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Faculteit der Economische Wetenschappen en Econometrie

Serie Research Memoranda

Sustainability, Efficiency and Equity: Project Appraisal in Economy

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Research Memorandum 1991-96
december 1991

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1. Introduction

Environmental decay is not exclusively a problem of the post-war period. In ancient times the Greek philosopher Plato complained already about human interventions which 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 smokey coal in London.

In the economic literature environmental deterioration has often 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 1970's - 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, materials balance models, etc.). The incorporation of environmental costs in social cost-benefit analysis and in project appraisal received some attention, but did not develop into a mature methodology.

In the mean time the scene has changed. Next to the recognition of the important socio-economic consequences of the environmental problem, two new developments have taken place. First, 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. Secondly, 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 the time horizon in conventional economic models.

These two developments imply that standard economic tools based on efficiency and allocation are in various cases no longer applicable. This has provoked in recent debates in international agencies the notion of ecologically sustainable economic development as a central element for environmentally benign policy strategies. Especially following the Brundtland report *Our common future* (WCED, 1987), the interest in the question of how to treat the natural environment in economic theory has increased considerably. An important new element in recent contributions -in comparison to the literature published particularly in the 1970s and 1980s (see for instance Mäler, 1985; Seneca and Taussig, 1984, Nijkamp, 1979; Hueting, 1980)- refers to the notion of sustainable development. The number of definitions is overwhelming (for an

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excellent overview see Pezzey, 1989), but the interpretation in the Brundtland report is still one of the clearest. It says that sustainable development is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Whereas "needs" may be translated into social welfare, "ability" is especially concerned with the availability of ecological resources ("ecological sustainability"). Sustainable development requires that the use of such resources by the present generation remains below certain levels. The definition of sustainable levels of resource use is a normative affair (Opschoor and Reijnders, 1989).

This article is concerned with the analytical consequences the growing emphasis on ecological sustainability may have for project appraisal, not only for developed but also for developing countries (or regions). Traditionally, development policies, and hence project appraisal, started from two independent objectives, viz. aggregate welfare (income) maximization implying an optimal allocation of scarce resources (*efficiency*), and a "fair" distribution of income (*equity*).

Economic theory gives unequivocal guidelines on how to achieve and measure efficiency. Various, basically similar indicators show the extent to which growth and development activities through their use of resources contribute to aggregate welfare improvement. In many developing countries (and regions), the existing distribution of income (as well as productive assets) is relatively unequal. This explains why the scope of project appraisal, especially for developing countries (or regions), has been broadened to incorporate ethical judgements on a just distribution of income generated by development activities among contemporaries (*intratemporal equity*). Value judgements on the fairness of the distribution of net income flows over time (*intertemporal equity*) have received much less attention. Efforts have been made, however, to account for growth objectives through a distinction between income used for consumption and for savings (i.e. investment). Again this particularly refers to project appraisal for developing countries.

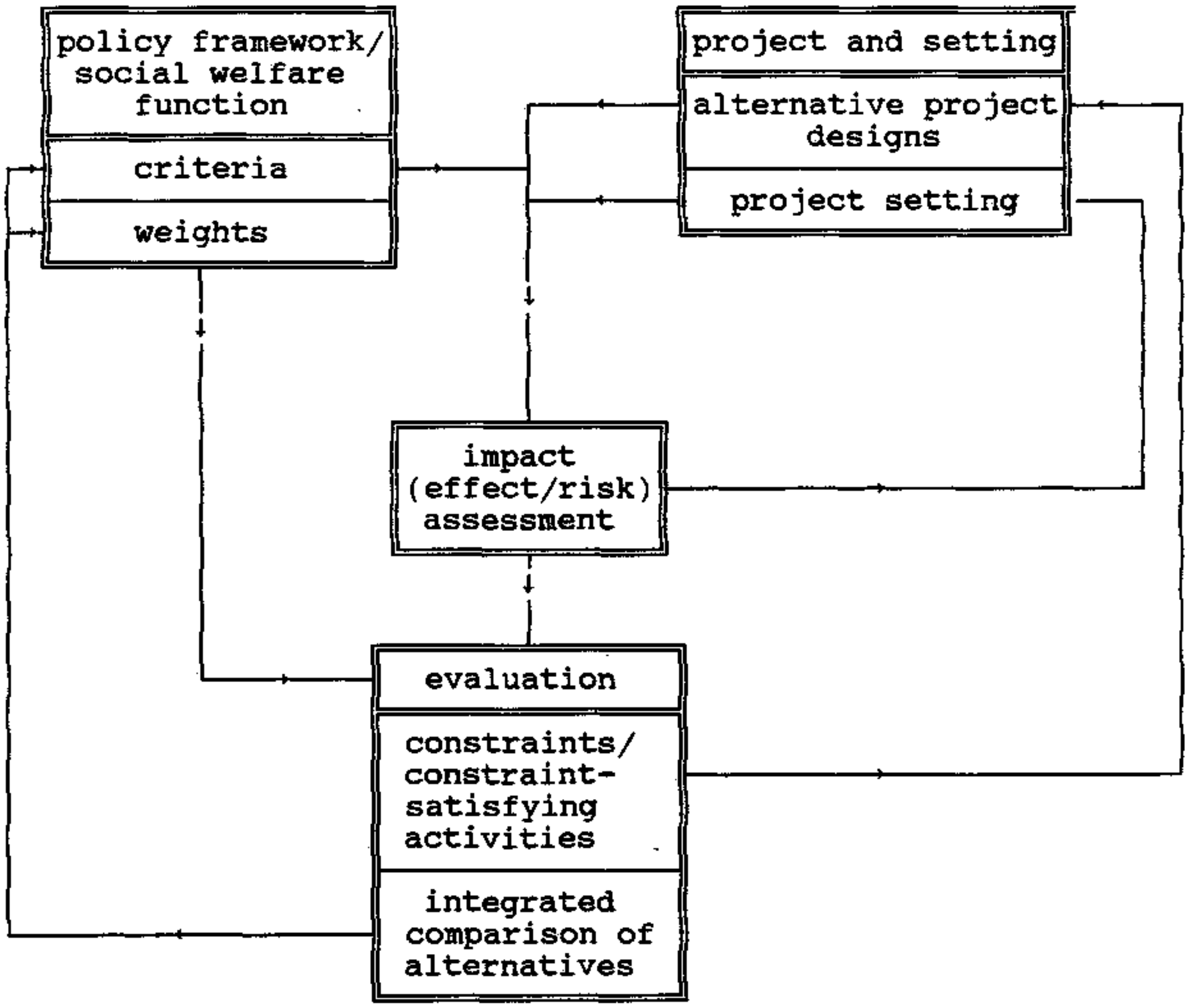
Daly (1990) argues that scale (*ecological sustainability*) should become the third macro-economic objective in addition to the existing objectives of optimal allocation (efficiency) and a fair distribution (equity). As a consequence, it may be a real challenge to incorporate sustainability as a third key criterion -in addition to efficiency and equity- in (micro-level) project appraisal for both developed and developing countries. This article explores how the structure of project appraisal, i.e. the kind of issues to be addressed, may be affected. Such an overview of issues is a prerequisite for investigating the applicability of *appraisal methods* to sustainability-oriented project appraisal. [1]

Project appraisal is a multi-stage process, and the impact of the sustainability criterion will be explored phase-by-phase. Our classification of project appraisal stages is summarized in diagram 1 [2].

[1] For a first analysis of the usefulness of two groups of appraisal methods, viz. cost-benefit analysis and multi-criteria analysis, see van Pelt, Kuyvenhoven and Nijkamp (1990).

[2] A more detailed note on project appraisal stages is available at request.

Diagram 1. Overview of main stages in project appraisal



Section 2 treats the incorporation of the sustainability criterion in the first phase, viz. the description of the *policy framework*. Starting from a social welfare function, appraisal criteria and criteria weights can be derived. Criteria weights show the relative priority of criteria, and may be quantitative (including (shadow) prices) or qualitative. Special attention is given to policies regarding possible conflicts between the "old" criteria of efficiency and (intratemporal) equity and the "new" sustainability criterion. An important question is whether sustainability is considered a precondition for approval of projects, or that trade-offs between, on the one hand, sustainability and, on the other hand, efficiency and equity are allowed.

Section 3 deals with the role of the sustainability criterion in the second phase, viz. the definition of the *project alternatives* and particularly the *project setting*. Gaining insight in the economic and environmental context of a project is a prerequisite for estimating its effects. Sustainability being a variable linking environmental and economic factors, the project setting should provide insight in welfare patterns, in socio-economic and environment systems in the project area, and in relations in these fields between the project area, and supra-project levels.

The third phase (section 4) comprises *impact assessment*, viz. the estimation of the effects of project alternatives on the criteria of efficiency, equity and sustainability. Incorporation of the sustainability criterion may drastically affect the treatment of time. Whereas the focus used to be on short- and medium-term effects, sustainability-oriented project appraisal requires an (additional) analysis in terms of generations. In view of the important role of risk strategies in sustainability policies, assessments of risk and uncertainty should be integrated in impact matrices. Possible measurement scales for efficiency, equity and sustainability are discussed. Finally, practical difficulties in assessing scores on the sustainabilty criterion are outlined.

The final phase in project appraisal concerns *evaluation*, the basis for decisions to reject or approve project alternatives (section 5). A first evaluation step assesses whether alternatives satisfy constraints on individual criteria, particularly sustainability. If a project does not comply with the sustainability constraint, i.e. involves resource use in excess of normative levels, the project may be reformulated in such a way that it does satisfy this constraint. The nature and various consequences of such constraint-satisfying activities are discussed. In the second evaluation step, the set of project alternatives that satisfy constraints are subjected to an integrated appraisal on the basis of their perfomance on all remaining criteria and the relevant criteria weights.

Section 6 contains some concluding remarks.

2. Sustainability and the policy framework

2.1. Defining efficiency, equity and sustainability

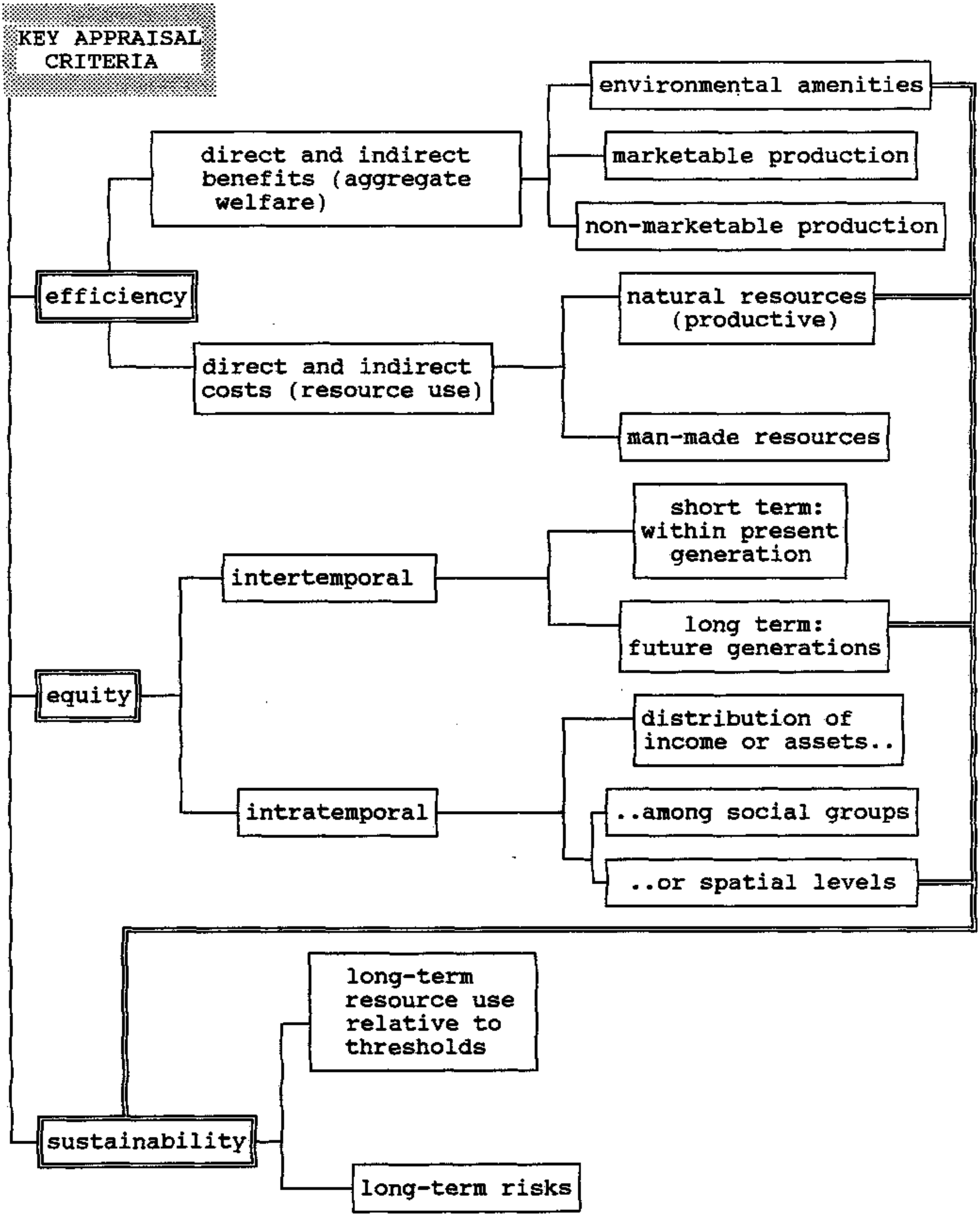
A policy framework elaborates on the objectives of development (and hence appraisal criteria) and how conflicts between objectives should be treated (criteria weights). An analysis of the impact of sustainability on project appraisal starts with understanding the difference this criterion will make for policy frameworks. Differences between policy frameworks in traditional and sustainability-oriented project appraisal are addressed in two steps:

- definition of the key criteria of efficiency, equity and sustainability, and the weighting of respective sub-criteria (this section),
- possible conflicts between the key criteria, and basic weighting policies (section 2.2).

Diagram 2 (see next page) contains an overview of the key criteria of efficiency, equity and sustainability, as well as their attributes (i.e. subcriteria). It shows that the definition of the sustainability criterion is related to several efficiency and equity attributes. These linkages will be outlined below. The following observations serve as a starting point for this analysis.

- Sustainability is *expressed* in a) acceptable levels of natural resource use, and b) acceptable long-term ecological risks, both at a certain level of decision-making (global, national, regional, local/project).
- Sustainability *depends on* views on a) the direct impact of the environment on social welfare, b) substitutability between man-made and natural capital as factors of production, and c) the responsibility of the present generation to future generations (intergenerational equity).

Diagram 2. Key appraisal criteria



The choice of efficiency, equity and sustainability as main appraisal criteria can be illustrated by the Netherlands policy for development co-operation. Since the early 1980s the overall objective has been "structural combat of poverty". It combined the objectives of increases in production and income (efficiency) and a fair distribution (intratemporal equity). In 1990, without altering the overall objective, ecological sustainability was added as a third attribute (Ministry of Foreign Affairs, 1990).

Of course there may be several other development goals besides efficiency, equity and sustainability. Dutch development policy, for example, aims at strengthening the position of women, institutional development, promoting appropriate technology and several other attributes of development. In the remainder of this article we will either show that these goals may be considered an attribute of one of the key criteria (women - intratemporal equity) or assume that they are of a lower order than efficiency, equity and sustainability.

Efficiency

The attributes of aggregate welfare correspond directly with the *efficiency* criterion. Efficiency has been a key criterion in policy frameworks in conventional (economic) project appraisal for developing countries (milestones have been Little and Mirrlees, 1974; UNIDO, 1972; Squire and van der Tak, 1975; Squire, 1989). Efficiency constitutes the difference between gross aggregate welfare changes (benefits) and all use of scarce resources (costs). [3] In the past, welfare benefits tended to be equated with availability of material goods and services produced in the socio-economic system (maximization of material consumption or income). Such goods are partly traded in markets, partly non-traded (social overhead, public goods). Increasingly, shortcomings of the narrow welfare concept are acknowledged (see for instance Hueting, 1980; van Pelt, Kuyvenhoven and Nijkamp, 1990). Assuming a broader interpretation of welfare, the availability of environmental amenities with a direct impact on the well-being of men has also been considered a welfare attribute.

On the cost side basic resources comprise man-made capital and natural capital. Each of these categories can be further subdivided. Natural capital, for instance, may be subdivided in classes related to its functions: assimilation of waste, provision of renewable and non-renewable resources, supply of environmental amenities essential to production processes. It has been proposed to differentiate between objectives

[3] No agreement exists on how welfare losses and benefits accruing to individual households are to be aggregated. The authors refered to all argue in favour of differential weighting on the basis of the individual's pre-project income. Thus, equity concerns are explicitly introduced into the selection criterion (see Squire, 1989).

regarding irreversible vis-a-vis reversible environmental problems (Hedman, 1990).

The policy framework should elaborate on the weighting function converting individual classes of costs and benefits (sub-criteria) into overall efficiency performance. Traditionally, cost-benefit analysis (CBA) techniques have been applied, whereby prices serve as weights. If available and a true reflection of the value to society, market prices are applied. If markets are imperfect, generate external effects, or are considered distorted, shadow prices may be applied. The latter approach, among other things, sets project appraisal for developing countries apart from approaches for developed countries. Problems occur if no price can be determined for one or more efficiency attributes, particularly environmental amenities (benefits) and environmental resource use (costs). In such circumstances there are two possible approaches. The first is to replace the (comprehensive) efficiency criterion by at least two other criteria, viz. a partial-efficiency criterion (covering all monetarized efficiency attributes) and other criteria covering the remaining efficiency attributes (such as environment). An alternative approach would be to fully decompose the comprehensive efficiency criterion in its respective attributes: contributions to material welfare, contributions to environmental amenities, use of man-made capital, use of natural capital, etc. Both approaches require other weighting mechanisms than prices to arrive at conclusions regarding efficiency. The emphasis is then likely to be on weights derived from views of policy-makers (see Nijkamp, Rietveld and Voogd, 1990).

Equity

The policy framework should provide insight in preferences regarding *intertemporal equity*, viz. the distribution of welfare over time. In traditional project appraisal usually a time horizon encompassing not more than one generation is assumed, which in diagram 2 is considered a short-term approach. The frequently applied discounting technique implicitly assigns consequences of projects affecting future generations a negligible or zero weight.

In view of the long-term focus implied by sustainability concerns, the diagram also emphasizes inter*generational* equity, the distribution of welfare among successive generations. In other words, 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? Moreover, what are views on the possibility to compensate future generations for a lower level of environmental amenities by higher material welfare levels?

Sustainability concerns draw particular attention to long-term ecological risks. Such risks may have various specific characteristics (Quiggin and Anderson, 1990). One is that "surprises" may occur, 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. Judgements on the present generation's responsibility to future generations should therefore contain a risk strategy, describing subjective attitudes towards risks 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. An alternative approach consists of assigning weights to risks and their possible consequences. Reijnders (1990), for instance, argues that long-term ecological risks are unacceptable. This implies that he assigns a weight of 1 to the environmental risk criterion. "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.

A main factor in the present generation's willingness to avoid risk possibly affecting future generations are views on future possibilities for substitution in two fields. First, to what extent may an increase in man-made capital compensate for a loss of environmental capital in the production of goods and services? Second, to what extent is it possible to compensate a reduced availability of one type of environmental resources by enhancing the quality or quantity of another environmental stock attribute? According to some, ecological decay may not be unacceptable because technological progress and increases in man-made capital may provide compensation, or because of optimism regarding the environment's capacity to recuperate over time. Others may prefer a much more cautious approach, arguing that compensation possibilities are very limited.

In the 1950s and 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 in project appraisal. In reality, however, economic growth often showed a biased distribution. It was observed that welfare benefits often did not equally accrue to all population groups and that central governments were unable to redistribute income. Efficiency and *(intratemporal) equity* turned out to be potentially conflicting goals. In the late 1960s, redistribution of income to the benefit of low-income groups became a second key objective in project appraisal for developing countries. Moreover, it was recognized that not only the direct redistribution of income should be addressed, but also the question of who owns or has access to productive assets.

In view of linkages between poverty, distribution and environmental problems (WCED, 1987), intratemporal equity will continue to be a central issue in sustainability-oriented project appraisal. To account for possibly conflicting interests of different social groups, the policy framework should include, as in the past, value judgements (weights) regarding the distribution of material welfare among contemporaries, particularly among higher- and lower-income groups. Moreover, views should be elaborated on the question of who owns or has access to environmental resources upon which income-generating activities depend.

Another dimension of intratemporal equity, viz. the distribution of welfare between spatial levels, used to be reflected in project appraisal from a national point of view. Supra-national effects were implicitly assigned a weight of zero. In sustainability-oriented project appraisal, views on trade-offs between welfare at the project level, the national level and the supra-national (continental, global) level need to be addressed. Are welfare objectives defined at higher levels, implying that welfare trade-offs at and between lower levels are allowed? Or do welfare objectives show a spatial disaggragation?

Sustainability

In the traditional approach, no constraints used to be imposed on the use of environmental resources, one of the efficiency sub-criteria. 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. The environment sub-criterion continues to play this role in sustainability-oriented project appraisal. Through the *sustainability* criterion, "environment" is given a second function. Sustainability, whatever its definition and operationalization, always refers to a certain *threshold level* regarding the use of environmental capital (or the total stock of capital, comprising man-made capital as well; this approach is taken up later). In its basic form (actual resource use is either lower or higher than sustainable levels), this third key criterion therefore is of a different nature than efficiency and equity, which are expressed in terms of desired directions of change (maximization of aggregate real income, enhancement of the part of income accruing to target groups). More data-demanding forms of sustainability criteria involve measurement of the *degree* of sustainability on a cardinal or ordinal scale expressing the relative difference between normative threshold levels and actual resource use (see Opschoor and Reijnders, 1989).

The choice of threshold levels for sustainable resource use to a great extent depends on how the present generation judges its responsibilities to future generations, including assessment of risks and possibilities for substitution in production functions (intergenerational equity).

Two important normative interpretations of sustainability can be illustrated using the two types of resources shown in diagram 2, viz. man-made capital (M) and environmental capital (N). The two approaches, termed strong sustainability (sS) and weak sustainability (wS; see Foy and Daly, 1990), are summarized below:

definition	sustainability condition
wS	$d(N+M) \geq 0$
sS	$d(N) \geq 0 \wedge d(M) \geq 0$

The wS approach (see for instance Bojö, Mäler and Unemo, 1990) puts a non-negative constraint on the total of man-made and natural capital. This approach may be explained by the view that especially thanks to technological progress, man-made capital may increasingly substitute for natural capital in the production of material goods, and the opinion that the loss of one type of environmental resource may be compensated for by increasing the supply of another type. The sS definition (advocated by among others Pearce, Barbier and Markandya, 1990), involving a non-negative constraint on the two stocks separately, is much more cautious in these respects. [4]

An important question concerns policies regarding the weighting of attributes of particularly the environmental stock. This stock may be disaggregated in types of environmental resources (for instance, renewable and non-renewable resources) and environmental functions (for instance, waste assimilation and life support systems, such as the ozon layer). Following the sS approach, the question arises to what extent a decline in one environmental attribute, for instance the ozon layer may be compensated for by an improvement in another attribute, for instance the number of species. One weighting strategy would be to impose non-negative constraints on each attribute. Sustainability would then require that these constraints on individual attributes are complied with. Alternatively, trade-offs between attributes may be allowed. Scores on attributes then need to be standardized. In principle, prices could be taken as weights, but valuation problems are likely to be significant. The alternative is to use other willingness-to-pay indicators or policy weights (Opschoor and Reijnders, 1989).

If the wS approach is applied, even more difficult weighting problems occur. How to compare changes in man-made capital (attributes) with changes in environmental capital (attributes)?

[4] For a more elaborate discussion on sustainability constraints and underlying assumptions, see van Pelt, 1991.

Besides specifying normative limits to resource use, the sustainability criterion should specify a certain *spatial level* as a point of reference. Is sustainability defined and to be achieved at the project level or at a supra-project level? Hence, are limits to resource use defined at the project level, the programme level, the national level, or the global level?

Starting form the "strong sustainability" requirement, (viz. a non-declining stock of natural capital), Klaassen and Botterweg (1976) proposed to apply the sustainability constraint at the project level. Hence, no individual project should negatively affect the size of the stock of environmental resources. Consequently, the sustainability constraint is also adhered to at higher levels (as far as projects are concerned). Pearce, Barbier and Markandya (1990) consider this approach not feasible. They argue that the sustainability condition should be applied at the "programme level", i.e. across a set of projects. In this case, individual projects may use environmental resources as long as this is compensated elsewhere in the programme (see section 5.1).

In view of practical problems in impact assessment (see section 3), it is desirable that global sustainability levels are at least expressed in national parameters. Winpenny (1990) elaborates on approaches to translate global climate policies into national targets for emissions of greenhouse gases or energy efficiency. When a project uses up a part of that target, emissions elsewhere in the country would need to be decreased or abatement measures would need to be undertaken.

The impact of the sustainability criterion on the outcomes of project appraisal has an inverse relationship with the level at which sustainability is defined. Global sustainability may be commensurate with unsustainable development at some places and individual projects that do not satisfy overall constraints. When sustainability is defined at the project level, however, its impact on the design of individual activities is much larger.

In summary, ecological considerations play a dominant role in policy frameworks if:
- the strong sustainability applies instead of the weak sustainability approach,
- non-negative constraints on overall stocks are applied to attributes as well,
- extreme risk-aversive strategies are followed,
- sustainability is defined at the lowest spatial level.

2.2. Weighting efficiency, equity and sustainability

Policy frameworks would not need to include relative priorities of the key criteria sustainability, efficiency and equity if one alternative may be expected to outrank all other alternatives in every field. In reality, however, conflicts between, on the one hand, efficiency and equity, and, on the other hand, sustainability are likely to prevail.

Possible *conflicts between efficiency* (real income increases in a narrow sense) and *sustainability* are at the core of the public debate on the Brundtland report. The WCED (1987) holds the fairly optimistic view that economic growth need not be at the expense of the environment. Economic growth is even considered a prerequisite for sustainable development in developing countries. The WCED emphasizes that the nature of growth patterns would need to be adjusted. This view has raised fundamental criticism, for instance by Hueting (1990), who has repeatedly argued that economic growth and preservation of ecological resources cannot go together. The present debate appears to give little support for the assumption that trade-offs between short-term efficiency and long-term sustainability can be ruled out at the project level.

Similar questions refer to possible *conflicts between sustainability and intratemporal equity*. Pearce, Barbier and Markandya (1990) have discussed the consequences of this problem following the "strong sustainability" approach. They claim that maintaining the present stock of natural resources over time in low-income countries 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 for several reasons. First, without a proper definition of ethical notions such as "fairness" and "justice", it cannot be assessed whether the sustainability goal would be beneficial in this respect. Second, if it is assumed that the goal would be redistribution of welfare towards the poor at various levels, it is doubtful whether optimism regarding the effect of the sustainability constraint on these groups in the present generation is justified. Possible trade-offs between long-run benefits of ecologically sound policies and short-run economic costs are ignored. These trade-offs, however, may be particularly strong at low-income levels (see van Pelt, Kuyvenhoven and Nijkamp, 1990).

In many developing countries the poor are extremely dependent on natural resources. Reducing their use of natural resources may often be difficult without unacceptable income sacrifices (opportunity costs). One reason is that as long as market prices do not (fully) account for ecological costs and benefits, differences between private and social valuation can be large. Investments aimed at improving the efficiency of resource use in existing activities may therefore be costly. Moreover, income-generating alternatives for environmentally problematic activities may simply be absent. Hence, at least in the short and medium run, and before market prices fully incorporate ecological costs and benefits, a key question is who will pay for the transition from non-sustainable to sustainable practices. From the view point of the poorest countries and social groups, for whom combat of poverty is a primary objective, it is imperative that sustainability concepts not only focus on the interests of future generations but also on those of the present generation, especially the poorest groups.

Given the possibly conflicting nature of efficiency, equity and sustainability, policy frameworks should elaborate on their relative priority. Particularly interesting cases involve at least one criterion with a negative score. Through weighting, criteria may be assigned specific roles in an appraisal. A key question is whether values of weights are made dependent on (ranges) of values of a criterion. Depending on the answer to this question, criteria may be converted to objectives, goals and veto criteria (this terminology is a mixture of approaches of Zionts, 1989, and Voogd, 1983):

- objectives: weights are independent from scores on criteria,
- goals: weights vary with specific intervals of possible scores of criteria, but do not take the maximum value of 1, and
- veto criteria: weights take the maximum value of 1 above or below a threshold for a criterion. In the relevant range, veto criteria (constraints) overrule all objectives and goals.

Threshold levels for *efficiency* may be used to divide sets of alternatives in efficient and inefficient activities. For instance, a project is efficient (inefficient) if its net present value is positive (negative). If a positive net present value is considered a prerequisite for accepting a project, efficiency is a veto criterion. Efficiency, however, may also be treated as a goal. Whereas a strong preference to avoid inefficient alternatives might exist (i.e. a high efficiency weight in the range of negative net present values), the option of compensating inefficiency by positive scores on equity or sustainability need not be ruled out.

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 some cases equity may therefore be considered an objective, implying a constant equity weight. It is possible, however, to define thresholds, for instance a minimal part of net benefits that should accrue to specified target groups. Then equity may be expressed as a goal or even a veto criterion.

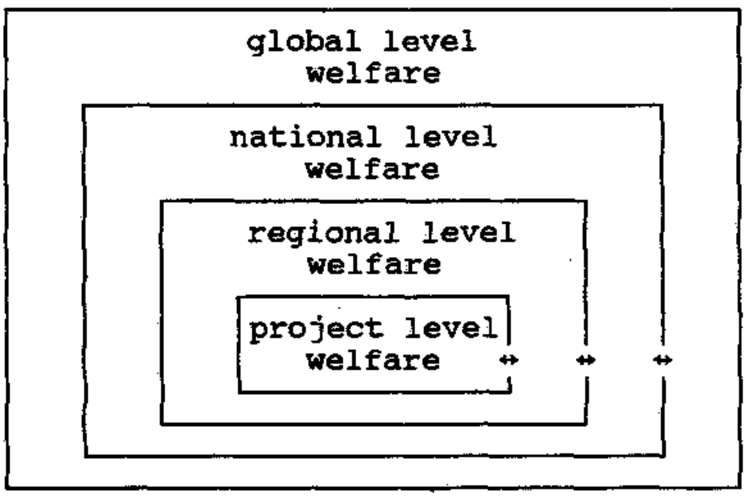
Almost by definition, *sustainability* is either a goal or a veto criterion. Sustainability as a goal criterion implies a strong preference for alternatives, satisfying normative levels of natural resource use. It is not ruled out, however, that non-sustainability is compensated for by sufficiently large efficiency and/or equity gains. The weight assigned to sustainability is lower in the range of sustainable resource use than in the range of non-sustainable resource use. If sustainability is converted into a goal, it is preferably measured on a cardinal (quantitative) or ordinal (ranking) scale. Measurement on a binary (0/1) scale is sufficient if sustainability is a veto criterion. Compliance with sustainable resource use levels is a prerequisite for accepting a project, whatever the scores on efficiency and equity.

3. Sustainability, the project and the project setting

There is no major difference between traditional and sustainability-oriented project appraisal regarding the definition of *alternatives*. In view of the emphasis on environmental issues in the new approach, and to facilitate subsequent analysis, however, projects may be classified according to their potential environmental relevance. Project profiles may, for instance, inform about resource use: changes in renewable resources use, changes in farming and fishing practices, exploitation of water resources, infrastructure, industrial activities, extractive industries and waste management disposal (OECD, 1990).

A sustainability-oriented analysis of the *project setting* should provide insight into welfare (development) patterns in the project area, and into linkages between the project area and supra-project levels affecting welfare potentials both in the project area and at higher levels (diagram 3).

Diagram 3. Interlevel welfare linkages



Project setting profiles provide insight into attributes of the three key criteria of efficiency, equity and sustainability. They are built upon four cornerstones: welfare patterns, socio-economic system, environmental system and linkages between the socio-economic and environmental systems. In every field questions of intratemporal distribution (what is the position of specific social groups with respect to the issue concerned?), and of intertemporal distribution (how do variables change over time, and particularly what are the positions of present and future generations?) should be addressed. Especially where ecological variables are involved, shortcomings in knowledge in terms of risk and uncertainty should be identified.

The project setting profile would focus on the following issues:

- The analysis starts with a description of *welfare* levels, and its attributes (consumption of material goods and environmental amenities). What are income and consumption levels; what is the extent of poverty? How is income distributed? What are expected changes in welfare levels? 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? How do economic policies affect these variables?
- With respect to the *environmental system* an environmental profile is prepared which informs about the natural resource base, i.e. type of ecosystems prevailing and on the problems in these systems. The analysis of the environmental system should provide insight into the stock of environmental resources, with specific attention for 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). 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. If possible, actual resource use and sustainable resource use levels are compared and expressed in cardinal or ordinal sustainability indicators. Environmental policies and their impact can be presented. Again the distributional dimension is important: where do problems occur, who are affected and at what pace?
- From a sustainability point of view the *linkages between socio-economic and environmental systems* are extremely important. These linkages can be approached from various angles:

  . the dependency of production and consumption (differentiated by social groups) on the environment: what is the 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? How do socio-economic policies affect natural resource use?

  . what are economic explanations (poverty, distribution of resources, population growth, economic policies, 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 possibilities for income-generating activities? How is long-term welfare affected?
Analysis of these linkages may result in an outline of level-specific sustainable development patterns and their short- and long-term economic costs and benefits. This should *inter alia* provide insight into the question of how and to what extent sustainability prospects at various levels are interrelated. Special attention should be given to critical success factors (see Nijkamp et al, 1990). They simultaneously provide insight into the environment as a potential means for development and the environment as a set of constraints on human activities. Critical success factors determine the boundaries of feasible projects in the project area. Projects that influence environmental parameters which are already close to critical levels are less attractive than projects which operate in less sensitive areas.

In the context of a flexible approach to sustainability, which emphasizes location-specific conditions, information about the project setting may be used to change elements of the policy framework, particularly the choice of and policies regarding the sustainability constraint. 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.

4. Sustainability and impact assessment

4.1. Format of the impact matrix

Impact assessment starts from an impact matrix with several possible dimensions: alternatives, criteria, intratemporal distribution among social classes or spatial levels, time, uncertainty. In traditional impact assessment studies, this matrix usually has two (alternatives, criteria) or three (time added) dimensions. Below the basic format of a traditional impact matrix is shown in two dimensions (criteria and time), assuming that such a matrix would be prepared for each alternative.

Traditional impact matrix (to be prepared for all alternatives)

criteria	time (years) 0 1 2 3 4 5 30
efficiency	effects
intratemporal equity	

As was argued above, efficiency and, to a somewhat lesser extent, intratemporal equity have been key appraisal criteria. In general effects were assessed from a project and/or the national point of view, ignoring cross-border effects. The time horizon has usually been confined to a period of ten to thirty years. In principle, environmental effects were part of efficiency analysis. The attention for environmental effects has usually been confined to local impacts directly affecting production or productivity. In practice, at least within the framework of cost-benefit studies, environmental effects tended not to be included at all because of measurement or valuation problems, or because they were considered not specific to the project.

Quiggin and Anderson (1990) describe the traditional treatment of risk and uncertainty. They 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. A more data demanding approach, viz. probability analysis, has less often been applied (see for instance Reutlinger, 1970). Quiggin and Anderson found that expected values are generally calculated on the basis of unskewed, especially normal distributions. In the final appraisal stage, estimates tend to be subjected to partial sensitivity analysis to show the dependency of the outcomes of the appraisal on assumptions.

Because sustainability-oriented project appraisal starts from a different policy framework, the format of the impact matrix needs to be adjusted in several respects. The basic structure is shown below:

Sustainability-oriented impact matrix (to be prepared for all alternatives)

criteria	time	
	present generation	future generations
efficiency		
equity	effects/risks	
sustainability (resource use/ availability)		

The following adjustments have been made:
- An obvious change is that three instead of two criteria should be included, sustainability being added. Scores on the sustainability criterion involve a comparison between actual and normative resource use at specified levels. From these scores changes in environmental stocks (i.e. resource availability) can be calculated.
- The time dimension changes considerably. A distinction should be made between short-term and long-term effects, and more in particular between effects on the present and on future generations. The period encompassing the present generation may still be accounted for in terms of years and cover scores on all criteria. With respect to impacts on future generations two approaches may be applied. In the least data-demanding approach, only scores on the sustainability criterion are shown, i.e. actual availability of natural resources compared to threshold levels, possibly expressed in cardinal or ordinal indicators. This approach does hence not comprise efficiency and equity impacts on future generations. It can be justified if the interests of future generations are considered to be fully accounted for if normative resource levels are respected. If not, a second, much more data-intensive, approach needs to be followed, involving estimates of scores on all criteria.
- The traditional treatment of risk and uncertainty does not meet requirements in sustainability-oriented impact assessment. Apparently, environmental effects often involve surprises, especially unpleasant ones. Moreover, probability distributions may often be skewed to the left. Uncertainty is significant, and probabilities may not be know at all or only the available in the form of beliefs people may have on ranges or intervals of probabilities for an event (Quiggin and Anderson, 1990).

  From the start, impact assessment should therefore be in terms of effect-risk combinations. This particularly refers to the sustainability criterion, which would have two attributes, viz. relative resource use, and risk and uncertainty involved. 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 only one "best-case" impact matrix, several matrices may be added showing outcomes under extreme scenarios.
One way to incorporate risk and uncertainty associated with environmental effects has been proposed by Markandya and Pearce (1987). Trough "certainty equivalence procedures" decision-makers express how much net benefits they would be willing to sacrifice in order to avoid the risk associated with expected values.

- The sustainability criterion requires a more differentiated analysis as far as spatial levels are concerned. Much more than in the past, contributions to supra-national environmental and welfare changes need to be taken into account.

4.2. Measurement scales for efficiency, equity and sustainability

Now that the basic issues regarding the format of the impact matrix have been identified, the dimension of the effects themselves needs attention. What are the measurement scales for efficiency, equity and sustainability. What are critical levels, dividing the set of alternatives into a group with a positive score on a criterion and a group with a negative score?

Efficiency has mostly been assessed on the basis of basically similar CBA indicators that share the monetary dimension. In the previous section reference was made to one of them, viz. the net present value (NPV). Under certain assumptions the NPV can be used to rank alternatives, a higher NPV being more attractive than a low NPV. The critical value on the NPV-scale is 0. Similar critical values would be the value of the rate of discount if the internal rate of return (IRR) is applied, and 1 on a benefit-cost ratio (BCR) scale. Assessing the score on the efficiency criterion in terms of NPV, IRR or BCR indicators, however, assumes that all efficiency attributes, including the use of environmental resources, can be assigned a monetary value (valuation techniques are described in Dixon et al., 1988; Hufschmidt et al., 1983). When the scores on one or more attributes cannot be measured on a monetary scale, by definition no comprehensive efficiency score in monetary terms can be assessed (see section 2.1). One possibility is to standardize scores on all attributes and consequently weigh the standardized scores, resulting in a dimensionless efficiency score.

Intratemporal *equity* scales are not unequivocal. With respect to distribution of income, inequality measures used at the national level may be taken as a starting point (see Gilles et al., 1987). The national distribution of income is often shown in the Lorenz curve. It shows the percentage of total income accounted for by any cumulative percentage of recipients. From such a Lorenz curve the Gini concentration ratio can be calculated on a scale between 0 and 1. In the case of perfect equality the Gini ratio is 0, whereas it is 1 in the case of perfect inequality. An alternative is the Kuznets ratio, which sums up the differences between income shares and population shares of all the cells into which a population might be divided. An even more crude approach is to focus only on the income share of the group that is considered to comprise the poor (bottom 20 or 40%).

In the context of project appraisal the question is which part of net benefits accrues to specific groups. Distribution patterns could be shown in simplified types of Lorenz curves. The degree of inequality in principle might be assessed trough Gini or Kuznets coefficients, but these approaches are likely to be too cumbersome in general. A relatively straightforward approach might be to measure the part of the net efficiency gains that accrue to specified target groups, for instance landless labourers, people with a below average income level, etc. [5] Alternatives might be ranked according to the score on this equity indicator. Critical values may be established for equity. For instance, a project may be considered attractive from an equity point of view if at least 40% of efficiency gains accrue to the target groups. Actual scores on this measure might be represented at a scale with 40 as a target level. Alternatively, the outcomes might be transformed to a dimensionless scale with -1 (0% of benefits accruing to target groups) and +1 (all benefits accruing to target groups) as extremes, and 0 (threshold part of benefits accrue to target groups) as centre value.

Possible *sustainability* scales have already been referred to. In its most simplest form, it is measured on a binary scale: a project either does or does not satisfy resource use constraints. It was proposed to use cardinal or ordinal sustainability indicators if sufficient data are available. In any case, the critical value on the sustainability scale would be the threshold level discussed above. If measured on cardinal or ordinal scales, scores would show the relative distance between actual and normative resource use levels at a scale with 0 as critical level. The sustainability criterion may furthermore include a long-term risk attribute, whereby risk and uncertainty is expressed on a dimensionless scale.

Principal measurement scales and critical levels (*NPV: 0; share to poor: x%; resource use: sustainable level*) are summarized below. For all criteria scores might also be expressed in terms of relative distances between actual and threshold levels on a scale with 0 as centre value. With respect to presentation, scores of all alternatives might be

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[5] The income distribution measures mentioned thusfar are inequality measures in terms of *relative* incomes. Poverty measures relate to attributes of specified target groups in some *absolute* sense (income, nutrition) and are often considered a better criterion for measuring equity at low levels of income.

gathered in a three-dimensional Euclidian space, with the three criteria at the axes. Differences between actual and threshold levels might also be gathered in a Möbius triangle (see Nijkamp et al., 1990) or in circles (with threshold levels at the edge of the circle and actual scores within or outside the circle)(cf. the AMOEBA model of ten Brink, 1991).

criterion	scale	appreciation		
			critical level	
efficiency	NPV	negative	0	positive
equity	% to target groups	negative	40%	positive
sustaina-bility	resource use	positive	sustainable use	negative

The conclusion from this section is that principal effects in sustainability-oriented project appraisal are likely to be in different dimensions. Often, a mixture of monetary, quantitative and qualitative data may result. [6]

4.3. Problems in measuring scores on environment and sustainability [7]

As scores on the environment criterion provide the basis for an assessment of the score on the sustainability criterion we will devote some attention to the measurement of environmental effects.

Measuring environmental effects focuses on the environment system and is known as environmental impact analysis (EIA)(for a discussion centred on developing countries, see Biswas and Geping, 1987). An EIA focuses on the difference between expected environmental changes a) in the absence of the project under consideration (see project setting profile) and b) if the project is implemented, at the project and higher

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[6] For an example of impact matrices with mixed scores see Nijkamp and van Pelt (1989). Using a simple qualitative system model for Bhubaneswar (India) and its surrounding region, various scenarios for urban development in the region have been analyzed. Impacts were assessed on very different criteria, such as poverty, employment, social climate and migration. Time was accounted for by introducing ten stages, without a direct linkage to particular years.

[7] Parts of this section were published in van Pelt, Kuyvenhoven and Nijkamp, 1990.

levels. To measure b) an analysis is required of how the project influences the environment both during the construction phase and during normal operation. Here 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 that possibly have 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.

Regarding the type of ecological effects a distinction should be made between several groups of receptors (residient and migratory fish, resident and migratory animal spacies, natural vegetation, materials in structures, materials in vehicles, agricultural and forestry activities, industrial and commercial activities, other activities, residences, humans; see Hufschmidt et al., 1983). Effects should be assessed both on-site and off-site, including transboundary effect. Chains of effects should be assessed, and possible time-lags identified. Besides assessing short-term costs (or benefits) of environmental effects, particular attention is required for possible irreversiblities (Toman and Crosson, 1991). Due attention should be given to risk and uncertainty. From the start, the EIA should have a distributional focus: who benefits from environmental improvement and who faces the social costs of environmental degradation?

Systematic research on a wide scale on environmental effects of human activities has only recently started in developing countries. The data base is still rudimentary. Many difficulties in measuring environmental effects tend to arise. Hufschmidt et al. (1983) give the following ones: 1) discharges of material and energy residuals into air, water and land are of many different types; 2) 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; 3) there is a wide range in the time rates of effects on receptors from changes in environmental quality; 4) 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; 5) residuals discharged from human activities are not the only factors affecting the quality of the environment.

But there are several more specific problems. Sustainability has a long-term focus and forecasting environmental effects over periods of several decades usually involves considerable degrees of uncertainty. Assessing environmental decay which is strongly localized may often be easier than environmental problems that tend to spread in space. Contributions to global environmental problems such as the greenhouse effect are a clear example. Pearce et al. (1990) mention effects on life support systems, such as contributions to geochemical cycles. Nijkamp et al. (1990) emphasize the importance of synergetic environmental impacts. This refers to the process that numerous, by themself small impacts on the environment together can have significant environmental effects. Nentjes (1989) stresses the importance of stock-type environmental problems. This refers to the cummulative effect of annual emissions. In such cases overall problems increase even if annual emissions are decreasing. The most well-known example is acid rain. Such problems increase till the latest year that the annual discharge of effluents is positive.

A particular problem with respect to impact assessment at the project levels refers to the question of which environmental effects should be attributed to the project. [8] 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.

With respect to the assessment of scores on the sustainability criterion a distinction has been made between estimating only long-term ecological effects and estimating all welfare effects for future generations. In the former case, i.e. the assessment of the difference between actual and threshold levels of long-term resource use, the EIA might provide all necessary information. Threshold levels being determined in the policy framework (see section 2), they can be compared with actual resource use as established in the EIA. Actual resource use should particularly be estimated for the level at which sustainability is defined. Hence if sustainability is defined at the project level (see Klaassen and Botterweg, 1976), the resource use of individual projects need to be known. If it is defined at higher levels (regional, national, global), it should be estimated how a project would contribute to resource use at these levels. The higher the level concerned, the more problematic measurement of the environmental effect and hence sustainability becomes for an individual project. What would be the score of a project on sustainability in view of its contribution to national acidification, let alone depletion of the ozon layer?
Assessing the score on sustainability might be based on the following guidelines:

- if the supra-project level of sustainable resource use is already exceeded without the project, a project using more resources should be considered non-sustainable. The degree of non-sustainability increases with the relative size of the resource use by the project.

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[8] For a discussion on this issue from the perspective from a country, see Opschoor and Reijnders, 1989.

- if the supra-project level of sustainable resource use is not exceeded without the project but will be exceeded with the project, the project is not-sustainable if resource use cannot be reduced elsewhere (opportunity costs).
- if the supra-project level of sustainable resource use is not exceeded both with and without the project, the project may be considered sustainable. The degree of sustainability decreases with the relative size of the project's use of natural resources.

In general, assessing scores on the sustainability criterion is more difficult under "weak sustainability" than under "strong sustainability" strategies. Whatever the sustainability condition, a "no trade-off" position implies much weaker methodological and data demands than a "trade-off allowed" policy (see section 2.1).

If not only ecological but also efficiency and equity impacts on future generations should be assessed, data problems become extremely large. Whatever the ultimate time horizon, ecologic-economic models would need to be applied. Although much progress has been made in this field in the past decades, such models are still at an infant phase (Braat and van Lierop, 1987; van den Bergh, 1990). The format of a comprehensive sustainability study is illustrated below through the example of the construction of large dams.

The first level at which sustainability should be analyzed is the project level. This involves an investigation of how environmental parameters may affect expected direct (i.e. within the project area) net benefits of the project in the short and long run. Sustainability analysis may then focus on the possibility of sedimentation. Although not a problem in the short run, this could in the long run lead to much higher than expected operation and maintenance costs and less benefits in the form of electricity and irrigation water. This would negatively affect welfare in the project area.

The second step analyses national sustainability effects. The issue here is whether the project would have sustainability-relevant effects at the regional and national level. Hence, to what extent does the project have a negative impact on the social welfare development potential, either through the possibility to produce goods and services or through environmental amenities, in the country? This step in particular requires special attention for distribution effects and poverty-environmental decay relations. The construction of the dam could, for instance, have a strong negative effect on water availability for downstream farmers. This would negatively influence income generation possibilities for those farmers. If these farmers were already near a subsistence level, they may have to turn to environmentally unsound agricultural practices. If such a process occurs, the sustainability of previously environmentally sound economic activities is threatened, although the project itself need not be rejected on sustainability grounds. Another possibility would follow a different chain. The dam could greatly improve the competitiveness of upstream farmers who benefit from the dam. Due to considerable cost reductions and roads constructed within the framework of the project, they can now sell at much lower prices than the traditional downstream farmers. Again their income may drop below minimum levels, which may lead to unsustainable agricultural practices.

Finally, cross-border sustainability effects may be evaluated. Sustainability-relevant effects across national borders would need to be traced in a similar way. An example would be the flooding of rivers, and consequent negative income and behaviour effects, in neighbouring countries due to erosion in the project country as a result of deforestation.

5. Sustainability and evaluation

5.1. Constraints and adjustment of project design

In this section we explore possible consequences of the transformation of sustainability into a veto criterion. This implies that no project is accepted that involves resource use in excess of levels commensurate with normative sustainable levels. A strategy which turns sustainability into a goal, i.e. allows trade-offs between sustainability and other criteria, is addressed in 5.2.

Assuming that sustainability is a veto criterion, EIA outcomes provide the means to divide the initial set of alternatives in two groups: non-sustainable projects and sustainable projects. A project in the first group might be 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 an analysis of what will be called *constraint-satisfying activities*. The aim of such activities, which should actually be implemented, is to ensure that the adjusted project proposal would comply with the sustainability constraint. Constraint-satisfying activities might be classified as follows:
- changing the design of the project itself. The timing, site or technology might be adjusted. Measures may be included to prevent or mitigate negative environmental effects (defensive expenditures). A dam could be made lower, special filters could be installed or reforestation activities could be conducted to avoid sedimentation.
- additional activities may be embarked upon to compensate for negative environmental effects of the original project. Such activities have been called "compensating projects" (Pearce et al., 1990) or "shadow projects" (Klaassen and Botterweg, 1976). In both cases as much environment (in physical terms) should be "created" as will be lost due to the original project. Hence, environmental damage is allowed provided similar quantities of environmental resources of similar quality can be created by men. It should be noted that Klaassen and Botterweg propose to apply the sustainability constraint at the project level, whereas Pearce et al favour the "programme" approach.
- other activities should reduce their use of resources (Winpenny, 1990). In this way the negative sustainability impact of the proposed project is compensated for externally.

If constraint-satisfying activities are included in the project proposal, the impact of the project should be reassessed. This includes environmental effects, which now should comply with sustainability conditions. It should be assessed whether the constraint-satisfying activities themselves need any resource input which might affect sustainability. In addition, costs need to be reestimated. Adjusting project design may often involve larger outlays, whereas additional activities by definition raise costs. Whether it is feasible to assign costs of additional activities to a project depends to a great extent on the level at which sustainability is defined. Following Klaassen and Botterweg's approach, the sustainability condition should be satisfied at the project level. Consequently, the costs of shadow projects can be attributed to and directly affect the economic feasibility of resource-using projects. Such a linkage cannot unequivocably be established if the sustainability constraint is defined at the programme level, as proposed by Pearce, Barbier and Markandya, or 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 or mitigate environmental damage. Moreover, Pezzey (1989) poses the question of who will pay for the economically unattractive constraint-satisfying activity.

If constraint-satisfying projects are implemented on the supra-project level, a tentative solution to attributing costs to individual projects might involve the following steps:

- an *ex ante* estimate of total environmental damage in a year in a specific area,
- *ex ante* determination of corresponding shadow projects and their aggregate costs,
- determination of shadow project costs per unit environmental damage,
- assign unit shadow project costs to projects in proportion to environmental damage.

It should be acknowledged that the notion of compensating projects focused at sustainability constraints implies a fairly optimistic view on men's capability to "build" natural capital. In other words, possibilities for substitution in the environment production function are stressed. Not all ecologists would agree with such a view. Irreversible environmental and synergic effects by definition cannot be compensated.

Besides the impact on environment (sustainability) and costs, distributional aspects should be reconsidered after including constraint-satisfying activities. If compensating projects are not implemented at the same site as the resource-using project, a transfer in space of environmental capital takes place. Similarly, the social groups benefiting from a shadow project need not be the same as those that take the burden of the resource-using project. A recent proposal of Dutch suppliers of electricity may serve as an example. To compensate for emissions of greenhouse gases by a new Dutch power station, a contribution to reforestation in Brazil was offered. In theory, global environmental stabilization might be achieved in this way (although many ecologists will think otherwise), but this might be of little comfort to people living close to the power station. One might justify this particular transfer on the basis of intragenerational redistribution goals. But it is easy to think of examples of constraint-satisfying projects where the environmental burden will fall on poor groups or nations.

Constraint-satisfying activities may also raise questions of intergenerational 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 face the bulk of the constraint-satisfying projects costs.

In the examples given above, it was assumed that the "strong" approach to sustainability applies. Constraint-satisfying activities then by definition involve saving or building natural resources. If the "weak sustainability" approach, which aims at maintaining the total stock of resources (whether man-made or environmental), constraint-satisfying projects could be of two types. The first possibility would be to implement an environmentally constraint-satisfying project, like above. The other possibility is to conceive an economic constraint-satisfying activity, which would involve investments in factors of production other than the environment.

The discussion above centred on activities aimed at satisfying ecological sustainability constraints. Efficiency and equity, however, may also be interpreted as veto criteria. If a proposed project fails to satisfy an efficiency precondition (for instance, NPV>0), constraint-satisfying activities might be designed in similar ways. Activities might also be embarked upon to ensure that a sufficient part of net project benefits accrues to target groups. The relocation of tribes who are negatively affected by large dams is an example.

5.2. Integrated comparison of alternatives

In the final appraisal stage, the overall performance of all project alternatives that have passed veto criteria requirements, is assessed on the basis of their scores on efficiency, equity and sustainability and the criteria weights. Basically two approaches may be followed. The former takes one criterion as a point of reference and subsequently adjusts the score on this criterion for scores on the other criteria. This single-indicator approach is represented by the CBA technique. Social CBA involves adjusting net cost and benefit flows in terms of economic efficiency for income distribution objectives. Through what may be termed a "social-sustainability" CBA, it might be attempted to integrate sustainability objectives into a social CBA. The "rod of money" would continue to be the *numeraire*, and the result would still be in terms of indicators such as an IRR or NPV.

The alternative approach does not aim at a such a transformation whereby one criterion (and hence one measurement scale) is taken as bench mark. The starting point involved separate scores on key criteria. Through arithmetical operations the combinations of weights and criteria scores are used to arrive at a ranking of project alternatives. This is the multi-criteria approach (MCA; see Voogd, 1983; Nijkamp, Rietveld and Voogd, 1990; Pétry, 1990; van Pelt, Kuyvenhoven and Nijkamp, 1990).

From the above follows that the difference between the two approaches does not necessarily refer to the number of objectives. In theory CBA might cover not only efficiency but also equity and sustainability, and in that sense be considered a "multi-criteria" approach. The major difference between CBA and MCA concerns the integration of criteria, and in particular the use of multiple denominators (and hence data requirements).

The findings of this paper may be considered an appropriate means to explore the extent to which CBA and MCA can address the specific analytical problems associated with sustainability-oriented project appraisal. Such an analysis, however, is beyond the scope of this paper.

When sustainability is incorporated in project appraisal in ways outlined above, the outcome in terms of projects accepted and rejected will change. Differences will be most significant in the case of strong-sustainability concepts based on risk-aversive strategies. In principle, a shift can then be expected towards projects in the field of renewable energy, energy conservation and efficiency, recycling of non-renewable resources, development of substitutes for non-renewables, etc. The probability that projects like large dams and deforestation for agricultural development are accepted will be considerably smaller.

6. Conclusions

Incorporating sustainability in project appraisal for developing countries raises a number of issues which have been outlined in this paper. Fields in which the most far-reaching changes are required include the following:

- Sustainability parameters (what are sustainable levels of resource use? what are acceptable ecological risks? at which spatial levels?) should be based on explicit views of policy-makers regarding the responsibility of the present to future generations and the possibility of substituting man-made for natural capital.
- Adding sustainability to efficiency and equity adds to weighting problems in project appraisal. In addition to conflicts between efficiency and equity, conflicts between sustainability and efficiency and between sustainability and (intra)temporal equity need to be addressed.
- Impact assessment will need a long-term time horizon covering more than one generation.
- Instead of emphasizing "best-case" impacts, combinations of effects and associated risk, especially with respect to ecological variables, need to be presented.
- In view of measurement and valuation problems, accounting for several types of environmental effects in the determination of the effiency criterion may be impossible. In such cases only partial efficiency outcomes can be arrived at.

On the basis of further research on these topics, appraisal methods may be selected that offer the best opportunities to address specific issues in sustainability-oriented project appraisal. The basic choice is between integrating sustainability concerns and other priorities in a single indicator (like the NPV or IRR in CBA), or treating various criteria separately and the application of policy weights (MCA).

With respect to appraisal processes, we expect that much more than in traditional analysis an interactive approach is required. Combinations of trade-off regimes, sustainability concepts (for instance strong and weak sustainability), risk attitudes (for instance various degrees of risk-aversion; no-regret strategies), and outcomes in terms of short-term and long-term economic and ecological effects and uncertainty may first be presented to decision-makers. In subsequent steps project redesign and constraint-satisfying activities may be considered and their impact assessed. On the basis of the respons of decision-makers, further adjustments may be made. In the course of this process, the number of alternatives is likely to reduce.

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