For example, has all natural resource use been incorporated in the marginal rate of return, irrespective of the question whether resources are marketed? This is an even more difficult question, and a satisfactory answer would probably demand an in-depth study. Even if such a study is beyond the possibilities offered within the framework of the appraisal of an individual project, raising the question will help in appreciating the outcome of discounting exercises.
- What are the arguments, if any, for the use of multiple discount rates? The possibility exists to use a lower rate for projects with long-term objectives that would benefit future generations, particularly through strengthening of the natural resource base. Such options need a careful approach, as the risk of arbitrary choices is significant.

Risk and uncertainty

The reliability of CBA outcomes will depend largely on assumptions made regarding the factors determining environmental (and other) costs and benefits. In a particular case, the following circumstances may occur:

If at least one constraint is not met, the project may be reformulated by developing constraint-satisfying activities for incorporation in the project. The following, not mutually exclusive strategies may be considered as far as environmental issues are concerned (sections 5.5 and 6.7):

Problem	Possible constraint-satisfying activities
The project is inefficient.	- Adjustments leading to higher environmental benefits or lower costs for environmental protection. - Cost-effective measures to reduce negative environmental externalities.
The distributive pattern does not comply with the policy-maker's objectives.	- The design is adjusted so as to increase the share of target groups in income from natural-resource exploitation, to enhance their access to natural resources, or to increase their ownership of such resources. - Development of a social programme to compensate target groups for deteriorating income or access opportunities related to natural resources.
The project's resource use is non-sustainable.	- The original design is adjusted to reduce natural resource use. - An additional project is designed to compensate for the overuse of resources by the original project by creating natural capital elsewhere.

The examples show that two types of constraint-satisfying activities exist. First, the design of the project itself may be adjusted by incorporating new or deleting original components. As argued earlier, it may be more efficient to study possibilities to incorporate such components at the start of the appraisal (stage I.1). Second, without adjusting the original project, additional activities are undertaken, the benefits of which would compensate for the negative score of the original project.

One of the disadvantages of incorporating constraint-satisfying activities after the impact assessment phase is the need to study all impacts again. A time-intensive procedure might evolve if in the second round other constraints would be violated. For instance, measures to reduce resource use, aimed at satisfying the sustainability constraint, might incur a switch from a positive to a negative efficiency score.

11.7. Stage VI: Integrated evaluation (multi-criteria analysis)

11.7.1. Stage VI.1: Basic factors determining the applicability of MCA

MCA aims at ranking alternatives on the basis of their performance regarding several criteria. Although the method can be used to obtain scores on individual key criteria that have several components (see stage IV), its application should particularly be considered in the integrated evaluation phase, when the scores on all criteria are to be compared (section 7.3).

The present section runs parallel to section 11.4.1, where the factors determining the applicability of CBA were listed. Like CBA, MCA will be tested in terms of absolute applicability, appropriateness/usefulness, and reliability. In contrast to the discussion on CBA, however, factors that facilitate MCA's application will not be investigated. MCA being an umbrella for a wide range of techniques, is extremely flexible in its ability to respond to different types of data on impacts and weights.

MCA is *not applicable* if:

Feature	Explanation
There is a single alternative.	MCA requires at least two alternatives.
There is a single criterion (which, moreover, has a single attribute).	MCA requires at least two criteria.
All (single-attribute) criteria are converted into constraints.	MCA requires that trade-offs between criteria are allowed.
It is impossible to determine at least one criteria weight vector.	MCA requires that weights are available to indicate the relative priority of criteria.

These issues all relate to general methodological features of MCA, i.e. they are not specifically related to environmental issues. If none of these circumstances occur, MCA is applicable. If MCA is applied, the following factors will enhance its *appropriateness and/or usefulness* in the appraisal study:

Feature	Explanation
The choice problem is complex because the impact matrix is large. This occurs if environmental issues are to be compared with several other criteria and/or if the number of alternatives is large (most likely in early procedural stages).	When impact matrices are large it is more difficult to obtain an overall impression without the help of analytical tools like MCA.
The choice-problem is complex because many agents in society, with possibly conflicting interests, would be affected by the ecologically-sensitive project.	The existence of multiple agents adds to the complexity of a decision-problem, which increases the need for analytical tools like MCA.
The scope for trade-offs between environmental and other criteria is broad (i.e. the number of criteria converted into constraints is relatively small).	MCA is most useful to treat choices that involve trade-offs between criteria.
The information about environmental and other impacts is mainly qualitative or mixed quantitative-qualitative (most likely in early procedural appraisal stages).	Unlike quantitative methods, MCA offers the opportunity to process qualitative or mixed data.
Environmental impacts are relatively uncertain, and decision-makers apply uncertainty and risk as a separate appraisal criterion.	MCA offers the opportunity to include risk as a separate criterion, as opposed to the CBA requirement to adjust impacts for risk and uncertainty.
CBA outcomes, i.e. scores on the efficiency criterion, are available as an MCA input.	In that case MCA can uses the results of the most appropriate method to determine the efficiency score.
Decision-makers (and possibly other agents) are familiar with MCA approaches[6].	Otherwise, MCA applications may easily be considered "black box" exercises.
Decision-makers are interested in an interactive approach, whereby MCA outcomes are used to adjust basic project parameters (like design and implementation strategy).	MCA is more useful in an interactive approach than in a one-way transfer of results from the analyst to the decision-maker.

Given its methodological characteristics, the outcomes of MCA will be more *reliable* if the following conditions occur:

6 For an exploration of how MCA could be incorporated in appraisal procedures and training programmes of donor agencies, see Van Pelt (1991).

Features	Explanation
The choice problem is complex because the impact matrix is large. This occurs in the case of large numbers of criteria and/or alternatives. Such a situation is most probable in early procedural appraisal stages.	Stability of MCA results increases with the complexity of the impact matrix.
The information about environmental and other impacts is mainly quantitative. This is most likely in later procedural appraisal stages.	MCA results are most stable in the case of quantitative data.
Impacts are relatively certain. Certainty generally increases in the course of procedural appraisal stages.	MCA outputs depend on impacts, which in their turn rely on assumptions.
Several weight determination techniques are applied, and give comparable outcomes.	This addresses the problem that MCA outcomes may be sensitive to the selected weight determination technique.
Several impact standardization techniques are applied, and give comparable outcomes.	This addresses the problem that MCA outcomes may be sensitive to the selected standardization technique.
Several MCA techniques are applied, and give comparable outcomes.	This addresses the problem that MCA outcomes may be sensitive to the selected MCA technique.

In general then, MCA will be an appropriate appraisal tool especially in earlier stages in project appraisal, characterized by sufficient scope for the exploration of several options for projects, a lack of data, and a fuzzy institutional setting. MCA will also be useful in later project appraisal stages if insufficient time is available to investigate complex linkages between ecological and socio-economic systems, if scientific knowledge puts constraints on the quantification of such linkages, and if a project is likely to involve multiple criteria and to evoke diverging views in society.

Comparing MCA and CBA makes sense to a certain extent only because the two methods partly focus on different types of problems. Nevertheless, some interesting conclusions can be drawn regarding the factors that determine their applicability. Perhaps most important is that in the case of CBA much depends on empirical information, whereas MCA factors are generally in the field of methodology (which is not case-specific). It should be acknowledged, however, that MCA "weaknesses" exist precisely because it is focused at conditions CBA cannot treat at all, viz. multiple criteria, multiple agents, and weak data. The basic problems hence are the complexity of the decision-making process and weak data availability. MCA nor CBA can fully solve this problem.

11.7.2. Stage VI.2: Some specific issues

A prerequisite for MCA (or an integrated part of it) is the willingness of policy-makers and other parties that may be involved in or affected by projects to express their views in terms of criteria rankings or weights. Regarding the treatment of environmental objectives, three situations may be distinguished (see stage I.3):

- Environment is not considered a separate criterion. Assuming that efficiency is among the criteria, all environmental impacts would be accounted for in CBA calculations (if data are adequate)(stage III). In an integrated evaluation MCA would then take CBA outcomes and scores on eventual other, non-environmental criteria into account.
- Environment is considered a separate criterion, possibly divided in several elements (preferably environmental functions). MCA will then incorporate the score on the environment criterion (stage II) and compare it with scores on efficiency, equity and possibly other types of criteria (stage III and IV).
- Environment is considered separately, and converted into a sustainability criterion. MCA application will be based on the scores on the sustainability criterion (stage IV.1), the efficiency criterion (stage III), and possibly other criteria.

In these cases, MCA requires that weights are assigned to, respectively, efficiency versus other criteria; environment, efficiency and other criteria; and sustainability, efficiency and other criteria. In the derivation of weights the following issues need to be taken into account (see section 3.2.3):

- Weights may be qualitative or quantitative. The least time-demanding, and institutionally perhaps most feasible, option is to ask agents to rank criteria from most to least important (see the two cases). More intensive discussions are required to arrive at, for instance, quantitative weights. A choice for a particular type of weight (quantitative, comparative, qualitative) usually implies that a particular weight determination technique will be required.
- The choice of weighting mechanism may affect the set of applicable MCA techniques. For instance, many MCA techniques require the availability of quantitative weights. If these are not available, either qualitative weights should be converted into quantitative weights, or an MCA technique should be selected that can cope with qualitative weights.
- Policy-makers (or others) may not want to assign constant weights to a criterion, but be able to vary the level of the weight with the magnitude of the score on the criterion concerned (the impact). In principle some MCA techniques allow for such options, but frequently there will be a need for case-specific MCA software. This limits the scope for widespread application.
- Preferably time should be reserved to discuss the consequences of initially applied weight sets in terms of ranking of alternatives. In such an interactive

approach, the possibility exists to reconsider weight sets and better explore trade-offs. This may be a particularly relevant feature if, in the first round, a particular criterion (for instance costs) has been assigned an unrealistically low or high weight. By outlining the consequences, parties may be willing to adjust weights.

- Sometimes the government, private sector agents or both are not willing to express their views on the relative priority of environmental and other types of objectives in terms of (qualitative or quantitative) weights. In such cases it may be useful to investigate whether weights may be derived from past policies, statements or other forms of communication. Appraisal teams may also impute weights to these agents, while clearly outlining that these are not weights approved by the agents concerned. In this indirect way, consequences of different sets of priorities, assumed to represent interests of various agents in society, may still be explored.

After determination of impacts and weights, the application of one or MCA techniques is the final appraisal step. The range of applicable MCA techniques is restricted by the dimensions of impacts and weights. To account for method uncertainty it is recommended to use several MCA techniques. If they produce roughly the same rankings of alternatives, method uncertainty is not a serious problem. If rankings differ considerably, however, MCA's role in decision-making will be limited.

11.8. Stage VII: Overall conclusions and implementation of optimal alternatives

In the final appraisal stage all information gathered during preceding stages is taken into account to allow a conclusion about the relative performance of project alternatives. If policy-makers are satisfied with the available information, they may decide to reject or approve of a particular alternative. Alternatively, they may commission further studies, for instance to investigate other project designs, to obtain more data on environmental impacts, to enhance insight into the political and social feasibility of proposed natural resource use mechanisms, and so on.

In the discussion on alternatives (stage I.1), it was proposed to investigate a) a wide range of designs for a particular project, particularly to ensure maximum effectiveness in achieving environmental objectives, and b) opportunities elsewhere that would address non-environmental objectives applying to that project. In the final phase the original project and the project elsewhere will be considered simultaneously. Policy-makers should then indicate whether the extra costs of the project elsewhere (opportunity costs) are worth more or less than the benefit of safeguarding certain environmental characteristics in the project area.

A question largely beyond the scope of this study is how to assure that the project alternative that shows the best performance in the appraisal study can actually be implemented. Difficulties may particularly arise if a project is attractive from the viewpoint of society (expressed in the key criteria of economic efficiency, equity and normatively defined sustainability), but meets resistance in the private sector due to, for instance, financial consequences. In addition, different criteria weights of donors and recipient countries may give rise to different views on what is the preferable project alternative.

In the first case, the problem is similar to the traditional problem of a project with a sufficient rate of return in economic terms and an insufficient return in financial terms. Without elaborating in detail on options, first-best solutions include changes in environmental (and non-environmental) policies: removal of price distortions (including those related to environmental goods and services), removal of subsidies and taxes affecting natural resource use, internalization of the costs and benefits of externalities (for instance through a system of tradable permits). Second-best options would include the subsidization of the preferred alternative.

In the second case, the outcome of the opportunity cost exercise referred to above may be an important element in negotiations between recipient and donor countries that hold different views about the priority of environmental conservation and improvement. If application of the opportunity cost principle shows that natural preservation requires the willingness of a government to pay more for or achieve less benefits from socio-economic activities elsewhere, aid funds may be used to support such activities, thereby making preservation of the natural asset a more attractive option. In general, donors may be particularly interested in supporting environmentally attractive, but financially non-viable projects. Such projects generally involve positive environmental externalities, which due to domestic policies are not reflected in market prices. Besides supporting projects directly, donors and recipient countries may also agree to use other instruments, such as debt-for-nature swaps (see for instance Barbier et al., 1991).

11.9. Organisation of appraisal studies

As the two cases illustrate, it is impossible to seriously deal with environmental issues if appraisal teams only comprise of economists, sociologists and other social scientists, as well as agronomists, engineers and other technical experts. Depending on the type of project, an analysis of ecological impacts requires that such specialists work together with ecologists, biologists, hydrologists and so on. Whereas this conclusion applies to the industrialized world, it is especially relevant to developing countries, where data availability is usually weaker. Without participation of specialists in varying fields, ecological impacts cannot be estimated, nor can economic techniques like CBA and CEA be applied. All experts should, however, agree upon and operate within a well-defined methodological framework, to which this chapter has been devoted.

On average, appraisal studies will become more expensive due to the need for an inter-disciplinary rather than a multi-disciplinary approach, involving close co-operation and feedback mechanisms throughout the study. Costs of studies will also increase because more time is required to collect base-line data on ecological processes and to work on models for environmental impact assessment. This especially applies to cases where base-line data are weak, and appraisal teams -for instance- need to investigate complex factors such as maximum sustainable yield. The intensified search for ecological impacts and their consequences for human welfare is likely to constitute over half of the total period available for appraisal. The collection of weight sets of different parties, as a part of MCA, would also demand extra time, especially if interactive procedures are applied. The application of MCA techniques to the collected impacts and weight sets itself does not require much time thanks to the enhanced availability of user-friendly software.

12. RETROSPECT AND PROSPECTS

12.1. Lessons learned about sustainability-oriented project appraisal

In section 1.2 the aim of this study was described as the development of a framework for sustainability-oriented project appraisal, which would explain the treatment of sustainability concerns in each appraisal phase. More in particular, three questions were to be addressed: a) which new issues would arise in the various appraisal phases (i.e. the format of appraisal)? b) what may be project-specific manifestations of the sustainability-related issues?, and c) to what extent are appraisal techniques, viz. CBA and MCA, able to deal with both new questions and their possible manifestations?

The distinction between the three dimensions of the study has been maintained throughout the theoretical (A) and the practical part (B) of the study. To a certain extent this reflects our observations gained in several years of advisory work on development aid programmes. Representatives of government agencies in developing countries and of aid agencies, as well as external advisors, often do either too much or too little justice to appraisal techniques. In the first case, a great concern with the economics of development may go hand in hand with a superficial interest in the empirical limitations of CBA methodology and a rather uncritical review of the project-specific assumptions on which CBA outcomes are based. A comparable attitude is to consider MCA a very attractive appraisal method only because it can address an aid agency's wide range of appraisal criteria.

Others exercise too harsh a judgement on appraisal techniques. The use of CBA may, for instance, be rejected on the ground of the complexity of development. Similarly, some may claim that MCA should not be applied because of the problem of method uncertainty. In our view it is important to recognize that uncertainties associated with development planning are not due to techniques such as CBA and MCA, but are a fact of life. Such techniques may help in efforts to systematically deal with uncertainty and complex environments.

An optimal use of appraisal methods requires that their methodological pros and cons are taken into account, as well as their applicability in different institutional contexts and practical circumstances. Such an approach leads to an optimal use of techniques, as well as to appropriate modesty about their results. This philosophy underlies this study about the questions of how to incorporate sustainability concerns in project appraisal, and of how to determine the applicability of MCA and CBA.

Second, factors such as: a) the a priori choice of a methodology, b) time available for appraisal, c) data collected in the available period, d) composition of the study team, and e) institutional context, have set constraints on the extent to which the theoretical framework could be implemented in practice. In the Egypt-case, much more issues could be covered and in greater depth than in the Colombia-case because of more favourable institutional circumstances. Rarely, however, will the situation allow a comprehensive use of the theoretical framework.

Third, the cases show that the possibility to use CBA and MCA as well as the usefulness of their results is determined by the same factors mentioned above: EIA results, decision-makers interests, team composition, and so on. Differences in these fields explain why in the Colombia-case CBA could not be applied and MCA was not desired, and why in the Egypt-case the use of both methods was requested, possible and useful. Consequently, in the Colombia-case, decision-makers could just be provided a systematic, though qualitative impression regarding impacts of project components, and an identification of some trade-offs. However, no concrete economic justification for the project or its specific components could be given. In contrast, in the Egypt case decision-makers obtained a fairly comprehensive picture about possible development policies for Lake Burullus, and about a) interrelated economic and ecological impacts, b) economic feasibility, c) different views in society about the desirability of the alternatives, d) the opportunity costs of preservation of a natural asset, and e) possible financing mechanisms.

The practical framework developed in part B reflects the findings of the cases. While the basic structure of the theoretical framework has been preserved, its focus is more oriented towards possible practical manifestations of sustainability issues. It is also flexible: it incorporates relatively few obligatory steps and many moments where a set of options is offered (for instance, regarding the use of appraisal methods). It is the combination of comprehensiveness and flexibility which distinguishes this study from other publications on environment and project appraisal, which focus on a single subject such as EIA, valuation techniques, or MCA.

A flexible use of CBA and MCA is appropriate in view of both methodological and practical features of these techniques. In sustainability-oriented appraisal, CBA would be the preferred tool to assess efficiency if sufficient data are available. However, data about environmental effects and their value to society may be scarce. Consequently, evaluators will need to make numerous assumptions about ecological-economic interaction and about the valuation of environmental goods and services, which will often introduce a significant subjective element in their studies. Moreover, CBA outcomes may be incompatible with long-term sustainability concerns due to mechanic application of discounting. By definition, MCA is better suited to address integrated evaluation, covering the three key criteria. MCA outcomes, however, necessarily involve asssumptions about methodological parameters such as choice of techniques for weight determination, standardization, and overall evaluation. These factors as well as the need to make value judgements explicit may be obstacles to a wide scale use of MCA in developing countries. The framework of part B provides guidelines for the project-specific choice of appraisal techniques, as well as for a proper treatment of empirical and methodological uncertainty.

12.2. The validity of the framework

The proposed framework for sustainability-oriented project appraisal may be applied in both developed and developing countries. It has, however, special relevance to developing countries. First, the framework focuses on environmental issues and their relation with the economy. This implies that it would be of most interest to countries that strongly depend on the use of natural resources. Many developing countries have such economies. Second, due to the relatively weak data base in many developing countries, the analysis of project appraisal teams is often founded on "soft" information. This study is particularly concerned with the treatment of such data. Third, the framework appears to cover the main issues that -according to lessons learned over the past decades of development co-operation- determine the success of development projects. This may be illustrated by a recent analysis of the Directorate General for Development of the Commission of the European Communities, based on an evaluation of the work of the national aid agencies in numerous sectors and countries (Eggers, 1992). Below the key lessons are mentioned, and the relation with the framework presented in this study is indicated.

Factor determining the success of a project according to EC	Corresponding issue in the framework for sustainability-oriented appraisal
The existence of a policy environment favourable to the project.	Emphasis on ecological and economic profiles, and the role of policies in ecological-economic interaction models.
The protection of the environment and the renewable resources.	Stressed in all stages (alternatives, criteria, impacts, etc).
The respect for socio-cultural variables as to ensure sustained involvement of the people.	The socio-economic system description as a basis for impact assessment, as well as the analysis of the means and objectives of all groups possibly affected by or involved in a project.
The institutional and management capacity to run the project properly.	Careful analysis of the capacities and objectives of all government agencies at all levels involved in the project.
The design of the project should be flexible to ensure the resilience of the project.	Careful design and review of alternatives, also in view of the ecological and economic systems they would affect.
Economic and financial soundness.	Efficiency as a key appraisal criterion; cost recovery as an issue in the question whether the project can be implemented.

The framework would be applicable to all types of ecologically-sensitive projects. Although the findings of the two cases have played an important role in the development of the practical framework, its relevance is not confined to projects in the -extensive- field of management of forests, wetlands and other ecologically-sensitive areas (through forestry, fisheries, agriculture, etc.). An important reason to assume that the framework may have relevance to other activities as well is that its main components are essential to choice problems in any sector: alternatives, criteria, relative priority of criteria (weights), base-line data as a basis for impact assessment, and integrated evaluation. With regards to the use of techniques, CBA nor MCA is confined to specific sectors.

Differences may be expected, however, in terms of intermediate and final results obtained during application of the framework. Particularly in the impact assessment phase differences will occur. For instance: it will generally be easier to quantify localized environmental impacts of the construction of a dam, than transboundary contributions to acidification due to an industrial power plant. Or: the loss of a natural area due to the construction of a highway is easier to predict than the possible contribution of reforestation to mitigation of the greenhouse phenomenon. And such differences would translate into the use of different appraisal techniques. Such questions can be accounted for within the framework, and do not affect its structure.

12.3. Limitations of the framework and suggestions for further research

The framework developed in this study has several limitations, some of which are due to shortcomings of the framework itself, whereas others follow from the limited scope of the study. Such limitations include:

- The framework starts from the assumption that because governments and aid agencies have committed themselves to the objective of sustainable development, they would also be interested in the incorporation of this objective in the appraisal of development projects. As the Colombia case illustrates, this hypothesis need not always be correct.
- The issue of the level at which the EUS should be defined needs further clarification. A distinction has been made between a project-, a programme-, a national-, and a global-level approach. An interesting question is the level which policy-makers will take as a point of reference. Much can be said in favour of defining sustainability thresholds at supra-project levels, and imposing effective instruments at the corresponding level. However, until now effective instruments at the level of regions or countries are scarce. For instance, the instrument of tradable permits for pollution at such levels does not seem an option that many developing countries will introduce in the near future. Nor have instruments been implemented that assure that agricultural activities in ecologically fragile areas acknowledge the carrying capacity of soils. In such conditions, applying sustainability constraints at the project level is more feasible. However, it has been argued that not every single activity should be required to fulfil such constraints. This study has not found a way out of this dillemna.
- In general, the framework assumes that environmental policies are still weak compared to traditional socio-economic policies. In other words, if a country succeeds in integrating economic and environmental policies, the need for a project-level approach as outlined here is reduced.
- The strengths and weaknesses of both CBA and MCA have been exogenous to the study. Our recommendations regarding the use of these tools acknowledged the present state of the art. Future methodological progress, not necessarily related to sustainability-oriented project appraisal, may be a reason to adjust the framework. Similarly, more experience with the use of MCA in developing countries, particularly in terms of the issues that determine its acceptability to policy-makers, may lead to adjustments.
- The study focuses on project appraisal, not on the question of how to implement projects that appraisal studies recommend for approval. Projects

aimed at long-term environmental protection, however, may raise serious problems of financing and organisation.

Further research, both through theoretical and empirical work, would be required to to improve and refine the framework. The following issues would be of most interest:

- What is the scope for a more thorough analysis of possible alternatives, particularly in terms of their ability to achieve environmental objectives, and for adjustments to their design in the course of an appraisal? Of special interest is the possibility to simultaneously explore alternatives for a particular project and options to achieve non-environmental objectives in other ways than through that project (see Egypt-case).
- To what extent are policy-makers (including donor agencies) able and willing to define specific environmental thresholds for individual projects, particularly in terms of a separate sustainability criterion? This question is at the core of sustainability-oriented project appraisal. A greater role of normative issues would greatly change the nature of project appraisal. Strong institutional factors, however, might impede such an evolution.
- What would be the optimal level at which the EUS may be defined, considering existing and possible future policy instruments? This touches upon a moral as well as a technical question, which could not fully be resolved in this study. A promising approach may be to integrate progress in the field of project appraisal and regional development.
- Do policy-makers agree with the necessity to devote more time to ecological-economic modelling and impact assessment, even if this would increase cost of appraisal studies? Such changes are essential but budgetary constraints may block them. If more funds would be devoted to this field, ecologists, economists and other specialists will need to learn to improve cooperation and integration of findings.
- What opportunities do decision-makers provide for the estimation of economic valuation of environmental impacts? This question determines to a great extent the role CBA may play in future sustainability-oriented appraisal studies.
- What is the institutional feasibility of introducing MCA as an additional appraisal tool, besides traditional CBA? In developing countries, more experience with MCA is desirable to better understand its potential. Its flexibility may be expected to raise enthusiasm, but institutional factors may have the opposite impact.
- To what extent are appraisal teams allowed to investigate the political nature of projects involving natural resources, and to derive weight sets from discussions with public and private sector representatives? At first sight this issue would seem a severe bottleneck, but the Egypt-study shows that this need not be so. In any case, the position of poor groups dependent on

natural resource exploitation deserves to be treated as a key issue in project appraisal in developing countries.

Two other challenges remain. The first would be to develop a manual for sustainability-oriented project appraisal on the basis of the present study. The second would be to incorporate the principles of sustainability-oriented project appraisal in traditional texts on project appraisal.

REFERENCES

Adams, W.M. (1990), *Green development*, Routledge, London
ADB (Asian Development Bank) (1988), *Guidelines for integrated regional economic-cum-environmental development planning*, Environment paper no 3, vol 1, Environment Unit, Manila
ADB (Asian Development Bank) (1991), *Environmental evaluation of coastal zone projects: methods and approaches*, Manila
Ahmad, Y.J., S. El Serafy and E. Lutz (eds)(1989), *Environmental accounting for sustainable development*, World Bank, Washington
Ancot, J.-P., and J.H.P. Paelinck (1982), "Recent experience with the Qualiflex multicriteria method", in: J.H.P. Paelinck (ed), *Qualitative and quantitative mathematical economics*, Martinus Nijhoff, The Hague
Ancot, J.-P., and J.H.P. Paelinck (1990), *Modèles et choix: une initiation á la modélisation pour pays en développement*, Universites Francophones UREF, Economica, Paris
Anderson, D. (1989), "Economic aspects of afforestation and soil conservation projects"; in G. Schramm and J.J. Warford (eds), *Environmental management and economic development*, World Bank, John Hopkins University Press, Baltimore
Anderson, M.B. (1990), *Analyzing the costs and benefits of natural disaster responses in the context of development*, Environment working paper no 29, Environment Department, World Bank, Washington
Archibugi, F., and P. Nijkamp (eds)(1989), *Economy and ecology: towards sustainable development*, Kluwer Academic Publishers, Dordrecht
Archibugi, F., P. Nijkamp and F.J. Soeteman, "The challenge of sustainable development", in F. Archibugi and P. Nijkamp (eds)(1989), *Economy and ecology: towards sustainable development, Kluwer Academic Publishers*, Dordrecht
Arrhenius, E., and T.W. Waltz (1990), *The greenhouse effect: implications for economic development*, Discussion paper 78, World Bank, Washington DC
Balassa, B. (1976), "The 'effects method' of project evaluation", *Oxford Bulletin of Economics and Statistics*, 38 (4), 219-231
Barbier, E.B. (1989), *Economics, natural resource scarcity and development: conventional and alternative views*, Earthscan Publications, London
Barbier, E., J. Burgess, A. Markandya, J. Arntzen, A. Gilbert, O. Kuik and H. Verbruggen (1991), *Environmentally sensitive project appraisal*, report for the Netherlands Ministry of Foreign Affairs (DGIS), LEEC/IVM, London/Amsterdam
Barde, J.-P., and D.W. Pearce, (1991), *Valuing the environment*, Earthscan, London
Barnes, D.F. and J. Olivares (1988), *Sustainable resource management in agriculture and rural development projects*: a review of bank policies, procedures, and results, Environment working paper no 5, Environment Department, World Bank, Washington
Batie S.S. (1989), "Sustainable development: challenges to the profession of agricultural economics", *American Journal of Agricultural Economics*, 71, 1083-1101
Baum, W.C., and S.M. Tolbert (1985), *Investing in development: lessons of World Bank experience*, World Bank/Oxford University Press, New York
Beckerman, W. (1992), "Economic growth and the environment: whose growth? whose environment?", *World Development*, 20(4), 481-496
Bie, S.W. (1990), *Dryland degradation measurement techniques*, Environment working paper no 26, Environment Department, World Bank, Washington
Binswanger, H.P. (1989), *Brazilian policies that encourage deforestation in the Amazon*, Environment working paper no 16, Environment Department, World Bank, Washington

Biswas, A.K., and Q. Geping (eds.) (1987), *Environment impact assessment for developing countries*, Tycooly Publishing, London

Bojö, J., K.G. Mäler, L. Unemo (1990), *Environment and development: an economic approach*, Kluwer, Dordrecht

Braat, L.C., and W.F.J. van Lierop (eds)(1987), *Economic-ecological modelling*, North-Holland, Amsterdam

Breman, H. (1990), "No sustainability without external inputs", in: Ministry of Foreign Affairs (ed), *Sub-saharan Africa: beyond adjustment*, The Hague

Brent, R.J. (1990), *Project appraisal in developing countries*, Harvester Wheatsheaf, Hertfordshire

Chankong, V., and Y.Y. Haimes (1983), *Multiobjective decision making*, North Holland, New York

Chapman, D., and R. Barker (1991), "Environmental protection, resource depletion, and the sustainability of developing country agriculture", *Economic Development and Cultural Change*, 39(4), 723-737

Chenery, H., and T.N. Srinivasan (eds) (1988), *Handbook of development economics*, North-Holland, Amsterdam

Collard, D., D.W. Pearce and D. Ulph (1988), *Economics, growth and sustainable environments*, MacMillan, London

Cook, P. and P. Mosley (1989), "On the valuation of 'external effects' in project appraisal", *Project Appraisal*, 4(3), 143-150

Cooper, C.M. (1981), *Economic evaluation and the environment*, published for the United Nations Environment Programme by Hodder and Stoughton, London

Cox, L.C. (1991), "Introduction: facts and uncertainties", *Energy Journal*, 12(1), 1-8

Cracknell, B. (1989), "Evaluating the effectiveness of the Logical Framework system in practice", *Project Appraisal*, 4(3), 163-167

Cropper, M.L., and W.E. Oates (1992), "Environmental economics: a survey", *Journal of Economic Literature*, XXX (June), 675-740

Daly, H.E. (1989), "Towards some operational principles of sustainable development", *Ecological Economics*, 1(4), 1-6

Daly, H.E. (1990), "Towards environmental macroeconomics", paper presented at the international congress "The ecological economics of sustainability", World Bank, Washington DC, 21-23 May 1990

Daly, H.E. (1992), "Allocation, distribution and scale: towards an economics that is efficient, just and sustainable", *Ecological Economics*, 6(3), 185-192

Dasgupta, P., S. Marglin and A. Sen (1972), *Guidelines for project evaluation*, UNIDO, New York

Dasgupta, A.K., and D.W. Pearce (1978), *Cost-benefit analysis*, MacMillan, London

Dasgupta, P., and K.G. Mäler (1991), "The environment and emerging development issues", in: *Proceedings of the World Bank annual conference on Development economics 1990*, World Bank, Washington D.C.

De Boo, B., P. Bosch, C. Gorter and S. Keuning (1991), "An environmental module and the complete system of national accounts", paper for the special IARIW conference on Environmental accounting, 27-29 May 1991, Netherlands Central Bureau of Statistics, Voorburg

De Groot, R.S. (1992), *Functions of Nature*, Wolters-Noordhoff, Groningen

Despotakis, V.K. (1991), *Sustainable development planning using Geographic Information systems*, PhD thesis, Free University, Amsterdam

Dixon, J.A., R.A. Carpenter, L.A. Fallon, P.B. Sherman and S. Manopimoke (1988), *Economic analysis of the environmental impacts of development projects*, Earthscan Publications, London

Dixon, J., and M. Hufschmidt (eds)(1986), *Economic valuation techniques for the environment: a case study workbook*, Johns Hopkins, Baltimore

Dixon, J.A., D.E. James, and P.B. Sherman (1989), *The economics of dryland management*, Earthscan, London

Dorfman, R. (1988), "Benefit-cost analysis of environmental protection programs in less developed countries", *International Journal of Development Planning Literature*, 3(3), 111-128

Drèze, J., and N. Stern (1987), "The theory of cost-benefit analysis", in A.J. Auerbach and M. Feldstein (eds), *Handbook of public economics*, vol II, Elsevier Science Publishers, Dordrecht

ECLAC (Economic Commission for Latin America and the Caribbean)(1991), *Sustainable development: changing production patterns, social equity and the environment*, Santiago

Eggers, H. (1992), "The integrated approach to project cycle management", *Project Appraisal*, 7(1), 3-10

EIP-Cell (1986), *Report of the appraisal mission 1986*, Bangladesh Water Development Board, Dhaka

Fisher, A.C., J.V. Krutilla and C.J. Cichetti (1972), "The economics of environmental preservation: a theoretical and empirical analysis", *American Economic Review*, 62, 605-619

Folmer, H., and E.C. van Ierland (eds)(1989), *Valuation methods and policy making in environmental economics*, Elsevier, Amsterdam

Foy, G., and H. Daly (1989), *Allocation, distribution and scale as determinants of environmental degradation: case studies of Haiti, El Salvador and Costa Rica*, Environment working paper no 19, Environment Department, World Bank, Washington

Freeman, A.M. III (1979), *Benefits of environmental improvement: theory and practice*, Johns Hopkins University Press, Baltimore

Fresco, L., H. Huizing, H. Luning and R. Schipper (1989), *Land evaluation and farming systems analysis for land use planning*, FAO, Rome

Friend, A.M., and D.J. Rapport (1991), "Evolution of macro-information systems for sustainable development", *Ecological Economics*, 3(1), 59-76

Gijsbers, D., and P. Nijkamp (1987), *Non-uniform social rates of discount in natural resource models: an overview of arguments and consequences*, Research memorandum 1987-73, Free University, Amsterdam

Gillis, M., D.H. Perkins, M. Roemer and D.R. Snodgrass (1992), *Economics of development*, 3rd ed, Norton, New York

Goodland, R.J.A. (1989), "The environmental implications of major projects in Third World development", in P. Morris (ed), *Major projects and the environment*, Major Projects Association, Oxford

Goodland, R.J.A., H.E. Daly and S. El Sarafy (eds) (1991), *Environmentally sustainable economic development building on Brundtland*, Environment Working Paper no 46, Environment Department, World Bank, Washington DC

Goodland, R.J.A., and G. Ledec (1987), "Neoclassical economic and principles of sustainable development", *Ecological Modelling*, 38(1987), 19-46

Gottfried, R.R. (1990), "The value of a watershed as a series of linked multiproduct assets", paper presented at the international congress "The ecological economics of sustainability", World Bank, Washington DC, 21-23 May 1990

Green, C.H., S.M. Tunstall, A. N'Jai and A. Rogers (1990), "Economic evaluation of environmental goods", *Project Appraisal*, 5(2), 70-82

Hacker, R. (1988), "The Delphi technique", *Project Appraisal*, 3(1), 55-56

Hall, D.C., and J.V. Hall (1984), "Concepts and measures of natural resource scarcity with a summary of recent trends", *Journal of Environmental Economics and Management*, 11, 363-379

Hanley, N. (1992), "Are there environmental limits to cost benefit analysis?", *Environmental and Resource Economics*, 2, 33-59

Hanley, N., and S. Graig (1991), "Wilderness development decisions and the Krutilla-Fisher model: the case of Scotland's 'flow country'", *Ecological Economics*, 4, 145-164

Hardoy, J.E., and D. Satterthwaite (1991), "Environmental problems of Third World cities: a global issue ignored?", *Public Administration and Development*, 11, 341-361

Hartog, J.A., E. Hinloopen and P. Nijkamp (1989), "A sensitivity analysis of multi-criteria choice methods", *Energy Economics*, (October 1989), 293-300

Hayami, Y., and V.W. Ruttan (1985), *Agricultural development: an international perspective*, Johns Hopkins Press, Baltimore

Hedman, S. (1990), "Reversibility as a weighting factor in integrated least cost planning methodologies", reversed version of paper presented at the international congress "The ecological economics of sustainability", World Bank, Washington DC, 21-23 May 1990, University of Maryland, College Park

Heijman, W.J.M. (1991), *Depletable resources and the economy*, PhD. thesis, Wageningen Agricultural University

Helm, D., and D.W. Pearce (1990), " Assessment: economic policy towards the environment", *Oxford Review of Economic Policy*, special edition, 6 (1), 1-16

Hill, M. (1973), *Planning for multiple objectives: an approach to the evaluation of transport problems*, Regional Science Research Institute, Philadelphia

Hinloopen, E., P. Nijkamp and P. Rietveld (1982), "The Regime method: a new multicriteria method", in P. Hansen (ed), *Essays and surveys on multiple criteria decision making*, Springer, Berlin

Hufschmidt, M.M., D.E. James, A.D. Meister, B.T. Bower and J.A. Dixon (1983), *Environment, natural systems and developments: an economic valuation guide*, John Hopkins University Press, Baltimore

Hueting, R. (1980), *New scarcity and economic growth*, North-Holland, Amsterdam

Hueting, R. (1990), "Correcting of national income for environmental losses: a practical solution for a theoretical dillema", paper presented at the international congress "The ecological economics of sustainability", World Bank, Washington DC, 21-23 May 1990

IOV (Inspectie Ontwikkelingssamenwerking te Velde) (1992), *Milieu en ontwikkelingssamenwerking*, Directorate-General for International Co-operation, The Hague

Irvin, G. (1978), *Modern cost-benefit methods*, Macmillan, London

Jagannathan, N.V. (1989), *Poverty, public policies and the environment*, Environment working paper no 24, Environment Department, World Bank, Washington DC

Jagannathan, N.V., H. Mori and H.M. Hassan (1990), *Applications of geographical information systems in economic analysis: a case study of Uganda*, Environment working paper no 27, Environment Department, World Bank, Washington DC

James, D.E., H.M.A. Jansen and J.B. Opschoor (1987), *Economic approaches to environmental problems*, Elsevier, Amsterdam

Janssen, R. (1992), *Multiobjective decision support for environmental management*, Kluwer, Dordrecht

Kanbur, R. (1990), *Projects versus policy reform*, paper presented at the World Bank annual conference on Development economics, April 26 and 27, 1990, Washington D.C.

Klaassen, H.L., and D.J.D. Wijnmalen (1988), "Multicriteria analyse: nuttig middel voor overheidsbesluitvorming?", *Beleidsanalyse*, 88-1, 26-32

Klaassen, L.H., and T.H. Botterweg (1976), "Project evaluation and intangible effects: a shadow project approach", in P. Nijkamp (ed), *Environmental economics*, vol 1 (theories), Martinus Nijhoff, The Hague

Klaassen, L.H., and R. Iwema (1981), "Het probleem van de discontering", *Economisch Statische Berichten*, 25-11-1981, 1167-1170

Kneese, A.V., and J.L. Sweeney (1985), *Handbook of natural resources and environmental economics*, volume 1 and 2, North-Holland, Amsterdam

Kula, E. (1988), "Future generations: the modified discounting method", *Project Appraisal*, 3(2), 85-88

Kuyvenhoven, A., and L.B.M. Mennes (1985), *Guidelines for project appraisal*, Government Printing Office, The Hague

Lélé, S.M. (1991), "Sustainable development: a critical review", *World Development*, 19(6), 607-621

Lichfield, N. (1988-a), "The cost-benefit approach in plan assessment", paper presented at the international colloquim "Assessment methods in urban and regional planning", Napels, April 1988

Lichfield, N. (1988-b), "The use of community impact evaluation in planning assessment: East Midlands airport expansion", paper presented at the international colloquim "Assessment methods in urban and regional planning", Napels, April 1988

Lichfield, N. (1992), "The integration of environmental assessment into development planning", *Project Appraisal*, 7(2), 58-66

Lichfield, N., and D. Lichfield (1992), "The integration of environmental assessment and development planning: Part 2, a case study", *Project Appraisal*, 7(3), 175-185

Lind, R.C. (1990), "Reassessing the governments discount rate policy in light of new theory and data in a world economy with a high degree of capital mobility", *Journal of Environmental Economics and Management*, 18 (2, part 2), S8-S28

Little, I.M.D., and J.A. Mirrlees (1974), *Project appraisal and planning for developing countries*, Heinemann Educational Books, London

Little, I.M.D., and J.A. Mirrlees (1991), "Project appraisal and planning twenty years onwards", in: *Proceedings of the World Bank annual conference on Development economics 1990*, World Bank, Washington, D.C.

Mahar, D. (1988), *Government policies and deforestation in Brazil's Amazon region*, Environment working paper no. 7, Environment Department, World Bank, Washington DC

Mäler, K-G. (1985), "Welfare economics and the environment", in A.V. Kneese and J.L. Sweeney (eds), *Handbook of natural resource and energy economics*, vol 1, North-Holland, Amsterdam

Mäler, K-G. (1991), "National accounts and environmental resources", *Environmental and Resource Economics*, 1(1), 1-16

Markandya, A., and D.W. Pearce (1987), *Environmental considerations and the choice of the discount rate in developing countries*, report prepared for the Overseas Development Administration, London

Massam, B.H. (1988), "Multi-criteria decision making (MCDM) techniques in planning", *Progress in Planning*, 30, 1-84

McGaugney, S.E. (1980), *Investment criteria for agricultural and rural development projects*, Reprint series no 105, Inter-American Development Bank, Washington DC

Mikesell, R.F. (1991), "Project evaluation and sustainable development", in: R. Goodland, H. Daly and S. El Sarafy (eds), *Environmentally sustainable economic development building on Brundtland*, Environment Working Paper no 46, Environment Department, World Bank, Washington DC

Mikesell, R.F. (1992), "Project evaluation and resource sustainability", *Contemporary Policy Issues*, X(4), 83-88

Ministry of Finance (1986), *Evaluatiemethoden: een introductie*, 3rd edition, Government Printing Office, The Hague

Ministry of Foreign Affairs, Directorate-General for International Co-operation (1990), *Een wereld van verschil. Nieuwe kaders voor ontwikkelingssamenwerking in de jaren negentig*, Tweede Kamer der Staten-Generaal, 1990-1991, 21813, 1-2, SDU, The Hague

Ministry of Housing, Physical Planning and Environment / Ministry of Agriculture, Nature and Fisheries (1992), *Inventarisatieonderzoek "wegen van effecten"*, Den Haag

Mishan, E.J. (1988), *Cost-benefit analysis*, 4th edition, George Allen and Unwin, Boston

Munasinghe, M. (1992), *Environmental economics and valuation in development decisionmaking*, Environment working paper no 51, Environment Department, World Bank, Washington DC

Munasinghe, M., and E. Lutz (1991), *Environmental-economic evaluation of projects and policies for sustainable development*, Environment working paper no. 42, World Bank, Washington D.C.

Musgrave, R.A. (1964), *Fiscal systems*, Yale University Press

Myers, N. (1989), *Natural resource systems and human exploitation systems: physiobiotic and ecological linkages*, Environment working paper no. 12, Environment Department, World Bank, Washington DC

Nentjes, A. (1989), "Macroeconomic cost-benefit analysis of environmental programmes", in H. Folmer and E. van Ierland (eds), *Valuation methods and policy making in environmental economics*, Elsevier, Amsterdam

Nijkamp, P. (1977), *Theory and application of environmental economics*, North-Holland, Amsterdam

Nijkamp, P. (1979), *Multidimensional spatial data and decision analysis*, John Wiley, Chichester

Nijkamp, P (1989), "Multicriteria analysis: a decision support system for sustainable environmental management", in F. Archibugi and P. Nijkamp (eds), *Economy and ecology: towards sustainable development*, Kluwer Academic Publishers, Dordrecht

Nijkamp, P. (1991), "Climate change, sea-level rise and Dutch defense strategies", *Project Appraisal*, 6(3), 143-148

Nijkamp, P. in collaboration with J. van den Bergh and F. Soeteman (1991), "Regional sustainable development and natural resource use", *Proceedings of the World Bank annual conference on Development economics 1990*, World Bank, Washington D.C.

Nijkamp, P, and M.J.F. van Pelt (1987), "Spatial and urban impact analysis for developing countries: methodology and application", *International Journal of Development Planning Literature*, 2 (3), 138-172

Nijkamp, P. and M.J.F. van Pelt (1989), "Spatial impact analysis in developing countries", *International Regional Science Review*, 12(2), 211-228

Nijkamp, P. and M.J.F. van Pelt (1991), "Spatial impact analysis for developing countries: a framework and a case-study", in Shri Bhagwan Dahiya (ed), *Theoretical foundations of development planning*, vol. IV, Vedam Books, New Delhi

Nijkamp, P., P. Rietveld and H. Voogd (1990), *Multicriteria evaluation in physical planning*, North-Holland, Amsterdam

Nijkamp, P., H. Schaffers and J. Spronk (1989), "Multiple futures and multiple discount rates in multi criteria analysis", *Project Appraisal*, March 1989, 2-8

Norgaard, R.B., and R.B. Howard (1991), "Sustainability and discounting the future", in R. Constanza (ed), *Ecological economics: the science and management of sustainability*, Colombia University Press, New York

ODA (Overseas Development Administration) (1988), *Appraisal of projects in developing countries*, 3rd ed, HMSO, London

OECD (1989), *Sustainability in development programmes: a compendium of evaluation experience*, Paris

OECD (1990), *Development co-operation 1990 report*, Paris

OECD (1992), *Market and government failures in environmental management: wetlands and forests*, Paris

Opschoor, J.B. (1987), *Duurzaamheid en verandering*, inaugural lecture, Free University, Amsterdam

Opschoor, J.B. (1992), "Sustainable development, the economic process and economic analysis", in: J.B. Opschoor (ed), *Environment, economy and sustainable development*, Wolters-Noordhoff, Amsterdam

Opschoor, J.B., and L. Reijnders (1991), "Towards sustainable development indicators", in O. Kuik and H. Verbruggen (eds), *In search of indicators for sustainable development*, Kluwer, Dordrecht

Opschoor, J.B., and J. van der Straaten (1991), "Sustainable development: an institutional approach", paper presented at the annual meeting of the European Association of Environmental and Resource Economists, Stockholm, June 10-14, 1991

Pearce, D.W. (1976), "The limits of cost-benefit analysis as a guide to environmental policy", *Kyklos*, 29, 97-112

Pearce, D.W., E.B. Barbier and A. Markandya (1990), *Sustainable development: economics and environment in the Third World*, Edward Elgar, Aldershot

Pearce, D.W., E.B. Barbier and A. Markandya (1991), *Blueprint 2: greening the world economy*, Earthscan, London

Pearce, D.W., and R.K. Turner (1989), *Economics of natural resources and the environment*, Wheatsheaf Books, Brighton

Pearce, D.W., R.K. Turner and I. Bateman (1992), *Environmental economics*, Harvester Wheatsheaf, Brighton

Pearse, P.H. (1991), "Scarcity of natural resources and the implications for sustainable development", *Natural Resources Forum*, 15(1), 74-79

Peskin, H.M (1989), *Accounting for natural resource depletion and degradation in developing countries*, Environment working paper nr 13, Environment Department, World Bank, Washington DC

Peskin, H.M., with E. Lutz (1990), *A survey of resource and environmental accounting in industrialized countries*, Environment working paper no 37, Environment Department, World Bank, Washington DC

Pétry, F. (1990), "Who is afraid of choices? A proposal for multi-criteria analysis as a tool for decision-making support in development planning", *Journal of International Development*, 2 (2), 209-231

Pezzey, J. (1989), *Economic analysis of sustainable growth and sustainable development*, Environment working paper no 15, Environment Department, World Bank, Washington DC

Powers, T.A. (ed)(1981), *Estimating accounting prices for project appraisal*, Inter-American Development Bank, Washington DC

Quiggin, J., and J. Anderson (1991), "Risk and project appraisal", in: *Proceedings of the World Bank annual conference on Development economics 1990*, World Bank, Washington D.C.

Rawls, J. (1972), *A theory of justice*, Oxford University Press, Oxford

Ray, A. (1984), *Cost-benefit analysis*, World Bank publication, Johns Hopkins University Press, Baltimore

RDC (Rural Development Consultants)(ed)(1991), *The control of reservoir sedimentation*, report for Ministry of Foreign Affairs, The Hague

Rees, W.E. (1988), "A role for environmental assessment in achieving sustainable development", *Environmental Impact Assessment Review*, 1988(8), 273-291

Rees, W.E. (1990), "Why economics won't save the world", paper presented at the international congress "The ecological economics of sustainability", World Bank, Washington DC, 21-23 May 1990

Reijnders, L. (1990), "Normen voor milieuvervuiling met het oog op duurzaamheid", *Milieu*, 1990-5, 138-140

Repetto, R. (1987), "Economic incentives for sustainable development", *The Annals of Regional Science*, XXI(3), 44-59

Repetto, R. (1988), *Economic policy reform for natural resource conservation*, Environment working paper no. 4, Environment Department, World Bank, Washington DC

Repetto, R., W. Magrath, M. Wells, C. Beer and F. Rossini, (1989), *Wasting Assets: Natural Resources in the National Income Accounts*, World Resources Institute, Washington DC

Romero, C. and T. Rehman (1989), *Multiple criteria analysis for agricultural decisions*, Developments in agricultural economics 5, Elsevier, Amsterdam
Sachs, I. (1989), "Sustainable development: from normative concept to action", paper presented at the seminar on Environment, 30th annual meeting of the board of governers of the Inter-American Development Bank, Institute of Social Studies, The Hague, March 22, 1989
Sang, H.K. (1988), *Project evaluation: techniques and practices for developing countries*, Wilson Press, New York
Schärlig, A. (1985), *Décider sur plusieurs critères*, Presses Polytechniques Romandes, Lausanne
Schramm, G., and J.J. Warford (eds) (1989), *Environmental management and economic development*, Johns Hopkins University Press, Baltimore
Seneca, J.J., and M.K. Taussig (1984), *Environmental economics*, third edition, Prentice-Hall, London
Seo, F., and M. Sakawa (1988), *Multiple criteria decision analysis in regional planning: concepts, methods and planning*, D. Reidel, Dordrecht
SER (Sociaal-Economische Raad)(1991), *Economie en milieu*, report of the Commission economic experts on environment and economics, publication nr 91/18, The Hague
Siebert, H. (1982), "Nature as a life support system. Renewable resources and environmental disruption", *Journal of Economics*, 42(2), 133-142
Siebert, H. (1985), "Spatial aspects of environmental economics", in A.V. Kneese and J.L. Sweeney (eds), *Handbook of natural resource and energy economics*, vol 1, North-Holland, Amsterdam
Smith, V.K. (1986), "A conceptual overview of the foundations of benefit-cost analysis", in J.D. Bentkover, V.T. Covello and J. Mumpower (eds), *Benefits assessment: the state of the art*, D. Reidel, Dordrecht
Soeteman, F.J. (1988), *Ecologische duurzaamheid en economische ontwikkeling*, Raad voor het Milieu- en Natuuronderzoek, Rijswijk
Solow, R.M. (1988), "On the intergenerational allocation of natural resources", *Scandinavian Journal of Economics*, 88(1), 141-149
Squire L., and H.G. van der Tak (1975), *Economic analysis of projects*, Johns Hopkins University Press, Baltimore
Squire, L. (1989), "Project evaluation in theory and practice", in H. Chenery and T.N. Srinivasan (eds), *Handbook of development economics*, vol II, Elsevier Science Publishers, Dordrecht
Stewart, F., and E. Ghani (1991), "How significant are externalities for development?", *World Development*, 19(6), 569-594
Summers, L.H. (1992), "Summers on sustainable growth", *The Economist*, May 30, 1992
Ten Brink, B.J.E. (1991), "The AMOEBA approach as a useful tool for establishing sustainable development?", in O. Kuik and H. Verbruggen (eds), *In search of indicators for sustainable development*, Kluwer, Dordrecht
Theil, H (1964), *Optimal decision rules for government and industry*, North-Holland, Amsterdam
Thiriez, H., and S. Zionts (eds)(1976), *Multiple criteria decision making*, Springer Verlag, Heidelberg
Tinbergen, J. (1952), *On the theory of economic policy*, North-Holland, Amsterdam
Tisdell, C. (1988), "Sustainable development: differing perspectives of ecologists and economists, and relevance to LDCs", *World Development*, 16(3), 373-384
Todaro, M.P. (1989), *Economic development in the Third World*, 4th ed, Longman, New York
Toman, M.A., and P. Crosson (1991), *Economics and sustainability: balancing tradeoffs and imperatives*, working paper ENR-91-05, Resources for the Future, Washington D.C.
UNDP (United Nations Development Programme)(1992), *Human Development Report 1992*, Oxford University Press, New York

Winpenny, J.T. (1991), *Values for the environment*, HMSO, London

World Bank (1991), *Environmental assessment sourcebook*, volumes 1-3, Environment Department, Technical papers nrs 139, 140 and 154, World Bank, Washington DC

World Bank (1992), *World development report 1992/Development and environment*, Johns Hopkins, Baltimore

World Resources Institute (1991), *World resources 1991-92*, Oxford University Press, New York

Zeleny, M. (1982), *Multiple criteria decisionmaking*, Wiley, New York

Zionts, S. (1989), "Multiple criteria mathematical programming: an updated overview and several approaches", in B. Karpak and S. Zionts (eds), *Multiple criteria decision making and risk analysis using computers*, Springer-Verlag, Berlin

SAMENVATTING

Doel van de studie

Evenals vele andere takken van de wetenschap buigt de economie zich steeds meer over de plaats die het begrip ecologisch duurzame ontwikkeling moet krijgen in het theoretisch en toegepast onderzoek. Daarbij doen zich drie vragen voor. Ten eerste, wat wordt onder duurzame ontwikkeling verstaan? De steeds bredere consensus dat milieu en welvaart elkaar wederzijds beïnvloeden, is een belangrijk aanknopingspunt, maar biedt toch onvoldoende grond voor een heldere definitie. Ten tweede, is het nodig en mogelijk het begrip duurzame ontwikkeling te koppelen aan theorieën op specifieke gebieden, zoals macro-economie, internationale handel, bedrijfseconomie en micro-economie? Ten derde, is het noodzakelijk en wenselijk onderscheid te maken tussen onderzoek voor rijke, geïndustrialiseerde landen en ontwikkelingslanden?

Deze studie richt zich op de vraag in hoeverre het begrip (ecologisch) duurzame ontwikkeling gevolgen moet hebben voor de ex ante beoordeling van projecten in ontwikkelingslanden. Zij beweegt zich zo op het nog tamelijk onontgonnen terrein waar milieu-economie, welvaartseconomie en ontwikkelingseconomie elkaar overlappen. Meer in het bijzonder is het doel van de studie een systeem te ontwikkelen voor *op duurzaamheid gerichte projectbeoordeling voor ontwikkelingslanden*. Zo'n systeem kent drie lagen:

- Welke nieuwe vragen roept het duurzaamheidsbegrip op in de verschillende fasen van beoordeling van ontwikkelingsprojecten? Dit betreft aanpassingen in de structuur van projectbeoordelingsstudies.
- Welke project-specifieke antwoorden op deze vragen kunnen zich in de praktijk voordoen? Daarbij is in ontwikkelingslanden de in het algemeen beperkte beschikbaarheid van gegevens van belang.
- In welke mate zijn economische technieken voor projectbeoordeling in staat de nieuwe, met duurzaamheid samenhangende vragen te behandelen? Meer in het bijzonder gaat het om de mate waarin deze technieken mogelijke varianten van project-specifieke informatie over die vragen kunnen verwerken. In deze studie wordt vooral aandacht besteed aan de technieken kosten-baten analyse (KBA) en multi-criteria analyse (MCA).

Het systeem voor op duurzaamheid gerichte projectbeoordeling wordt in twee fases opgebouwd: deel A van de studie (hoofdstuk 2-7) beoogt de theoretische aspecten in kaart te brengen, terwijl deel B (hoofdstuk 8-12) meer op praktische toepassing is gericht.

Deel A: Concepten en theorie

Milieu beïnvloedt welvaart via twee wegen. Ten eerste impliceert de menselijke behoefte aan bijvoorbeeld schone lucht, drinkwater en een onaangetaste ozonlaag dat milieugoederen en -diensten zelf een welvaartscomponent zijn, naast de beschikbaarheid van door mensen geproduceerde goederen en diensten. Ten tweede worden milieugoederen en -diensten gebruikt in produktieprocessen, waardoor zij de welvaart ook op indirecte wijze bepalen. Deze rol van het milieu is de eerste factor die ten grondslag ligt aan duurzame ontwikkeling. De tweede factor wordt gevormd door het ethische vraagstuk van een rechtvaardige welvaartsverdeling in de tijd, en tussen generaties in het bijzonder. Indien de huidige generatie toekomstige generaties een zeker minimum welvaartsniveau wil garanderen, impliceert dit dat zij de beschikking moeten hebben over een zekere "voorraad" aan milieukapitaal. En omdat milieu een schaars goed is, moet de huidige generatie zich beperkingen opleggen in het gebruik van milieugoederen en -diensten. Er is sprake van ecologisch duurzame ontwikkeling wanneer aan deze voorwaarde wordt voldaan (hoofdstuk 2).

De vraag hoe dit duurzaamheidsbegrip tot uitdrukking kan komen in projectbeoordeling in ontwikkelingslanden wordt behandeld op basis een aantal hoofdfases in een projectbeoordelingsstudie (hoofdstuk 3).

De *eerste* fase behelst de bepaling van een beleidsraamwerk (hoofdstuk 4). Hierbij gaat het om de keuze van alternatieven voor het project, de keuze van beoordelingscriteria, en de keuze van gewichten (die het relatieve belang van criteria aangeven). Keuzes van beleidmakers zullen hierbij in het algemeen centraal staan, maar vaak zullen ook de meningen van andere belanghebbenden bij het gebruik van natuurlijke hulpbronnen een rol spelen. In deze studie wordt een onderscheid gemaakt tussen drie kerncriteria: naast de voor ontwikkelingslanden traditionele criteria van doelmatigheid en (intratemporele) verdeling, wordt duurzaamheid als een derde criterium aangemerkt. Alleen op deze manier kunnen waardeoordelen over het juiste gebruik van natuurlijke hulpbronnen in de uiteindelijke afweging van voor- en nadelen van een project expliciet tot uitdrukking komen.

Het nieuwe criterium duurzaamheid roept twee vragen op: hoe wordt het geoperationaliseerd, en hoe vindt de afweging ten opzichte van doelmatigheid en verdeling plaats. Ten aanzien van de interpretatie van het duurzaamheidsbegrip wordt gepleit voor een flexibele benadering. Dit impliceert dat niet bij voorbaat gekozen zou moeten worden uit specifieke interpretaties als "sterke duurzaamheid" en "zwakke duurzaamheid", waarbij de voorraad aan milieukapitaal, respectievelijk de som van de voorraden van milieu- en door mensen voortgebracht kapitaal, niet verkleind mag worden. In een flexibele benadering wordt een project-specifieke, op de lokale institutionele en ecologische omgeving afgestemde interpretatie bepaald. Daarin moet een antwoord gegeven worden op onder meer de volgende vragen: onder welk niveau moet het milieubeslag blijven? wordt deze randvoorwaarde gespecificeerd voor bepaalde milieucomponenten? voor welk ruimtelijk niveau geldt de randvoorwaarde? Afhankelijk van de voorkeuren van beleidsmakers zal het duurzaamheids-criterium "sterker" of "zwakker" zijn. Daarbij zal ook het relatieve belang dat aan duurzaamheid, doelmatigheid en verdeling wordt toegekend, een rol spelen. Met name in ontwikkelingslanden kan verwacht worden dat deze doelstellingen vaak van conflicterende aard zullen zijn.

De *tweede* fase van projectbeoordeling behelst het schatten van de effecten van een project, inclusief de scores op de drie hoofdcriteria. In deze studie staat met name milieu-effect analyse (MEA) centraal (par. 5.2.1, 5.3). Milieu-effecten zijn cruciaal, omdat zij direct de score op het duurzaamheidscriterium bepalen, en van grote invloed kunnen zijn op de doelmatigheids- en verdelingsscores. In een MEA moeten economen en ecologen in nauwe samenwerking een aantal stappen doorlopen:

- Het opstellen van milieu- en sociaal-economische profielen voor het gebied dat voor een project van belang is. Deze profielen bieden inzicht in het huidige niveau van ecologische en economische variabelen, de ontwikkeling van die waarden in het verleden, en de mate waarin problemen optreden. In het ecologisch profiel is een kernvraag wat de draagkracht van de project-omgeving is, en daarmee corresponderend wat het maximale niveau van exploitatie is waarbij de milieuvoorraad kwalitatief en kwantitatief niet aangetast wordt.
- Het opstellen van een ecologisch-economisch interactiemodel. Omdat milieu en economie vooral in ontwikkelingslanden nauw verbonden zijn, is het essentieel inzicht te verkrijgen in de wijze waarop ecosystemen en sociaal-economische systemen in de projectomgeving elkaar beïnvloeden. De opstelling van een interactiemodel biedt de mogelijkheid gevonden waarden in profielen te verklaren: wat zijn ecologische verklaringen voor economische problemen (en vice versa)? Bovendien is het model noodzakelijk voor de schatting van milieu-effecten.
- Bepaling van de milieu-effecten van (de alternatieven voor) het project. Gegeven de complexe, en veelal nog maar deels begrepen relaties tussen ecosystemen en de mens, zal het resultaat vaak in meer of mindere mate een combinatie van "harde", kwantitatieve, en "zachte", kwalitatieve informatie tonen.

De uitkomsten van de MEA kunnen vervolgens gebruikt worden bij de bepaling van de duurzaamheidsscore van een project (par. 5.2-3, 5.4-5). Eerst moeten echter twee andere vragen onderzocht worden:

- Bepaling van de mate waarin ontwikkeling in de projectomgeving duurzaam is. Daarbij wordt de draagkracht van het milieu vergeleken met het werkelijke exploitatieniveau door de mens. Het relatieve verschil tussen het wenselijke en feitelijke milieubeslag kan uitgedrukt worden in kwalitatieve of kwantitatieve duurzaamheidsindicatoren voor de projectomgeving.
- Bepaling van de milieugebruiksruimte voor nieuwe projecten. Uit het verschil tussen gewenst en feitelijk gebruik van natuurlijke hulpbronnen, kan de milieugebruiksruimte voor nieuwe activiteiten afgeleid worden. Wanneer verwacht wordt dat zonder het uitvoeren van een project ontwikkeling al niet duurzaam zal zijn, zouden nieuwe projecten tot een vergroting van de milieuvoorraad moeten leiden.

Bepaling van de duurzaamheidsscore betreft de vergelijking tussen de milieugebruiksruimte en de verwachte milieu-effecten van het project. Gebruikt een project minder milieugoederen en -diensten dan toegestaan, dan is deze score positief. Een negatieve score ontstaat wanneer een project de milieugebruiksruimte overschrijdt.

Bij de bepaling van de score op het tweede kerncriterium, doelmatigheid, wordt in principe getracht gebruik te maken van (economische) KBA (par. 6.1-4). Of dit in een concreet geval ook mogelijk en voor de besluitvorming nuttig is, hangt af van informatie over de volgende stappen in KBA:

- Aannemende dat MEA leidt tot kwantitatieve schattingen omtrent milieu-effecten, vereist KBA dat hieraan een geldswaarde wordt toegekend. Daartoe staat de econoom een scala van waarderingstechnieken ter beschikking. Terwijl een groter en systematischer gebruik van deze technieken wenselijk is, dienen hun beperkingen in het oog gehouden te worden. Zo bestaat het risico op onderschatting van de waarde van een milieu-effect, kunnen onderzoeken meer tijd vragen dan veelal beschikbaar is, en kan het onaanvaardbaar geacht worden dat de waarde van milieuschade sterk afhankelijk is van het inkomensniveau van ondervraagden.
- Zoals alle kosten en baten moeten milieu-effecten gedisconteerd worden. Dit kan uit milieu-oogpunt ongewenste consequenties hebben voor de beoordeling van projecten met (positieve of negatieve) milieu-effecten op lange termijn. Voorstellen in de literatuur om in dit licht de hoogte van de disconteringsvoet te wijzigen, verdienen in het algemeen geen ondersteuning. Juister is het KBA principes beter toe te passen, waardoor aan de ene kant sommige problemen (deels) verholpen kunnen worden, en aan de andere kant de beperkingen van de methode duidelijker voor het voetlicht komen.

- Schatting van milieu-effecten gaat vaak gepaard met flinke onzekerheid ten aanzien van de waarschijnlijkheid dat bepaalde effecten zich zullen voordoen, terwijl soms zelfs de aard van mogelijke effecten onbekend is. Afhankelijk van de aard en omvang van onzekerheid, biedt KBA de mogelijkheid om via waarschijnlijkheidsanalyse en gevoeligheidsanalyse onzekerheid te onderzoeken. In de praktijk zal met name het eerste instrument weinig relevant zijn in ontwikkelingslanden.

Wanneer waardering van milieu-effecten (grotendeels) onmogelijk is, en/of grote onzekerheid bestaat over die effecten, kan MCA toegepast worden om een indruk van de doelmatigheidsscore te verkrijgen (par. 6.5). Daarbij zal vaak een weging moeten plaats vinden tussen de uitkomsten van een partiële (d.w.z. niet alle relevante aspecten omvattende) KBA en de niet-meetbare of niet op geld waardeerbare milieu-effecten en -risico's.

Bij de bepaling van de score op het derde kerncriterium, verdeling, past een onderscheid tussen effecten van projecten op de verdeling van inkomen en op toegankelijkheids- en eigendomspatronen voor natuurlijke hulpbronnen (par. 6.6). Vaak zal het eenvoudiger zijn vast te stellen hoe een project de toegang van doelgroepen tot grond en water zal beïnvloeden dan de corresponderende veranderingen in inkomensniveau. Wanneer de analyse van verdeling complex is door de noodzaak verschillende aspecten en verschillende groepen in aanmerking te nemen, kan het gebruik van MCA overwogen worden om projectalternatieven te rangschikken op grond van hun verdelingsscore.

De *derde* hoofdfase in een projectbeoordelingsstudie betreft de evaluatie. De eerste vraag daarbij is of voldaan wordt aan eventuele randvoorwaarden die beleidsmakers gesteld hebben. Zulke randvoorwaarden kunnen betrekking hebben op elk van de drie kerncriteria. Zo kan geëist worden dat een project: a) een positieve duurzaamheidsscore heeft, b) een positieve netto contante waarde ten aanzien van doelmatigheid heeft, en c) minimaal gewenste veranderingen in verdelingspatronen oplevert. Indien een project niet aan zo'n voorwaarde voldoet, kan getracht worden door bepaalde wijzigingen in het project daar in tweede ronde alsnog voor te zorgen. De aard van deze activiteiten verschilt voor duurzaamheid (par. 5.5), en doelmatigheid en verdeling (par. 6.7). Een voorzichtige houding is gepast ten aanzien van het voorstel in de literatuur om door compenserende milieuprojecten te voldoen aan een duurzaamheidsrand-voorwaarde: de capaciteiten van de mens om nieuwe vormen van milieu te creëren ter compensatie van door projecten veroorzaakte milieu-aantasting zijn beperkt.

Het tweede evaluatie-onderdeel betreft geïntegreerde evaluatie, waarbij de scores op de drie hoofdcriteria en hun gewichten leiden tot een conclusie over de relatieve aantrekkelijkheid van de gekozen alternatieven voor een project (hoofdstuk 7). Gegeven het als gevolg van methodologische en institutionele factoren beperkte gebruik van sociale KBA (welke zich tegelijkertijd richt op doelmatigheid en verdeling), zijn de mogelijkheden om ook duurzaamheid binnen een KBA-raamwerk te verwerken beperkt. In deze fase ligt gebruik van MCA meer voor de hand. Of scores op de drie hoofdcriteria nu kwalitatief, kwantitatief of gemengd zijn, er zijn MCA-technieken beschikbaar om deze te verwerken. Via MCA-toepassingen in ontwikkelingslanden moet het inzicht vergroot worden in mogelijke beperkingen van institutionele aard.

Deel B: Naar de toepassing van op duurzaamheid gerichte projectbeoordeling

Deel B bevat twee toepassingen van het ontwikkelde theoretische systeem voor op duurzaamheid gerichte projectbeoordeling. De eerste betreft de beoordeling van een bosbouw- en milieuprogramma in Colombia, waarvoor financiering was aangevraagd bij een grote internationale instelling (hoofdstuk 9). De tweede toepassing omvatte een scenario-analyse voor Lake Burullus, een ecologisch waardevol kustmeer in Egypte (hoofdstuk 10). In beide gevallen richtte de toepassing zich op vragen als: wat was de doelstelling van de studie en welke disciplines waren in het studieteam opgenomen? in hoeverre hebben milieu- en duurzaamheids-doelstellingen de keuze van de alternatieven beïnvloed? was duurzaamheid een van de beoordelingscriteria en hoe vond de afweging met andere criteria plaats? in hoeverre was er sprake van conflicterende belangen in de maatschappij? is in de MEA gebruik gemaakt van ecologisch-economische interactiemodellen? was het mogelijk milieu-effecten kwantitatief te schatten? in hoeverre was toepassing van KBA wenselijk en mogelijk bij de bepaling van de duurzaamheidsscore? in hoeverre was toepassing van MCA wenselijk en mogelijk in de geïntegreerde evaluatie?

De twee toepassingen blijken zeer verschillende antwoorden op deze vragen op te leveren. In de Colombia-studie was toepassing slechts beperkt mogelijk, waardoor een aantal belangrijke beleidsvragen niet beantwoord kon worden. In de Egypte-studie was het juist wel mogelijk het systeem op hoofdpunten te doorlopen, wat tot voor de besluitvorming veel nuttiger resultaten leidde. De verschillen zijn samengevat in onderstaand schema.

Aspect van de studie	Colombia-studie	Egypte-studie
Organisatie	Studieteam bevatte geen ecologische experts. Tamelijk weinig tijd voor onderzoek.	Team bestond uit diverse disciplines. Langduriger studie mogelijk.
Alternatieven	Project bestond uit vier componenten. Er zijn geen alternatieven onderzocht.	Twee van de vier alternatieven zijn gebaseerd op het principe van sterke duurzaamheid. Bovendien zijn opties onderzocht om elders in Egypte water te besparen om ecologische aantasting van Lake Burullus te voorkomen.
Criteria, gewichten en partijen	Aparte milieudoelstelling opgenomen, naast verdelings- en doelmatigheidsaspecten. Project maatschappelijk zeer gevoelig als gevolg van wijzigingen in de prijs van natuurlijk hout en het beheer van tropisch regenwoud.	Aparte milieudoelstelling opgenomen, naast verdelings- en doelmatigheidsaspecten. Project maatschappelijk zeer gevoelig als gevolg van mogelijk zware ingrepen in het meer, en wijzigingen in het beheer van de visstand.
Interactiemodellen	Voor het projectgebied is geen model ontwikkeld.	Voor Lake Burullus is een model ontwikkeld waarin opgenomen ecologische kenmerken en niveau en aard van de visserij.
MEA	Door het gebrek aan expertise en het ontbreken van een model konden milieu-effecten slechts in zeer algemene zin aangegeven worden.	Mbv het model konden een belangrijk deel van de milieu-effecten en de daarmee corresponderende effecten op inkomen en welvaart geschat worden.
Doelmatigheid: KBA	Wegens het ontbreken van milieu-effecten kon KBA niet toegepast worden.	KBA kon het grootste deel van de milieu-effecten verwerken. De doelmatigheid kon vastgesteld worden door ook de niet op geld waardeerbare milieu-effecten in aanmerking te nemen.

Aspect van de studie	Colombia-studie	Egypte-studie
Geïntegreerde evaluatie: MCA	MCA was niet toepasbaar door het ontbreken van projectalternatieven en niet geschikt door een gebrek aan interesse van besluitvormers.	Mede dankzij de medewerking van de meeste besluitvormers kon MCA toegepast worden, en daarmee de uiteenlopende meningen in de maatschappij in kaart worden gebracht.
Beleidsconclusies	Door gebrek aan gegevens kon geen ecologische of economische onderbouwing van het project gegeven worden.	Inzicht kon worden verstrekt in: a) de voor besluitvorming essentiële afwegingen op het terrein van milieu en economie, b) de prijs voor het behoud van Lake Burullus in termen van kosten van waterbesparing elders in Egypte, en c) de politieke gevoeligheid van beleid ten aanzien van het meer.

Op basis van het theoretische deel A en de ervaringen in de twee toepassingen is een praktisch systeem ontwikkeld voor op duurzaamheid gerichte projectbeoordeling in ontwikkelingslanden (hoofdstuk 11). Voor elke beoordelingsfase, zoals hierboven gedefinieerd, worden richtlijnen gegeven voor de behandeling van met duurzaamheid samenhangende aspecten: alternatieven, criteria, effecten, afwegingen. Ten aanzien van de keuze van de technieken KBA en MCA wordt de gebruiker gevraagd naar project-specifieke informatie. Daarmee is het mogelijk zich een oordeel te vormen over de toepasbaarheid en het nut van deze technieken voor de besluitvorming. Het systeem kan integraal of gedeeltelijk worden doorlopen, en biedt de mogelijkheid tot terugkoppeling van resultaten.

De conclusie van deze studie, en de twee praktijkstudies in het bijzonder, is dat het ontwikkelde systeem een nuttig instrument kan zijn bij de beoordeling van ecologisch gevoelige projecten (hoofdstuk 12). Het biedt een methodologische basis voor multi-disciplinaire onderzoeksteams. Het benadrukt ook het belang van institutionele factoren, zowel wat betreft de vormgeving van een onderzoek, als de mogelijkheid en wenselijk-heid om alle fases van het systeem te doorlopen. Tenslotte illustreert de studie dat een nieuwe benadering van projectbeoordeling noodzakelijk is. Kernpunten zijn daarbij flexibiliteit ten aanzien van de meting van effecten (liever betrouwbare, zachte informatie, dan schijnbaar harde gegevens) en de keuze van technieken (gegeven de kenmerken van een beslisprobleem en van de beschikbare technieken, kan de meest geschikte methode geselecteerd worden).

ABSTRACT

SUSTAINABILITY-ORIENTED PROJECT APPRAISAL FOR DEVELOPING COUNTRIES

Michiel J.F. van Pelt

In this study a framework is developed for sustainability-oriented project appraisal, with special reference to developing countries. It is characterized by a systematic coverage of issues related to the objective of sustainable development in all phases of the ex ante appraisal of development projects. Major issues are the following:

- ecological sustainability should be considered a third key appraisal criterion, besides the traditional criteria of efficiency and (intratemporal) equity;
- as many environmentally-sensitive projects are politically highly sensitive, the possibly conflicting nature of these criteria should be investigated, as well as the different views a project may evoke among various private and public sector agents;
- to allow for a proper assessment of environmental impacts of a project, it is necessary to develop qualitative or quantitative models for ecological-economic interaction in the project setting;
- depending on the specific features of a project, particularly the choice of criteria and the measurement scale for environmental impacts, cost-benefit analysis, multi-criteria analysis or a combination of these techniques should be applied.

The framework for sustainability-oriented project appraisal has been applied in two case-studies, in Colombia and Egypt respectively. In the final chapter, guidelines are provided for the treatment of sustainability concerns for each appraisal phase.