A Risk Focused Approach by the State on the Subject of Sustainability

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1. Introduction

Environmental policies show a distinct evolution over the last two decades. The seventies were dominated by acute problem solving policies. Problems such as summer-smog and surface water pollution asked for sanitation through a range of policies. In the eighties environmental policies were designed that showed a more structural approach. New products and processes had to comply with a set of environmental standards. The purpose of this shift was to avoid future environmental problems by imposing standards that were deduced from the earlier identification of pollution problems.

This line is continued in the nineties, but now the call for more general preventive policies becomes apparent. New words emerge that indicate a shift in thinking: pro-active policies, no-regret policies, precautionary principles etc. In all these actions governments are supposed to play a prominent role. However, preventive policies need some type of reference value. Especially if these policies should encompass more than a statement of good intentions, it must be clear for all parties what falls within the acceptable range and what should be prevented. To tackle this problem numerous governments have embraced the concept of sustainable development as it was introduced by the World Commission for Environment and Development (the Brundtland Commission) to act as an indisputable reference value (World Commission on Environment and Development, 1987).

In the Brundtland Report the concept of sustainable development was defined as one "that meets the needs of the present without compromising the ability of future generations to meet their own needs". From the outset of the political debate on sustainable development many studies have been set up to investigate the possible implementation of sustainable development in operational policies. The bottom line in this discussion is formed by the question: what needs the present generation should safeguard

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for itself and next generations? Such a decision cannot be based on objective measurable ecological data alone: radical subjective choices are also at issue. In this paper a somewhat diverging effort to implement the concept of sustainable development is described. In a study the Netherlands Scientific Council for Government Policy has tested the usefulness of sustainable development for policy making (Netherlands Scientific Council for Government Policy, 1995). Differing perceptions of societal and environmental risks are the starting point of the approach taken in the study. This asks for a discussion on how sustainable development is related to perceptions of risk.

2. Difficulties with the concept of sustainable development

The concept of sustainable development arose in reaction to a general and diffuse sense that the environment was being increasingly harmed by human activity. This widespread feeling of unstoppable deluge is fed by numerous scientific publications on all sorts of environmental problems, such as the deteriorating condition of agricultural soils and of forests, the carcinogenic properties of various chemicals, the depletion of the ozone layer, species threatened with extinction, as well as highly prominent incidents such as algae plagues, oil-spills, Chernobyl and floods due to erosion. Cumulating negative information, however, may sometimes also evoke simplistic generalisations, in which the massive amount of uncertainties that surround the scientifically based "evidence" of coming disaster is underestimated. For example, a few hot summers might easily be looked upon as evidence of the anthropogenic increased greenhouse effect. However, human endeavours do not only have negative implications for the environment but primarily have brought prosperity and quality to our lives. It is easy to overlook the fact that agriculture has been capable of feeding an increasing world population, that life expectancy has increased substantially, that people's health has improved significantly and that on average the standard of living has increased on a world-wide scale. At the same time, recognition of the benefits should not automatically deny the fact that these achievements are also associated with the possible exhaustion of resources and with potential or acute damage to the natural environment.

So, if one tries to assess the value of developments, both aspects of human activities should be fully understood. Human endeavours have led to the fulfilment of many needs, but this positive outcome is sometimes overshadowed by a number of undesired side-effects on the environment. Not because there is an intention to destroy our environment, but because there is an urge to meet the growing needs and demands of the people.

The Brundtland Commission rep. placed the concept of sustainable development firmly on the political agenda of national governments and international forums. The report gives a clear indication towards a two-sided appraisal of human activities, both fulfilling needs and endangering the environment. The message in the report that sustainable development is threatened by both wealth (over-exploitation) 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 that sustainable development is concerned with at least two dimensions: 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 to meet human needs. This does not, however, say anything about the extent to which human needs should be met. The Brundtland Report does not elaborate what is meant by the harmonious treatment of the environment or when human activities will result in unacceptable damage to the environment. In society different opinions are present on what are legitimate human needs or what are essential environmental values. This has led to a wealth of different operation definitions of the original concept of sustainable development.

2.1 Ecological and economic sustainability

The differences in definition and elaboration make it clear that sustainable development is not an objective feature of a process. Rather, it involves assigning the label of sustainable or non-sustainable to human activities and their consequences for the environment. This implies an appraisal of both the well being of mankind and society and that of the environment. Social well being can be measured in terms of the extent to which needs are satisfied. The well being of the environment can be measured in terms of the extent to which environmental functions and assets are left unharmed. In defining these needs, we are dealing with a broad concept; these cover the needs not just of the present generation but also of future generations. However, the definition of the needs of future generations must be viewed as a need felt by the present generation on behalf of the future generations. The assessment as to whether human activities deserve to be labelled “sustainable” consequently needs to be based on these two fundamentally different approaches towards developments that are deemed desirable.

In figure 1, the relationship between the impact on the environment and the fulfilment of economic needs by human activities is given. The figure shows that there are

Figure 1: Interrelationships between activities, needs and the environment in the economic and ecological system.

two "circles" to be observed. Primarily all activities find their origin in the economic domain, but sometimes the activity 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.

In many interpretations of sustainable development just one of the two circles is taken into consideration, either as a condition of the ecological system to be defined in isolation (the large circle) or the economic system (the small circle). In the former case, a standard is assigned to elements of the environment that may not be exceeded: ecology prevails. In the second case, the satisfaction of defined needs is considered necessary no matter the consequences for the environment: economy prevails. Both cases are dealing with sustainable development from their own particular vantagepoint.

2.2 *Ecology prevails*

Where the emphasis is placed on the ecological system this may manifest itself in a proposal to set a sustainability norm in order to adjust national income (Huetting, 1990). Others propose to put greater priority to "environmental criteria" than to human needs (Daly, 1990). In this approach, "ecological constraints" are determined in absolute values. The advocates of this position, sometimes referred to as "strong sustainability", put forward that the natural resource base should be kept intact, no matter the consequences for society. Therefore, limits are defined within which human activity must take place if it is to be sustainable (Daly, 1995). The maximum allowable impact on the environment is determined by specifying requirements for environmental values and functions. This means that the impact must decline in relation to the present situation. This decline must be realised either through an adjustment of the number of people involved, or through a decline in the level of affluence, or finally in an alteration of the technologies involved in production and consumption.

The most far-reaching are 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 would impose an unacceptable burden on the ecological system. In these cases, the view may be taken that environmental criteria necessitate an active population policy. Instead, proposals may also relate to the adaptation of material welfare or affluence. Under this perspective per capita income is reduced so as to relieve the burden on the environment¹. Finally, it may be urged that the technology of production be modified. This would involve investments in new, replacement technology in order to turn the negative effect on the environment around.

If the sole focus is on the assets and functions of the environment, this means that a significant element of the social satisfaction of wants is either left out of account or becomes a derivative factor. This position is justified with the notion that the

¹ This should not be confused with a variant under which it has been proposed that consumption, especially in the rich West should be "de-materialised". In the latter case the starting point is that the impact on the environment will be reduced if human wants on average assume a less material nature. For example, the consumption of culture (e.g. going to a concert) is less harmful to the environment than the procurement and use of a speed boat. Under this approach, however, policy does not come to bear on living standards but on the level of technology applied in consumption.

environmental risks are exceptionally great. This ignores the fact that others may have an - in their eyes - equally as justified although totally different perception of environmental risks involved.

In these circumstances "hard" environmental requirements come into conflict with the "hard" requirements of society, with a difference of interpretation concerning the risks involved in the background. If the required standard of living, the environmental intensity of production and consumption or population size cannot be regulated, or only with difficulty, a stalemate is reached. The most common response to an absolutist but unattainable norm is to find a way of escaping the burden imposed by that norm. There is always a risk that when concrete choices have to be made, the skin will prove closer than the shirt. Hence, priority will be given on imperative grounds to employment, economic growth, improvement of the infrastructure and so on - in brief, to more "worldly" needs.

2.3 Economy prevails

Alternatively, confidence in the ecological system may be so robust that emphasis is placed lop-sided on the economic system. In these circumstances, the evaluation of activities is conducted entirely against the background of social needs. The satisfaction of those wants is given primacy and any consequences for the environment are justified in terms of the express desire of meeting those needs. Under this viewpoint, 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. Under this approach environmental interests 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 of 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 feedback mechanisms in society and that there is enough reaction time.

2.4 Balancing subjective preferences

Both one-sided approaches discussed above fail to do justice to the complexity of society. In the one case environmental requirements are imposed and the rest of the social system has to fit in as best as possible. In the other 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 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 to be respected and the socio-economic norms and values to be respected.

Failure to take into account all the relevant aspects in elaborating the concept of sustainable development is the rule rather than the exception. Therefore, it is essential for

both the broadly interpreted socio-economic and ecological dimension to be incorporated in the analysis for the purposes of rendering sustainable development operational. Choices in favour of certain environmental values or certain human needs need to be determined in the light of the consequences of those choices or the other dimension. This is not in itself a new notion, but this “double goal” is not always equally clear in the present policies aimed at bringing about sustainable development. This will be addressed in the next section.

3. Sustainable development as a policy tool

The concept of ecological carrying capacity is used to underpin environmental policies. The possibility that a scientific concept might lead to an impartial appraisal of sustainability is very tempting indeed. Tempting as this approach may be, this type of decision support tool for policy-making presupposes scientific information that is capable to distinguishing between the sustainable and the unsustainable in a way convincing enough to overcome political differences of opinion.

The idea behind the use of carrying capacity in this context is that the environment will be damaged if it is excessively burdened. In these circumstances serious and possibly even insuperable environmental problems can arise, as a result of which people die or get ill, suffer serious inconvenience or loss of well-being and animal and plant species die out, ecosystems are ruined, water supplies, soil fertility and the agricultural heritage are damaged while physical and economic development can be held back. By determining the carrying capacity of the environment, constraints can be defined for the various activities that impose a burden on the environment. In turn, these constraints can be used to determine the necessary changes in behaviour for sustainable development.

3.1 Political robustness and scientific uncertainty

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

The notion that scientific information can be used to objectively and unequivocally indicate the margins within which human activities must take place is, to begin with, at variance with the observation made earlier that sustainable development is about 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 accordingly 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 about the need to strive for sustainable development, this can suddenly prove paper-thin once the consequences become visible and tangible. Instead of providing clarity, the application of the concept then simply leads to escapist behaviour.

Moreover, the notion of decisive scientific information denies the dynamic nature of science. New knowledge is consistently 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 on-going process. Especially in the environmental field, many of the areas of scientific investigation are still in their infancy. Furthermore, relevant knowledge also derives from action itself, or in other words from experience. Every experience with new technologies or actions and with the abatement of existing environmental problems leads to the gathering of new scientific information and knowledge.

The main scientific problem in discerning the sustainable from the unsustainable is the lack of the requisite information for a complete and coherent analysis. In many cases, the knowledge concerning environmental developments and the impact of human activities on those trends is no more than fragmentary. In particular two problems arise: *inherent ignorance* and *uncertainty*.

3.2 *Inherent ignorance*

To assess the sustainability of a given development information is needed to which extent this development exceeds critical limits of both the ecological and the economic system. But even if one restricts oneself to the physical environment, one has to deal with a very complex system. The environment does not exist as a unit or entity but needs to be defined as a system of differing ecosystems (such as forests, fenlands and river deltas, etc.) 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 environmental quality standards. To date, however, it has proved all but possible to determine unambiguously which elements are vital for the sustainable functioning of an ecosystem. Ecology is not ready to deal with questions of this type, and will probably never come up with the definitive answers to these 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 of the system is limited. The majority of natural ecosystems, however, form part of the 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 aimed at generating useful products, the most important goals of natural ecosystems, and consequently the most important elements in it, are less clear. With respect to complex natural ecosystems, knowledge of the resilience, robustness and persistence of the system is highly limited.

Hence, science is at best able to provide a partial and conditional insight into positive and negative feedbacks of natural ecosystems. Policy, by contrast, is interested in the net result and seeks absolute statements: is the earth warming up or not? Especially in the case of unique systems, science is unable to indicate all the determining factors for the functioning of the ecosystems. In the absence of such knowledge, it is impossible

unambiguously to determine the quality of the environment. Similarly, it is also often impossible to provide a response to questions about ecological disruption. The inherent ignorance about the consequences of change is virtually characteristic of unique systems. Therefore, clear-cut, non-controversial definitions of sustainable development prove impossible.

3.3 *Uncertainty*

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

Sometimes it is possible within reasonable limits to predict the consequences of a given intensity of human activity. By means of a dose-effect relationship, the effects for the quality of the environment can be assessed. In many cases, however, this relationship is surrounded by uncertainties and ambiguities. Industrial activities, for example, result in the emission of acidifying substances such as nitrogen oxides and sulphur dioxide, but the effects on the vitality of forests can only be determined by averaging a large number of observations on lowered vitality of trees. In this regard, the system is treated as a black box and the impact is only examined on the outside of that box looking at the dose (i.e. the imposition of acidifying substances) and the effect (declining vitality). 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 disturbed by background interference that cannot be screened out.

In the case of 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 that much scientific research into these relationships does not only reveal statistical uncertainties, but also fundamental uncertainties that prove unbridgeable. A good example is provided by the theoretical foundations for 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. The IPCC, however, has examined the status of the various data by classifying these into facts, suppositions and guesses (Houghton et al., 1990). It is for example a scientifically established *fact* that the CO₂ content of the atmosphere has been increasing at an accelerating rate due to human activity. It is *suspected* that the increase in CO₂ 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, revealing all the problems mentioned earlier. This means that, depending on the feedbacks allowed for, the results can vary considerably. Finally there are *guesses* that the greenhouse effect will result in a rise in sea levels; these are not based on hydrological models of the world but are generally no more than speculative in nature and therefore highly controversial.

However, even if the relationship between (for example) the use of fossil fuels and the rise in sea levels is unknown, choices have to be made for policy purposes. In these circumstances, the potential risks thought to be incurred become the determining factor in the choice. In the case of statistical uncertainties, these risks can be estimated and both the distinguishing capacity and the reliability of the statements can then be assessed. In the case of fundamental uncertainties, one is confined to making 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, etc., adapt to new activities without problems).

3.4 *Perceptions of risks and sustainable development*

Uncertainty, ignorance and risk put limits to the applicability of scientific analysis in a policy context. Funtowicz and Ravetz (1991) identify three different stages in scientific policy-oriented analyses. In *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 in small-scale problems that need a policy decision. Most of our policy problems, however, are not that simple. They deal with considerable (societal) stakes and with substantial (scientific) uncertainties. This implies that stakeholders do no longer comply with the scientific analysis, but they seek their solution in *Professional consultancy*. Experts are consulted that give their opinion, based on an acclaimed scientific experience. This expert judgement is no longer subject to a peer review. On the contrary, different stakeholders employ different experts that give different advice.

Over time, the uncertainties and stakes 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. The feeling arises that because of the uncertainties and stakes involved, private opinions are equally relevant. For these policy problems we still lack a sound methodology. Funtowicz and Ravetz propose the term *Post-normal science* for this area.

The case of sustainable development typically belongs to the third category. Stakes involved are extremely high and, as we have seen, uncertainties are ample. One way of dealing with this problem is accepting the fact that a plural interpretation of sustainable development is possible. This calls for an analysis of current and future situations that are believed to be essential to sustainable development. Haavelmo and Hansen (1992) note that policies aimed at attaining sustainability first need a good knowledge of the consequences of alternate directions of human activities both in production and in consumption. The Netherlands Scientific Council for Government Policy has tried to generate just the type of information that Haavelmo and Hansen asked for (Netherlands Scientific Council for Government Policy, 1995). Instead of trying to define the sustainable development, the Council proposes four different paradigms of sustainability. Essentially, these paradigms are sets of assumptions that together define the locus of risk to be taken or avoided with respect to society and the environment. Consequently, points of departure for actions to realise a sustainable development materialise from these paradigms.

4. Exploring sustainable developments

Possible sustainable developments can be explored by examining the trade-offs with respect to current environmental and societal values involved. Next to that, the trade-offs with respect to time (or the “future generations”) should also be brought to sight. The needs of future generations are - at least beyond trivial statements such as: they want to be fed etc. - unknown by definition. Therefore, the “time trade-off” deals with our perception of the needs that future generations might have. This indicates a method that refrains from quantitative or qualitative assessments of current and future needs, but 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 one feels that the environment is very vulnerable and that society should be able and willing to accept rather drastic changes, an idea can be formulated about the “sustainable developments” that go with this point of view. This notion of what is sustainable will differ considerably from the view in which the environment is considered as highly flexible and society as very reluctant to accept changes. In a 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.

4.1 Four action perspectives

Four paradigms are selected that can be considered as defining the corners of the playing field of most of the discussions on sustainability. The paradigms are denoted *Utilising*, *Saving*, *Managing* and *Preserving*.

In the *Utilising* paradigm the environment is thought to redress to its original position after a disturbance has taken place. Human activities do have an effect on the environment, but the environment can generally absorb the impacts. This does not imply that there are no risks for the environment, but these risks are relatively small and, moreover, timely adjustments in technology can be made if major problems with the environment occur. So, technology is assumed to be self regulatory to a certain extent.

In the *Saving* paradigm it is accepted that the environment has a limited absorbing capacity. However, the risks involved in the productive structures adapting to a new situation are considered prohibitive. Technology is very difficult to steer in a certain direction and forced shifts in economic production systems will cause massive societal obstruction. Therefore, the solution must be found in redressing the levels of consumption. Although this is not an easy task, in the long run the consumer society will prove to be mouldable.

In the *Managing* paradigm the environment is also considered vulnerable. The solution must be found in adapting technologies to these environmental conditions. There are no major limitations to transforming the technology, but changing the level of consumption would lead to unacceptable societal risks.

Table 1: The characteristics of the four paradigms of sustainable development

<p>UTILISING</p> <p>“utilisation protects the environment” self regulating technology predominantly trial-and-error</p>	<p>SAVING</p> <p>“consumption must come down” environment is vulnerable technology cannot be adapted</p>
<p>MANAGING</p> <p>“production must be adapted” environment is vulnerable technical solutions are feasible</p>	<p>PRESERVING</p> <p>“all hands on deck” environment is fragile trial-without-error</p>

In the *Preserving* paradigm the environment is considered very fragile. The risks of any human activity for the environment are thought to be very severe. So, all adaptations of society that we can think of should be put into effect. The risks for society related to these drastic changes are acceptable. Society is very flexible and with the proper measures and efforts changes can be initiated before major damage to the environment becomes apparent. The summary of the four paradigms and their contents is given in Table 1.

These four paradigms hardly represent all the political possibilities. In reality, many more than only four such paradigms may be observed. For example, a stance may also be that any environmental risk should be avoided, regardless of the consequences for society. However, this position is not considered, nor the opposite one that says 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, as this concept should always refer to a weighing up of ecological and socio-economic needs. So, at least some hint must be given as to how the effects of the position in one dimension (e.g. safeguarding the environment) on the other dimension (society) are dealt with. This is not the case in the extreme positions.

4.2 Sustainable scenarios for environmental themes

The paradigms *Utilising*, *Saving*, *Managing* and *Preserving* all aim at sustainability, however different their assumptions may be. These assumptions can be considered as input or motivation for behaviour. Whether this behaviour will result in a sustainable situation cannot be assessed a priori, but should be judged by the effects of this behaviour in the long term. Thus, the impact on future generations becomes visible and subject to feedback. Scenarios can be helpful in shedding some light on the long term effects of the initial behaviour. To that end, the four paradigms are translated into action perspectives by considering specific environmental themes.

Five different environmental themes are selected to illustrate the diverging outcomes of sustainable development if the assumptions are taken to their logical conclusion. They are:

1. world food supply
2. energy supply
3. conservation of nature
4. use of raw materials
5. regional water supply

A uniform method is applied to all these themes that consists of defining the action perspectives based on the four paradigms, translation of the action perspectives into scenarios and evaluation of the results.

4.2.1 Action perspectives

Roughly speaking, the four paradigms lead to action perspectives that reveal distinct risk perceptions related to the demand-side and the supply-side of society. With respect to the demand side, *Utilising* and *Managing* do not have much faith in the flexibility of consumer society, so all given demands should be fulfilled. *Saving* and *Preserving* on the other hand, reflect a perception that society is able to assimilate the risk of (drastic) changes in consumption. From the supply-side, a different distinction is apparent. *Utilising* and *Saving* show no great confidence in the possibilities of technological adaptations. The risks for society involved are a too high price to pay. *Managing* and *Preserving* show the opposite belief. Society is capable of adopting technological changes at the necessary pace to alleviate environmental problems. The five environmental themes of course are all different in the operational outcome of these divisions. The variables with respect to the perceived risks on the “demand-side” and the “supply-side” for all environmental themes are given in Table 2.

Table 2: “Risk-variables” with respect to demand and supply side changes in society for the five environmental themes

	“DEMAND-SIDE”	“SUPPLY-SIDE”
world food production	diet (luxury vs. moderate)	orientation (global vs. local)
energy supply	energy intensity	structure change
conservation of nature	aim (features vs. unspoiled area)	space (minimal vs. maximal)
use of raw materials	raw material intensity	means of extraction
regional water supply	consumption	water quality standards

4.2.2 Scenarios

The action perspectives can be translated into scenarios by adding a time dimension. Based on the views and attitudes that are made visible through the action perspectives, choices are made as to future developments. Confrontation with the consequences of those choices can lead to a review of the a priori attitudes. To that end, the action perspectives

for the five environmental themes have been elaborated into scenarios of possible developments up to the year 2040. These scenarios illustrate the incompleteness of the information and the scientific uncertainty and demonstrate how different attitudes need to be adopted in various areas if sustainability is to be a “realistic” concept (Table 3).

Table : Some results of the scenarios

	unit	UTILISING	SAVING	MANAGING	PRESERVING
world food production	people	25×10^9	44×10^9	11×10^9	17×10^9
energy supply	EJ use	1183	625	1032	433
	Gton CO ₂ emission	22.1	9.1	13.9	5.6
nature conservation	nature area	5%	10%	10%	60%
use of raw materials	tonnes extraction	22.6×10^6	15.3×10^6	15.9×10^6	6.3×10^6
(cooper)	tonnes consumption	825×10^6	875×10^6	675×10^6	500×10^6
regional water supply	m ³ groundwater	900×10^6	3200×10^6	900×10^6	3200×10^6

4. 2. 3 Evaluation of the results

It can be concluded from Table 3 that a variety of possibilities emerges if different perceptions of risk are taken seriously in the debate on sustainable development. Maximum population sizes that can be fed in a sustainable fashion ranges from 11 to 44 billion people. Emissions that may give rise to an enhanced greenhouse effect range from 5 to more than 20 gigatonnes of CO₂. The area reserved for nature conservation purposes ranges from 5% to 60% of the total landmass. These examples illustrate that sustainable development by itself does not give a strict formulation of the target that society should aim for. Instead, the concept of sustainable development clearly shows a need to incorporate perceptions of risk in the policy making process.

Another striking outcome is the incompatibility of the scenario results. An example may clarify this. If one opts for the *Preserving* action perspective with respect to world food supply, this implies an extensive use of landmass for agricultural production. However, the Preserving paradigm with respect to nature conservation leads to the reservation of 60% of total landmass for nature conservation purposes. These two goals can not be combined. The earth simply is not big enough to accommodate these two requirements. Together with the diverging results per environmental theme, this indicates the need for a more informed political debate on the real goals of sustainable development.

5. Conclusion

The scenario results illustrate that attempts to specify the abstract concept of sustainable development show wildly differing and far reaching outcomes. World food production can be carried out in different ways, that all can be labelled “sustainable” from different points of view. The same holds true for global nature conservation. The analysis of different possibilities of sustainable developments shows clearly that there is not one best solution. This creates room to manoeuvre for governments to arrive at a commonly

carried agenda. The challenge for the next generations of policy makers is to find the vocabulary and mechanisms to bring this situation to reality.

There are numerous doomsday predictions with respect to sustainable development. The analysis given by the Netherlands Scientific Council for Government Policy is an effort to go beyond the point of surrender to inevitable developments. The examples show that the concept of sustainable development - in one way or another - can lead to the identification of intervention points for policy. They also show that these policy tasks are tremendous and most of them are not even within eyesight. The results of the different scenarios illustrate that a careful scrutiny of the objectives of sustainable development can lead to the formulation of a research agenda. For a first step towards more comprehensive policies that may rightly carry the label "sustainable development" this may prove of utmost importance.

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