9

Policy scenarios for sustainable development

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9.1 Introduction

Environmental policies have been through a distinct process of evolution over the past two decades. The 1970s were dominated by problem-solving policies. Problems such as summer smog or water pollution (e.g. of the River Thames, the River Rhine and Love Canal) were addressed through a range of policies.

The 1980s saw the advent of environmental policies with a more structural approach. New products and processes were forced to comply with certain environmental standards. The purpose of this shift was to avoid future environmental damage by imposing standards that resulted from the identification of earlier pollution problems.

Although this approach was continued into the 1990s, calls have now begun for more general preventive policies. New terms have emerged that suggest a shift in thinking: 'proactive policies', 'no-regret policies', 'precautionary principles', etc. The basic idea is very simple: we can prevent the occurrence of new environmental problems by taking account of the environmental impacts of all products and processes from the outset. In theory, this would seem to provide a promising opportunity for changing the current trends. In practice, however, the situation is much more complicated. If preventive policies are to encompass more than a statement of good intentions, it must be clear for all parties what action is permissible and what is not. It is here that the relatively new concept of sustainable development comes into play.

This chapter discusses the efforts which have been made to operationalise the concept of sustainable development in the form of policies that are capable of implementation. The analysis presented here is based on a study by the Dutch Scientific Council for Government Policy (known in Dutch as the WRR), which was designed to assess the usefulness of sustainable development in terms of policy making (Dutch Scientific Council for Government Policy, 1995). The chapter begins (Section 9.2) with a discussion of the concept of sustainable development from the viewpoints of ecology and economics and suggests that the right balance must be found for the purposes of policy making. Section 9.3 considers the problem of assessing indicators for sustainable development and the constraints imposed on policy making by scientific uncertainty and varying perceptions of risk. This is followed in Section 9.4 by an analysis of policy scenario building using case studies relating to the world food supply and Nature conservation in order to evaluate four action perspectives for sustainable development. Finally, in Section 9.5, the problems facing decision makers in choosing between alternative strategies are described.

9.2 Environmental policy and sustainable development

The nature of the concept

The concepts of sustainability and sustainable development arose in response to the still present feeling that the environment is being increasingly harmed by human activity. The fear is that if things go on as they are, an untenable situation will arise. There is a strong feeling that people will not only degrade the physical environment by their actions, but will ultimately also threaten human existence itself. This untenability manifests itself in the waste of finite raw materials, the utilisation of natural resources in excess of their regenerative capacity and the damage caused by human activity to the conditions required to enable the existence of all manner of plant and animal species. Such damage may be regarded as reprehensible enough in itself, but is particularly calamitous if potentially vital information for human survival is lost. This sense of unease promotes the reasoning that this untenable relationship with the environment must be moulded into a tenable, sustainable relationship.

The general feeling of the immiment approach of an unstoppable catastrophe has undoubtedly been fed by numerous scientific publications on all sorts of environmental problems. These include the deteriorating condition of forests and agricultural soils, the carcinogenic properties of various chemicals, the depletion of the ozone layer and the threatened extinction of species as well as highly prominent incidents such as algae plagues, oil spills, the Chernobyl nuclear disaster and floods caused by soil erosion.

Cumulative negative information, however, may sometimes also evoke simplistic generalisations, which underestimate the massive degree of uncertainty surrounding the scientifically based 'evidence' of impending disaster. Most notably, a few hot summers in Northern Europe may easily be looked upon as evidence of an anthropogenically enhanced greenhouse effect. At the same time, it is easy to overlook the fact that, although human endeavours have negative implications for the environment, they have also brought prosperity and quality to people's lives. For example, it is tempting to forget that agriculture has been able to feed the sharp rise in the world population, that life expectancies have increased substantially, that people's health has improved significantly and that average standards of living have increased on a world-wide scale. At the same time, this recognition should not automatically deny the fact that these achievements are also associated with the exhaustion of natural resources and with damage to the natural environment.

So, in order to assess the value of developments, we need to understand fully both aspects of human activities. Although human endeavours have led to the fulfilment of many needs, this positive outcome is sometimes overshadowed by various undesirable side-effects on the environment. The destruction of the environment is not an intentional goal, but springs from an urge to meet the growing needs and demands of people. The notion of sustainable development was introduced so as to encourage a two-sided appraisal of human activities and thus create a more balanced relationship.

Although the idea of sustainability was formulated as far back as the 1970s, it was the work of the World Commission for Environment and Development (WCED), usually called the Brundtland Commission that placed the concept firmly on the political agenda of national governments and international fora. By way of a follow-up, a wide range of slightly differing definitions have since been given for the term. The problem of defining sustainable development has been discussed at various points in the three volumes of this series, most notably by Blowers and Glasbergen (1995; see also Section 7.3 of the present volume). We do not intend to repeat the debate here, but rather merely to observe that the concept embraces both a scientific conception of 'sustainability' and a social conception of 'development'. It is an elusive concept that is difficult to pin down in operational terms. The latter is what this chapter attempts to do.

In its report entitled *Our Common Future*, the Brundtland Commission gave a formulation of the concept of sustainable development that leaves a good deal of room for individual interpretation (WCED, 1987). The underlying tenor of the report that 'sustainable development' is under threat from both wealth (in the form of overexploitation) and poverty (neglect) has, however, been broadly adopted. The report states that:

> In essence, sustainable development is a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations.

This definition underlines the fact that sustainable development is concerned with at least two aspects: the continued existence and well-being of humankind and that of the environment. In doing so, harmony must be established between all the activities required in order to meet human needs. This does not, however, suggest anything about the extent to which human needs should be met. In addition, attitudes will vary towards which human needs or environmental values are acceptable or not. The Brundtland Report does not elaborate on what is meant by the harmonious treatment of the environment or the point at which human activities will result in unacceptable damage to the environment. The fact that these questions can elicit divergent responses is evident from the differing measures used to determine these factors. In other words, the two aspects of sustainable development (i.e. scientific and human) require some further consideration.

Ecological and economic sustainability

The differences in definitions and interpretations make clear that sustainable development is not an objective feature of a process, but instead involves assigning the

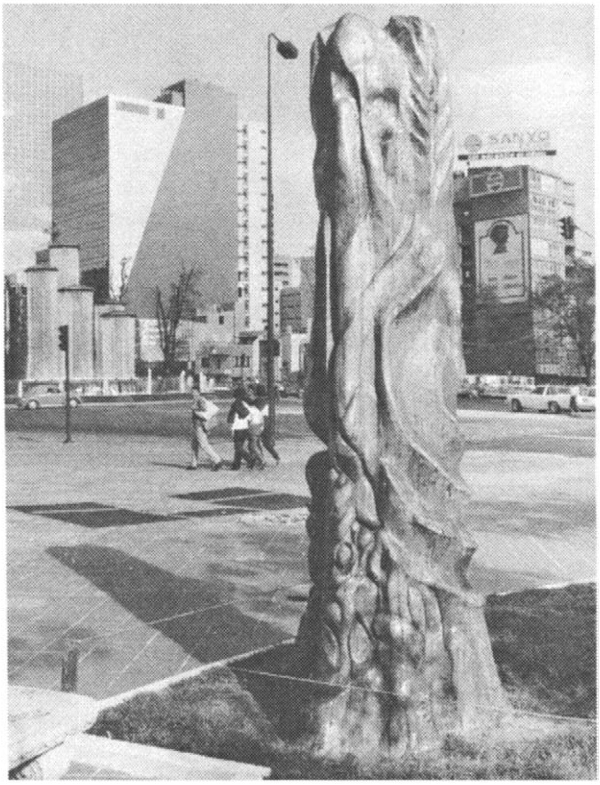

Plate 9.1 Deadwood: this sculpture on Paseo de la Reforma in Mexico City is made from the trunk of a huge tree and symbolises the alarming rate at which the city is falling prey to environmental degradation. Photo: ANP Foto

label of sustainable or non-sustainable to human activities and their effects on the environment. Sustainable development is a two-sided relationship, since the well-being of both society and the environment plays a role in the evaluation of these activities. Social well-being can be measured in terms of the extent to which needs are satisfied, whilst environmental well-being can be measured in terms of the extent to which environmental functions and assets are left intact. In defining these needs, we are dealing with a broad concept which covers the needs not just of the present generation, but also of future generations. However, the needs of future generations must be defined as those felt by the present generation on behalf of future generations. The decision as to whether human activities deserve to be labelled as 'sustainable' must consequently be based on two fundamentally different approaches to developments which are deemed to be desirable.

Figure 9.1 indicates how the satisfaction of social needs and the quality of the environment are interrelated. In fact, there are two separate 'boxes'. In the economic box, activities affect society via the satisfaction of existing needs. In the ecological box, activities affect environmental functions and values via the inevitable emissions of polluting substances, for example. The burden imposed on the environment by a

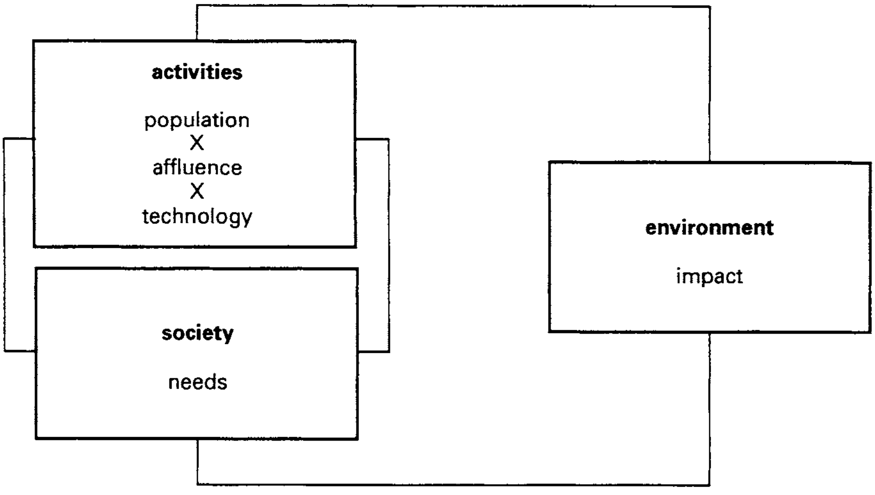

Fig. 9.1 Interrelationships between activities, needs and the environment in the economic and ecological systems. For an explanation, see text in this chapter.

particular activity may take many different forms. Apart from emissions, the effect may be disruption, fragmentation, exhaustion, etc. Together, these influences are known as an 'impact'. In other words, besides having a positive effect on the satisfaction of needs, an activity may also have a negative impact on the environment. Moreover, there may also be a causal link with the economic system if the impact causes damage to an environmental function or asset that helps meet an identified need in the economic system.

The impact of a human activity on the environment bears a relationship to the number of people involved in the activity in question and the way in which the activity is carried out. Take, for example, the environmental impact of the production and use of paper. The impact on the environment depends on:

- the number of people using paper
- the amount of paper each person uses
- the way in which the paper is manufactured and consumed, i.e. the way in which wood fibres are processed into pulp, whether or not the paper is bleached, whether or not the waste paper is recycled, etc.

The relationship between the impact on the environment and the fulfilment of economic needs by human activities is illustrated in Figure 9.1. All activities originate primarily in the economic domain; some activities, however, will have a negative impact on the environment. The magnitude of the impact is related to the number of people involved in the activity, the level of affluence of society and the technologies used.

Many interpretations of sustainable development take just one of the two boxes into consideration, either as a condition of the ecological system to be defined in isolation (i.e. the larger box) or the economic system (i.e. the smaller box). In the former case, a standard is assigned to elements of the environment that may not be exceeded. In the latter case, it is the satisfaction of defined needs which is the central feature. Both cases view sustainable development from their own particular vantage points.

Ecology prevails

Where the emphasis is on giving greater priority to 'environmental criteria' than to human needs (Daly, 1990), 'ecological constraints' are determined in terms of absolute values. The advocates of this position, sometimes referred to as *strong sustainability*, argue that the natural resource base should be kept intact, despite the effect which this will have on society. Limits are therefore defined within which human activity must take place if it is to be sustainable (Daly, 1995). The maximum permissible impact on the environment is determined by specifying criteria for environmental values and functions. Generally speaking, this means that the impact must decline in relation to the present situation. This decline is to be realised either through an adjustment of the number of people involved, or through a decline in the level of affluence, or else through an alteration of the technologies involved in production and consumption.

We have now identified the three steering policy variables. The first and most far-reaching of these, involves proposals for population control. This is generally prompted by the anticipated growth of the population in developing countries. Combined with a rise in living standards, this is regarded as being likely to impose an unacceptable burden on the ecological system. The view may therefore be taken that environmental criteria necessitate an active population policy. In his farewell lecture as Professor of Atmospheric Hygiene and Pollution at Wageningen Agricultural University, The Netherlands, Professor Adema referred to evolutionary development, which '[...] as long as human beings do not get in the way, in my view [...] is the purest form of sustainable development.' On the basis of a postulated maximum permissible burden on the environment and a desired level of prosperity, he calculated that the maximum sustainable global population by the year 2040 would be 2 billion (Adema, 1992).

Secondly, proposals may relate to the adjustment of material welfare or affluence. Viewed from this perspective, per capita income should be reduced so as to relieve the burden imposed on the environment. This should not be confused with a variant proposing that consumption, especially in the rich West, should be 'de-materialised'. The underlying principle in the latter case is that the impact on the environment will be reduced if average human wants assume a less material nature. For example, the consumption of 'culture' (by attending a concert, for example) is less harmful to the environment than the procurement and use of a speedboat. With this approach, policy does not impinge on living standards, but affects the level of technology applied in the process of consumption.

Thirdly, it may be urged that the technology of production should be modified. This would involve investments in new, substitute technology which is capable of reversing the negative impact on the environment.

If the sole focus is on the assets and functions of the environment, a significant element of the social satisfaction of wants is either left out of account or becomes a derivative factor. Proponents of environmental interests may, for example, adopt the uncompromising standpoint that any use of chlorinated hydrocarbons is unacceptable on account of its environmental consequences, without taking into account the effects on human activities and other interests. Such a position is justified by those concerned because of their view that environmental risks are exceptionally great and that the environment must not therefore be exposed to a 'corrupting' process of trade-offs. This ignores the fact that others may have a totally different, though equally justifiable attitude towards the use of these substances, in which the environmental risks are kept within acceptable limits.

'Hard' environmental requirements, then, come into conflict with the 'hard' requirements of society, with, in the background, a difference of interpretation concerning the risks involved. If the required standard of living, the environmental intensity of production and consumption or the population size cannot be regulated, or only with difficulty, we will find ourselves in a stalemate. The most common response to an absolutist but unattainable norm is to find a way of escaping the burden imposed by that norm. In these circumstances, there is a risk that, when concrete choices have to be made, charity will begin at home and priority will be given on grounds of necessity to employment, economic growth, the improvement of the infrastructure and so on – in brief, to more 'worldly' needs.

The economy prevails

Alternatively, confidence in the ecological system may be so robust that emphasis is placed lopsidedly on the economic system. In such circumstances, activities are evaluated entirely against the background of social needs. The satisfaction of these wants is given primacy and any effects on the environment are justified in terms of the express desire of meeting these needs. In this view, the risks of undermining these social needs are regarded as excessive.

This approach does not primarily examine whether needs can be satisfied in an 'environmentally friendlier' manner. Environmental interests, however, automatically come into focus if the perceived social needs which the environment is required to facilitate can no longer be achieved. If the impact on the environment should prove too great, the scope can then be examined for improving the 'ecological performance' of technologies used in production and consumption. In some cases, even an adjustment to the level of affluence with respect to this problem or an effort to bring down population growth might be considered. This 'learning by doing' approach implies that there are sufficient response mechanisms in society and that there is enough time in which to respond. One of the prime exponents of this vision is Wildavsky: 'Formerly people always needed a justification for doing nothing. These days we need a justification for doing something. Progress is based on trial and error, but now we suddenly want a trial without error. We want a free lunch. Unfortunately, there's no such thing' (Rozendaal, 1992).

Balancing subjective preferences

Both one-sided approaches discussed above fail to do justice to the complexity of society. In the first case, environmental requirements are imposed and the rest of the social system simply has to fit in as well as possible. In the second case, economic requirements prevail and the resulting quality of the environment is accepted as an inevitable factor. These partial approaches cloak a risk of an imperative denial of other potential approaches.

In the case of sustainable development, there is a danger of reducing the debate to the views of proponents and opponents. It is, however, critically important to acknowledge that there are a number of highly divergent and in some cases conflicting, perceptions of sustainability that exist side by side. Each of these perceptions provides its own interpretation of the two most important aspects of sustainable development: the ecological norms and values which must be respected on the one hand and the socio-economic norms and values which must be respected on the other.

A failure to take all the relevant aspects into account when elaborating the concept of sustainable development tends to be the rule rather than the exception. It is therefore essential for both the broadly interpreted socio-economic and the ecological dimension to be incorporated in the analysis for the purpose of rendering sustainable development operational. Choices in favour of certain environmental values or certain human needs must be determined in the light of the consequences of these choices. Although it is not in itself a new notion, this 'double goal' is not always equally clear in the present policies aimed at bringing about sustainable development.

9.3 Sustainable development as a policy tool

Carrying capacity and indicators of sustainable development

There is a clear dichotomy in current policy. Economic and socio-economic policies have traditionally been geared towards the attainment of economic goals. At best, these policies sometimes take the environment into account as a marginal limiting factor. As a reaction to this one-dimensional thinking, environmental policies have often been based on the same attitude. Again, at best, the economic situation is regarded as a marginal limiting factor. Those environmental policies that seek to attain sustainable development do not usually incorporate any notion of limiting factors outside the environmental domain. Here, the sole focus is on environmental conditions, as is reflected by the concept of the carrying or absorbent capacity of the environment which underpins these policies. The possibility that a scientific concept might lead to an impartial appraisal of sustainability is very tempting indeed. Tempting as it may be, this type of decision support tool for policy making presupposes scientific information that is capable of distinguishing between the sustainable and the unsustainable in a way convincing enough to overcome political differences of opinion.

The idea behind the notion of an *ecological carrying capacity* in this context is that the environment will be damaged if it is excessively burdened. Serious and possibly even insuperable environmental problems may arise, as a result of which people will die or fall ill, suffer serious inconvenience or loss of well-being and animal and plant species will die out, ecosystems will be ruined, water supplies, soil fertility and the agricultural heritage will be damaged and physical and economic development may be held back. If the absorbent capacity of the environment is known, constraints can be defined for the various activities that impose a burden on the environment. These constraints can in turn be used to determine the behavioural changes which are needed in order to achieve sustainable development.

A particular branch of the literature which was published in the wake of the Brundtland Report addressed the problems in assessing the 'right' constraints with respect to the environment's absorbent capacity. The idea was that, once these were identified, then sustainable development would come within reach. Daly suggested that the carrying capacity of the environment could be represented as a set of Plimsoll lines drawn on the hull of a ship. Plimsoll lines are used to indicate a ship's maximum loading capacity and there are different Plimsoll lines for different weather conditions and for different types of water (i.e. different degrees of salinity). Daly used this metaphor to illustrate the environment's limited absorbent capacity (Daly, 1973).

Various researchers and groups started a quest to identify a number of environmental Plimsoll lines in the guise of indicators of sustainable development. This search for indicators is a logical extension of the same line of thought. The notion of an indicator is based on the assumption that the system as a whole can be monitored efficiently by studying a limited set of key organisms or state variables (Keurs and Meelis, 1987). The results of this quest so far have shown that there are still many difficulties to be overcome before indicators can be used in practical situations (Kuik and Verbruggen, 1991). Nevertheless, a number of authors remain firmly committed to the need for such tools, notwithstanding the problems that have been encountered (Arrow *et al.*, 1995).

Other attempts have recognised that sustainability must be considered in terms of the multi-dimensional nature of environmental space. In this case, two problems arise if we try to identify indicators and establish the target values which need to be met in order to bring about a sustainable environment (van Latesteijn *et al.*, 1994). The first is the problem of assessing the right dimensions of the environmental space. This is the same question as: *What* exactly are the indicators of sustainable development? Or, in more general terms, what exactly does sustainability encompass? The second problem is how to assess the values on each axis that bound the multidimensional environmental space. This is the same question as: *Which* levels are critical for the indicators of sustainability? Or, in more general terms, how can one discriminate between the sustainable and the unsustainable?

Scientific uncertainties and conflicts of interest

The notion that scientific information can be used objectively and unequivocally to indicate the margins within which human activities should take place is, to begin with, at variance with the observation made earlier that sustainable development relates to the quality of both the environment and society. If the 'demands' of the environment do not cut across social desiderata, there is of course no problem. In practice, we find that the greatest progress is made in 'win-win' situations of this kind. Where ecological and social desiderata come into conflict with one another, however, problems arise. If a criterion that is laid down as absolute proves to be unattainable, the policy in question will cease to provide a guiding framework.

Even if an abstract consensus has been reached on the need to strive for sustainable development, it can suddenly prove paper-thin once the consequences become visible and tangible. This is evident from the conflicts that arise, such as following attempts to reduce human dependence on cars or to curb industrial production. In such situations, it becomes apparent that fundamental changes in behaviour are required, often in circumstances when the public fail to accept the need for such changes. Instead of providing clarity, the application of the concept then simply encounters problems of political feasibility.

The concept of sustainable development suggests that definitive knowledge is achievable in principle, i.e. knowledge that enables the limits to and the criteria for behaviour to be determined. This is what makes the whole idea so attractive to governments: hard, scientifically formulated constraints and parameters can render all sorts of political debates superfluous.

This denies, however, the dynamic nature of science. New knowledge is constantly generated that qualifies or tightens previously formulated 'demands' on society. What was previously regarded as incontrovertible knowledge then proves to have been no more than provisional knowledge. This is a consequence of the fact that the accumulation of knowledge is an ongoing process. Many areas of scientific investigation are still in their infancy, particularly in the environmental field. In addition, relevant knowledge also derives from action itself or, in other words, from experience. Every experience gained with the use of new technologies in dealing with certain environmental problems leads to the gathering of new scientific information and knowledge. (The role of scientific knowledge in the conceptualisation of environmental problems and the relationship of this knowledge to the problems of policy making are fully explored in Sloep and van Dam, 1995; Liberatore, 1995; Blowers and Glasbergen, 1995.)

The main scientific problem in distinguishing the sustainable from the unsustainable is the lack of the information which is needed for a complete and coherent analysis. In many cases, knowledge of environmental trends and the impact of human activities on these trends is no more than fragmentary. There are two problems in particular: inherent ignorance and uncertainty.

Inherent ignorance

In order to assess the sustainability of a given development, information is needed on the extent to which the development exceeds the critical limits of both the ecological and the economic system. But even if we restrict ourselves to the physical environment alone, we are still dealing with a highly complex system. The environment does not exist as a unit or entity, but as a system of differing ecosystems (such as forests, fenlands and river deltas) supplemented by abiotic elements (e.g. a supply of raw materials). Ecology is concerned with the analysis of ecosystems and could therefore provide the most important building blocks for setting quality standards for the environment. To date, however, it has proved all but impossible to determine unambiguously which elements are vital for the sustainable functioning of an ecosystem. Ecology is not ready for questions of this type and will probably never be able to come up with definitive answers to such questions.

This may be clarified by drawing a distinction between repeatable and unique systems. Repeatable agro-ecosystems, such as a field of potatoes or wheat, can be identified and the mechanisms of their functioning explained. The time-scale of the system is known and the number of elements in the system is limited. Hypotheses on its functioning are testable and can be experimentally falsified, because the object of the system is clear, i.e. to produce potatoes or wheat. All non-productive elements of the original natural ecosystems, such as weeds and vermin, are therefore eliminated as far as possible in the development of this agro-ecosystem. All other external influences on the system are related to the ultimate goal. In a productive sense, this knowledge is used in order to respond to changing influences. If, for example, the density of a plague organism exceeds an experimentally determined threshold, a decision may be taken to take certain counteractions. To a great extent, therefore, scientific information can be used to identify the characteristics of these comparatively simple systems. This does not imply that there is no ambiguity concerning the relevant indicators of sustainable development. The concepts of stability, resilience, productivity and tenability are employed side by side and attention is given to the use of both renewable and non-renewable resources.

The majority of natural ecosystems, however, form part of unique systems in which the time-scale is in fact infinite. Unique systems are characterised by a large number of unknown positive and negative feedbacks, so that the characteristics of the system cannot be described. In contrast to repeatable agro-ecosystems, the most important goal of the system and consequently the most important elements in it, are less clear in the case of natural ecosystems. Numerous qualitative standards are therefore imposed on ecosystems that are highly constrained in space and time. They therefore draw for their frame of reference on the state of Nature in the past. One such standard might be based, for example, on the goal of encouraging salmon to return to the Rhine. Various indicators of sustainable development can coexist, without it being possible to assign priority to them on scientific grounds. For example, a range of indicators might be used in order to establish the ecological value of the Wadden Sea, such as the state of feeding grounds for birds of passage, the number of seals, the size of the region and the wealth of lower organisms.

If quality standards relate to the entire system, the characteristics of the system become important. In the case of more complex natural ecosystems, however, our knowledge of the resilience, robustness and persistence of the system is highly limited. On the other hand, much may be known about individual elements of such systems and the consequences of disruption can therefore be estimated. The consequences of such disruption for the system as a whole, however, remain largely confined to speculation. The tropical rainforest, for example, is known especially for its abundance of species but their precise numbers, their frequencies and the situation concerning persistence are unknown.

Whereas science is at best able to provide a partial and conditional insight into positive and negative feedbacks, policy, by contrast, is interested in the net result and seeks to find answers to absolute questions, such as 'Is the earth warming up or not?'. Especially in the case of unique systems, science is unable to identify all the determinants of the functioning of ecosystems. In the absence of such knowledge, it is impossible, especially in relation to these unique systems, to determine the quality of the environment. Similarly, it is also often impossible to provide a response to questions about ecological disruption. An inherent ignorance of the consequences of change is more or less characteristic of unique systems. In other words, it is not possible to come up with clear-cut, non-controversial definitions of sustainable development.

Uncertainty

The debate on sustainable development is also hampered by statistical and fundamental uncertainty. The statistical uncertainty stems from the lack of knowledge of human intervention and its effects on the environment, while the fundamental uncertainty stems from a partial knowledge of complex relationships that may lead to differences in insight about them.

It is sometimes possible – within reasonable limits – to predict the effect of a certain intensity of human activity on the quality of the environment. This applies, for example, to the relationship between urbanisation and Nature conservation. Clearly, nature must give way where urban development takes place. In many cases, however, this relationship is surrounded by uncertainties and ambiguities. Although industrial activities result in the emission of acidifying substances, such as nitrogen oxides and sulphur dioxide, their effects on the vitality of forests can be determined only by averaging a large number of observations of the reduced vitality of trees. Causal relationships can sometimes be established at the level of the component elements. This applies, for example, to the effects of acidification on the biochemical process that forms part of photosynthesis. The extrapolation of these relationships is controversial and it is difficult to draw direct conclusions with respect to the growth and production of forests. In this case, therefore, we have to make do with a statistical estimate of the average effect of acidifying deposition on the vitality of forests. The relationship between the dose and the effect may then be portrayed in the form of a scatter diagram indicating that a number of effects have been observed for a particular intervention. The relationship between the intervention and the effect is evidently disrupted by background interference that cannot be screened out.

In many dose–effect relationships, it is not even possible to provide an indication of the size of the background interference and there is total uncertainty about the precise position of the points. The reason for this is not only that much scientific research into these relationships reveals statistical uncertainties, but also that more fundamental uncertainties prove unbridgeable. A good example is provided by the theoretical basis of measures in the field of climate control. Far-reaching statements have been made about climatic changes due to the greenhouse effect, all of varying reliability. These statements range from the belief that the next ice age will be brought forward to a claim that there will be no effect and to the more prevalent conviction that there will be an acceleration in the process of global warming. (A full account of the relationship between scientific knowledge and policy making in relation to climate change is presented by Beukering and Vellinga, 1996.)

A study conducted by the IPCC, however, has examined the status of the various data and has classified them into three categories: facts, suppositions and guesses (Houghton *et al.*, 1990). For example, it is a scientifically established *fact* that human activity (i.e. the combustion of fossil fuels and deforestation) has caused the CO_2 content of the atmosphere to increase at an accelerating rate. It is *suspected* that the increase in CO_2 levels will enhance the greenhouse effect and result in higher average temperatures on Earth. This supposition is based on calculations using incomplete models of the 'unique' climate system, embracing all the problems mentioned above. Tests can be conducted on the component elements of these models, but not on the models as a whole. This means that, depending on the feedbacks for which allowance is made, the results may vary considerably. For this reason, it is necessary to speak of estimates and suppositions and not of probabilities and facts. Finally, there are *guesses* that the greenhouse effect will result in a rise in the sea level; these are not based on hydrological models of the world and are generally no more than speculative in nature and therefore highly controversial (Böttcher, 1992).

However, even if the relationship between, for example, the use of fossil fuels and the rise in the sea level is unknown, choices still have to be made for policy purposes. In these circumstances, the *potential risk* becomes the determining factor in the choice. In the case of statistical uncertainties, this risk can be estimated and both the distinguishing capacity and the reliability of the statements can then be assessed. In the case of fundamental uncertainties, we cannot do anything beyond make a subjective estimate of the risks. In fact, we are therefore concerned here with the *perception of risks*, with respect to both the environment (i.e. can the environment cope with a particular impact?) and the socio-economic order (can society, with its needs, wishes and institutions, adapt to new activities without problems?).

These perceptions of risk come into play when a decision has to be made in a specific instance to adapt certain economic activities in order to reduce the burden imposed on the environment. Generally speaking, this will then mean that environmental investments have to be made. If the relationship between environmental investments and environmental quality is a diffuse one, it will not be clear how great the investment will need to be in order to achieve a given level of environmental quality and conversely it will be unclear what level of environmental improvement will be achieved by a given investment. The recent debate on the cost imposed on the agricultural industry by the Dutch government's manure abatement policy (see Bolsius and Frouws, 1996) and the supposed benefits in the form of vital forests provides one example. Although many farmers are by definition well disposed towards the natural environment, they are not all convinced of the need to eliminate every last emission of ammonia from animal pens at high cost, given that the benefits are not immediately apparent to them. For Nature conservationists wishing to conserve the Peel region in the Dutch province of Brabant from negative external influences, the benefits in the form of an unspoiled natural environment are clear. The estimation of risks therefore invariably comes with a price tag.

It is, however, by no means always the case that life as we know it will cease to exist if a set critical value or an indicator is exceeded. Accordingly, it is virtually impossible to base policy decisions on scientifically established facts. An attempt has been made to draw up sustainability indicators in the case of copper and aluminium (Van Egmond *et al.*, 1992). The researchers in question compared the present level of consumption with the 'permitted level of consumption' as derived from a calculation based on the exhaustion of reserves in 50 years' time. The concept of 'permitted consumption' is subject to highly different interpretations, however. Taking the case of aluminium, there is an enormous difference (by a factor of 400 million) between the present commercially exploitable reserves and the actual geological reserves. On the basis of what is considered technically feasible at present, the technically extractable reserves are estimated at roughly 700 times the current commercial reserves. Differing assumptions about technological progress may lead to lower, but equally to substantially

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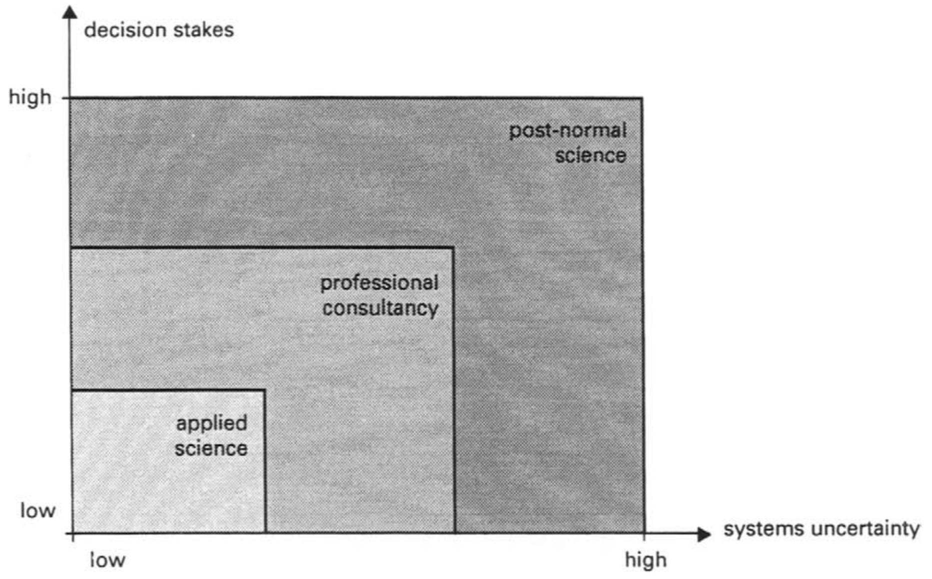
Limits to scientific analysis

Uncertainty, ignorance and risk impose limits on the applicability of scientific analysis in a policy context. Funtowicz and Ravetz (1991) identify three different stages in scientific policy-oriented analyses. In a context of *applied science*, the normal scientific quality standards hold true. The policy problem is translated into a standard scientific puzzle that is solved using the standard methodologies and the standard quality control in the guise of a peer review. This is applicable to small-scale problems that need a policy decision.

Most policy problems are not that simple, however. There is much more uncertainty involved in most cases and there is much at stake which may be affected by the policy decision. This means that stakeholders no longer comply with the scientific analysis and instead seek their solution in *professional consultancy*. Experts are consulted who give their opinion, based on lengthy scientific experience. This expert judgement is no longer subject to a peer review. On the contrary, different stakeholders employ different experts to give different advice.

Over time, the uncertainties and interests involved in policy decisions show a tendency to increase. Most environmental problems are characterised by huge uncertainties and huge stakes. In these situations, people do not even rely on the judgement of professional consultants. There is a feeling that, because of the uncertainties and stakes involved, a personal opinion is equally relevant. We still lack a sound methodology for this sort of policy problem. Funtowicz and Ravetz propose the term *'postnormal science'* for this area. The different stages are summarised below.



Source: Funtowicz, S.O. and Ravetz, J.R. (1990) *Uncertainty and Quality in Science for Policy*. Dordecht: Kluwer Academic Publishers.

higher estimates of these technical reserves. Reducing all these uncertainties to a 'safe' margin of 50 years is therefore, at the very least, a gross simplification of reality. The length of the critical reserve period is in fact determined by the uncertainty surrounding the volume of the reserves and the development of suitable substitutes. If that uncertainty is assessed differently, the result is a different indicator. The problem of relating scientific uncertainty to policy analysis is examined in Box 1.

Perceptions of risks and sustainable development

The problems surrounding the determination of indicators of sustainable development arise at both scientific and ethical levels (Opschoor and Reijnders, 1991). For example, the question of whether species and quality characteristics need to be taken into account in order to determine the functioning of an ecosystem lends itself only partially to a scientific answer. Subjective arguments also enter into the debate: which elements of the environment may be regarded as vital for the quality of the environment? Opinions on this aspect tend to differ very widely. All this indicates that there is no single definition of sustainable development, but a range of subjective value judgements leading to different opinions on what the term 'sustainable development' should encompass.

9.4 Exploring sustainable developments

Scenarios for future developments

Potential sustainable developments can be explored first by examining the trade-offs in terms of current environmental and societal values. Next, the trade-offs with respect to time (i.e. future generations) can be examined. The needs of future generations – at least beyond trivial statements such as that they have to be fed – are by definition unknown. In other words, the time trade-off is our perception of the needs that future generations may have. This implies a method that refrains from quantitative or qualitative assessments of current and future needs, but points to the use of scenarios that visualise the consequences of positions that we might take in the debate on the values that are at stake.

The starting point for this type of analysis is an identification of the different positions that exist in the perceptions of risks involved. If we feel that the environment is very vulnerable and that society should be willing and able to accept fairly drastic changes, we should be able to conceive some idea of the sustainable developments that go with this point of view. This notion of what is sustainable will then differ considerably from a view that considers the environment to be highly flexible and society as very reluctant to accept changes. In the next step, these different positions can be used to sketch possible future developments in a number of scenarios that point to the consequences of current policy decisions for future generations.

The Dutch Scientific Council for Government Policy (1995) has proposed four different paradigms of sustainability. They can be considered as defining the corners of the playing field of most of the debates on sustainability. The paradigms are denoted as *utilising*, *saving*, *managing* and *preserving*.

1 In the *utilising* paradigm, the environment is thought to revert to its original state after a disturbance has taken place. Although human activities do have an effect on the environment, the environment can generally absorb the impacts. This does not imply that there are no risks for the environment, but rather that these risks are relatively small and, moreover, that timely adjustments in technology can be made if major problems occur in connection with the environment. In other words, technology is assumed to be self-regulatory to a certain extent.
2 The *saving* paradigm accepts that the environment has a limited absorbing capacity. However, the risks involved where the productive structures have to adapt to a new situation are considered to be prohibitive. Technology is very difficult to steer in a certain direction and forced shifts in economic production systems will cause massive societal obstruction. The solution must therefore lie in reducing the levels of consumption. Although this is not an easy task, the consumer society will prove to be malleable in the long run.
3 The *managing* paradigm also regards the environment as a vulnerable entity. The solution must lie in adapting technologies to environmental conditions. While there are no major limitations to transforming technology, changing the level of consumption is viewed as leading to unacceptable societal risks.
4 The *preserving* paradigm considers the environment as being highly fragile. Human activities are thought to entail very great risks for the environment. In other words, all possible adaptations of society that we can think of should be put into effect. The risks for society emanating from these drastic changes are acceptable. Society is very flexible and, with the right measures and proper efforts, changes can be initiated before major damage is caused to the environment.

These four paradigms hardly represent all the possible courses of action. In reality, the number of possible paradigms is far greater than four. For example, some people hold the view that any environmental risk should be avoided, regardless of the consequences for society. However, we have not taken this position into account, nor the opposite one that states that socio-economic needs deserve absolute priority whatever the environmental consequences. The reason for this is that these extreme positions have little to do with sustainability, given that the latter concept always involves a weighing up of ecological and socio-economic needs. In other words, any standpoint should at least give some hint as to how the position in one dimension (e.g. safeguarding the environment) affects the other dimension (society). Both extreme positions fail to do this.

All four paradigms aim at sustainability, however different their underlying assumptions may be. These assumptions may be considered as inputs or motivations for behaviour. Whether this behaviour will result in a sustainable situation cannot be assessed *a priori*, but should be judged by its effects in the long term. Scenarios can help by shedding some light on the long-term effects of the initial behaviour. To this end, these paradigms can be translated into action perspectives by considering concrete examples in relation to the environment. Two such examples are now considered: world food production and nature conservation.

Sustainable development and world food production

The most elementary prior condition for sustainable development is an undisrupted food supply, as the continued survival of the human race obviously depends critically on the presence of a guaranteed food supply. At the same time, agriculture poses a threat to the conservation of Nature and environment in many places. This forms the essence of the trade-off problem.

The explosive growth of the world population has been accompanied by an enormous expansion in food production. Although part of the increase has been due to an expansion of the area under cultivation, the bulk comes from an increase in agricultural productivity. Sharp increases in agricultural productivity have been the result of a combination of improved operational technological know-how, coupled with an ability to apply this knowledge. In particular, the hefty increases in output per hectare have been due to the ability to overcome poor soil fertility and water shortages by using fertilisers and irrigation techniques. The increase in labour productivity has been even more impressive. During the course of this century, labour productivity in agriculture has risen in the industrialised world from 4 kg of wheat per man hour to 600 kg per man hour. This is reflected in a reverse effect: an enormous decline in employment in agriculture.

According to the FAO, the growth in food production in the rich countries is falling sharply to less than 1% a year due to the large production surpluses, the virtual stagnation of exports and a limited rise in the demand for food. The FAO expects that food production will continue to increase in many poor countries until the year 2010, at a rate of just under 3% a year. Compared with the period from 1970 to 1989, this

Plate 9.2 Large-scale food production. Combines unload harvested wheat 'on the run' in central Oregon, USA. Photo: UPI/Bettmann

represents a fall in growth (Alexandratos, 1988). Nearly two-thirds of the increase in food production in the poor countries has been achieved by higher yields per hectare and around a third by an expansion of the cultivated area. The latter creates enormous problems, because it means using increasingly marginal agricultural land and environmentally highly vulnerable land.

Ranged against this growth in agricultural output has been a growth in the population which needs to be fed. The most recent FAO projections suggest that the growth in food production will outstrip population growth in virtually every region in the world. The overall conclusion reached by the FAO is that the availability of food in developing countries may rise from 10.5 kJ to 11.5 kJ in the year 2010. This will not eliminate the problem of continuing malnutrition in numerous developing countries, especially in southern Africa and southern Asia. Of the 800 million people who are

Plate 9.3 Somalia, August 1992. Starving Somali children in a feeding centre run by the International Red Cross in Baidoha, one of the many Somali towns accommodating thousands of people affected by the famine that hit Somalia after 18 months of civil war. Photo: ANP Foto

currently beset by hunger and malnutrition, 650 million will still be in the same situation in 2010 (FAO, 1993).

Other institutes have put forward somewhat different figures and, more particularly, have reached different conclusions. According to the Worldwatch Institute, for example, per capita food production has not increased throughout the world since 1984 (Brown *et al.*, 1993). According to these figures, the average growth in production from that point on has been less than 1% a year, while the population has continued to increase at over 2% a year. The Worldwatch Institute concludes on this basis that a major problem is looming. The 6% fall in per capita food production between 1984 and 1992 cannot be viewed in isolation. The degradation of the environment and the threat of a growing greenhouse effect combined with a loss of momentum in food production and an inability to check the growth of the world population will ultimately result in growing hunger throughout the world (for a more extensive discussion of this topic, see Sage, 1996.)

Whatever interpretation is chosen, the distribution of food is a source of major concern. The main causes of the distribution problems are war, natural disasters and poverty. The disastrous food situation in a number of African countries is largely attributable to the consequences of war, poor government and the self-perpetuating effect of the poverty spiral. Healthy agriculture requires investment in the means of production. The lack (due to poor harvests) of the financial resources which are needed in order to undertake such investment results in a further decline in agricultural yields. This, in turn, reduces the chance of the necessary investments being made in the following season.

Environmental problems associated with the supply of food

For all the benefits that agricultural production has brought, humankind has been aware for many centuries that certain forms of agriculture also come at a cost. The exhaustion of soils and the overutilisation of irrigation systems have resulted in erosion and the irreversible loss of good soils. The bare hills in the Mediterranean, especially in Greece, are evidence of this tragedy. Although these problems have been recognised for centuries, newly eroded areas continue to appear. Soil degradation due to erosion occurs primarily on less fertile soils. Farming on excessively steep slopes or shallow soils or in semiarid areas is inviting difficulties. In many cases, however, the local population is forced to put these less fertile soils to productive use as a result of population pressures and poverty. Farmers lack the capital to maintain the soil fertility, so that the soils become overfarmed and soil degradation continues.

In sharp contrast to the environmental problems in agriculture caused by poverty are those arising from prosperity. In certain parts of the industrialised world and, increasingly, also in the *newly industrialised countries* (NICs), fertilisers and pesticides have been overused in both environmental and agricultural terms. This has caused major environmental problems. The same applies to large-scale irrigation projects that use water in an uncontrolled manner.

Environmental problems arising from poverty and wealth are endangering the continuity of food production. Food security is not, therefore, wholly guaranteed.

The current trends in the world food supply cannot be characterised as sustainable. The issue of the world food supply is, however, subject to numerous uncertainties when it comes to describing possible trends. There is also a great dearth of knowledge about the relevant relationships: is the environment suffering more from over-input or from under-input? Can erosion be countered by changes in agriculture or do all activities result in a loss of soil quality? These uncertainties and questions have resulted not only in differences in attitudes towards the present situation, but also in major differences of opinion as to how agriculture could develop.

A universal starting point for any analysis of the possibilities for sustainable food production is the *potential* for agricultural production. This potential is restricted only by the quality of the soil, climate conditions and the properties of the crop. In addition, sustainable production is also affected by the assumptions which are made about production techniques and consumption patterns.

Production techniques

The first assumption concerns the possibility of closing all the material cycles in the production system as effectively as possible. Agriculture makes use of nature's productive capacity, tapping outputs from the system in the form of products. If agriculture is to be maintained over a lengthier period, inputs need to be added to the system in order to compensate for the outputs which have been tapped off. By definition, it is never possible to convert 100% of inputs into outputs; this implies that some of the inputs will inevitably be lost to the environment in the form of leakages.

Various strategies may be pursued so as to minimise these losses. Attempts can be made to close the cycles at either a global or a regional level. At a global level, sustainability may be achieved by trying to maximise agricultural efficiency on a global scale. This then makes it possible for comparatively high local leakages to the environment to be accepted with a view to reducing the overall burden on the environment. If we make use of efficiently produced fertiliser and transport it to places where such nutrients can be converted as efficiently as possible into agricultural products, we can attempt to limit the aggregate losses as much as possible. Sustainability may be achieved at a regional level by aiming at the lowest possible rate of input loss *per hectare*. This principle results in the deployment of techniques that avoid the use of external, alien substances such as fertilisers and pesticides wherever possible. Efficiency is therefore defined at a totally different level of scale.

Consumption patterns

Opinions on sustainable food production differ not only in relation to the potential agricultural techniques, but also as to the amount of food which the average world citizen should consume in the future. The choice in favour of either a *luxury* or a *moderate* diet is prompted by differing estimates of the environmental consequences. The choice of a moderate diet is based on the view that, in the long term, the world population cannot be fed at the present level of Western consumption, as this would impose an undue strain on the environment. In the case of a Western diet, by contrast, the environmental risks are deemed acceptable. It may be noted that neither of these two diets is extreme; the moderate diet is substantially higher than the present world average, while the luxury diet is lower than the present level of consumption in, for example, the United States.

	'Luxury' diet	'Moderate' diet
Globally oriented agriculture	Utilising	Saving
Locally oriented agriculture	Managing	Preserving

Table 9.1 Action perspectives for the sustainable development of the world food supply

Action perspectives

The four action perspectives introduced earlier can be related to the different combinations of diet and production techniques, as is shown in Table 9.1.

The *utilising perspective* aims at the provision of a luxury diet on a world-wide scale as quickly as possible. It assumes that this level of consumption is consistent with people's aspirations in large parts of the world. Potential environmental problems are regarded as not being insuperable. In addition, there is marked confidence in technological solutions to environmental problems. In particular, increasing agricultural output on good soils is thought to result in the highly efficient utilisation of physical inputs such as fertilisers and pesticides, to the benefit of the environment. This agricultural technique requires a minimum level of physical inputs per unit of product. Furthermore, comparatively little land is taken up at maximum levels of production. The utilising perspective regards the social risks associated with the introduction of a globally oriented agricultural system that is required to meet a sharply increasing demand for food as being acceptable. The relevant know-how is also increasingly exploited by food producers throughout the world.

The *saving perspective* considers that major environmental risks are attached to feeding a rapidly rising world population. Locally oriented agriculture would, however, involve an excessive change in relation to the present forms of agriculture, for which reason the system seeks to minimise the risks for the environment by limiting the demand for food. This would involve a substantial reduction in the pressure exerted by the agricultural system on the environment. The aim is a moderate diet for each world citizen both now and in the future. This situation is to be realised by the redistribution of the food output. Residual environmental problems that could arise under the globally oriented system are regarded as soluble. The system can be fine-tuned to the point that alien substances such as fertilisers and pesticides need not be released in large quantities into the environment.

The *managing perspective* departs from the aim of a moderate diet on account of the social risks that are associated with it. This may not, however, be at the expense of subsequent generations. The risks to the environment of a globally oriented agricultural system are therefore regarded as excessive. The environment faces threats not so much from the losses per unit of product as from the local losses to the various environmental compartments. Water, soil and air must be of high quality and energy and resources must be used sparingly. The comparatively high uptake of land that may be expected under a locally oriented agricultural system is regarded as less of a problem, as are the necessary adjustments in the structure of production.

The *preserving perspective* regards the risks to the environment as so grave that the demand for food needs to be limited and local material cycles optimised by the development of modified agricultural systems. The introduction of alien substances and the long-range transportation of potentially harmful substances (e.g. fertilisers) are considered to pose an undue risk to the environment. The social risks of 'adjusting' the demand to a moderate diet are regarded as acceptable. The reduction in demand combined with careful chain-management on a local scale would guarantee a sustainable world food supply. Here too, the emphasis is on achieving an equitable distribution of a supply of food which is by no means overabundant.

Self-sufficiency is realisable at a global level in all four scenarios. However, only in the saving scenario (i.e. based on a moderate diet, produced by a globally oriented agricultural system) can self-sufficiency be achieved in each region. This implies that, in all the other scenarios, certain regions suffer from shortages and that interregional trade is required in order to meet food needs.

A self-sufficiency index does not of course tell us much about the absolute quantities. The potential surplus production can be estimated by comparing the maximum production per region with the regional demand, which is set equal to a self-sufficiency index of 1.1. This calculation shows that the managing scenario is unattainable. The combination of locally oriented agriculture and the wish to provide a luxury diet is therefore not a practical proposition. At world level, there remains a shortfall of around 1.5 billion tonnes of grain equivalent.

The other scenarios show a surplus. The imposed rate of 110% self-sufficiency can therefore be achieved. In all three of these scenarios, however, there remain regions with a shortfall, especially Asia (East, Southeast, South and, to a lesser extent, West Asia in particular). Food supplies in these regions will need to be supplemented by supplies from other regions with a food surplus.

The biggest trade flow is required under the utilising scenario and amounts to around 5.5 billion tonnes. This is followed by the preserving scenario, with around 4 billion tonnes and finally the saving scenario with around 1 billion tonnes. The figures also reveal that the impact of a change in the diet is greater than that of the production technique applied.

Evaluation

Enough food can be produced to feed the entire world in almost any of the scenarios. Depending on the level of consumption selected, the agricultural system in question and the availability of water, between 11 billion (in the managing scenario) and 44 billion (in the saving scenario) people can be fed world-wide. A sustainable food supply does not therefore run up against physical limits for the world as a whole. The extent to which the world population can be fed depends rather on political and socioeconomic factors.

The results indicate that sufficient food can always be produced in South America, North America, Central Africa and Oceania to meet the demand, irrespective of the preferred diet. In East and South Asia, however, this is only the case given a moderate diet and a globally oriented agricultural system. Problems may arise in various regions. In a limited number of regions (i.e. North and South America and Europe), the luxury of a Western diet combined with locally oriented agriculture can be afforded, but this is an exception. For the rest of the world, the distribution of food is a possibility. This presupposes an economic climate that is conducive to international trade, adequate purchasing power in the deficit regions and a high degree of international solidarity. In terms of the present world community, these are extremely exacting conditions.

In all cases, the scenarios outlined above will involve enormous changes in the agricultural system in comparison with the present structure. These adjustments will require across the board co-operation among all concerned. In a system either aimed at self-sufficiency or based on international trade, considerable demands will be made on international co-operation and solidarity. Just how likely this is to succeed will be judged differently by different people.

Sustainable development and Nature conservation

Humankind has never been particularly careful with the natural environment. It is only in recent decades that a general awareness has arisen that current human practices are a threat to Nature. Direct exploitation for the purposes of food production, timber and other raw materials is resulting in the withdrawal of large areas of land from the natural environment. In addition, considerable damage is being caused indirectly by the pollution of the soil, water and the air. The result is a substantial change in natural conditions, in turn reflected by changes in the flora and fauna (Bink *et al.*, 1994). The scale and severity of the damage has led to a realisation that a halt must be called to these developments, both nationally and internationally.

Global concern for the quality of the natural environment has increased in recent decades. Since 1970, the amount of land surface officially designated as 'Nature conservation areas' has increased sharply from 5 to 7.5 million km^2. More than a sixth of the total land surface of the world now consists of protected Nature conservation areas. These protected areas are intended not only to preserve wildlife, but also to conserve landscapes that are deemed to be 'characteristic' in terms of what the World Conservation Union (IUCN) calls the 'harmonious interaction between inhabitants and land'. In recent years, this attitude towards conservation has not merely been a response to acute problems. More and more emphasis is now being placed on the prevention of problems; it is no longer a matter of waiting until a particular species is threatened with extinction, but rather of preventing threatening situations from arising in the first place. In The Netherlands, this preventive strategy has been translated into a network of protection areas, in which the government envisages considerable expansion (Nature Policy Plan, 1990).

In the present situation, a limited part of the global wildlife area is afforded protection against direct harm, but not against indirect disturbance. Once again, the question arises as to what the concept of 'sustainability' in the relationship between people and Nature actually implies. In order to decide which natural areas need to be protected from the viewpoint of sustainability, one first of all needs to define what 'natural' means. This is a matter of considerable ambiguity and attitudes vary widely. What is regarded as natural may on further reflection in fact be a feature that has arisen as a result of human activity, such as excavated peatland or an artificial lake. Furthermore, the frame of reference may vary from one person to another: a city

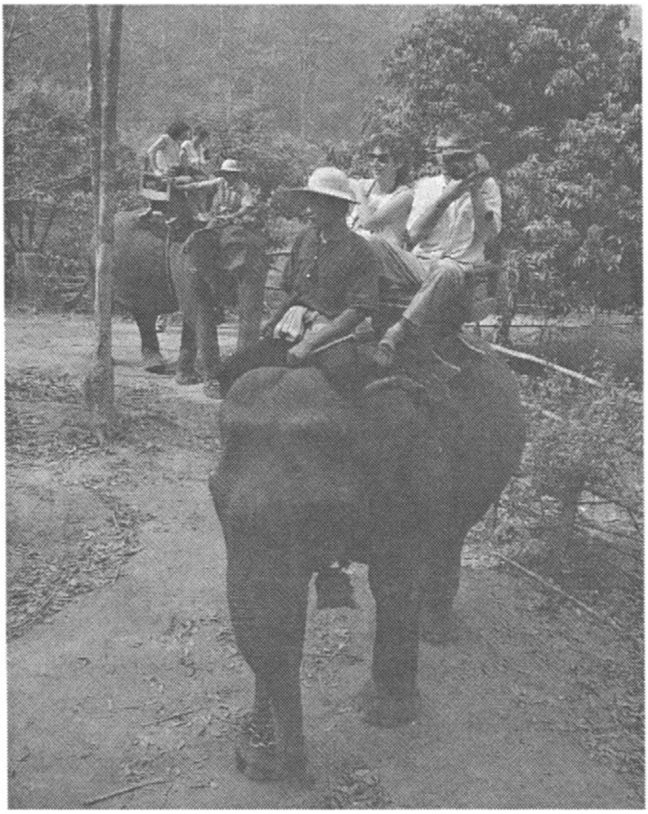


Plate 9.4 Eco-tourism in Thailand. Photo: Ron Giling/Lineair

dweller may regard a trip through farmland as a venture into 'Nature', whereas a biologist may regard the same farmland as being short on natural features. From both perspectives, however, 'Nature' is defined here as the occurrence of interesting natural assets in an area and the latter also includes areas or landscapes affected by human activity. The extent to which one considers that an area contains certain natural assets is determined on historical, aesthetic, educational and recreational grounds. As the example of the city dweller and the biologist indicates, these are all subjective variables. For this reason, it is not possible to assign an objective, universally valid substance to this category of 'Nature'. (The problem of defining landscape quality is discussed in Blunden and Curry, 1996 of this series.)

For the purpose of this section, a distinction is made between 'primary' and 'secondary' Nature' (van der Meij *et al.*, 1995). Primary nature consists of wildlife areas, i.e. areas largely untouched by human activities. Secondary Nature consists of highly visible animal species (such as seals, beavers and black-tailed godwits) or valued natural features (such as peatlands, sand drifts and reed beds) within a cultivated area influenced by mankind. Although this is often assumed, there is no correlation between the distinction between primary and secondary Nature and the distinction between ecocentric and anthropocentric views of Nature. When it comes to the protection of unspoilt areas, some people argue that this is in the interests of Nature itself, in that Nature has intrinsic assets and deserves to be protected on these grounds. However, it is of course once again human beings who form a judgement on the intrinsic value of Nature. Since we are concerned in both cases with the assignment of a value, anthropocentric motives apply.

The distinction between primary and secondary Nature is also open to debate for other reasons. Ultimately, natural assets (i.e. secondary Nature) also form part of the goal of Nature conservation in wildlife areas (i.e. primary Nature). If human activity constitutes a threat to the maintenance of natural assets, a system of limiting conditions may be imposed on the activity in question. This is the case with the EC Regulation on hill farming, which imposes a number of conditions on agricultural activities in order to give natural assets, such as meadow birds and hedgerows, an opportunity for continued existence in the areas in question. With this type of regulation, there is no longer a clear distinction between Nature conservation aimed at wildlife areas (i.e. primary Nature) and Nature conservation aimed at natural assets (i.e. secondary Nature); indeed the difference is somewhat blurred. Nevertheless, for the sake of the analysis, the two categories will be treated as distinct types of Nature conservation.

Lack of knowledge and structural uncertainties

If we wish to form a picture of developments in the natural environment, we run into major gaps in our knowledge. Global evaluations do not, for example, pay any systematic attention to the occurrence of natural assets in urbanised areas. This can result in a distorted picture of the state of Nature, at least in the eyes of someone who includes these assets in the definition of Nature. Similarly, our knowledge of the species living in large natural areas and of past developments is no more than fragmentary. The total number of plant and animal species on Earth has not even been remotely established; estimates range from 5 to 80 million. Only some 1.7 million species have actually been described (see Barnes, 1996).

Significant differences in definition also interfere with the comparison and interpretation of research findings. How unspoiled must a wildlife area be in order to qualify as such? What is meant by tropical rainforest? What precisely is a species and which organisms belong to it? For how long must there have been no sightings of a particular species for it to be regarded as extinct and how intensively should it have been looked for? In other words, estimates of declining natural assets differ widely, as may be seen from Table 9.2. This makes it difficult to make any precise judgements about the current state of affairs.

Against the background of the deterioration of the natural environment, the question arises of what a sustainable relationship with Nature would involve. The notion of sustainability means that account needs to be taken not just of the general or specific natural features that *currently* need to be safeguarded or realised, but also of what general or specific natural features need to be passed on to future generations. Opponents may argue that natural conditions are always dynamic and have always been changed by human activity. The present generation does not miss the dinosaur or those species which are associated with the cultivated landscape which existed in the last century. This argument is based on an assumption that adjustments will always be made to changes in specific natural features and the amount of unspoiled Nature; why,

	1990			1992		
	Extinct	*Threatened*	*Known*	*Extinct*	*Threatened*	*Known*
Plants	384	19.078	294.650	595	23.078	400.000
Mammals	83	497	4.170	60	507	4.170
Birds	113	1.037	9.198	116	1.029	8.715
Fish	23	343	19.056	29	713	21.000
Reptiles	21	170	6.300	23	169	5.115
Amphibians	2	50	4.184	2	57	3.125
Invert.	98	1.355	1.046.361	252	1.977	1.300.000

Source: WRR, 1995

Table 9.2 Different estimates of globally extinct and endangered species, since 1600. Source: van der Meij, T., Hendriks, J.H.W. and Musters, C.J.M. *et al.* (1994) *Ontwikkelingen in de natuur; visies op de levende natuur in de wereld en scenario's voor het behoud daarvan.* Leiden: Milieubiologie Rijksuniversiteit Leiden.

therefore, could not future generations in turn adjust to an environment with less 'Nature' or fewer specific natural features? The question is, however, whether the present generation actually wants this. The perspective also takes on a different complexion if it is borne in mind that the processes of decline have increased sharply throughout the world in recent decades as a result of population growth and economic activity.

Action perspectives

The action perspectives for future developments differ primarily in their definition of what should be aimed for in terms of Nature. The aim of the preserving and saving action perspectives is the preservation of an unspoiled natural environment, while the managing and utilising action perspectives seek to sustain specific natural features. Clearly, the responsibility *vis-à-vis* future generations is given widely differing interpretations in these two pairs of action perspectives. Both pairs are designed to combat irreversible trends, though in the case of one pair this attempt is *non-selective* (i.e. involving all primary Nature), whilst in the case of the other pair it is *selective* (i.e. concentrating on various valued natural assets).

An attempt can be made to translate these basic principles into claims on an area of countryside which is in need of protection. This gives rise to a difference within each of the pairs of action perspectives because, although the aim is to preserve as large an area as possible of unspoiled Nature, the actual extent of that area depends greatly on whether this basic principle means 'the total area which is still unspoiled' (i.e. under the preserving perspective) or 'all current options for the natural environment must be kept open' (i.e. under the saving perspective). The same distinction can be made between an action perspective which seeks to realise natural assets primarily in cultivated areas (i.e. the utilising perspective) and one which is focused mainly on natural areas (i.e. the managing perspective) (see Table 9.3).

The *utilising action perspective* is based on the principle that humans have a need not only for natural products, but also for green spaces and contact with interesting, attractive, fascinating and appealing plants and animals which deserve their care. In order to satisfy the need for these natural resources, however, it is not considered necessary to set aside separate areas on a large scale. It is perfectly possible to enjoy and study Nature within built-up and non-built-up cultivated areas, zoos, botanical gardens and parks and to maintain species in cultivated settings, if necessary through breeding and cultivation programmes. The creation of separate spaces in the form of Nature reserves is therefore only necessary if certain valuable species or ecosystems cannot be sustained in a cultivated setting. The population size of these species and the extent of these ecosystems must be large enough to enable samples to be taken from them at intervals in order to enable the populations of botanical gardens, zoos, etc. to be supplemented.

The *saving perspective* is based on the principle that natural areas must be safeguarded. Moreover, the opportunities for using these areas must also be retained for the future. At least one representative section of each type of ecosystem must be protected in as complete a form as possible. The size of the systems must be such that they are self-sustaining, possibly supported by a certain amount of management aimed at maintaining important parameters for the system. This supportive management must then be focused on important environmental factors, such as the supply of clean water and the maintenance of the soil structure and/or key species, such as the most important producers, consumers, predators and reducers. The knowledge required for this is already available or should be made available in the short term. Nature management using 'large grazers' is an example of the application of this approach.

In the *managing action perspective*, the need for contact with Nature can be satisfied only by observing plants and animals in natural conditions. Space has to be created for this and Nature conservation therefore has to concentrate on preserving and developing plants and animals and their respective biotopes. Opportunities must also be created for the recreational and educational use of these natural areas, though this must take place in such a way that the species concerned and their biotopes are disrupted or eroded as little as possible. National parks may be regarded as an example of the application of this approach.

The *preserving perspective* is based on the view that all the Earth's existing unspoiled Nature must as far as possible be allowed to develop freely. In places where this Nature has been eroded or has become extinct, the natural conditions should be restored as far as possible. This is the only way to keep all the options open for future generations. It is acceptable for the preservation and restoration of wildlife to take up

	Natural features	**Unspoiled nature**
Minimum space	Utilising: Interesting nature in cultivated areas and towns	Saving: Preservation of representative ecosystems
Maximum space	Managing: Interesting nature in natural areas	Preserving: Preservation of all unspoiled nature

Table 9.3 Action perspectives for the sustainable development of nature.

a lot of space, though this should not be at the expense of all else. This view is based on the idea that each component in an ecosystem has a function which cannot be substituted. Systems cannot be sustained by simply protecting a typical part of them, because this brings with it the risk of the system becoming isolated and thus impoverished. A Nature policy which allows Nature a completely free hand to develop in a given area is typical of this view. This does not mean, however, that areas which are currently not used by humans are by definition areas of unspoiled Nature; the natural environment in these areas may have been indirectly disrupted or may not yet have recovered from severe disruption in the past.

Scenarios

Habitat destruction, i.e. a reduction in the amount of space available for Nature, is the most important threat to many specific natural features and valuable natural areas. The various solutions have therefore been translated into claims on that space. Although this is a rough criterion, it does give an indication of what the concept of sustainability could entail, if taken seriously. The question is whether science can help in explicating the subjective action perspectives. For example, what area would be needed in order to sustain the present wealth of species?

Clearly, the amount of space needed in the utilising scenario is limited. In this scenario, it is perfectly possible to study and enjoy Nature within agricultural areas, productive forests, the urban environment and in museums, although some protected Nature reserves will be needed in addition to this in order to sustain species which cannot as yet be bred or cultivated. In this scenario, the existing acreage of protected areas, which adds up to at least 5% of the total land area, is assumed to suffice. This would appear to be a realistic option for the preservation of some species. In Africa, for example, it has been estimated that the present acreage of protected areas is the minimum needed to preserve the large mammals (Soulé *et al.*, 1979). What will be necessary is a relocation of the protected areas in order to ensure that sufficient space is created for Nature conservation. This will involve an expansion of the protected areas in Asia and Africa and, to a lesser extent, in Europe and the former USSR; the existing acreage in North and South America is more than adequate.

There is a greater need for space in the managing scenario. The assumption is that 10% of the total land area will be required, i.e. twice the size of the present protected areas. This choice is relatively arbitrary, since the information that is needed in order to carry out a precise determination is not available. What is clear, however, is that the present protected area is too small, so much so that many attractive species are already facing extinction.

The saving scenario also opts for a total protected area covering 10% of the overall land area, though here again a great deal of research is needed in order to confirm this figure more precisely. This estimate is based on calculations by Wolf, who produced a figure of 1.3 billion hectares as a minimum requirement for the preservation of at least one representative ecosystem (Wolf, 1987). The location of this 10% is not identical to that in the previous scenario, since the saving scenario covers all possible ecosystems.

The preserving scenario designates all presently uncultivated areas – totalling 60% of the total land mass – as worthy of protection.

Obviously, the size of the areas chosen is open to debate; there is no hard scientific proof of either the minimum or the maximum area required. Nonetheless, the choices appear defensible. It is plausible, for example, that the preservation of the existing wealth of species and ecosystems will not permit further domestication and a resultant reduction in the present area of unspoiled Nature. The 'hardest' consequences of the scenarios relate to the use of space. The amount of space available on Earth is fixed and if part of it is reserved for Nature, the question arises as to how much space will be left for other purposes, in particular for the other activity which demands large amounts of space, namely agriculture. In addition, other 'softer' factors are equally relevant, including the cost of establishing protective measures or refraining from the exploitation of Nature for other purposes. Whether there is a willingness to pay the price this will demand depends on the priorities set, the physical scarcity of raw materials, etc.

Each scenario has its own specific measures and costs. In the utilising scenario, for example, it will be necessary to relocate a number of protected areas in order to ensure that sufficient space for Nature conservation can be realised in areas where many attractive species originate; these are principally the relatively warm and wet regions on land and the coastal areas in warm regions. The area needing to be protected in Africa and Asia and to a lesser extent in Europe and the former USSR, will have to increase, while a slight reduction will be feasible in North and South America.

The utilising scenario demands certain changes, particularly in the way in which agriculture, forestry and urban development interact with Nature. Rural areas will have to sustain a varied landscape and use of land, while urban areas will have to contain extensive green spaces. The present decline in specific interesting natural features due to overexploitation and cultivation must be stopped. The space needed for forestry and agriculture will thus have to increase still further in this scenario. Many plants and animals will benefit from smaller scale agriculture and forestry, although these will mainly be 'culture followers'. The remodelling of urban areas will also demand more space for parks, zoos, botanical gardens, museums, etc. and substantial financial investments will be needed to achieve this. Moreover, this scenario relies strongly on the knowledge which is needed in order to determine which species can be cultivated and in which areas they can be preserved. This knowledge will have to be accumulated in the short term.

In the managing scenario, interesting plants and animals will be preserved in natural conditions. The risk of extinction is regarded as lower where natural populations are preserved. No requirements are set in terms of natural features in cultivated areas, since the occurrence of plant and animal species in these areas is not the result of natural processes. It is not necessary to protect the entire population of the species selected in designated natural areas; instead, only sufficient subpopulations need protection so as to guarantee the continued existence of the species in conditions which are accessible to humans. Natural areas can also be used for other purposes in this scenario, such as for timber harvesting and fishing, as long as the continued existence of the population is not placed in danger.

The doubling of the size of the protected areas envisaged by the managing scenario will demand a considerable international effort in order to reach sound agreements on locations, the degree of protection and the funding of purchases and management. Recreational facilities will have to be introduced in the protected natural areas and supervision will be necessary to limit the pressure on the natural environment and the populations within it. A great deal of knowledge will have to be acquired for this purpose: how large must a population be in order to be able to survive? How much space is needed for this? What quality standards will that space have to meet? The establishment of designated natural areas, their organisation, management and maintenance, as well as the provision of more information on the conservation of species in these areas, will all have to be financed. On the other hand, money will also flow in from Nature tourism which, under this scenario, should go through a boom. It is even feasible that this economic interest will offer a certain degree of guarantee for the preservation of natural areas.

The saving scenario seeks to preserve at least one characteristic part or example of each ecosystem. This does not mean that all species of plants and animals would automatically be protected. In order to achieve this, several examples of each ecosystem would have to be protected or supportive conservation techniques such as zoos and gene banks would be needed. A large body of information would also be needed on ecosystems and their limitations. Given the very patchy state of our current knowledge, a safety strategy which takes the objectives of this scenario seriously could mean that protected areas would initially demand even more space. All of this carries a substantial price tag. Due to the minimal area which is set aside for Nature in this scenario, natural areas could easily be disrupted. The harvesting of products such as timber, minerals and energy, as well as recreational activities, would accordingly have to take place almost exclusively outside the natural areas, unless it can be demonstrated that no damage would be caused to the ecosystem.

In the preserving scenario, a great deal will be invested in protecting natural areas to preserve as much of the natural environment as possible. A very large area will have to be protected and this will be very expensive. Not only will the initial costs be high, but monitoring and maintenance of the protected status – a very weak point at the moment – will also cost a great deal of money. Moreover, it will be possible to meet the demand for agricultural products and timber only by means of a large-scale shift to high-production agriculture and plantation forestry.

Clearly, this scenario demands great advances in knowledge. Not only will the productivity of agriculture and forestry have to be radically increased, but solutions will also have to be found to the problems of harvesting raw materials and energy from the protected areas. This can only be achieved through the use of highly advanced, environmentally friendly techniques. The availability of water in the natural areas must be left essentially intact; this means it will not be possible to draw water on a large scale from nature reserves, for example for irrigation purposes. This limitation alone may lead to major conflicts with agriculture and other human activities.

Evaluation

The concept of sustainability in the relationship between humanity and Nature can be interpreted in a variety of ways, each of which is value driven. In other words, the adoption of a given position means other positions are perceived as unsustainable.

For example, if sustainability is interpreted as the preservation of the existing unspoiled Nature and the diversity of species, the utilising and managing scenarios will be seen as 'blasphemous' in view of their acceptance of the loss of certain species. Conversely, supporters of the other positions will see the preserving perspective as unsustainable, because of the high social price that must be paid in order to preserve natural areas.

At the same time, these scenarios highlight important directions for choices. The continuing impoverishment of both Nature in general and specific natural features creates an obligation to take a stand on whether this process should be allowed to continue unchecked. If not, the question unavoidably arises as to what sort of protection is needed, i.e. selective or non-selective. If it is felt that non-selective protection is not desirable or is no longer possible, the question of the selection criteria then arises. What sort of plants and animals should be protected, why and at what cost?

The debate on sustainability in relation to Nature also depends on the temporal context. It is still possible at the moment to consider the various sustainability options alongside each other. As domestication and the concomitant impoverishment of Nature progress, however, in tandem with ever-increasing competition between claims made on the available space, the need to make a choice becomes more and more urgent.

9.5 Sustainable development – the challenge to environmental policy in an international context

Sustainability is not a magic stone which, once found through scientific effort, automatically produces answers. Although scientists can elucidate the choices which have to be made, the final decision is of a political nature. The choices are not self-evident. Even if agreement can be reached on the choice dimensions, at what levels must efforts be made in order to be able to talk of sustainability? The measures currently being taken – through international agreements amongst other channels – are necessarily just the first steps. But how far must the following steps go? If the discussion of sustainability is to become more substantive, greater clarity on this question is essential. The scenarios presented here show that there are no firm foundations at present for producing clear results. Nonetheless, such provisional choices can pave the way for continued discussion.

The two examples given in the previous section illustrate the fact that any attempts to specify the abstract concept of sustainable development end in wildly differing and far-reaching outcomes. Food can be produced around the world in different ways; each method can be labelled as 'sustainable' from a different point of view. The same is true of global Nature conservation. The various scenarios also make clear that the distribution of benefits and costs is not always equal. Efficient agriculture will not ultimately lead to a situation of local self-sufficiency. This shows the need for co-operation between nations to balance out the inequalities through trade. If one looks at the major environmental threats of tomorrow, international solutions to the problems will be needed in order to arrive at practical solutions.

The same conclusion can be drawn from the case of Nature conservation. Though this topic is surrounded by pitfalls and traps, the general impression is that an internationally co-ordinated effort to safeguard elements of our natural environment is vital. The combination of the value-driven political choices that have to be made and the necessity of operating at an international level places a heavy weight on the international environmental policy agenda for the next decades. First, different governments will have to agree on the 'right' values that should be pursued in terms of environmental policy. What is equally important, however, is the recognition that the burden of resolving major environmental problems will be unevenly distributed.

The same combination of aspects may also be looked upon as a challenge for further international co-operation. The analysis of the scope of sustainable development shows clearly that there is no single 'best' solution. This creates room for manoeuvre for governments, so that they can produce a commonly agreed agenda. The challenge for the next generations of policy makers is to find the vocabulary and mechanisms in order to translate words into action.

Numerous doomsday predictions have been made with respect to sustainable development. The analysis given in this chapter represents an attempt to go beyond the point of surrender to inevitable developments. The examples show that the concept of sustainable development can – in one way or another – lead to the identification of intervention points for policy. They also show that these policy tasks are tremendous and that most of them are not even within sight. The results of the various scenarios illustrate that a careful scrutiny of the objectives of sustainable development can lead to the formulation of a research agenda. This may be of the utmost importance as a first step towards more comprehensive international environmental policies.