Lessons from global environmental assessments

Netherlands Environmental Assessment Agency

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Summary

Four assessments relating to global sustainable development

Never before have so many global assessments in the field of the environment and sustainable development been published as in the last year. This report is about the outcomes of four global assessments published by international organisations in the field of environment and global sustainability in the period 2007-2008:

1. *Global Environment Outlook 4: Environment for Development*, published by the United Nations Environment Programme (UNEP, 2007).
2. *Climate Change 2007. Fourth Assessment Report*, published by the Intergovernmental Panel on Climate Change (IPCC, 2007a, b, c and d).
3. *Environmental Outlook to 2030*, published by the OECD (OECD, 2008).
4. *International Assessment of Agricultural Science and Technology for Development* (IAASTD), which is supported by amongst others the UN's Food and Agriculture Organisation (FAO), the UN Development Programme (UNDP), the UN Environment Programme (UNEP) and the World Bank (IAASTD, 2008).

However, these global assessments are rather far removed from the practice of Dutch and European policy-making. Therefore, they need to be translated in terms of specific national circumstances, so that policymakers, in this case in the Netherlands and in the EU, can derive practical consequences from them. This report was written at the request of the Dutch Ministry of Housing, Spatial Planning and the Environment. Its purpose, while not claiming to produce complete and detailed suggestions prescriptions for policy-making, is to contribute to that translation. By analysing these assessments, this study draws lessons for Dutch and EU policies in relation to sustainable development. The focus is specifically on two important areas of global concern: 'agriculture, food and biodiversity' and 'energy, climate and air pollution'. This analysis builds on the second Dutch sustainability outlook entitled 'The Netherlands in a sustainable world' (*Nederland in een Duurzame Wereld*, MNP, 2007).

Unanimous view on the main global challenges

The four assessments are unanimous in identifying the main global challenges in sustainable development. Extreme hunger and poverty will not be halved by 2015 in all countries (UN Millennium Development Goals). The rate at which biodiversity is being lost will not be reduced by 2010 (a goal set in the Convention on Biological Diversity, the CBD) and the impacts of climate change will not remain within safe limits (the goal of the United Nations Framework Convention on Climate Change, the UNFCCC). Rapid action is, therefore, needed to bring these goals closer and to ensure that the world deals with land and energy in a more sustainable way. The assessments conclude that many solutions are already known and that the measures that could be taken are theoretically affordable. The assessments emphasise the interaction between the environment and development and

the necessity to better balance the various aspects of sustainable development. Effective policy requires a balance between the costs and benefits of policy. That is not easy, especially in relation to the distribution of costs and benefits. Less poverty, maintaining biodiversity and a safe climate are in everyone's interest. These are global collective goods: everyone benefits from them, but under the current circumstances there are not enough options to ensure that biodiversity loss and climate change will be limited. The biggest challenge, therefore, is to find effective political and economic mechanisms to achieve the required global cooperation, while paying special attention to distributional issues.

Competition between agricultural, food and biodiversity targets

Competition for land is a new theme that is highlighted by the assessments. The elimination of hunger, concerns about a secure and affordable food supply, the goal of maintaining biodiversity and the demand for bio-energy all affect – and are affected by – the demand for land. Because further loss of biodiversity appears inevitable, priorities will need to be set in policies extending beyond 2010: which natural areas really must be preserved and should, therefore, be protected? The question for the other areas is whether land should be managed in a more multi-functional and low-intensity way, or would it be better to develop more intensive agriculture that would leave more room for nature? The assessments discuss policies and measures that can lead to a type of agriculture that is both more compact and more sustainable. A clear biodiversity strategy is required to ensure both the effective protection of biodiversity and the sustainable use of biodiversity on productive land. International policies do not have mechanisms to weigh up the various claims on land use in a comprehensive way. Yet, the increasing competition for land makes this extremely important. The assessments offer little guidance as to which policy instruments and international agreements correspond to the available strategies.

Tension between energy, climate and air pollution, especially in implementation

Energy and climate are major themes in the assessments. It is important that policies for sustainable energy are implemented with a combination of measures that will give all of the world's poor access to modern energy services, ensure continuity of energy supply, and mitigate climate change and air pollution. Although the four assessments devote relatively little attention to access to modern sources of energy, they are unanimous in concluding that the world is not on track in terms of ensuring a sustainable energy supply. The assessments show that a mixture of existing technologies and measures can be used to reduce emissions of greenhouse gases in the energy sector. It is clear that drastic reductions in global greenhouse gas emissions will continue to be needed after 2020, if the EU's goal of limiting global warming to 2 °C above the temperature in pre-industrial times is to can remain within reach. This requires the establishment of a broad international coalition and investments in technology to achieve more far-reaching

emission cuts. Large-scale reliance on bio-fuels entails the risk that it may exacerbate other global concerns, such as food supply and preserving biodiversity. By transferring existing technology to developing countries it is quite possible to achieve a sustainable energy supply in those countries.

Policies for sustainable development require global coalitions

Effective policy for sustainable development requires in the first place that society and politicians are aware of the problems identified in relation to development, food, energy, the environment and nature. More particularly, the assessments state that they must recognise that these problems require urgent solutions. The Netherlands and the EU as a whole can significantly contribute to solving these global problems. To achieve the goals that have been set, it is necessary to strengthen policies, and especially to implement them systematically. Public support for these measures will increase if the solutions chosen are seen to be efficient ones. Market instruments can play an important role here, for instance, by integrating environmental costs into the prices of goods and setting prices for ecosystem services. A broad range of technological solutions are available, but various promising technologies need to be further developed. However, the most important challenge remains the creation of coalitions around the world for dealing with global issues related to sustainable development.

It is precisely on this essential point of developing international policies that the assessments provide few concrete answers. While this aspect has not been worked out in detail, on the basis of the assessments can be concluded that the Netherlands – and the EU – should work primarily towards global cooperation to reach agreement about the goals and ways of distributing the costs and benefits of policy and on strengthening the international governance structures for sustainable development. It is also necessary to make international production and consumption chains more sustainable and to make policy more coherent to prevent future problems, both inside and beyond the EU.

Possible key points for Dutch and EU policies

For the global problems analysed in this report, the assessments suggest a number of possible solutions, in which the Netherlands and the EU – according to the Netherlands Environmental Assessment Agency – can play a crucial role:

- Establishing global alliances, both with rapidly emerging countries, such as Brazil, Russia, India and China and with the least developed countries. This can be done, in negotiations, by linking important issues related to sustainable development, such as trade, technology, development cooperation, energy, agriculture, climate and air pollution, and biodiversity. Consideration could also be given to how countries can best be won over to global climate goals, such as the 2 °C limit to global warming, or new targets for biodiversity.
- Giving more attention to the consequences of EU policy on other world regions when developing policy. This can be done by setting sustainability criteria, by introducing

product requirements to make production and consumption chains more sustainable and, in impact assessments, by specifically including the consequences of EU policy for other regions. The Netherlands can use its position as a trading nation to make international production and consumption chains more sustainable.

- In international policies there are, as yet, no integrated decision-making mechanisms for land use, while competition for land will continue to grow. The Netherlands could urge the EU, for example, as part of the reform of the European Agricultural Policy, to better include the consequences for land use in its decision-making.

1 Introduction to four global environmental assessments

The Netherlands has committed itself to sustainable development, domestically, in Europe and globally. The World Commission on Environment and Development's report *Our Common Future* (WCED, 1987) demonstrated that development and the environment are inextricably linked. Although there have been successes in many areas of environmental policy, such as reducing acid rain in Europe and banning the use of CFCs, the world still faces a number of persistent problems, including poverty, the loss of biodiversity and climate change (MNP, 2007).

Both nationally and internationally, there is a great need for a knowledge base which policymakers can use to solve these major global issues. This is why, in recent years, studies have been published under the flags of international organisations, such as the United Nations (UN), the Organisation for Economic Cooperation and Development (OECD) and the World Bank, which provide an integrated picture of the situation of the environment worldwide, highlight the implications of observed developments for people and the environment, and explore possible solutions. These assessments have increasingly examined environmental issues from the perspective of sustainable development.

However, never before have so many global assessments been published in the field of the environment and sustainable development as in the past year (2007-2008), which has seen the publication of:

1. *Global Environment Outlook 4*. Environment for Development, published by the United Nations Environment Programme (UNEP, 2007).
2. *Climate Change 2007. Fourth Assessment Report*, published by the Intergovernmental Panel on Climate Change (IPCC, 2007a, b, c and d).
3. *Environmental Outlook to 2030*, published by the OECD (OECD, 2008).
4. *International Assessment of Agricultural Science and Technology for Development* (IAASTD), which is, among others, supported by the UN Food and Agriculture Organisation (FAO), the UN Development Programme (UNDP), the UN Environment Programme (UNEP) and the World Bank (IAASTD, 2008).

These global assessments provide an extensive picture of the current state of knowledge about the environment and sustainable development. They also outline which future developments can be expected and the advantages and disadvantages of the various policy options for solving these problems. Figure 1.1 shows the environmental problems that are covered in the assessments, in relation to two criteria: reversibility or irreversibility of the problems and the availability of solutions. This report addresses a number of irreversible environmental problems that are of global importance and for which the solutions are not yet clear (the problems shown top right in the figure). These problems are arranged in two clusters: 'agriculture, food and loss of biodiversity' and 'energy, climate change and air pollution'.

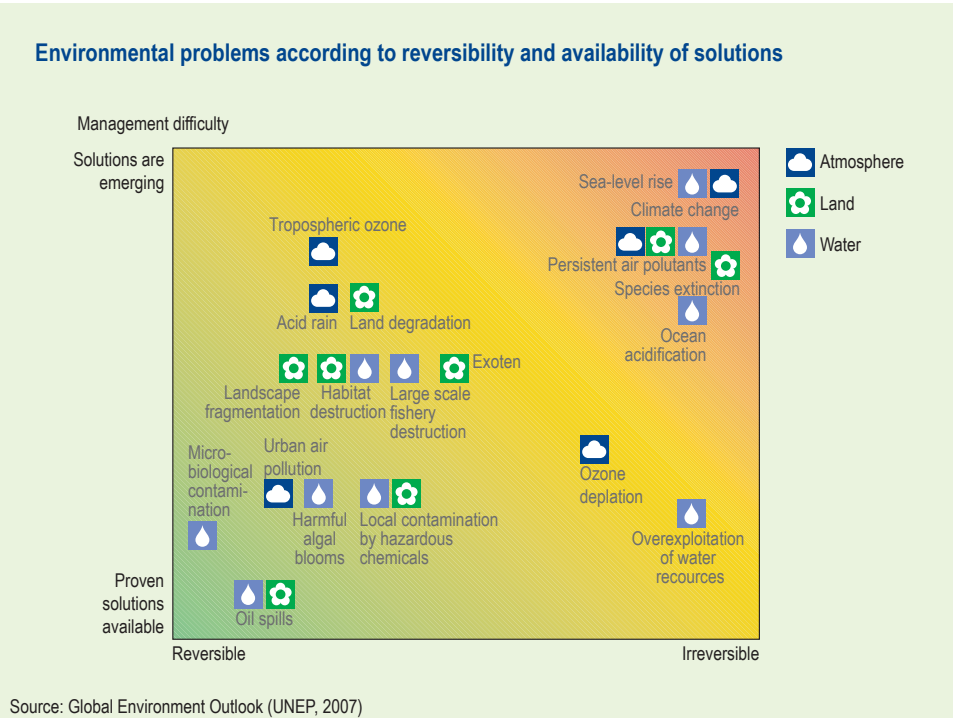

Figure 1.1 Overview of the environmental problems related to reversibility or irreversibility of the problems and the availability of solutions. In the top right corner are the hard-to-solve, global sustainability issues on which this report focuses; at the bottom, on the left, are problems ó generally of a more local nature ó for which proven solutions already have been found. Source: Figure 10.2 in UNEP, 2007.

The focus is on balancing environmental problems with social and economic development. Sustainable development also requires that the long-term consequences of short-term action in the Netherlands and Europe be taken into account, as well as their impact on people and areas outside the Netherlands and Europe.

However, these global assessments are rather far removed from the practice of Dutch and European policy-making. They, therefore, need to be translated in terms of specific national circumstances, so that policymakers, in this case those in the Netherlands and the EU, can derive practical consequences for policy from them. The purpose of this report, while not claiming to produce complete and detailed suggestions is to contribute to this process. Written at the request of the Dutch Ministry of Housing, Spatial Planning and the Environment, this report offers an insight into the context and the process of compiling the global assessments, summarises the most important conclusions, goes in more depth into the implications for agriculture and energy and, finally, makes a number of links to Dutch and EU policy. This report does not pretend to be exhaustive; other hard-to-solve problems for sustainable development, such as those related to fisheries and water use, are not addressed. Thus, this concise summary can do no more than partial justice to the extensive analyses and results of the assessments, which comprise in all

more than five thousand pages. It can, however, serve as a useful introduction to the assessments.

The Netherlands Environmental Assessment Agency played a major role in conducting all four assessments. Its staff participated as authors and calculated scenarios using its models. One staff member was co-chair of the IPCC working group *Climate Change 2007 – Mitigation of Climate Change* and the Netherlands Environmental Assessment Agency provided the secretariat for that working group. This analysis reflects its two key specialisations in contributing to the assessments: carrying out integrated analyses from a policy perspective and quantitative analyses of future scenarios.

In concrete terms, this report addresses the following questions:

- What were the goal and the approach of the assessments (Chapter 2) and what main messages can be derived from the separate assessments? (Chapter 3).
- What are the outcomes of the four assessments in relation to two key themes: agriculture, trade and biodiversity (Chapter 4) and energy, air pollution and climate change (Chapter 5)? These two chapters relate the progress in achieving Dutch and EU policy targets to measures and policy options in the different assessments. In addition, an 'Intermezzo' text discusses the findings relating to the use of bio-energy. This topic clearly shows how much agriculture and energy are linked.
- What lessons can be learned from the assessments for Dutch and EU policies sustainable development? (Chapter 6). Chapter 6 builds on the insights reported in the second Dutch sustainability outlook entitled *Nederland in een Duurzame Wereld* (The Netherlands in a sustainable world, MNP, 2007). This assessment, which was intended for Dutch policymakers, adopts the same baseline scenario as that used in the *OECD Environmental Outlook.*

The report concludes with an Epilogue, which considers the design of future assessment processes and lists questions for further study.

2 The assessments in context

For the problems covered in this report science does not provide us with simple, straightforward solutions. The purpose of the assessments is to synthesise the often fragmented scientific knowledge that is available to policymakers and to explore possible future scenarios. Policymakers play an important role in this process by asking the questions that the assessments must answer. The assessments support them by indicating the issues on which scientists are in agreement and those on which they differ. In this way, the assessments constitute a shared base of knowledge that enables politicians to weigh up scientific and political considerations when deciding on their strategy. The assessments are intended to provide information that is relevant to policy-making, not to prescribe ready-made national policy solutions. That is the domain of politicians.

By way of introduction, this chapter first provides an overview of the topics and the central research questions in the four assessments (Section 2.1). Section 2.2 then explains how the assessments came about. Finally, Section 2.3 lists those points on which the scenarios in the different assessments share similar assumptions, and those on which they differ.

2.1 What are the assessments about?

All four assessments focus on the relationship between the environment and sustainable development, but each has its own central research questions. Table 2.1 provides a concise overview.

UNEP GEO-4: Environment for Development shows how both current and possible future deterioration of the environment can limit people's development options and reduce their quality of life. This assessment emphasises the importance of a healthy environment, both for development and for combating poverty.

The fourth report of the IPCC, *Climate Change 2007*, addresses the climate problem, its consequences and possible directions for solutions. Both learning to deal with the consequences of climate change and finding solutions to prevent further climate change are important components of sustainable development. (See also Van Dorland and Jansen (2007), for a more detailed analysis for the Netherlands.)

The *OECD Environmental Outlook to 2030* explores possible ways in which the global environment may develop, emphasising the economic rationality of ambitious environmental policy and showing why it is desirable for the OECD to work with large developing countries such as Brazil, Russia, India and China (see also the MNP/OECD background report, MNP/OECD, (2008).)

The *International Assessment of Agricultural Science and Technology Development* (short title: the *Agriculture Assessment*) assesses developments in agriculture in relation to policy goals, such as reducing hunger and poverty, improving living conditions in rural areas and

preserving the quality of the environment and biodiversity. This assessment focuses strongly on the role of technology and agricultural expertise.

2.2 How did the assessments come about?

The questions addressed in the assessments have been wholly or partly determined by national and international policymakers. An insight into the process that led to the compilation of the assessments will help contextualise their outcomes.

Table 2.1 Overview of the four assessments discussed in this report.

	Global Environment Outlook -4	IPCC 4th Assessment Report	OECD Environmental Outlook to 2030	IAASTD (Agriculture Assessment)
Focus	Environment for development	Climate change	International environmental policy	Agricultural knowledge, hunger, rural development and sustainable agriculture
Initiated by	UNEP	IPCC	OECD	IAASTD (Secretariat provided by the World Bank)
Most important questions	How do changes in the environment influence human well-being and people's opportunities to develop? How can environmental policy be efficiently and effectively implemented?	How are people influencing climate change, what are the consequences, how can people and nature adopt, which options are there for mitigating climate change?	Which environmental policy is needed? Which instruments are effective? How can OECD countries and others, such as Brazil, Russia, India and China, best work together?	How can agricultural expertise and technology be used to solve the challenges of poverty and malnutrition in a way that is sustainable from an environmental, social and economic point of view?
Most important issues	All international environmental issues, regional analyses, the design of environmental policy	Causes of climate change, energy, land use, consequences for people and nature; solutions	Land use, energy and climate change, air pollution, biodiversity, fisheries, nitrogen loading on surface waters, health effects of pollution, policy instruments, costs of policy	Agriculture, land use, combating hunger and poverty, Rerearch & Development; solutions
Policy processes in focus	Environmental policies of national governments + UNEP	UNFCCC + climate policies of national governments	Agenda-setting; a 'pre-negotiation' platform	National and international agricultural policy
Own research?	Summary of scientific literature + scenario development	Summary of scientific literature	New projections	Summary of scientific literature + new projections
Approach	Separate analysis of status and trends to 2015, contrasting scenarios for 2050, extensive global and regional analyses	Overview and synthesis of 'peer-reviewed' literature of the climate system, the consequences of climate change, the potential for adaptation and vulnerability of people and nature, combating climate change; overview of a broad range of scenarios but no new scenarios	Baseline scenario and various policy packages with different degrees of cooperation between global groups of countries; policy horizon in 2030, horizon for consequences in 2050; estimates of the costs of doing nothing extra (no more than is already being done)	One global and five regional reports; review and synthesis of peer-reviewed literature. 50 years in retrospect, and 50 years forwards; a baseline scenario with policy variants is quantified, plus a review of other relevant scenarios
Websites	www.unep.org/geo	www.ipcc.ch	www.oecd.org/environment/outlookto2030	www.agasessment.org

Products of science and policy

The assessments are generally intended to inform policymakers in a balanced way about the current state of knowledge with regard to a particular policy issue and to explore possible future developments. Therefore, it is crucial that both scientists and policymakers are involved in the establishment of such assessments. Most global assessments involve hundreds of scientists as authors or reviewers, from different regions and disciplines. Intended users (policymakers) are also involved in designing the assessments: they formulate relevant questions, review the results and approve the summary for policymakers. Their direct involvement is intended to increase the policy relevance of the assessments.

In accordance with their goals and intended uses, the four assessments adopt different positions along the spectrum between policy and science. At one end there are the broad, scientifically-oriented IPCC and *Agriculture Assessment* reports. These assessments mainly evaluate the current state of knowledge about causes, consequences and solutions – as far as that knowledge can be found in the scientific literature. To a very large extent, these assessments are based on peer-reviewed literature, to ensure objectivity and, especially, so that they will be regarded by policymakers as being objective. The 'production' of these assessments is governed by strict rules. The *Millennium Ecosystem Assessment* (MA, 2005), which is not discussed here, is another example of this method of approach. At the other end of the spectrum there are the more analytical assessments, such as the *OECD Environmental Outlook*.

The differences lie both in the methods used and in the organisation of the 'production' process. Whereas the first group of assessments mainly synthesise from existing work, the second group also includes original research conducted to support the analysis. This means that, for the second group of assessments, it is less important to refer to all the relevant literature. The first group, the IPCC report and the *Agriculture Assessment*, in particular, follow strict process rules regarding the production process, including a rule that the summary for policymakers must be approved line by line, by the participating countries. There are also gradations between the two sorts of assessments. The *UNEP Global Environment Outlook*, for example, has increasingly been using methods from the first group, but without seeking to achieve the same depth of study as is achieved in the reports by the IPCC. At the same time, showing which progress has been made in achieving policy goals in countries and regions is one of the main characteristics of the *UNEP Global Environment Outlook*.

Underlying world views

A political response is needed to solve the problems that are discussed in the assessments. Political preferences are related to world views and ideas about how the world functions and how problems should be solved. The assessments are intended as aids in developing consensus on the problems and possible solutions. If they are to fulfil that function, the information that they offer must be as objective as possible. In other words, it is important that they are not drawn up on the basis of one particular world view. Nevertheless, particular lines of approach can be identified in the assessments. These are related to the initiators and sponsors of each study, its intended use and the nature of the problems

addressed. The fact that the assessments reach comparable conclusions on important points means that, together, they offer an unintended broader legitimisation for policy.

The *UNEP Global Environment Outlook* deals with global environmental issues, relating this primarily to the situation of poor countries. The significance of global environmental problems is viewed from that perspective. Environmental problems are related to economic development, vulnerability and fair distribution. The focus then shifts to the role of the UN (UNEP) and national governments. The *UNEP Global Environment Outlook* has an important secondary purpose: to develop the research capacity needed to conduct assessments in developing countries. Of the four assessments, the *IPCC Climate Change 2007*, like the previous reports of the IPCC, is most explicitly intended to bridge the gap between policy and science. The IPCC process has become a symbol of consensus-building for policy-making purposes.

In the *OECD Environmental Outlook*, the future is explored using a solution-oriented approach: how can the various parties involved make adjustments to prevent an unwelcome development, who are the most important players, and which instruments are effective to solve these problems? Economic instruments receive a lot of attention. The *Agriculture Assessment*, like the IPCC reports, is intended to be a broad scientific assessment. In the process that eventually yielded the IAASTD assessment, the widely divergent interests and world views of the actors involved were more clearly visible than in the IPCC process. The major, extremely visible controversies in agriculture relate, among other things, to the liberalisation of world trade and the role of genetic engineering. These controversies are far from being resolved in the *Agriculture Assessment*. In that sense, the *Agriculture Assessment* offers useful insights into the controversies about agriculture, which will presumably be fiercely debated for years to come.

A number of issues illustrate the differences in perspective between the four assessments, both with regard to their prognoses for future developments and the presented strategies for solutions. One of these is whether globalisation is seen as the cause of many problems for sustainable development or as a contribution to the solution. Is globalisation in the environmental field a 'race to the top' or a 'race to the bottom'? The liberalisation of trade and investments can lead to the more efficient use of natural resources (as the *OECD Environmental Outlook*, for example, shows). However, the *UNEP Global Environment Outlook* and the *Agriculture Assessment* also point to the negative sides of globalisation, for example, the negative consequences of trade liberalisation for small farmers in Africa, its impact on the loss of biodiversity and the increasing distribution of diseases and introduced plants and animals. Liberalisation was a controversial issue for the authors of the *Agriculture Assessment*, and differences can be observed between those who prefer global, large-scale solutions and those who advocate more local, small-scale solutions.

Another difference in approach in the assessments relates to the extent to which policy should rely on market instruments. A number of assessments propose an important role for these – within a wider set of policy instruments – in order to achieve efficient solutions. However, the *Agriculture Assessment*, for example, is considerably more

critical about the options for managing processes via markets. The following chapters consider the differences between the assessments in more detail.

2.3 How do the assessments approach the future?

Sustainable development implies critically examining potential solutions in the light of their later consequences. Decisions must be placed in a long-term perspective, so that short-term considerations do not become the sole determinants of policy. The assessments use different scenario methods to achieve this goal.

Strategic orientation, developing a vision or optimising policy
The choice between different methods of scenario analysis depends, primarily, on the aim of the assessment. Future-oriented assessments can focus on strategic orientation and the development of vision on the one hand, and at policy optimisation on the other. In the first case it is often useful to explore the future with the aid of a number of contrasting scenarios which recognise a large degree of uncertainty in, for example, social, political and technological developments. When weighing up policy options, it is clearest to use one baseline scenario in which the current trends continue, or a scenario that assumes that no new policies will be implemented ('business as usual' or 'no new policy'). Then, from that baseline scenario, variants based on specific policy issues are developed to analyse the effect of possible policy interventions.

The *UNEP Global Environment Outlook* is an example of an assessment in which four contrasting scenarios are used to develop a vision and a strategic orientation. The IPCC has previously used contrasting scenarios in its Special Report on Emission Scenarios (IPCC, 2000). This is less evident in the fourth IPCC Assessment Report, because this mainly reviews existing literature. The *OECD Environmental Outlook* and the *Agriculture Assessment*, by contrast, are each based on a single baseline scenario. Since the OECD focuses on policy optimisation, a single policy scenario is a logical choice. In the case of the *Agriculture Assessment*, this choice is less self-evident, since it examines long-term developments and controversial topics. Partly for this reason, the process of producing the *Agriculture Assessment* has entailed a great deal of disunity, leading certain companies to withdraw from the process.

Comparing the scenarios
Despite the differences, it is possible to group the scenarios used in the assessments according to a number of shared characteristics. A number of scenarios not only produce comparable outcomes, they also contain comparable assumptions. There is also some 'recycling' between the assessments. For example, what is said in the IPCC about climate change appears to have strongly influenced other assessments. While the assessments' scenarios regarding energy, land use and agriculture are partly based on original research, a relationship can also be seen to the SRES scenarios produced by the IPCC, the *World Energy Outlook* produced by the International Energy Agency (IEA, 2006) and the FAO's report *World Agriculture: towards 2015/2030* (Bruinsma (ed.), 2003).

Table 2.2 The most important assumptions and examples of different categories of scenarios used in the assessments

	Conventional markets	Reformed markets	Global sustainable development	Competition between regions	Regional sustainable development	'Business as usual'
Examples in the assessments	IPCC A1, GEO-4 Markets first	GEO-4 Policy first, Policy cases in the OECD and *Agriculture Assessment*	IPCC B1, GEO-4 Sustainability first	IPCC A2, GEO-4 Security first	IPCC B2	OECD *Environmental Outlook* and *Agriculture Assessment*
Economic development	Very rapid	Rapid	Slow to rapid	Slow	From average to rapid	Average (globalisation)
Population growth	Low	Low	Low	High	Average	Average
Technological development	Rapid	Rapid	From average to rapid	Slow	From slow to rapid	Average
Primary goals	Economic growth	Different goals	Global sustainability	Security	Local sustainability	Not defined
Environmental protection	Reactive	Both reactive and proactive	Proactive	Reactive	Proactive	Both reactive and proactive
Trade	Globalisation	Globalisation	Globalisation	Trade barriers	Trade barriers	Weak globalisation
Policy and institutions	Policy creates open markets	Policy limits market failures	Strong global management	Strong national policy	Local management, local actors	Mixed

This table summarises the most important assumptions in broad terms. Where there are differences within a category of scenarios, the bandwidth is indicated.

Scenarios of the 'Conventional market' type put great emphasis on market dynamics. These scenarios reflect economic optimism, for instance, by assuming rapid technological development. The 'Reformed market' type of scenario is based on a similar philosophy (the power of the free market), to which policy is added to correct for imperfections in markets if, as a result of such imperfections, the free operation of markets is incompatible with social development, combating poverty and protecting the environment. The third type of scenario, referred to as 'Global sustainability,' focuses strongly on protecting the environment and reducing inequality. These goals are attained in such scenarios by bringing about a change in core values relating to global cooperation, lifestyle and the use of more efficient forms of technology.

Scenarios of the type 'Regional competition' are based on the assumption that world regions will increasingly concentrate on their own immediate interests, leading to an increase in tensions. The fifth type, 'Regional sustainable development,' includes scenarios in which the various regions try mainly to create regional solutions for their current social and environmental problems. Finally, 'Business as usual' scenarios are based on the assumption that the trends observed thus far will continue. Scenarios of this last type are, therefore, different in character to the scenarios in the other categories.

Important trends in the various scenarios

Changes in demographics and income have a substantial effect on global land use and energy consumption. Taken together, the assessments cover the most widespread expectations regarding future trends. All the scenarios assume that the world population and world economy will continue to grow over the next few decades, with major consequences for land use and energy consumption.

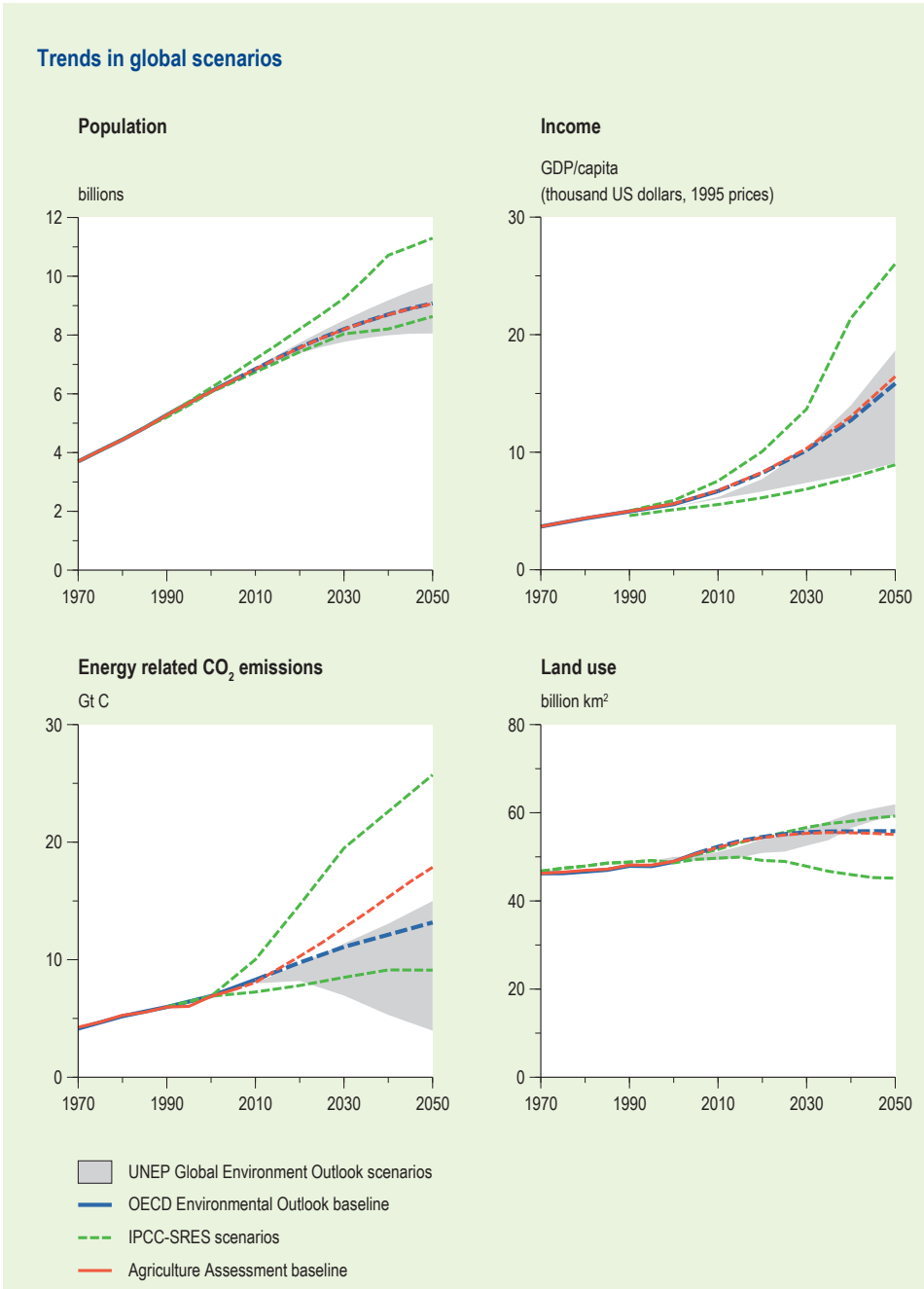

Figure 2.1 Historic trends and forecasts in population, income, land use and energy-related carbon dioxide emissions in the scenarios that are used in the four assessments.

Nowadays the world population in 2050 is estimated at a smaller number than it was a few years ago. The forecasts for economic growth diverge considerably: in the scenario with the largest expected growth, the world economy in 2050 is three times larger than in the scenario with the lowest expected growth.

In all scenarios without climate policy, carbon dioxide emissions also increase. A median estimate is that emissions in 2050 will be about twice as large as in 2000, but a much faster or slower growth is also possible. This trend shows that technological improvements and changes in lifestyle have thus far not been sufficient to outweigh the pressure on the environment as a result of population growth and the increase in production and consumption. Land use can develop in a number of different directions: there are scenarios with an increase in global human land use and scenarios with a reduction. The amount of land required is influenced by underlying competition from agriculture, nature, urban development and bio-energy. Figure 2.1 provides an overview of these trends in the assessments. These figures refer to the world as a whole, so the graphs do not show regional differences.

3 Main conclusions from the assessments

What is the current state of the environment world wide, which medium-term and long-term developments must be taken into account in policy-making, and what are the known and possible effects of existing and new policies? The most important conclusions of the assessments are summarised below. For more extensive conclusions see the summaries in the individual assessments.

Conclusions about climate change from the *IPCC Climate Change 2007*

- Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations.
- The consequences of climate change for nature and for people are becoming ever clearer. Food production and the availability of water are under pressure. Various ecosystems will disappear or change. Coasts and low-lying areas are in danger if sea levels rise. The poorest countries and the poorest people are the most vulnerable. The consequences depend on the rate at which temperatures rise, the extent to which the world is able to cope with the consequences of climate change, and on socio-economic developments that influence emissions of greenhouse gases.
- A certain degree of global warming is now unavoidable. The world will have to adjust to the consequences of climate change. By reducing greenhouse gas emissions, the global increase in temperature can be limited, with the result that the consequences of climate change in the long term will be less serious and the world will be able to cope better with these consequences.
- If the long-term increase in global temperature is to be limited to 2-3 °C, all social sectors will have to contribute. Technical solutions are already available that can reduce emissions considerably and, moreover, at modest direct and macro-economic cost.

Conclusions about the environment and development from the *UNEP Global Environment Outlook 4: Environment for Development*

- The environment is undergoing unprecedented global and regional changes. It is estimated that by 2025 about 1.8 billion people will face a lack of drinking water and two billion people will be suffering the consequences of unsustainable land use: pollution, soil erosion, water scarcity and salinisation.
- The protection and sustainable management of the environment and nature are important elements in combating poverty. The particular vulnerability of the poorest people to environmental changes cannot be seen in isolation from other changes in the world.
- The fair distribution of costs and benefits will play a crucial role if we are to find global solutions for environmental problems. The industrialised world is currently shifting part of the burden of its own environmental problems onto developing countries, with direct consequences for vulnerable groups there.
- The competition for land and water from different types of uses (such as agriculture, biofuels, nature and urbanisation) will lead to greater tensions. Such competition is mainly evident in the tropical regions, which are most dependent on their own natural resources.

Conclusions about international environmental policy from the *OECD Environmental Outlook to 2030*

- International environmental policy is necessary, achievable, affordable and urgent. With a contribution from the rising economies of Brazil, Russia, India and China (the 'BRIC' countries), international environmental policy can be much more effective. The most important issues are climate change, loss of biodiversity, water shortages and health impacts due to environmental pollution.
- Economic instruments can yield effective and efficient environmental policy. However, that effect will only be achieved if these instruments are combined with regulations, standards, investments in research and targeted information. Agreements about the international sharing of costs are crucial to climate policy. Whoever takes action need not necessarily be the one who must pay.
- Health impacts due to urban air pollution are increasing, particularly in Asia. Air pollution originating from elsewhere in the world will reduce the air quality in areas that have been clean, so far.
- As a result of free trade, the reduction of subsidies and rising demand from countries such as China, agricultural production in the tropics and sub-tropics will increase, for example, in Brazil. The net effect of that agricultural shift on biodiversity will depend very much on the existence of countervailing policies to prevent negative effects.

Conclusions about agriculture and development from the IAASTD *Agriculture Assessment*

- Despite increasing productivity in agriculture, people still suffer from malnutrition and poverty in many regions of the world. Agricultural development in the past strongly focused on productivity and the exploitation of natural resources. More attention needs to be given to the complex interactions between agriculture, local ecosystems and the local community, to make the sustainable use of natural resources possible. Drastic reforms to the global agricultural system are required.
- Much of the required knowledge and technology to deal with existing problems is already available. However, its application demands greater cooperation between those involved. Knowledge and technology must be urgently diversified to take differences in local ecological, social and cultural circumstances into account.
- The food supply can be improved by reducing transaction costs for small-scale producers, by strengthening local markets and protecting markets from sudden price fluctuations and the effects of extreme weather conditions.
- Small farmers and rural communities have often not profited from the advantages of global trade. These advantages can be realised, for example, by improving technology transfer, education and training, and by giving local actors more say in the management of natural resources.

4 Agriculture, food and biodiversity

Land use from a perspective of sustainable development
The land devoted to agriculture and built-up areas is still increasing substantially, which diminishes natural areas. In the next few decades, the world's population will grow further and prosperity will continue to increase. This will lead to an ever expanding use of land related to consumption. Meanwhile, continuing urbanisation and the associated expansion of infrastructure is also making demands on land.

Aspirations to use biomass as an alternative source of energy are also exerting extra pressure on – mainly – the land available for agriculture. A number of developments come together in the demand for land, which will affect the prices of agricultural commodities. The pressure on global land use will increase, not only from agriculture but also, for example, from forestry, in response to growing demand for wood and paper. The world has about 130 million km² of land, 15 million km² of which is used for crops and 35 million km² for pasture. The other 80 million km² can still be characterised as having more or less natural vegetation. Of this, 40 million km² is still wooded, and there are about 25 million km² of uncultivable areas such as ice, tundra and desert. The remaining 15 million km² are grass lands, savannah and suchlike.

In view of the crucial role of land for both food production and maintaining biodiversity, this chapter focuses on the results of the four assessments in relation to land use. Section 4.1 identifies the various policy goals relating to land use, while Section 4.2 surveys what the four assessments say about the extent of progress in implementing policies to realise these goals. Section 4.3 outlines the measures that are proposed in the assessments. The final Section (4.4) details a number of possible avenues for policy.

4.1 Policy goals

The Netherlands, and the EU as a whole, have committed themselves internationally to a number of policy goals relating to land use. These are the development goals for reducing hunger, ensuring there is sufficient and affordable food and maintaining biodiversity. Not all of these targets have been quantified In addition, many countries are striving to achieve a certain degree of self-sufficiency.

Eradicating extreme hunger and poverty
In 2000 the world committed itself, through the United Nations, to a number of quantitative development goals (to be achieved by 2015). The first so-called Millennium Development Goal aims at reducing extreme hunger and poverty. In 2015, according to this goal, the number of structurally malnourished people must be halved. This goal was formulated in 1996 during the second World Food Summit and was then included in the Millennium Development Goals. Primarily, extreme hunger and malnutrition are caused by poverty and the unequal distribution of food – not by global food shortages (IAASTD, 2008).

Ensuring sufficient and affordable food

Food is clearly a basic requirement of life. Therefore, many people and countries are concerned about the affordability of food. This is especially true for food-importing countries and for people in cities. Food price increases can lead to considerable social unrest and increasing migration. If food prices rise, the number of people suffering from hunger will increase, too. At the same time, higher food prices also present an opportunity. Theoretically, food producing rural areas could benefit from higher food prices, providing that they are well connected to food markets. For a variety of reasons, food prices have risen sharply in recent years.

Food security

Precisely because food security is a basic requirement, many countries strive for a certain degree of self-sufficiency in food. They often use trade policies, such as import barriers and income support for farmers, to promote self-sufficiency. Such trade policies disrupt world markets, reducing the food security of other countries. The pursuit of food security was a main rationale for the EU's Common Agricultural Policy.

Preserving biodiversity

The Convention on Biological Diversity (CBD, 1992) stipulates that the rate at which biodiversity is being lost should be reduced, significantly, by 2010. This aim has since become one of the Millennium Development Goals. The European Union has raised the bar of the CBD goal for its own territory: there should be a complete halt to the loss of biodiversity in the EU, by 2010. In addition to these overall CBD and EU targets, there are supportive goals, such as protecting 10% of the land area of all types of ecosystems, a target that was established during the third World Parks Congress (1982). Today, goals relating to the protection of nature are increasingly being specified for bedoeld smaller geographical units.

The measures that must be taken to achieve these targets have an effect on land use. The goals, therefore, have to be seen in relation to one another. In combating hunger in the world and to ensure there is affordable food, agriculture plays a central role. To maintain the level of biodiversity, the more natural elements of the land must be protected. Both play a crucial role in development, particularly in developing countries. Forty percent of the world's population work in agriculture; in many developing countries, agriculture is one of the most important sectors of the economy and the poorest part of the population is particularly dependent on natural resources.

4.2 Progress in achieving the goals

Extreme hunger not halved by 2015

The four assessments recognise the role and importance of agriculture in achieving the Millennium Development Goals. Nevertheless, the emphasis in most assessments is mainly on land use and the corresponding environmental impact of agriculture. Only the *UNEP Global Environment Outlook* and the *Agriculture Assessment* make explicit statements about achieving the Millennium Development Goal with regard to hunger.

Neither the UNEP *Global Environment Outlook* (GEO) nor the *Agriculture Assessment* expect the Millennium Development Goal for extreme hunger (which should be halved by 2015) to be achieved. Both assessments translate the Millennium Development Goal in terms of the number of malnourished children aged between 0 and 5 years. The *Agriculture Assessment* concludes – on the basis of a baseline scenario (i.e. without new policies) – that the number of malnourished children will decline from 150 million in 2000 to 130 million in 2025 and to 100 million in 2050. Malnutrition in children remains a problem, particularly for Sub-Saharan Africa; in other parts of the world, the number of malnourished children *will* decline by about half. In scenarios with focused policies, the number of malnourished children can be halved again, compared to the baseline scenario. These results are confirmed in the UNEP *Global Environment Outlook*: in the 'Security First' scenario the percentage of malnourished children remains constant up to 2050, which means that the absolute number of malnourished children would rise. The other three GEO scenarios show reductions in the percentage of malnourished children. However, in those GEO scenarios, as in the *Agriculture Assessment*, the percentage of malnourished children is not halved until around 2050.

Rising food prices

A striking feature of the *Agriculture Assessment* is that this is the first baseline scenario in which it is explicitly assumed that food prices will increase over the next few decades. This is a reversal of the trend in recent decades. Thus, current food price increases, according to the *Agriculture Assessment*, are not a short-term fluctuation. In 2050 – again according to the *Agriculture Assessment* – maize, rice and wheat will be 20% to 60% more expensive than in 2000. According to this assessment, this price increase is due to an increase in the demand for basic agricultural products, which in turn is due to population growth and the shift to more 'luxury' foods, and to the increasing difficulty of producing more food. This is partly due to lack of good land, but also, partly, to a shortage of water and to climate change.

More trade, less self-sufficiency in some regions

The volumes of food traded will also continue to increase, with the foremost developing countries becoming increasingly dependent on imports. It is even being concluded that the countries of Sub-Saharan Africa will import 330% more food in the next fifty years, despite substantial productivity increases in these countries. According to the *Agriculture Assessment*, world trade in grains will increase from 257 million tons in 2000 to 657 million tons in 2050.

Due to ongoing globalisation, farmers will increasingly specialise in the products for which their circumstances are favourable, leading to an increase in global food production. The trade in food, however, will increase even faster. Due to urbanisation and rapid population growth in a number of regions, self-sufficiency will decline.

Increasing productivity is the key to all goals

It is generally recognised that agricultural productivity (output per unit of land) must increase to bridge the conflict between food supply goals and biodiversity goals.

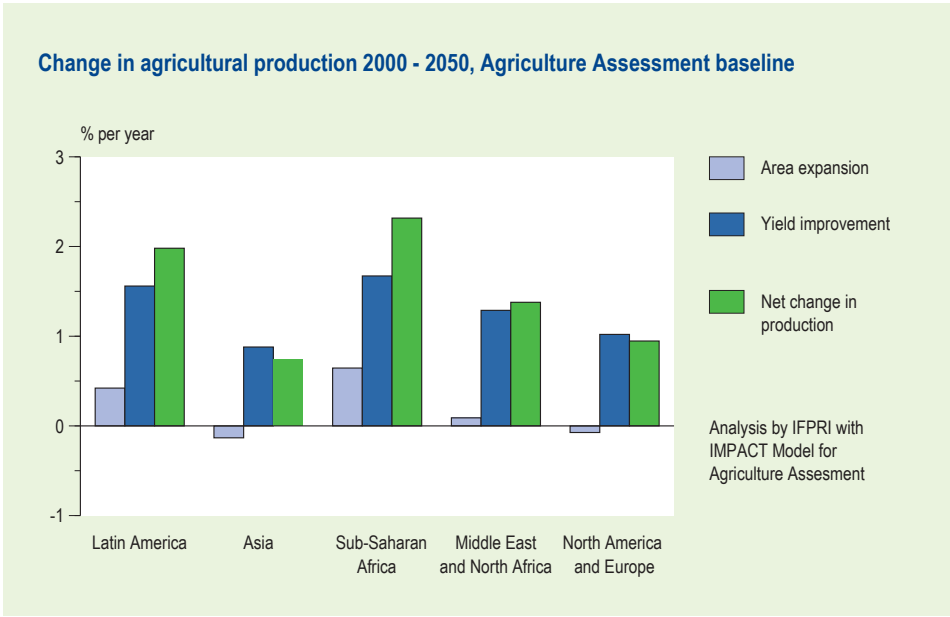

Figure 4.1 Causes of changes in agricultural production between 2000 and 2050.
Calculations by IFPRI with the IMPACT model following the baseline scenario of the Agriculture Assessment (IAASTD, 2008).

According to the *Agriculture Assessment's* baseline scenario, up to 2050, 80% of the required growth in global food production can be achieved through intensification (increasing productivity) and the rest by increasing the area devoted to agriculture (see Figure 4.1). This means that the total area of agricultural land, in the world, will have increased by about 10%, by 2050. Particularly in Sub-Saharan Africa and Latin America more agricultural areas will be added, at the expense of forests and grasslands areas in these regions.

The *UNEP Global Environment Outlook* also concludes that the total area in agricultural use will increase. It reckons with increases of 5 to 25%. The estimated increase in grassland areas in this assessment is more than that in the *Agriculture Assessment*, while both assessments state a comparable increase in the area used for food crops. The latter increase is strongest in the GEO 'Sustainability First' scenario, in which ambitions to limit climate change are high and a great deal of biomass is grown. In the longer term (2050), increases in land devoted to agriculture level off somewhat, because the world population will grow more slowly and consumption by the majority of the world's population will reach its saturation point (with the exception of low-income regions, such as Sub-Saharan Africa).

Climate change can certainly threaten the increase in agricultural productivity. The *IPCC Climate Change 2007* concludes that in dry tropical regions, a global warming of 1-2 °C is expected to lead to a reduction in crop yields, compared to the period 1980-1999. This increase can be expected in the coming decades, in a baseline scenario (see Chapter 5).

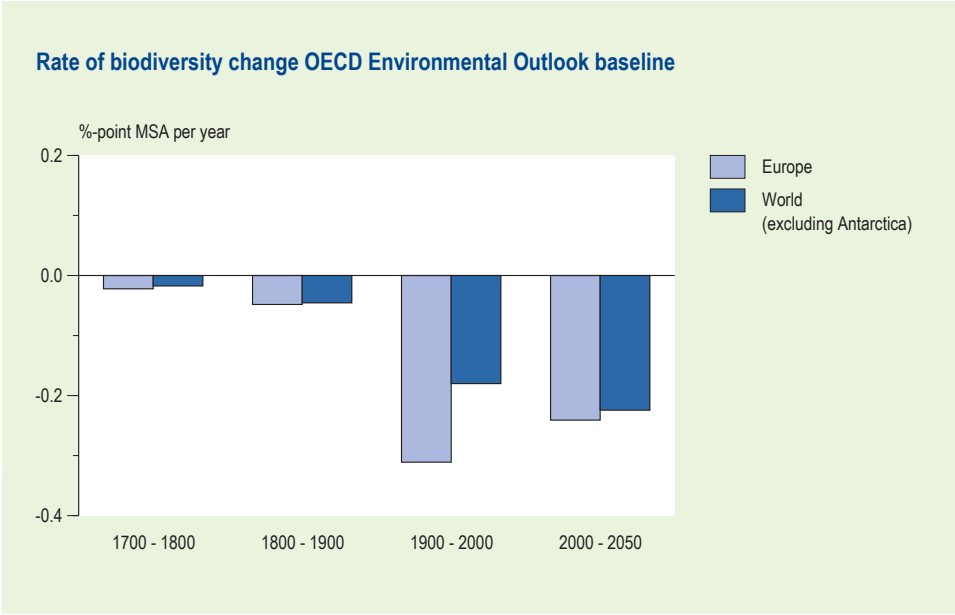

Figure 4.2 Rate of change in biodiversity in the OECD Environmental Outlook baseline scenario. Biodiversity loss is expressed in terms of Mean Species Abundance (MSA), the average abundance of species compared to the natural situation (OECD, 2008).

Another important uncertainty is the extent of the technical options for increasing yields: to what extent will it be possible to fully utilise this potential? The green revolution has bypassed a number of regions and previously projected improvements have not been achieved. If investments in agricultural expertise and its applications would be strongly stimulated, the increase in agricultural land areas could be somewhat reduced, within those particular regions. Such extra investments would lead to an increase in global food consumption, resulting from lower food prices. The *Agriculture Assessment* points out that not only technical but also social and institutional developments are necessary if the potential increase in productivity is to be realised.

Around the world, the loss of biodiversity will continue after 2010

All of the assessments conclude that global (and EU) goals for biodiversity protection will most probably not be achieved. Not by 2010, and not in the long term. In the baseline scenario of the *OECD Environmental Outlook*, for example, biodiversity continues to decline worldwide, up to 2050 (see Figure 4.2). While biodiversity in Europe in this period declines at a slower pace than in the twentieth century, the decline will certainly not be halted. For the world as a whole, the deterioration will actually go faster than it did in the twentieth century.

In historical terms, human development has always been accompanied by loss of nature. The global loss of biodiversity, thus far, has mainly resulted from habitat loss due to the exploitation and conversion of natural ecosystems. The most important causes of future biodiversity loss will be the continuing expansion of agricultural land, further development of infrastructure and continuing climate change. The assessments do,

however, differ as to the degree to which biodiversity is expected to decline. These differences result from the different assumptions the assessments make about agricultural production methods and ambitions with regard to biofuels. The differences in climate impacts to 2050 in the four studies are not large.

By 2003 the World Parks Congress goal of protecting 10% of the land surface had already been attained for nine of the fourteen different types of ecosystems. In 2003, a total of about seventeen million km² (13%) had a protected status. However, when you look in more detail, it becomes clear that this goal is far from being achieved. It has not been achieved for ecosystem types, such as lakes, coniferous forests and grasslands in moderate regions. It has also not been achieved for all ecosystems in all regions, and there are still very few protected areas in the sea. The results of efforts to protect biodiversity at sea lag far behind the measures taken to protect biodiversity on land.

4.3 Measures that could be taken in relation to agriculture, food and biodiversity

The assessments only partially address the question as to which policy measures can be taken to achieve the said policy goals. None of the assessments have explicitly studied how the various policy goals can be achieved simultaneously.

In the cases of agricultural and biodiversity policies, unlike climate policies, it is difficult to speak of synergy. In the first place, the goals are much more diverse, so that there is a larger probability of negative side-effects. In the second place, much is still unknown, for example, about the behaviour of agricultural markets, or the value of biodiversity. In the third place, climate change is more susceptible to an overall global solution. The emission of greenhouse gases must be reduced, and where this happens makes no difference. So emission rights can be traded. In the case of agriculture, land use and biodiversity, it is more difficult to design a trading system. The question is, on what basis could one establish a compensation mechanism? National sovereignty plays a much more prominent role in this field, too. This also means that the costs of possible policies are less well understood. Often, the agriculture, food and biodiversity theme features both winners and losers (from trade liberalisation, for example), rather than a global welfare loss (in monetary terms). Moreover, it is difficult to quantify the exact benefits in the different policy areas (for example, poverty reduction and biodiversity).

Increase in agricultural productivity is possible – estimations of the potential differ considerably

There are substantial differences between the assessments with respect to the projected growth in agricultural production per hectare. Many assessments have more optimistic growth estimates than the FAO's report *World Agriculture: towards 2015/2030* (Bruinsma, 2003), which forecast was already regarded as quite substantial by some people. There are opportunities to increase grain yields, particularly, in Latin America and Sub-Saharan Africa (see Figure 4.3). The differences between the scenarios that were studied for the *Agriculture Assessment* (baseline and two investment cases) are considerable.

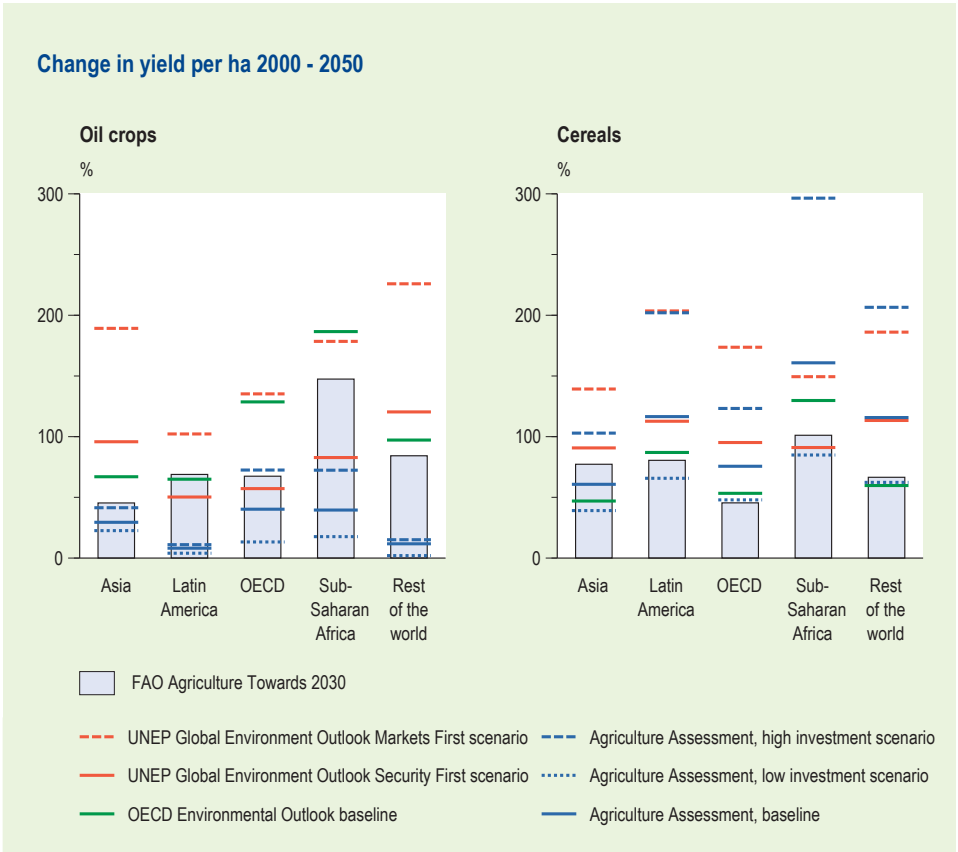

Figure 4.3 Increase in crop yields between 2000-2050, according to the FAO and three of the assessments discussed in this report. Source: Bruinsma (ed), 2003; UNEP, 2007; IAASTD, 2008; OECD, 2008.

This suggests that a great deal can be achieved by applying additional resources to develop measures related to increasing and disseminating agricultural expertise, in combination with additional policy. In this context, it is important to find ways of avoiding the negative impact of increasing agricultural productivity on the environment and nature.

Preserving nature: agricultural biodiversity may increase

The question as to whether agriculture will continue to intensify or (conversely) will need larger land areas is also crucial for biodiversity. As was noted above, given successful development and knowledge transfer, only a fifth of the total growth in food production will need to come from an increase in agricultural land (IAASTD, 2008). Biodiversity in natural areas will continue to decline globally, due to habitat loss, expanding infrastructure and ongoing climate change. On the other hand, there is a possible increase in biodiversity in agricultural areas, depending on the intensity and sustainability of the new production methods that are used. According to the *Agriculture Assessment*, one goal of agricultural research should be to increase agricultural production while preventing negative effects, such as pollution and erosion, and maximising the positive aspects (including biodiversity). The role of organic

and ecologically responsible agriculture is much debated, because lower yields per unit of land imply that more land will be needed for agriculture. In the *UNEP Global Environment Outlook*'s 'Policy First' and 'Sustainability First' scenarios, sustainable land use leads to expansion of the agricultural area under production.

Increasing food production - large-scale versus small-scale approaches

The *OECD Environmental Outlook*, the *UNEP Global Environment Outlook*, and the *Agriculture Assessment* all look, in detail, into boosting agricultural productivity as an important way to increase food production without a corresponding increase in the amount of land required (see also Figure 4.3). The assessments also examine the question of how such an improvement in productivity can be achieved. According to the *OECD Environmental Outlook*, with modern technology it will be possible to feed the expanded world population in 2030 and 2050. The OECD realises that it is mainly large-scale farms that will benefit from modern technology, but suggests that cooperation and leasing could enable smaller farms to benefit, also. Ultimately, a reform of agriculture is highly important to increase crop yields, according to the *OECD Environmental Outlook*.

The *Agriculture Assessment* takes a completely different view. On the one hand, the role of technology is recognised in this assessment, but at the same time it observes that the biggest challenges lie in the field of 'governance'. In addition, the *Agriculture Assessment* states that the less well-off benefit more from public than from private investments. Private investments, due to the profit motive, are said not to take into account the needs of the poorest. Therefore, the *Agriculture Assessment* takes a critical look at the increasing private investments and the – mainly in the developed countries, stagnating public investments. It does, however, conclude that a scenario of additional investments in technology and knowledge will lead to lower food prices and higher agricultural productivity. However, even in the case of this scenario, the goal of halving the number of malnourished children by 2015 is not achieved (see Figure 4.4). After 2015, however, this scenario does show a steady decline in the number of malnourished children.

Liberalisation of agricultural trade leads to more use of land

Another aspect of agricultural policy that receives a lot of attention in the assessments is trade. The *OECD Environmental Outlook* is reasonably positive about the continued liberalisation of world trade because, according to the OECD, this will stimulate the more efficient use of natural resources and, moreover, because many regions will then be connected to world markets. However, the OECD recognises that the range of policy instruments and the policy structures also need to be in place, to achieve optimal results. On this point, too, the tone of the *OECD Environmental Outlook* differs from that of the *Agriculture Assessment*, which explicitly considers the situation of small farmers who may suffer from cheap food imports. In the *Agriculture Assessment*, the temporary protection of developing countries is seen as a possible solution. It is even more negative about the impact that trade liberalisation will have on sharing costs and benefits. On balance, it says, the poorest developing countries will be the losers. It must be noted that there is a difference of tone within the *Agriculture Assessment* between its summary and outlook chapter, the latter of which does consider the positive effects of trade liberalisation.

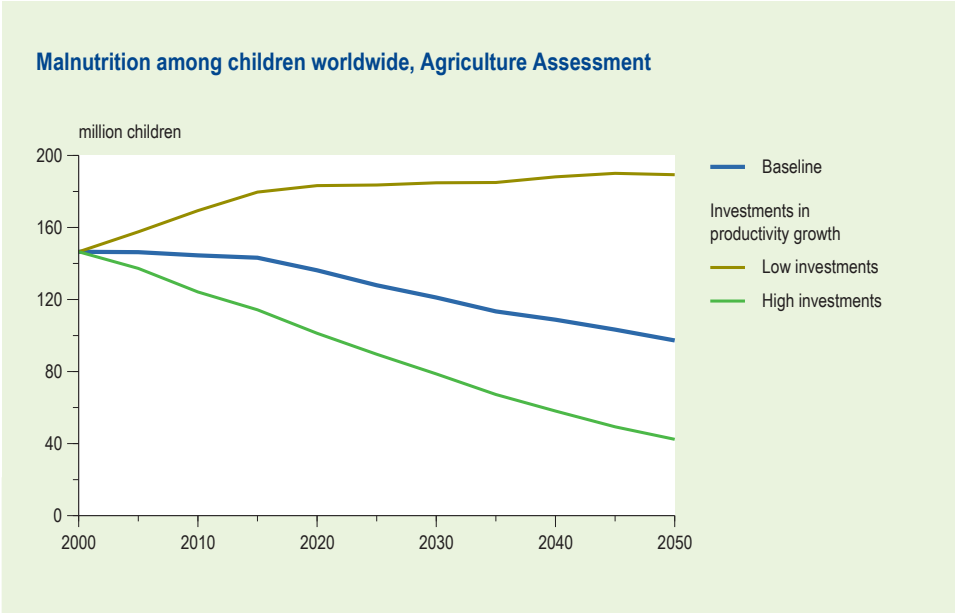

Figure 4.4 Numbers of malnourished children worldwide, baseline scenario plus a high investment and a low investment scenario. Source: calculations by IFPRI with the IMPACT model for the Agriculture Assessment (IAASTD, 2008).

As for the short term, both the *OECD Environmental Outlook* and the *Agriculture Assessment* show that trade liberalisation will initially lead to more land use. Because land is cheap in regions where much land is still available, more extra land would be taken into production in these areas if trade would be liberalised, compared to existing policy. The OECD, therefore, concludes that countervailing policies are required to ensure that further liberalisation of world trade is not at the expense of nature areas and, thus, of biodiversity. It is unclear what these countervailing policies might be.

Clearly, the *OECD Environmental Outlook* and the *Agriculture Assessment* represent contrasting world views. In the *UNEP Global Environment Outlook*, these world views are incorporated in scenarios. The 'Markets First' scenario is an example of a liberalising world, while in 'Security First' protectionism dominates. In the outcome, 'Security First' clearly gives the worst score for the number of malnourished people in 2050. 'Sustainability First' scores best on this point. In this scenario, markets are more open, but coupled with fair trade. On the basis of these scenarios, it appears that trade liberalisation offers opportunities but needs to be implemented in phases and accompanied by corrective measures. This aspect is not further dealt with in the assessments.

Biodiversity - policy options have little effect

Most of the assessments devote little or no attention to specific policies for biodiversity. In this respect, they hardly offer any better footing than does the scenario study for the second *Global Biodiversity Outlook* (sCBD, 2006). This study showed that various

solutions – such as reducing the consumption of meat and increasing the protected areas – would have a positive effect, but that this effect would be outweighed by the overall loss of biodiversity (sCBD & MNP, 2007). The various available policy options, when applied separately, can make only a limited contribution to slowing the loss of biodiversity.

The indirect drivers that influence biodiversity, such as faster population growth and increasing prosperity, are – all in all – much stronger than specific measures proposed to protect biodiversity (see Figure 4.5).

The assessments also show that, if ambitious measures are taken in the interests of biodiversity, there will also be undesirable side-effects, so that, worldwide, little or no net improvement will be achieved. For example, suppose that nature is given a chance to recover in Europe by reducing the area of agricultural land. (This is an option identified in some scenarios, based on far-reaching world trade liberalisation.) In that case, agricultural production would partially shift to other regions, in turn, causing the biodiversity in those regions to decline faster than the biodiversity in Europe could recover.

The *Millennium Ecosystem Assessment* strongly emphasises the value of biodiversity for people (MA, 2005). Ecosystems can be a source of exceptionally valuable products and services, such as clean water, flood protection and food. This is especially true for the world's poor, who cannot compensate for the loss of such services via technology (for example through water purification, dikes or advanced agriculture). None of the assessments incorporate this positive contribution by ecosystems to the socio-economic system (see the feedback via ecosystem goods and services in Figure 4.5). Our knowledge on this aspect is still surrounded by large uncertainties. This means that it is not yet possible to give a reliable indication of how measures – taken to promote the sustainable exploitation of natural ecosystems – would work out, in terms of preserving and developing biodiversity.

Biodiversity – protecting areas deserves a high priority

All in all, the assessments present a picture of continuing loss of biodiversity, which is virtually impossible to slow down. This makes it crucial to protect nature areas. For example, in the 'Sustainability First' scenario in the *UNEP Global Environment Outlook,* the size of protected areas is considerably extended – to about a fifth of the Earth's total land surface (see Figure 4.6). The 'Security First' scenario, in contrast, is more conservative in this respect. It does not reckon with an expansion of protected areas; contrarily, it reckons with a small decline.

The preparation of 'hot spot' maps for biodiversity is, however, a controversial topic. Many different choices could be made. For example, the criteria of 'vulnerability' and 'irreplaceability' lead to different priorities. How a global network of protected areas can best be designed, preserving the greatest possible diversity of species and populations, is a question for further research, with, perhaps, devoting special attention to exceptional and/or endemic species. In the 'Sustainability First' scenario of the *UNEP Global Environment Outlook*, the network of protected areas is expanded by protecting 20% of each type of ecosystem, and adding to this all areas that are particularly important to native species.

Biodiversity - measures to prevent climate change may create synergy

In addition to specific policies for promoting biodiversity, other forms of environmental policy can also have a positive effect on biodiversity. For example, if the expected climate effects after 2050 can be avoided by taking effective measures now, biodiversity will benefit. Among the various climate policy measures, biodiversity may be expected to benefit most from options such as energy efficiency and sustainable forms of energy generation. But that synergy will not be achieved if, as a result of climate policy, more land is brought into production, as would happen if biomass were to be used on a large scale (see Figure 4.5).

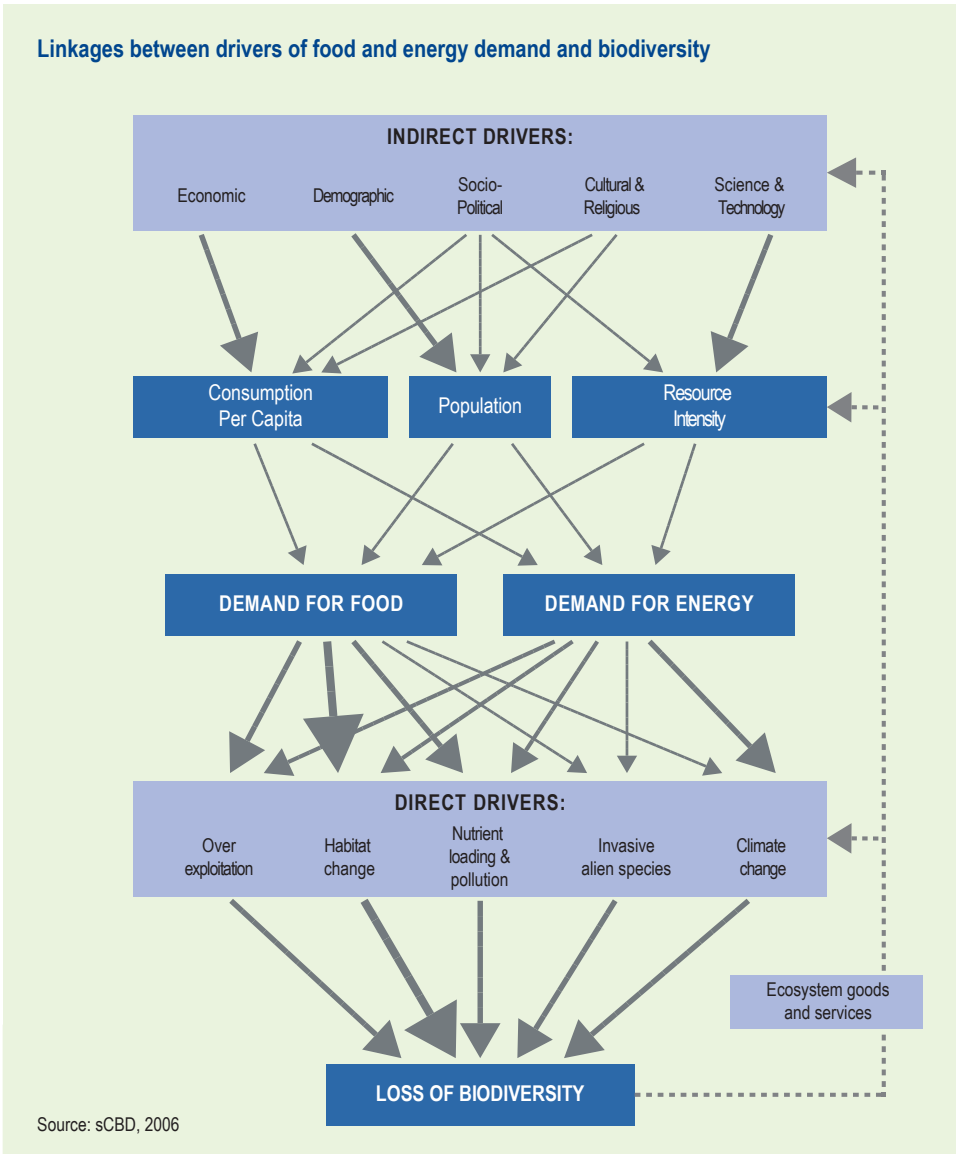

Figure 4.5 Relationships between factors determining the demand for food and energy and loss of biodiversity. Based on sCBD, 2006.

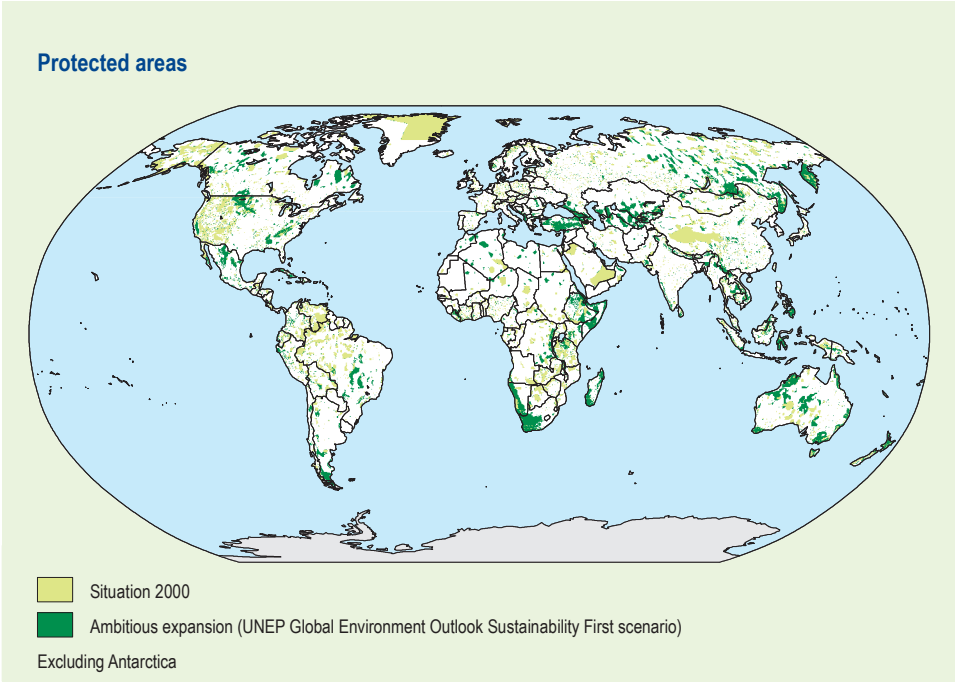

Figure 4.6 Protected areas for biodiversity: current situation and ambitious expansion.
The ambitious expansion is based on the Sustainability First scenario in the UNEP Global Environment Outlook (UNEP, 2007).

The issue of bio-energy and biofuels is addressed in several assessments and is discussed further in this report in the 'Intermezzo', following Chapter 5.

4.4 Strategies for policy

A number of goals has been set for agriculture, food and biodiversity. These goals affect one another through their implications for land use: increasing food production leads to a reduction in natural areas, unless agricultural productivity is greatly improved. The different demands they place on land use will lead to more and more competition over land. Policy coordination, in relation to the use of land, is not addressed in the global policy frameworks, and policy on land use is structured differently in all countries. Nevertheless, awareness of the importance of balancing claims on land in an integral way in spatial planning would make synergy more likely. This could, for example, include climate policy that focuses on increasing the volume of carbon stored in soils and biomass, which could easily be combined with protecting the natural condition of ecosystems.

Policy intensification

The four assessments offer little to help in identifying integral policy strategies that could incorporate the different goals. The assessments point out that policy should be

intensified, in view of the ever greater competition for land, rising food prices and the observation that the biodiversity goals, so far, have not been achieved. The *Agriculture Assessment* is most explicit with regard to agricultural policy. It advocates giving renewed attention to agricultural policy, because it is in need of change. In particular, it advocates institutional changes and the involvement of civil society in many developing countries. Civil society groups are better able to come up with local solutions for local problems. The *Agriculture Assessment* also argues for a focus on the multifunctional use of land, although it does not explore this concept,in detail. The *Agriculture Assessment* also recommends much more intensive contact between farmers from different parts of the world. At the same time, uniform ('one size fits all') solutions are rejected, in view of the complexity of agriculture. The *Agriculture Assessment* calls for much larger investments in agricultural research, especially publicly-funded research.

The assessments say little, or speak only in broad terms, about biodiversity policies. They project positive effects for biodiversity mainly resulting from the pursuit of other goals, such as intensifying land use and measures to prevent climate change (see Figure 4.5). However, the assessments do list various forms of policy instruments and measures intended to protect biodiversity, such as eco-labelling, setting sustainability criteria and charging for ecosystem goods and services, but without working out the resulting effects in their scenarios.

In the solutions to biodiversity problems discussed by the *OECD Environmental Outlook*, the emphasis is very much on market instruments. The *UNEP Global Environment Outlook* takes a much broader view. This assessment indicates that biodiversity is unvalued, from an economic point of view. Policy, according to this assessment, must seek to preserve areas that complement each other, to use areas in a sustainable way and to incorporate the value of biodiversity in economic transactions. However, as yet, there is no sufficiently powerful global policy forum for dealing with biodiversity-related issues.

The costs of policy

The four assessments say nothing about the costs of reducing hunger, preserving biodiversity and increasing food production. The *Agriculture Assessment* does point out that substantially larger investments will be needed in knowledge, science and technology, to be able to increase agricultural productivity in a sustainable way. Public investment in agricultural research, in particular, has declined markedly in recent decades, in both developed and developing countries.

The 'cost of policy inaction' – also referred to as the costs of business as usual – is also only described in a qualitative way: the continuing large number of people suffering from hunger, accompanying possible social unrest and migration, the negative effects on ecosystems and the loss of services to humanity that this entails. According to the UN Food and Agriculture Organisation (FAO), thirty billion dollars per year are required to eliminate hunger and increase agricultural productivity. Investments in agriculture through development aid have fallen by 60% in the last twenty years, to just over three billion dollars per year. Various studies have shown that the annual return on investments

in knowledge, science and technology is 20% to 40%, showing that costs can be recovered quickly.

However, on the whole, hunger, poverty and food supply are mainly questions of distribution. The liberalisation of world trade leads to greater prosperity on a global level, creating winners (including farmers in Latin America and Australia) and losers (farmers in the EU, the US, and Sub-Saharan Africa, as well as urban populations in developing countries in general).

The assessments make no attempt to present global estimates of the value that is lost together with the biodiversity, although this topic does emerge prominently in the *Millennium Ecosystem Assessment* (2005). The continuing decline in biodiversity is partly, and even largely, thought to be attributable to the fact that methods, which can be used to determine the value of ecosystem services, are not systematically applied. This means that this value is invisible in the formal economy, for example in its main indicator, the Gross Domestic Product. Better valuation of such services could, in view of this, provide a motivation for implementing biodiversity policy. The value of goods and services produced by ecosystems and their distribution, is being studied. However, large uncertainties remain: about the empirical data that is available, about the general validity of this data and about the economic valuation that should be applied. The further development of this field of research and integrating gained insights in future assessments, represents a major challenge.

Effective biodiversity policy requires clear choices

As the different assessments show, it is not possible to preserve all current biodiversity and, at the same time, meet the needs of a growing global human population. Similar to addressing the climate problem here, too, a combination of measures and associated instruments is required, designed to stimulate development. Separate measures could only make a small contribution.

However, the total potential of all these measures is unclear, in part because of the aforementioned trade-off between the different goals, but also because of the different definitions of biodiversity (for example, untamed nature versus cultural landscapes). It makes less sense to add up all the positive and negative effects, for biodiversity worldwide, than it does to do so for climate change. For global climate effects, it makes no immediate difference where emission cuts are made. This makes the climate problem is a global problem: it is a shared interests of the world and its peoples. The decline in biodiversity, in contrast, is a universal problem involving different local and regional interests.

Therefore, an effective strategy for biodiversity cannot be a direct copy of the strategy used to combat climate change, a field of policy that has made considerable progress in recent years, regionally and globally. In maintaining biodiversity, the problem is that choices have to be made as development levels steadily rise. The most important of these are: what should you protect, where should you intensify policy, and where is it better to use the land in a multi-functional way? In addition, sustainable production and consumption chains will need to be developed. Clarifying the added value of the

functions and services that depend on biodiversity can give an extra impulse to policy for biodiversity. In relation to this topic, which is hardly dealt with at all in the assessments, much more attention must be given to the local and regional levels than, for example, is the case with climate policy.

Instrumentation of policies

The instruments available for making land use policy are still very limited. At the local level, property rights are an important instrument, but at the international level countries are not yet prepared to accept any great degree of interference in the decisions they make about land use. This is the case in both the EU and around the world (therefore, the Natura 2000 areas can be seen as a breakthrough). The agreements in the Kyoto Protocol about carbon storage could perhaps be studied to see whether this instrument can also be used for other goals. For example, preventing deforestation and managing forests in a sustainable way benefits the climate goal, biodiversity and wood harvesting. Land use can be influenced, indirectly, through market instruments that incorporate the social costs of biodiversity loss in prices.

Within the framework of biodiversity policy, policy instruments can be used to protect, maintain and develop biodiversity, in combination with the removal of the direct and indirect causes of the loss of biodiversity (see Figure 4.5). One important element in this is integrating preservation and the sustainable use of biodiversity in sectoral development (in agriculture, energy and trade), and to seek synergy. The *Agriculture Assessment* regards 'sustainable intensification' of agriculture as an important strategy for solving problems, one in which knowledge transfer is a crucial element. In addition, the efficient incorporation of the spatial needs of different functions in the landscape (integrated spatial planning) will make it possible to serve different goals at the local level, avoiding the further conversion of natura areas, as much as possible. The last option mentioned involves changing the pattern of consumption in prosperous countries, so that people eat less meat, which would also yield health benefits. This needs to be done through public information campaigns, raising consumer awareness.

Policy coherence

None of the four assessments have explicitly asked, let alone answered, the question of how the policy goals mentioned above (elimination of extreme hunger, maintaining biodiversity, reasonable food prices and a certain degree of self-sufficiency) can be achieved in the most coherent way possible. The assessments do present solutions – as discussed in the previous section – that are positive for at least more than one goal. Increasing crop yields per hectare in a responsible way is a policy that has a positive effect on both food production (reducing hunger, while enhancing self-sufficiency) and biodiversity. According to the *Agriculture Assessment*, an increase in the world's agricultural productivity requires substantial investments.

In addition, policy coherence could be improved by integrating an awareness of, and concern for, biodiversity into other sectors (trade, agriculture and fisheries). This is discussed further in Chapter 6, which draws lessons from the assessments for Dutch and EU policy towards sustainable development.

5 Energy, climate and air pollution

Energy in the perspective of sustainable development
Energy is an important basic need, both economically and socially, and an essential element in sustainable development. The global assessments, therefore, devote a great deal of attention to trends in demand for energy and changes in the energy sector, as a whole. A sustainable energy supply is clean, reliable and affordable. This chapter discusses two goals of environmental policy to which a sustainable energy supply is crucial: limiting climate change and limiting air pollution. It also considers the pursuit of access to modern energy services worldwide and ensuring the continuity of energy supply (energy security).

On the basis of the global assessments, conclusions can be drawn about the availability, costs and interactions between those measures that could be taken to achieve these policy goals. It must be remembered, however, that the assessments devote a great deal of attention to environmental topics, such as climate change (all assessments) and air pollution (*UNEP Global Environment Outlook* and *OECD Environmental Outlook*), but only limited attention to the issue of energy security. The assessments barely consider the question of how global access to modern energy services can be achieved. Moreover, the *Agriculture Assessment* focuses on biofuels, which are discussed in a separate 'Intermezzo', following this chapter.

Section 5.1 identifies the various policy goals relating to energy and Section 5.2 surveys the extent of progress in implementing policy designed to meet these targets, according to the different assessments. Section 5.3 outlines the measures that are discussed in the assessments. The concluding section (5.4) details a number of possible directions for policy-making.

5.1 Policy goals

Limiting climate change
The long-term goal of international climate policy is to prevent human activities from influencing the climate system in a way that is dangerous to people and to nature. However, this goal has not yet been quantified at the global level, although.international negotiations for a successor to the Kyoto Protocol have started. The European Union assigns a high priority to limiting climate change. Its goal is that the global average temperature should not increase by more than 2 °C, compared to the pre-industrial level. On this basis, the EU has set itself the goal of decreasing greenhouse gas emissions by at least 20% compared to 1990, by 2020. In addition, the EU seeks to ensure that, by 2020, renewable energy makes up 20% of its energy mix and EU transport should use 10% biofuels. Finally, the EU Member States have adopted a non-binding national objective of 1% improvement in energy efficiency per year, in the period up to 2016. These targets serve both the environmental goals and energy security. The Netherlands, where there is relatively strong political support for climate policy, is more ambitious in this field than the EU: by 2020, Dutch greenhouse gas emissions are to be reduced; not by 20% (the EU target) but by 30%, compared to levels in 1990.

Limiting air pollution

With regard to air pollution, the assessments focus on urban air quality and, specially, on particulate matter and ozone at ground level. Emissions from the energy sector, from the use of fossil fuels and (traditional) biomass, in particular, account for much of the current air pollution. This has negative effects on both human health and natural ecosystems. There are no specific global objectives for reducing air pollution, but the World Health Organization (WHO) has formulated quality targets in the form of acceptable concentrations. The *UNEP Global Environment Outlook* emphasises the fact that reducing air pollution will make an important contribution to achieving the Millennium Development Goals. In the sixth Environment Action Programme, the European Union has set itself the goal of ensuring an air quality that entails no significant negative effects on and risks to human health and the environment. Objectives for cross-border air pollution also follow from the provisions of the treaty. The EU treaty provides a framework for intergovernmental cooperation to protect health and the environment from air pollution that could effect more than one country. In relation to this, energy – alongside manufacturing and transport – is identified as a priority for policy.

Access to modern energy services

Clean, reliable, affordable energy is necessary for economic growth, to combat poverty and to meet people's primary needs. It is, therefore, a prerequisite for achieving the Millennium Development Goals. Currently, a quarter of the world's population does not have access to electricity. An estimated 2.5 billion people rely on traditional biomass for cooking and heating; this is an important contributing factor to poor health. To achieve the Millennium Development Goals by 2015, it is necessary that people around the world who currently use traditional biomass should have access to clean and modern fuels and electricity. The Netherlands has, therefore, undertaken to provide ten million people in developing countries with clean and reliable energy services, by 2015.

Increasing energy security

The world's stocks of energy, mainly fossil fuels, and the options for supplying them are limited and unevenly distributed. Therefore, many countries are developing policies to ensure that they can continue to meet their energy needs in the long term. The EU, and the Netherlands within the EU, are vulnerable because of their dependence on imported energy, possible shortages, potential energy crises and uncertainty about future energy supply. In its energy policy, the EU puts the emphasis on diversification, both in imported sources of energy and suppliers and in modes of transport. Neither the Netherlands nor the EU has formulated specific policy goals for energy security. However, the EU's environmental targets – for example for increasing the share of renewables in the energy mix - will contribute to energy security in the long term.

5.2 Progress in achieving the goals

The four assessments are unanimous in concluding that the world is not on course for a future of sustainable energy supply. The objectives of limiting climate change and improving air quality – with an important contribution by energy-related changes – will not be achieved with current policy. Much of the world's population will not have modern energy services in the future. In many regions and countries, security of supply will not improve and may well deteriorate if current trends continue.

Energy consumption and greenhouse gas emissions continue to increase
Growing global energy needs are a major contributor to the increase in global greenhouse gas emissions. In qualitative terms, the assessments present a consistent picture, in part because the IPCC SRES scenarios (IPCC, 2000) are an important reference point for the scenarios in the other assessments. Population growth and increasing income per capita lead to rapidly growing demand for energy services. Although the average energy intensity in terms of primary energy demand per unit of energy service is expected to decline further, this will not be sufficient to compensate for the growing demand for energy services (see Figure 5.2). For example, according to the *OECD Environmental Outlook*, without new policies primary energy consumption will increase by more than half, up to 2030. The four scenarios in the *UNEP Global Environment Outlook* also forecast growing demand for energy. In the 'Policy First' and 'Security First' scenarios, the demand for energy increases up to 2030, compared to 2000, by half and by three quarters, respectively. In the 'Markets First' scenario, demand for energy grows even faster, due to the substantial growth in incomes and the intensive material consumption which this scenario incorporates.

Figure 5.1 shows the growth in the global primary demand for energy in the baseline scenario of the *OECD Environmental Outlook*. Most of the absolute increase in demand for energy occurs in developing countries. However, emissions per head of population remain lower than those in developed countries, even in the long term. The *OECD Environmental Outlook* also points out that emerging developing countries – China, India and Brazil, along with Russia (the so-called 'BRIC' countries) – account for a growing proportion of the increasing global need for energy. The other assessments also point this out.

Electricity generation, along with transport activities, is responsible for most of the increase in energy consumption. Since the global energy supply, in the scenarios without additional climate policy, continues to be largely dependent on fossil fuels, greenhouse gas emissions also increase, proportionally. In fact, in the baseline scenario of the *OECD Environmental Outlook*, fossil fuels will still account for more than 80% of the global energy mix, in 2030. Although the carbon intensity of the energy supply has declined in recent years, it is uncertain whether this trend will continue. The various assessments provide different outlooks for carbon intensity.

Figure 5.2 shows the underlying causes of changes in the growth of energy-related carbon dioxide emissions, based on the IPCC estimates, which were derived from analyses and scenarios in the *World Energy Outlook* 2006 of the International Energy Agency (IEA).

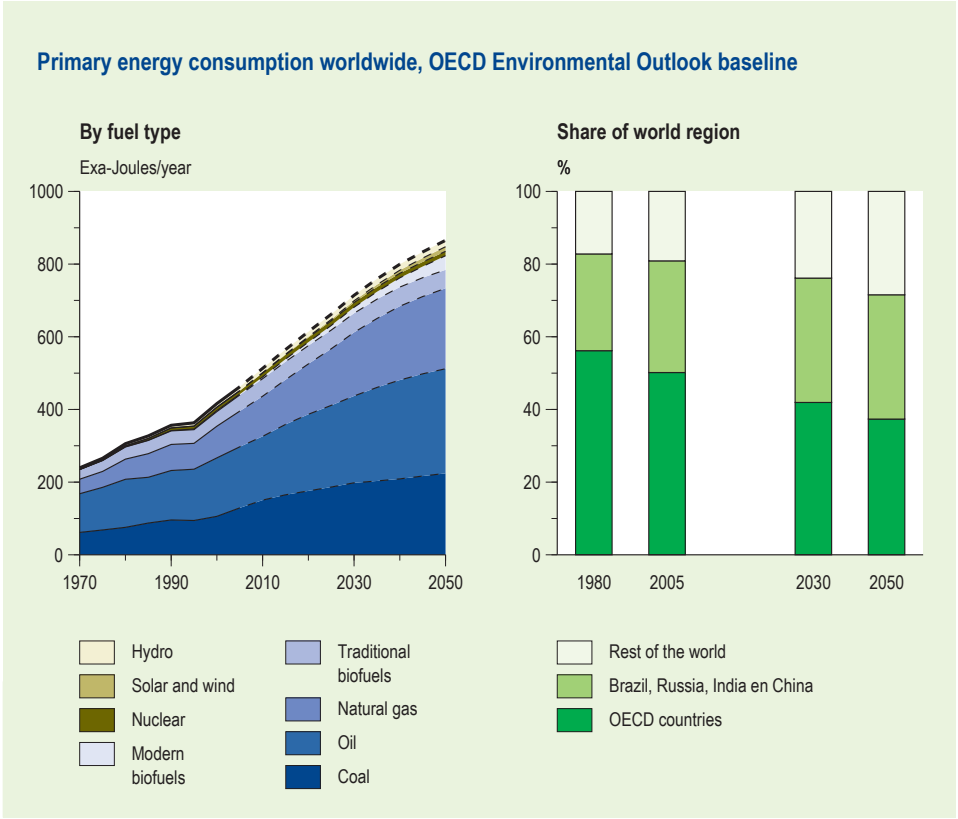

Figure 5.1 Global primary energy consumption in the OECD baseline scenario.
Source: Figure 17.1, OECD, 2008.

On the basis of the trends described above, energy-related carbon dioxide emissions, in 2030, will be 40% to 110% larger than in 2000, according to the *IPCC Climate Change 2007*. Two thirds to three quarters of this increase will come from developing countries. The *OECD Environmental Outlook*'s baseline projects an increase of about 50%. The IPCC projections depend, for the most part, on assumptions about global population growth and growth of economic activity, expectations about changes in the energy intensity of the economy in the absence of new policies, and the proportion of coal in the energy mix. This last factor depends, in turn, on the development of energy prices.

To achieve the climate goals, greenhouse gas emissions must be decreased. To achieve the EU's goal for climate change of limiting the increase in global average temperatures to 2 °C, it is – according to the *IPCC Climate Change 2007* – necessary to stabilise concentrations of greenhouse gases at no more than 450 ppm of carbon dioxide equivalents. This is ambitious. It requires that global emissions decrease between 50% and 85% by 2050, compared to 2000 levels. A less ambitious target, leading to an ultimate increase in average temperatures of about 3 °C, would be achieved if the amount of greenhouse gas emissions in 2050 were to ly between 30% less and 5% more, than in 2000. Much of these emission reductions will have to be achieved through measures in the energy sector.

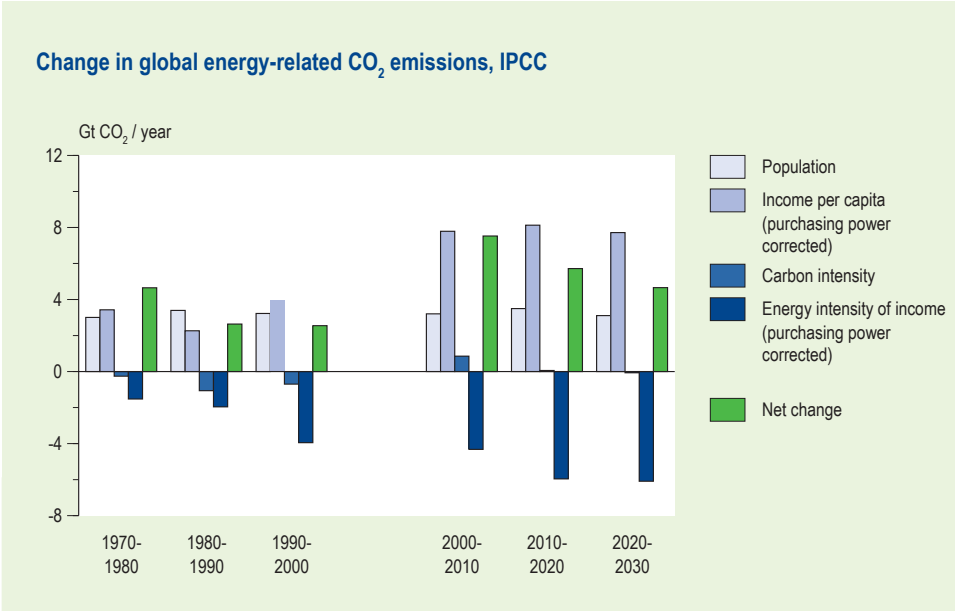

Figure 5.2 Determining factors for changes in energy-related carbon dioxide emissions.
Source: Figure 1.6 in IPCC 2007c.

The message in all of the assessments is unambiguous: the stated climate goals will certainly not be achieved without considerable intensification of current global and EU energy and climate policies.

Increasing impact of air pollution in developing countries

Of the four assessments, the OECD *Environmental Outlook* and UNEP *Global Environment Outlook* give the most consideration to air pollution. Every year more than two million people die prematurely, as a result of indoor and outdoor air pollution. Most OECD countries have been able to reduce air pollution, in recent years. In fact, the air quality in some cities has greatly improved. However, urban agglomerations in developing countries, in particular, still suffer from extreme air pollution. The assessments identify energy consumption in industry and by households, electricity generation and transport as the most important causes of air pollution.

According to the baseline scenario in the OECD *Environmental Outlook*, if there are no changes in policy, the effects of air pollution, especially from ozone and particulate matter, on health, ecosystems and agriculture will increase further over the next few decades, particularly in the urban agglomerations of Asia and Latin America. Between 2000 and 2030, the number of premature deaths as a result of exposure to ozone, will quadruple, and the number of premature deaths due to particulate matter, will double (see Figure 5.3). The UNEP *Global Environment Outlook* confirms these developments without quantifying them. The OECD *Environmental Outlook* refers to steadily increasing urbanisation and the aging of populations as factors that considerably worsen the health impact of urban air pollution. (Today, about 50% of the world's population live in urban agglomerations; in 2030, this figure will be about 60%).

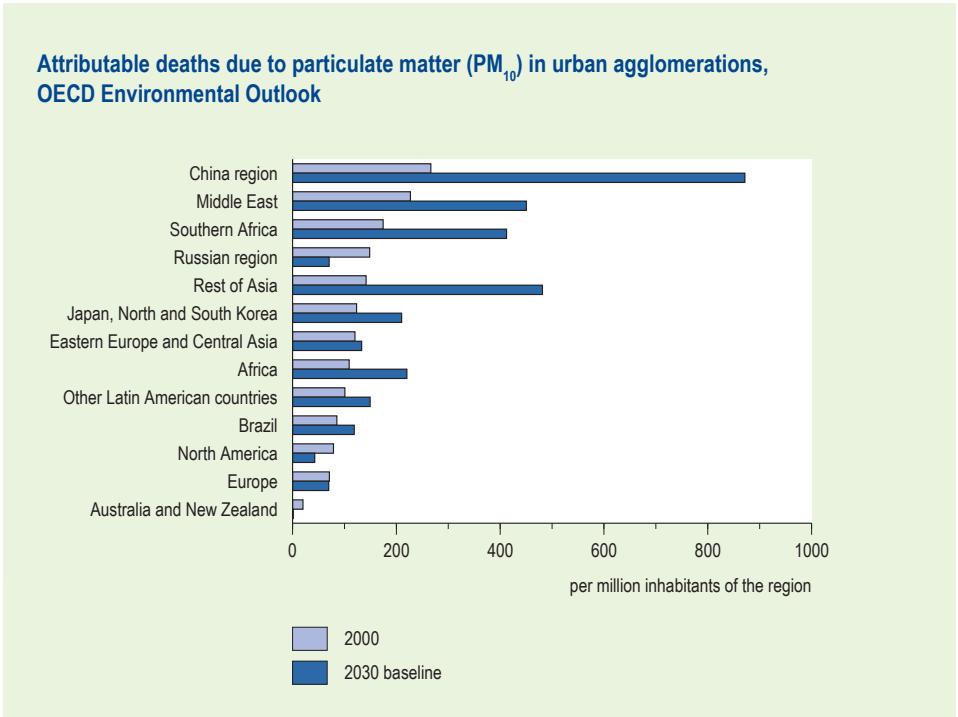

Figure 5.3 Premature deaths as a result of exposure to particulate matter in cities, baseline scenario in the OECD Environmental Outlook. Source: Figure 12.1, OECD, 2008.

Figure 5.3, from the OECD *Environmental Outlook*, shows the expected increase in premature deaths, as a result of exposure to particulate matter.

Access to modern energy services will not improve and energy security will decline

The global assessments devote relatively little attention to the goal of improving global access to modern energy services. There are a number of reasons for this: access to energy is not only an environmental issue, and its study demands a more detailed research method than that used in the global assessments. The OECD *Environmental Outlook* does briefly state that much of the world's population will continue to have little or no access to modern energy services, if current policy continues.

In the general trend described above (increasing demand for energy, much of which comes from fossil fuels), energy security will further decline in most regions, including the Netherlands and Europe. Even if the Netherlands and the EU achieve their objectives for energy savings and renewable energy, they will remain largely dependent on oil and gas, and will continue to be very dependent on imports for both. Moreover, the EU is becoming ever more dependent on a small group of gas and oil suppliers. As a result of further increases in the demand for energy in the rapidly-growing BRIC economies, there will be more competition for energy in future. The same is true of developing countries that have no fossil-fuel reserves. According to the *OECD Environmental Outlook*, the poorer and rural populations will be particularly hard hit, because energy-intensive basic needs, such as local transport from home to work and buying and preparing food, will be more expensive.

5.3 Measures that could be taken on energy, climate and air quality

The combined potential of measures can make climate goals achievable

All the assessments show that there is considerable potential to decrease greenhouse gas emissions. A combination of technologies and measures is needed to reduce emissions, sufficiently. According to *IPCC Climate Change 2007,* in future, technologies that are now known and available offer sufficient opportunities to limit greenhouse gas emissions to the degree that is required to limit the earth's warming to 2° or 3 °C. If it is decided that a less ambitious stabilisation of the concentration of greenhouse gases is acceptable (resulting in a greater degree of warming), there will be less dependence on certain critical technologies and more freedom of choice about the technology mix to deploy. Many of these technologies are already commercially available while other relevant technologies will be commercially available by 2030. Table 5.1 provides an overview of the main technologies for emission reduction related to energy production, and those designed to reduce demand.

The projected use of measures depends on assumptions regarding their costs, on technical factors, acceptance, competition among measures, the stabilisation target and technological developments. According to the IPCC's *Climate Change 2007*, energy saving, renewable energy, nuclear energy and carbon capture and storage are attractive options for additional climate policy. Technological developments and increasing acceptance will further increase the potential in these sectors, in the long term. Switching to natural gas, in contrast, plays no substantial role in ambitious targets, because its potential is relatively limited.

Table 5.1 Important technologies for decreasing greenhouse gas emissions

	Important emission reduction technologies and measures that are now commercially available	Important emission reduction technologies and measures expected to be commercially available by 2030
Energy production	Improved efficiency in production and distribution; switching from coal to gas; nuclear energy; renewable heat and electricity (water, sun, wind, geothermal and bio-energy); Combined Heat & Power units; first applications of carbon capture and storage	Carbon capture and storage for electricity generation from gas, biomass and coal; advanced nuclear energy; advanced renewable energy, including tidal and wave energy, concentrated solar energy and photovoltaics
Transport	More efficient vehicles; hybrid vehicles; clean diesel; biofuels; 'modal shift' to rail and public transport and to non-motorised transport; improved spatial planning and transport planning	Second generation biofuels, high-efficiency aircraft; advanced electric and hybrid vehicles
Buildings	Efficient lighting, appliances and heating and cooling; improved boilers and insulation, passive and active applications of solar energy for heating and cooling; alternative refrigerants and recycling of conventional refrigerants	Integrated design of utility buildings with intelligent energy management; integrated photovoltaics
Industry	Efficient electrical devices, heat and electricity recovery, recycling and replacement of materials, management of greenhouse gases other than carbon dioxide, various process technologies	Advanced energy saving; carbon capture and storage in cement, ammonia and steel production, inert electrodes for aluminium production

Source: IPCC, 2007c

In all four scenarios in the *UNEP Global Environment Outlook*, fossil fuels continue to dominate the energy mix. In the 'Policy First' scenario, climate policy is intensified on the basis of strengthened international cooperation. As a result, the proportion of fossil fuels in the total energy mix is limited and the proportion of sustainable and nuclear energy is increased, in combination with carbon capture and storage. In 'Sustainability First,' which has a more ambitious climate policy, these trends are even stronger.

The *IPCC Climate Change 2007* emphasises the potential for energy saving in end-use sectors, such as in build-up areas and in industry. In addition to technological measures, changes in end-users' lifestyles and behaviour can also decrease emissions, mainly through reducing the demand for energy. In particular, the 'Sustainability First' scenario in the *UNEP Global Environment Outlook* features a shift to less material-intensive consumption, in part stimulated by climate policy. Such a shift, in combination with more efficient energy consumption, can have a considerable influence on the demand for energy.

OECD countries have reduced air pollution mainly through regulations (leading to 'end of pipe' measures, increasing efficiency and cleaner fuels). In many developing countries, such measures have not yet been taken. Figure 5.4 shows the reductions in global emissions of nitrogen oxides and sulphur oxides that can be achieved through an additional policy package, compared to the baseline scenario. The analysis was carried out assuming that air pollution policies would be boosted in either OECD countries; or OECD and, somewhat later, BRIC; or, eventually, all countries. It is clear that the biggest reduction can be achieved in rapidly-growing economies (the BRIC countries) and in other developing countries.

All the scenarios in the *UNEP Global Environment Outlook* show declining global emissions of sulphur dioxide, except for the 'Security First' scenario, in which no measures are implemented to reduce emissions. The drastic decrease in global sulphur dioxide emissions in the 'Policy First' and 'Sustainability First' scenarios reflects a combination of the effect of specific emission reduction policies, slower growth in the demand for energy and a shift to cleaner fuels.

The *OECD Environmental Outlook*, in its chapter on globalisation, devotes more attention to ensuring the continuity of energy supply, than the other assessments: this is due to its focus on economic aspects. Energy savings by end users, renewable energy sources (including biofuels), nuclear energy and the use of coal, are all measures which can reduce the dependence on oil and gas. Some of these measures can also play an important role in reducing greenhouse gas emissions, making synergy with climate policy quite possible. This is not the case with other energy carriers.

The assessments devote little, or only indirect consideration to access to modern energy services. Increasing electrification in developing countries and the accompanying growth in demand for electricity *are* included in the scenarios. In view of the relatively small demand for electricity in developing countries, increasing electrification in those countries has relatively few consequences for global emissions. The evaluation of alternative, decentralised ('off-grid') solutions, mainly in the rural areas, is beyond the scope of the global assessments.

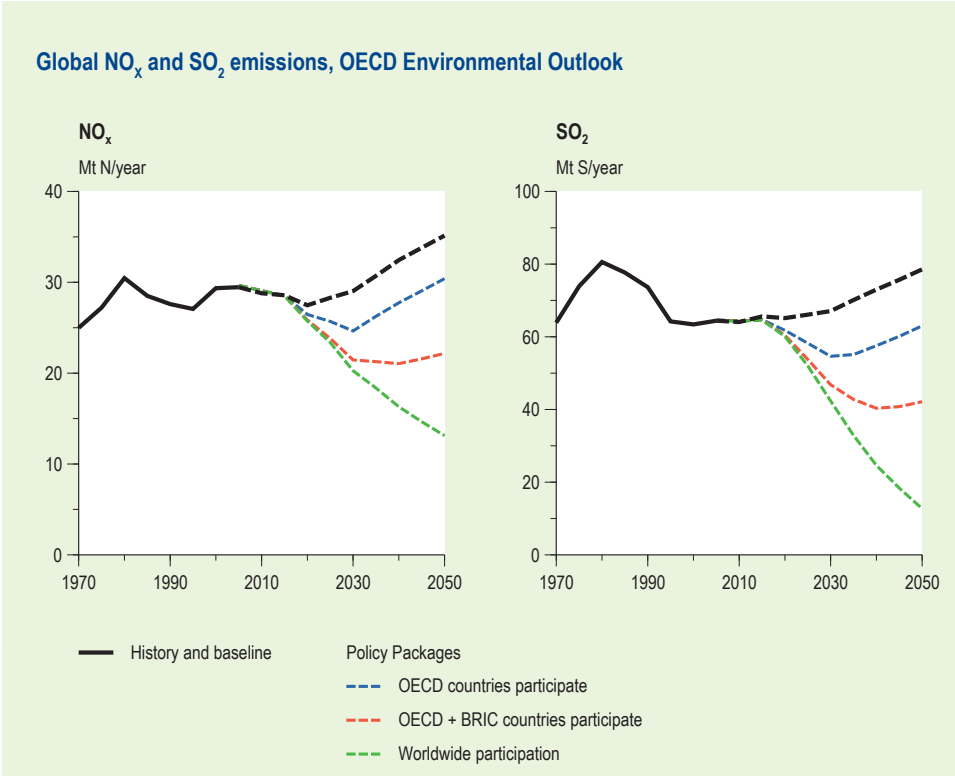

Figure 5.4 Global emissions of sulphur dioxide and nitrogen oxides. The policy packages differ in terms of participation by global groups of countries: only OECD countries; OECD countries, later including Brazil, Russia, India and China (BRIC); and global cooperation. Source: baseline and policy packages in the OECD Environmental Outlook (OECD, 2008, Figure 8.6).

Coherence of measures for sustainable energy supply

Many technical measures in the energy sector have an effect on the various goals related to sustainable development. Sometimes one measure contributes to different objectives, and in other cases there are negative effects. All assessments give a lot of consideration to connections between policy measures. In many countries, climate policy is not yet being given sufficient weight. Consequently, the contribution by measures preventing climate change to other objectives can be an important motivation for climate policy. Table 5.2 presents an overview, compiled from the assessments, of possible interaction between various measures for promoting sustainable energy supply.

As the *IPCC Climate Change 2007* shows, from a climate point of view, measures to prevent climate change can yield considerable effects of synergy. Savings on the immediate costs of air pollution-related health effects, can perhaps compensate for some of the cost of measures to reduce greenhouse gases, which are incurred in sectors such as manufacturing and transport. In addition, the benefits from reduced air pollution are felt mainly at the local level and in the short term, which would give them a higher priority for many developing countries.

Table 5.2 Interaction between measures to promote sustainable energy supply

	Effect on climate change	Effect on air pollution	Effect on security of energy supply	Effect on access to clean energy services
Climate change		Often positive, for example, less use of fossil fuels due to energy saving and renewable energy sources. Exceptions - some local biomass applications (NO_x and emissions of particulate matter)	Often positive (especially with a stringent climate policy) - energy savings, renewable energy, for biomass only by diversifying sources; negative - switching to gas, reduction in coal use (without carbon capture and storage)	The energy system could become more expensive; restrictive effect on electrification based on fossil fuels
Air pollution	Often little effect, because of many 'end of pipe' measures; sometimes positive, but can also be negative, such as decrease in aerosols, diminishing the regional cooling effect that partially counteracts global warming		Often little effect; limited negative effect, as a result of less use of coal and more of gas	Restrictive for electrification on the basis of fossil fuels
Security of supply	Negative - use of coal and exploitation of unconventional oil and gas sources; positive - biomass	Possibly negative - use of coal, less use of clean fossil fuels; positive - renewable energy		Slight
Access to clean energy services	Limited negative - electrification based on fossil fuels; neutral/positive if based on renewable energy	Positive, if renewable energy is used to replace traditional biomass; negative, if based on fossil fuels	Negative, if based on fossil fuels; positive, if based on local energy sources and renewable energy	

The relationship between climate measures and measures to improve access to modern energy services is not examined, in detail, in any of the assessments. The *UNEP Global Environment Outlook* does discuss the broad relationship between living conditions and environmental situation facing the population in developing countries. The *IPCC Climate Change 2007* explores the relationship between 'mitigation' (measures to prevent climate change) and sustainable development. The assessments conclude that carbon dioxide emissions from the electricity sector will increase rapidly, particularly in Asia, partly due to increasing rural electrification based on fossil fuels. Thus, it is important for climate change to be included in policies relating to improved access to modern energy services and the design of rural energy supply. There are various options, for example, via renewable energy sources and decentralised ('off-grid') solutions or via more centralised systems, based on 'clean' use of fossil fuels.

Policy measures intended to increase sustainable energy supply and those designed to mitigate climate change can also influence other policy areas. The IPCC's *Climate change 2007* identifies the following possible effects:

- Energy crops and food crops may compete for land. Accelerating the development from first- to second-generation biofuels may reduce this competition (OECD, IPCC and *Agriculture Assessment* – see the 'Intermezzo' on biomass, following this chapter).
- Hydroelectric power has great potential for climate policy, but it can have large (negative) social and environmental effects, locally.
- There may be competition for scarce water reserves. This relates to small-scale applications of hydroelectric power and the water needed to cool large power stations.

5.4 Strategies for policy

All the assessments say that more intensive policy is needed to achieve the long-term objectives for climate change and air pollution. The assessments outline directions for policy-making. Policies should, in broad terms, have four characteristics: rapid action, international cooperation, a combination of instruments, and a close relationship between policy for sustainable energy supply, climate policy and other policy areas.

Policy intensification recommended

The assessments unanimously conclude that these ambitious objectives can only be achieved if climate policy and energy policy are intensified, in the near future:

- The *IPCC Climate Change 2007* emphasises that the more the annual emissions are decreased in the near future (to 2030), the less drastic long-term policy will need to be in order to achieve the stabilisation target. If the increase in emissions is not halted and reversed by 2025, it will greatly reduce the likelihood of achieving the EU's 2 °C target for maximum global temperature increase.
- At the same time, emission reduction measures, implemented over the next twenty to thirty years, will have a large influence on the options for considerably reducing greenhouse gas emissions. The *OECD Environmental Outlook* emphasises that today's investments will cause choices in energy, buildings and transport infrastructure to be fixed, for a long time to come. In the next few years, a number of rapidly growing developing countries, such as China, will make large investments in their energy infrastructures. Therefore, according to the IPCC and the OECD, the coming ten to twenty years are crucial for faster innovations in the production and the use of energy.

The costs of policy

Affordability is an important consideration in the trade-off's and choices needed to achieve a sustainable energy supply. The assessments concentrate on estimating the costs and benefits of achieving *long-term* objectives for climate change and air pollution. They evaluate the goals, using a comparison between the gross global product and the costs of climate policy as an indicator.

For example, the costs of implementing the Kyoto Protocol – as a small first step towards a stringent global climate policy – are relatively low (for the full use of the Kyoto mechanisms: less than 0.05% of the total gross domestic product of Annex I countries, in 2012). According to the *IPCC Climate Change 2007* and the *OECD Environmental Outlook*, more ambitious climate policy also remains affordable. The costs depend on the stabilisation target for greenhouse gas concentrations, on the baseline scenario (i.e. no additional policy) to which the costs and benefits are compared, on the technologies that are foreseen and on the rate of technological progress. Decreasing global greenhouse gas emissions to such an extent that the EU's 2 °C target will be achieved, is expected to entail macro-economic costs of less than 3% of the gross global product, in 2030 (IPCC, 2007c). The *IPCC Climate Change 2007* notes the uncertainty involved, pointing out that only a limited number of studies have been done, on this issue. For a less ambitious target, the costs are significantly lower.

As an alternative cost indicator, the *IPCC Climate Change 2007* has calculated the carbon price at which, assuming a perfect market, the concentration of greenhouse gases would stabilise. For a stabilisation of approximately 550 ppm carbon dioxide equivalents, the price in 2030 would have to be in the range of US$ 20 to 80 per ton of carbon dioxide equivalent. This price could be realised through market instruments, such as emission trading, which makes measures to reduce emissions more financially attractive and, therefore, more likely to be introduced.

These long-term global average cost estimates are, however, uncertain. Assumptions about the reference levels and the reduction options still vary considerably in the different analyses. Moreover, there may be major differences in costs and benefits between separate regions, countries and sectors. The costs and benefits in the short term may also differ from the average costs and benefits in the long term. Therefore, these estimates have only limited value; for developing concrete policy, they need to be supplemented with more specific cost-benefit analyses.

According to the *OECD Environmental Outlook*, it would also be possible to implement additional global environmental policy, to improve air quality at moderate cost. For example, it would be possible to decrease emissions of nitrogen oxides and sulphur oxides by two thirds, by 2030, and the increase in greenhouse gas emissions could be reduced in the same period. The costs of the policy package, comprising measures on air pollution, as well as on climate change, trade liberalisation and other issues, are estimated at a 1% reduction in gross world product, by 2050. That is, the gross world product would still triple between 2005 and 2050, in real terms, but the increase would be 1% less.

The OECD *Environmental Outlook* and the IPCC *Climate Change 2007* also devote a great deal of attention to evaluating the costs of 'policy inaction'. These are costs that arise from the consequences of climate change, if no additional climate policy is introduced. These costs include:

1. Production losses in agriculture, forestry and in the energy sector, and loss of biodiversity.
2. Costs resulting from effects on human health and ecosystems.
3. Costs caused by the increase in extreme weather conditions, such as flooding and storms.
4. Damage to buildings and materials due to air pollution.

The estimates of the total damage due to climate change in the baseline scenarios (no additional climate policy) are considerable, but vary widely. The *OECD Environmental Outlook* estimates this damage at somewhere between 1% and 10% of global GDP. This estimate is consistent with the estimate in the *IPCC Climate Change 2007*, which suggests costs are likely to be between 1% and 5%, for a temperature increase of 4 °C. The IPCC and OECD point out that little research has been done, as yet, on the costs of the consequences of climate change, and that the estimates above are still very uncertain. Many of these estimates include only part of the costs, and there are also studies which say that the costs are over-estimated. The same is true for the costs of air pollution, which, according to the *OECD Environmental Outlook,* could be as high as several percent of GDP in the US, the EU and China.

International cooperation is essential

All four global assessments point to the need to ensure that more countries and regions are actively involved in global climate policy. The broadest possible international cooperation is necessary, in view of the size of the required emission cuts and because the cheap options are mainly outside the EU. This makes climate policy more effective and cheaper. The total global costs of measures to prevent climate change ('mitigation' costs), for various policy packages, are lower if there is broad participation. The four rapidly growing, large BRIC economies have an exceptional role to play. Without the participation of these countries, international environmental policy can easily become ineffective. Figure 5.5, derived from the *OECD Environmental Outlook*, shows that the BRIC countries are becoming ever more important for the achievement of stringent climate targets, such as the EU's 2 °C goal.

International agreements on distributing the burdens of climate policy are crucial to obtaining broad participation. Sharing these burdens will make it possible for developing countries to participate in climate policy. The phasing-in of their participation and the stringency of the targets are both crucial. The current emissions from the poorest developing countries are close to the levels in some proposals, based on equal emission rights per head of the population. If global emission rights were distributed in this way, these countries could even profit from climate policy by implementing cheap emission reduction measures and selling emission rights to the industrialised countries.

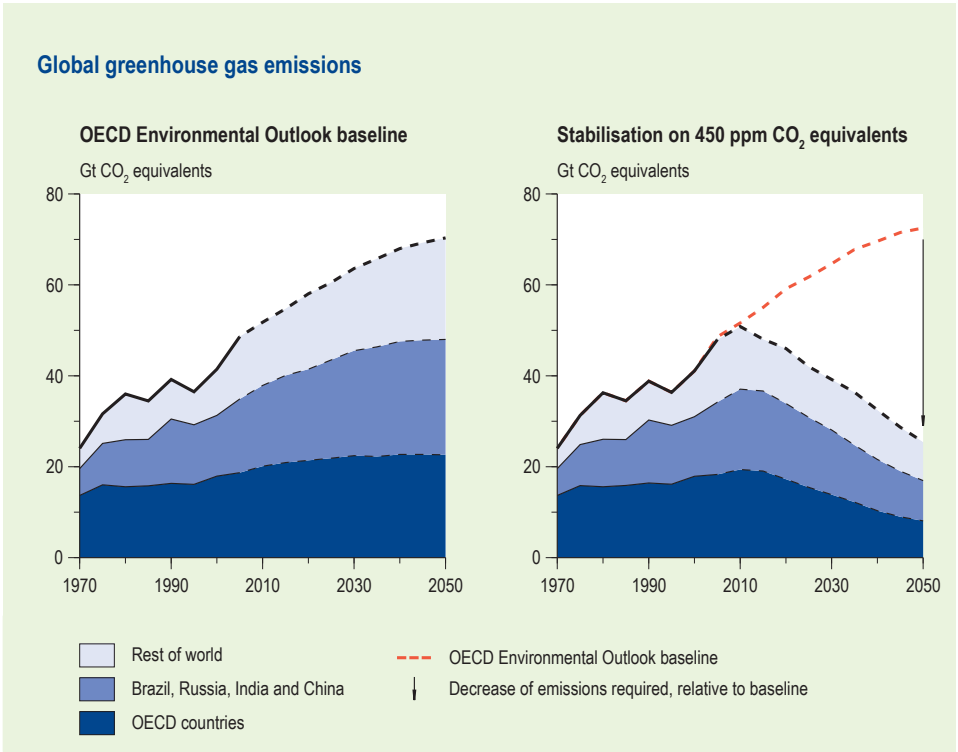

Figure 5.5 Emissions of greenhouse gases in the OECD baseline scenario and under a stringent climate policy. Source: Figure 0.2 in OECD, 2008.

Table 5.3 Overview and evaluation of national policy instruments for climate policy.

Instrument	Criteria			
	Environmental effectiveness	Cost-effectiveness	Sharing benefits and burdens	Institutional feasibility
Regulation and standards	Emission levels are directly influenced; depends on exceptions and maintenance	Depends on design; uniform application often leads to better enforcement	Depends on a 'level playing field'; smaller, as well as new players are sometimes disadvantaged	Depends on the technical capacity of institutions
Charges and fiscal measures	Only if the level of the charge leads to changes in behaviour	Better if broadly applied; higher administrative costs if institutions are weak	Can be improved by recycling income	Often politically unpopular; difficult to introduce where the institutions are underdeveloped
Tradable rights	Depends on the emission ceiling, participation and enforcement	Less where participation is limited, or if applied to limited sectors	Depends on allocation; can cause problems for small participants	Requires well-functioning markets and institutions
Voluntary agreements	Depends on design (objectives, references) and independent control	Depends on the flexibility and size of government stimuli, rewards and penalties	Only participants benefit	Often politically popular; requires relatively limited administration
Subsidies and other financial incentives	Depends on design; more uncertain than regulation	Depends on design; can distort markets	Advantages for participants; sometimes for those who do not need them	Popular among participants; difficult to abolish later
Research and development	Depends on consistent financing; long-term benefits are possible	Depends on the design of the support and the amount of risk	Advantage primarily for participants; probability of bad funding allocation	Requires many different decisions; depends on research and development capacity and long-term financing
Information provision	Depends on acceptance by users; most effective in combination with other measures	Potential for low costs, but this depends on design	Can be less effective for particular groups that have no access to information (such as those on low incomes)	Depends on cooperation with the business community and social actors

Source: IPCC, 2007c

The linkage between climate policy and policy against air pollution could motivate developing countries to participate in climate policy, because the benefits of a policy against air pollution are more local and can be realised in the short term. Moreover, by making this linkage, air pollution can be dealt with in a more preventative and integral way, compared to the current predominant focus on 'end of pipe' measures.

A *combination of* instruments is needed

The global assessments give a lot of consideration to the evaluation and choice of policy instruments for stringent national and international climate policy. All the assessments conclude that a mix of different instruments is needed if low stabilisation levels for the concentrations of greenhouse gases are to be achieved. Table 5.3 provides an overview of the national climate policy instruments that have already been applied. It is derived from the *IPCC Climate Change 2007*.

With regard to international climate policy, most assessments emphasise that it is important to use market mechanisms. Market mechanisms are effective, if international participation is guaranteed. In the quantitative analyses of the effects of market mechanisms, it is assumed that markets function perfectly and that market actors respond immediately to

price signals. This is characteristic of the models which are used for the assessments. However, market imperfections, as well as transaction costs and barriers to the introduction of different policy instruments, should also be included in weighing the pros and cons.

The increasing availability and use of more efficient, sustainable technologies in the energy sector has not been sufficient to compensate for the negative effect of increasing demand for energy, in recent decades. Therefore, if the goals of sustainable development in the energy sector are to be achieved, it is extremely important that technological development and innovation in the energy sector will be accelerated. Governments can take the first step in this direction, by investing in research and development in energy and so stimulating the development of new technologies. In recent decades, investments have hardly increased at all. According to the *IPCC Climate Change 2007*, government support can play a major role in getting new technologies to market. Such support could be offered in the form of financial contributions, tax incentives and product standards. Government support can also be used to transfer existing technology to developing countries.

A strong relationship between sustainable energy supply and other policy areas
The relationship between different policy areas should be strengthened further, in view of not only the great potential synergy, but also the risks of shifting burdens between different policy domains:

- *Agriculture and food security.* The potentially large future contribution of biofuels to energy supply must be coordinated with policy concerning agricultural productivity and food production. See also the 'Intermezzo' (after this Chapter) on biofuels, a topic in which these considerations play a major role.
- *Energy and development*. Ensuring access to modern energy services is also an important way to achieve development goals. See also Chapter 6.
- *Innovation and competitive strength*. More efficient energy consumption, for example in industry, often leads to higher productivity. Thus, new industries and services and new employment opportunities can be created, while jobs may be lost elsewhere The *OECD Environmental Outlook* has concluded that there is no proof that national or regional climate and environmental policy will weaken the competitiveness of a country or region, macro-economically.
- *Mitigation in relation to the energy sector and adaptation policy*. The *IPCC Climate Change 2007* argues that the risks of climate change can be reduced by coordinating measures for reducing greenhouse gas emissions ('mitigation') with measures to help society and the economy adjust to the effects of climate change ('adaptation'). Relevant areas in which mitigation and adaptation measures influence one another are hydro-electric power, biomass, nuclear energy and the demand for energy. Many energy systems are themselves sensitive to the consequences of climate changes. However, the *IPCC Climate Change 2007* emphasises the fact that scientific support for and analyses of this interaction are still incomplete.
- *Export and investment policy*. Big shifts are required in the flows of exports and investments for energy technology, particularly to and within the BRIC countries and developing countries. National governments, as investors and receivers, can facilitate these shifts.

The strong interconnections between climate policy and other areas of policy-making offer many opportunities to strengthen sustainable energy supply policies and give them a broad foundation. Some of these opportunities are already recognised in the Netherlands and in the EU as a whole, and efforts are being made to realise them. This is also discussed further in Chapter 6, in which lessons are drawn from the assessments for Dutch and EU policies towards sustainable development.

Intermezzo: bio-energy and biofuels in the four assessments

At the intersection of the themes of combating poverty and promoting development, food supply, energy supply, climate change and biodiversity, the four assessments give a lot of consideration to the potential and limitations of bio-energy. This 'intermezzo' presents an overview of the insights that the assessments offer on this subject: its short-term and long-term prospects, the types of applications, and the effects on food prices and biodiversity.

In the long run, bio-energy has potential

The *IPCC Climate Change 2007* concludes that bio-energy could, potentially, make a major contribution to reducing greenhouse gas emissions. Interest in bio-energy has clearly grown, because of climate policy. This form of energy can also make a major contribution to energy security, by reducing dependence on imported fossil fuels (see Chapter 5). In the context of stabilising the concentration of greenhouse gases at levels between 600 and 700 ppmv of carbon dioxide equivalents (corresponding to an eventual global temperature increase of 3 to 4 °C), bio-energy could contribute between 0% and 10% to the total demand for energy, in 2050. If a less ambitious target is to be achieved (up to 500 ppmv of carbon dioxide equivalents, corresponding to an eventual global temperature increase of about 3 °C), the contribution of bio-energy could be between 5% and 20%, in 2050. For even less ambitious stabilisation targets (leading to an eventual global temperature increase of 2 to 3 °C), the models differ, considerably. This is mainly due to uncertainties as to whether some options, such as bio-energy combined with carbon capture and storage, will be technologically feasible at a particular time (IPCC, 2007). A clear distinction must be made regarding the applications of biofuels in different sectors. With less ambitious stabilisation targets, biofuels are used chiefly as fuel for transport. However, in the short term bio-energy will be used mainly for electricity generation. If the combination of bio-energy with the capture and underground storage of carbon (BECCS) is assumed to be possible, bio-energy could also be used, in the long term, for electricity generation (IPCC, 2007).

Biofuels expensive in the short term

In the long term, according to the *IPCC Climate Change 2007*, bio-energy used in transport (biofuels) could play an important role in reducing carbon dioxide emissions. According to most baseline scenarios, 3% of the total demand for energy use in transport, in 2030, could come from biofuels (IPCC, 2007). This proportion could be as high as 5% to 10%, depending on oil and carbon prices, efficiency improvements in cars and technical progress in making lignocellulose biofuels (the second generation of biofuels). However, the *IPCC Climate Change 2007* also concludes, that the large-scale use of biofuels can lead to competition for land and negative effects for the environment and food security. The IPCC offers no assessment concerning the strategy for short-term policy.

The *OECD Environmental Outlook* is more explicit in this respect. The OECD advises against setting technology-specific objectives, because countries and regions or sectors – having invested in the technology concerned – might then create obstacles to the development and application of other and perhaps more effective technologies (the so-called 'lock-in' effect). The OECD, therefore, argues in favour of keeping all options in the various sectors open, for the time being (OECD, 2008). The *OECD Environmental Outlook* also concludes, that 'first-generation' biofuels probably yield only a limited climate benefit and that they can entail high costs (the OECD speaks of a 0.45% reduction in global GDP, to replace about 15% of fuels with first-generation biofuels, in 2030). This would have a large effect on grain prices: a 15% increase, worldwide, in 2030. The price effects on sugar and oil-yielding plants are smaller (2.5% to 3.5%). The *OECD Environmental Outlook* concludes that the negative effects (both ecological and economic) will be smaller for second-generation biofuels.

Small-scale applications of bio-energy embraced

The *Agriculture Assessment* examines the side-effects of the use of bio-energy, in detail. A clear distinction is made between the different applications of bio-energy: biofuels for transport, bio-energy for the electricity sector and for warming and cooling houses. It is positive about small-scale applications of bio-energy, particularly for the decentralised ('off-grid') generation of heat and electricity for local communities. The *Agriculture Assessment* is more sceptical about large-scale applications of bio-energy, and, above all, about the use of biofuels for transport activities. It points out that the effect of producing biofuels on food prices will not necessarily be less for second-generation biofuels, because with second-generation biofuels the indirect use of land and water will also affect prices. Therefore, the recommendation in the *Agriculture Assessment* is to do more research in this field. The *Agriculture Assessment* is also sceptical about counteracting the negative social and environmental effects by setting sustainability standards. Negative effects, such as deforestation, the unsustainable use of marginal land and the crowding-out of small farmers, in particular, are seen as difficult to manage by setting standards.

Effects on biodiversity estimated to be negative

All the studies that say something about biodiversity explain that reliance on biofuels, at least in the short term, will have a negative effect on biodiversity. The *UNEP Global Environment Outlook* is particularly explicit about this. It examines the negative effects of bio-energy on biodiversity, in detail, in terms of land use, increased use of fertilisers, and large-scale production. The interactions between food production, the use of bio-energy and biodiversity are described, in detail, in its four scenarios. For example, the 'Sustainability First' scenario shows a significant decline in biodiversity, because land is used for bio-energy to combat climate change. In the 'Markets First' and 'Security First' scenarios, the effect of biofuels on biodiversity is somewhat masked by the large contribution of infrastructure. In view of these insights, it can be concluded that, from the point of view of biodiversity, there are no reasons to argue in favour of using bio-energy.

New insights since the four assessments

During the time the assessments were written interest in bio-energy was growing. The topicality of the issue made it difficult, in many assessments, to devote explicit attention to bio-energy. In all four of the assessments, there are only short passing references to bio-energy in the sectoral chapters (about energy, transport, agriculture and forestry, etc.). The *IPCC Climate Change 2007* and the *UNEP Global Environment Outlook* give only limited consideration to bio-energy. The *OECD Environmental Outlook* takes note of the current discussions, by including a number of inset texts about bio-energy. The *Agriculture Assessment* treats bio-energy most explicitly. Nevertheless, on-going developments in bio-energy mean that all of the assessments are already outdated, in relation to this topic. Mainly due to EU policy initiatives, the focus of discussion is now on the use of biofuels for transport and the extent to which criteria related to sustainable development can be imposed on biofuels. Additional analyses of the indirect effects on land and agriculture (including price effects) are still required. In view of this, it is logical that the IPCC intends to devote a great deal of attention to the topic of bio-energy in its forthcoming special report on renewable energy sources.

6 Lessons for policy towards sustainable development

What overall lessons can be drawn for Dutch and EU sustainability policies? This issue was recently discussed by the Dutch Government in its 'Government wide approach to sustainable development' (2008), and by the EU in the revised 'EU Sustainable Development Strategy' (2006). The previous chapters discussed the outcomes of the assessments, in relation to food and energy. On the basis of all four assessments, this chapter identifies seven points of particular interest to the further development of policies for sustainable development of the Netherlands and the EU. Building on one of the second Dutch sustainability outlooks (*The Netherlands in a sustainable world*, MNP, 2007), these seven points will be further translated into policy options for the Netherlands and the EU. This analysis is based on the four assessments, supplemented by an 'interpretation' by the Netherlands Environmental Assessment Agency of their implications for the policy debate that is currently taking place in the Netherlands and in Europe.

Important points for policy

The four assessments together present their unanimous view on the urgency of the major global challenges for sustainable development and of the transitions that need to be made, for example, in agriculture, land use and energy supply. The assessments conclude, that there are many technical solutions that can be used already, to achieve development and environmental goals, including the Millennium Development Goals and those in the Biodiversity and Climate Conventions. The potential measures that have been identified are also affordable. One factor that hinders attaining the goals for biodiversity is that spatial planning choices with respect to biodiversity have not been made explicit.

Effective policy towards sustainable development requires, in the first place, that the problems relating to development, food and energy and environment – which are noted in the assessments – should be recognised by political actors, policymakers and society. In particular, it must be recognised that these problems urgently require solutions, implying the need for intensified policy if the goals are to be achieved. The challenge for policymakers, according to the assessments, is to fully develop and use promising technology and to find an acceptable way of distributing burdens and benefits.

In attempting to develop international policy, conflicting interests must be taken into account and the fact that there are not only short-term costs, incurred to achieve long-term benefits, but that there are also costs incurred 'here' for benefits 'elsewhere.' The biggest challenges are presented in finding ways to manage global collective goods (the 'global commons') and by the finite amount of land available in the world. This is true at the national and at the EU level, and even more so for measures with potential global impact. The assessments offer few concrete directions for new international policy. While the assessments do define interrelated problems, they say much less about

coherent solutions and concrete policy options for these combined problems. Despite this lack of detail, it is possible to conclude from the assessments that the Netherlands and the EU, as a whole, have much to gain from relying mainly on global cooperation, reinforcing governance structures for sustainable development, making international production and consumption chains more sustainable, and improving policy coherence.

On the basis of the assessments, it would appear that policy in the Netherlands and the EU towards sustainable development should, in any case, consider the following points:

- *Urgency and intensification.* A sense of urgency and intensified implementation of policy are required to tackle the climate issue, problems related to the integrated use of space, and to deal with issues, such as the continuing loss of biodiversity and increasing water shortages.
- *Efficient solutions.* A global coalition will make it possible to use the options that are cheapest, worldwide. This will, in theory, lead to an efficient solution (at the lowest cost). It requires a well-functioning market, in the true sense: one in which currently externalised environmental and developmental factors are incorporated in prices. Note that this still does not address the issue of how best to distribute costs.
- *Realising the promise of technology.* While many technological solutions to current problems may be known, a lot must still be done to apply them, around the world. Knowledge transfer and far-reaching social changes are required if the full potential is to be achieved, in practice.
- *Global cooperation*. Global coalitions are needed to agree on a joint approach to the problems that have been outlined. It is essential to agree on common goals and how best to share burdens and benefits.
- *Improved governance structures*. Governance structures at both the national and the international level need to be strengthened. One question is whether countries are prepared to transfer some powers to international organisations in areas of policy relevant to sustainable development.
- *Making international production and consumption chains more sustainable.* Governments can try to motivate individuals and companies to make production and consumption chains more sustainable, both nationally and internationally. One important issue is how to change consumer behaviour.
- *Policy coherence*. Compartmentalised solutions often take too little account of the effects on adjoining areas of policy. It is crucial to seize possible synergy, to explicitly address the trade-off's between goals, and to include the consequences of policy for areas outside Europe.

Urgency and intensification

The urgency that is clearly evident in the assessments, requires translation into more intensive policy if the stated goals are to be reached. This holds for the Netherlands as well as the EU, with regard to the energy and climate issues, as well as to agriculture, food supply, biodiversity and the associated competition for land. The persistent character of these problems requires consistent long-term policy. This will give markets more certainty, so that the private sector will be prepared to make the required investments. Moreover, such long-term policy must include concrete ambitious goals. This includes those areas of policy in which there are no such goals as yet, such as

energy supply (global access to modern energy services is not yet a formally agreed policy goal), or areas in which only short-term goals have been set (as is the case with biodiversity).

High food prices make it more difficult to achieve goals for reducing hunger. Environmental problems increasingly play a role, for example, because of the consequences of drought or the desire to combat climate change by increasing the use of biofuels. The EU has set itself a more ambitious goal for biodiversity: the 'Convention on Biological Diversity' (CBD) states that the rate of biodiversity loss should be reduced in 2010, whereas the EU target is a complete halt to biodiversity loss in the EU, by 2010. Since the assessments state that this CBD goal will probably not be achieved, neither in Europe nor worldwide, it is necessary to reflect again on objectives after 2010 and the policy measures needed to achieve them. As with climate policies, it seems advisable that in the CBD context a clear long-term target for biodiversity will be set. To prevent further loss of biodiversity, worldwide, priorities will have to be set for policies after 2010: choosing which nature really must be preserved and thus protected? In the other areas of concern, it is open to discussion whether land should be used in a more multi-functional and extensive way, or whether it would be better to develop a more intensive agriculture that would leave more room for nature? For this, the biodiversity value of multifunctional agriculture needs to be clearly defined. To be able to achieve biodiversity goals, it is essential to have clear definitions, so that options can be concretely identified, and implemented.

With regard to climate change, the EU has clear adopted objectives for 2020. These goals are intended to be a milestone towards the long-term ambition of limiting the global temperature increase to 2 °C. In principle, these goals create more long-term clarity and certainty for the investments that will lead to the desired changes. The EU has developed an extensive range of measures to achieve these targets. Moreover, it is clear that global greenhouse gas emissions will have to decrease drastically – also after 2020 – if the 2 °C goal is to be achieved. Investments must be made now and a broad international coalition needs to be formed.

Efficient solutions

A global coalition will make it possible to employ the cheapest options. In this way, the costs of policy for the world, as a whole, can be reduced (efficient solution). Naturally, choosing the most efficient solution to achieve a particular objective is not the only thing that counts. In choosing an objective, the costs of doing nothing must also be taken into account. Although such calculations are surrounded by many uncertainties, the costs of doing nothing extra, in terms of damage due to climate change, loss of biodiversity and damage to human health, appear to be larger than the costs of additional policies and measures. Moreover, one must also consider risks that cannot easily be calculated, such as the small possibility that –in the absence of additional climate policy – global temperatures could increase by more than 6 °C. In an optimal situation, the objectives chosen would keep both the total costs of policy and the damage as low as possible. This proves to be a difficult challenge.

The EU, whose chosen climate objective is the 2 °C target, relies strongly on market mechanisms to make policy as efficient as possible. These instruments are better developed in the field of climate change than in agriculture and biodiversity. Because, to the climate problem, it makes no difference where greenhouse gases are emitted, it is possible to trade emission rights, internationally. Trading emission rights, as a concept, appears to be a step in the right direction, but the system still has to prove its worth, in practice. Thus far, distributing emission rights in the European Emission Trading System (ETS) has been so generous that the emission price has been very low. By making a connection between climate policy and air pollution, the total costs of policy could be further reduced.

A system for biodiversity, comparable to the trading of emission rights, is much more difficult to design. After all, biodiversity protection takes place locally, where the services produced by the particular ecosystem are used locally, too. Therefore, it is not possible to simply 'exchange' biodiversity between areas. However, it may be possible to achieve synergy by applying market instruments in different areas of policy. For example, climate policy has much to gain from preventing deforestation. For synergy between agriculture and biodiversity, payments for ecosystem services could be further developed. For example, one option would be to create funds for financially compensating those countries that directly protect the biodiversity within their territories. Examples of possible compensation are debt-for-nature swaps and development support or payment for ecosystem services, such as clean water and carbon storage. The Clean Development Mechanism in the Climate Convention provides for the latter. Another option is to pass on all costs into economic transactions ('green pricing') to ensure that the consumer pays for sustainable production.

It is not only important to find efficient solutions; agreeing on the distribution of costs ('burden-sharing') is crucial. The efficiency of policy is not affected by how the costs are divided. But a global coalition for climate policy, which is necessary for an efficient solution, can only be established if the pain is shared fairly. In negotiations about policy, this seems to be the biggest stumbling block. The assessments do not give this aspect much attention.

Realising the promise of technology

According to the assessments, over the next two to three decades, there may be no need for big technological breakthroughs to solve the problems they outline, but the further development and large-scale introduction of technologies that are already available, require considerable effort. New technology needs to become cheaper. In agriculture and food processing, it is especially important that technological improvements – tried and tested in certain parts of the world – also will be applied elsewhere. This requires the development of new approaches which are attuned to local, social and cultural circumstances and which draw on local knowledge. Ensuring that farmers have access to regional and national markets is a promising initiative. Increasing productivity is a good way to limit the expansion of agricultural areas and to make better use of the most fertile soils. With enhanced agricultural productivity, food production can be increased while, at the same time, reducing the pressure on land, so that nature can be preserved. However,

the strategies needed to increase productivity are still not sufficiently clear. The debate about the course to be taken, basically, comes down to two options: more large-scale solutions involving intensification versus small-scale solutions.

With respect to the climate issue, various technological options, such as second-generation biofuels and carbon capture and storage, nuclear fusion and efficient solar energy must be tested further, before they can be introduced on a large scale. A broad analysis of these options, from a point of view of sustainable development is important to prevent technologies being adopted which may prove to be less desirable, in the long term. If the stringent climate policy targets that the EU has adopted are to be achieved, a greater contribution from new technologies for reducing greenhouse gas emissions will be needed, after 2020-2030. This requires close monitoring to determine whether current policy is sufficiently encouraging the required technological developments, or whether additional policy is needed.

The rate at which existing modern technologies are transferred to developing countries could be increased. These countries could then introduce the cleanest and most efficient technology in a single step. By giving financial support and covering the risks, governments can encourage EU companies to invest in sustainable technology and to export it to higher-risk markets. Moreover, the successor to the Clean Development Mechanism of the Kyoto Protocol could place a larger premium on technology transfer.

Cooperation on a global scale

To conduct an effective, efficient policy towards sustainable development, the Netherlands and the EU have to rely on global cooperation. International cooperation requires that countries or world regions set common goals and agree on sharing burdens. However, it does not appear realistic to build on the assumption that such cooperation will take place. After all, in practice, conflict, fragmentation and competition between regions are common. In the future, ambitious EU goals will probably be faced with the practical need to agree on compromises. With respect to sharing costs, there is little doubt that high-income countries will have to pay more than the rest of the world. The Netherlands should aim its efforts mainly at the EU. Although the assessments do not consider this explicitly, the EU – as a powerful intermediate body between the Netherlands and global decision-making – can play a major role in establishing international cooperation. The players emerging on the world stage, such as Brazil, Russia, India and China (the BRIC countries) need to be brought on board. If the EU were to play a leading role in policy towards sustainable development, this could conceivably harm its ability to compete, compared to other regions. However, in its assessment, the OECD concludes that modest additional environmental or climate policies will probably have no significant effect on income distribution and competitiveness. The effects of more ambitious environmental policies on the competitive position of the EU have not been analysed.

The EU has policy responsibilities for trade (including agriculture), climate and air pollution and, increasingly, also for international relationships, energy and development cooperation. The EU could link different policy areas as a first step to enlisting other

countries in achieving common goals. Large international coalitions could be built – for example with the BRIC countries in the field of energy, or with countries, such as Brazil and Congo in relation to biodiversity – by linking, for instance, aspects of trade policy and climate change and biodiversity in international agreements. For example, financial instruments could be used to protect globally valuable nature areas. Such an approach would entail industrialised countries being charged for the costs of the demands they place on the global environment, in a way that is comparable to the Clean Development Mechanism in the field of climate change. Cooperation with developing countries on climate change could be combined with urgent measures to control air pollution.

Improved governance structures

The governance structure for sustainable development needs to be strengthened, nationally and internationally. The assessments note an institutional 'gap' that hinders the achievement of national and, particularly, international goals. They emphasise that new, innovative forms of policy and institutional arrangements should be developed, but make few concrete proposals in this direction. The assessments indicate that it is not enough simply to set goals. There must also be sufficient capacity within countries to implement policy, and to monitor and enforce compliance. The right conditions for this can be created by simplifying the large number of environmental treaties, by giving international organisations, such as the UNEP and UNDP, more authority and by creating more coherence between relevant areas of policy and sectors. The previous chapters present some suggestions regarding policy coherence in the areas of food and energy. Countries will increasingly face the question, when dealing with cross-border problems, of whether they are prepared to transfer powers to regional organisations (such as the EU) or to global organisations (such as the UN or WTO), and what could better be left to individual countries (the subsidiarity principle).

Another relevant new development is the involvement of new actors in policy towards sustainable development. For example, both the business community and non-governmental organisations (NGOs) have been active in socially responsible business practices. Public-private initiatives have also emerged in production and consumption chains, such as international stewardship councils for resources and commodities, such as fish, forests, soya bean and palm oil. These developments present opportunities; after all, governments cannot do everything. But they also require national governments to adopt a different stance. The question for national governments is how they intend to relate to these developments. Governments can, for example, introduce criteria, from a perspective of sustainable development, for production and consumption chains, and they can take responsibility for monitoring and enforcing compliance. If the objective is to protect and preserve biodiversity, this will increasingly result in competition for land, requiring integrated spatial planning decisions, in which the different interests are weighed against one another. To maintain biodiversity at the desired level, the issue of biodiversity needs to be integrated into spatial planning policy and addressed with each major decision. By putting a price on ecosystem services, such as clean water and carbon storage, the maintenance of biodiversity can be given a larger value when balancing economic and spatial planning considerations.

Making international production and consumption chains more sustainable

The challenge for governments is to motivate individuals and companies, nationally and internationally. Many of the problems related to global sustainable development and their potential solutions are found in production and consumption chains. Making these chains more sustainable is a way to help share costs and benefits more equitably. Western consumers would then pay more for sustainable products; producers would take social, economic and environmental considerations into account and be paid for doing so. Companies can play an important role in this by making their own business operations environmentally responsible, as well as the whole supply and delivery chain that relates to their activities.

The assessments devote little attention to behavioural change in relation to consumption. Governments can stimulate or regulate changes in such behaviour, using policy instruments that include product standards and sustainable development criteria for production, putting a price on common goods, as well as public information and educational campaigns, designed to build broad public support. In making international production and consumption chains more sustainable, it is especially important to link policies with the international trade rules of the WTO, which provide ways of dealing with non-trade issues and prescribe the removal of trade barriers. A topic, such as the loss of biodiversity, is a matter of public concern. However, there seems to be little support for concrete solutions to this problem, such as to eat less meat. The question is: how can a linkage be made between people's behaviour and its effects on issues, such as land use elsewhere in the world? And also: how much are consumers prepared to pay for sustainable products and how much can they afford?

Policy coherence

To avoid problems resurfacing in the future, or elsewhere, it is advisable to create coherence, not only between policies and fields, but also between different levels of policy. This requires that social and environmental considerations are integrated into more policy areas. It also means that opportunities for synergy should be seized and the trade-off's between different policy areas must be weighed against each other in a realistic way. Greater coherence between policy areas can help bring solutions closer and make implementation easier. At the same time, this clearly makes policy more complex, while the political and economic mechanisms for establishing cooperation in sustainable development are weak and require reinforcement. The EU is seeking to achieve more integration between policy areas. One example is the integrated energy and climate package, which also takes the security of energy supply and the potential for innovation in Europe into account.

Another important area, in which more policy coherence is required, is free trade. According to the assessments, free trade can have both positive and negative effects in the fight against poverty and for the environment. Small farmers and the rural population often do not benefit from it. Additional policy measures are necessary to limit the negative consequences of free trade, while making the most of its advantages. The European Commission's recent proposal to introduce sustainable development criteria for the import of biofuels is another example of an integrated perspective and one which it is hoped

will set a good example for other regions. The EU, through its system of broad 'impact assessments' of the effects of EU-level policy initiatives, is trying to make its policy more coherent. However, thus far, the external dimension – the consequences of Europe's actions for the rest of the world – is not sufficiently taken into account. This aspect could clearly be strengthened. Current bilateral programmes for development cooperation can be combined in an EU policy to prevent fragmentation and – combined with trade policy – to achieve various policy goals, including those in the environmental field.

Possible key points for EU policy

Certain strategies for finding solutions are suggested by the assessments, in which the EU could play a crucial role in international policy. Here are a number of suggestions:

- Establishing global alliances, especially with the BRIC countries and the least developed countries. This can be done by linking important sustainable development themes in negotiations (trade, technology, development cooperation, energy, agriculture, climate and air pollution, and biodiversity), to come to an agreement. Consideration could also be given to how countries can best be won over to global climate goals, such as the 2 °C limit to global warming and new targets for biodiversity.
- Giving more attention to the effects of EU policy on other world regions when developing policy. This can be done by setting criteria from a perspective of sustainable development, by introducing product requirements to make production and consumption chains as a whole more sustainable, and by specifically including the consequences of EU policy for other regions in impact assessments.
- Further strengthening of research and development, in relation to sustainability. Special attention could be given to setting standards to stimulate the transfer and application of sustainable technology. In particular, the transfer of sustainable technology from EU to BRIC countries and developing countries could be fostered.

Possible key points for Dutch policy

On the basis of the assessments, the following suggestions can be made for the Netherlands:

- In developing policy, substantial coherence could be sought with and through EU policy. This means in the first place that the Netherlands could adopt a proactive strategy in the EU, focusing on promoting international cooperation between the EU and other world regions.
- The Netherlands could use its position as a trading nation to make international production and consumption chains, as a whole, more sustainable. The Netherlands could, for example, work through the EU to promote the setting of criteria from a perspective of sustainable development. The Netherlands could also argue for more sustainable EU product standards. Moreover, the Netherlands could stimulate socially and environmentally responsible business operations.
- Internationally, there are very different policy frameworks for land use, while competition for land will increase further. The Netherlands could lobby at the EU, for example as part of the reform of the EU Common Agricultural Policy, to give a higher priority to more integrated considerations to worldwide land use.

7 Epilogue

The likely impacts of the assessments discussed in this report are, as yet, difficult to ascertain. The fact that, under the leadership of a number of large organisations, four major assessments have been published almost at the same time – each with its own target group, focus of attention and approach – is a sign that more attention is being paid to long-term considerations by those who make national and international policies. Thanks in part to the work of the IPCC, global assessments and future scenarios are becoming a normal part of the interface between science and policy. For policymakers and advocacy groups in The Hague and Brussels, the assessments provide a useful foundation for long-term policies. Relevance, legitimacy and credibility are key factors that ensure that the insights, presented in such assessments, are taken into account in developing policy. These factors are largely determined by the process in which the assessments are produced.

Lessons for future assessments

The more or less simultaneous publication of these four assessments might lead to the question: isn't this 'too much of a good thing'? With so many extensive international reports, aren't policymakers being overloaded with information, whereas the assessments were actually intended to offer a synthesis? Moreover, in practice, these assessments place heavy demands on scientists' available time. It is, therefore, important to reflect on a global strategy for making global assessments. The challenge is to answer questions as efficiently as possible, to avoid overlap and to make the specific contributions of new assessments as clear as possible. The relationships between assessments that will be published more or less simultaneously should be considered, to ensure that their target groups and content do not overlap. Each assessment should also be dedicated to a clearly defined task. Where necessary, certain assessments could be combined. National governments and international organisations, such as the UNEP and the World Bank, can play an important role here.

The policymakers who are involved in future assessments could, therefore, ask themselves more explicitly which goals the initiator of an assessment has in mind, so that the specific approach to organising each assessment can be determined. So far, in our view, too little attention has been paid to this aspect. We would like to present some considerations which, in our opinion, should be taken into account when making future assessments:

- The accumulation of expertise in conducting assessments (capacity building) appears to be difficult to combine with the involvement of *individual experts*. This approach is, however, used by the IPCC to improve scientific quality and, following their example, is also used in drawing up the *UNEP Global Environment Outlook*. Clear choices need to be made here.
- The more international policies are developed, the more important it will be for organisations, such as UNEP, UNDP and FAO, to monitor the results of policy and evaluate them. This requires a structure in which national governments are involved.

Another important point, that needs to be addressed in setting up new assessments, is how the assessment is linked to the field of policy which it intends to support. The *Millennium Ecosystem Assessment* (MA) benefited from a relatively informal process and has, therefore, been able to set the agenda for national and international policy-making. In a future round, the MA could perhaps be formally linked to the Convention on Biological Diversity (CBD), just as the IPCC is linked to the Climate Convention (UNFCCC), to ensure greater involvement by policymakers.

Given the need for more integrated analysis of environmental and development issues, future editions of the *UNEP Global Environment Outlook* and the *Human Development Report* might perhaps be prepared by the UNDP and UNEP, working together. Such a sustainability analysis could contribute to the development of more integrated policy in these two fields.

Looking back at the process of producing the assessments, there sometimes seems to be a delicate balance between substantive quality and the degree of participation of interested parties. For many problems there are numerous possible strategies for seeking solutions, each with its own proponents and opponents. So the scientific debate about the various options is an important element in the assessments. Of the four assessments discussed here, the *Agriculture Assessment,* in particular, has involved a range of stakeholders in the writing process. Both the advantages and the disadvantages of this approach are apparent. Over-involvement by stakeholders can lead to the promotion of special interests. The actual purpose of their active involvement – to establish consensus about the knowledge available and its limitations – is then lost. On the other hand, too little participation by stakeholders can lead to a scientific study that lacks relevance for policy.

Future assessments will focus more on policy options and less on the problems themselves. This may also make the process of preparing assessments more political. The ground rules for preparing an assessment and for the involvement of the various actors should be re-examined in the light of this shift of focus. The whole process would benefit from an independent scientific analysis. Political preferences and special interests should not be allowed to unilaterally determine outcomes.

Questions for future assessments

Is there a need to answer new or different policy questions, and thus, perhaps, a need for new assessments? One of the functions of assessments is to propose new questions for research and for policy. Some important new and fundamental topics are:

- Insight into the options for reducing biodiversity loss, the importance of biodiversity for delivering ecosystem services, and the valuation of ecosystems and ecosystem services. Currently, biodiversity and ecosystem services are almost entirely ignored in cost-benefit analyses.
- The costs of doing nothing extra (‘business as usual’) have, so far, been studied in detail for only a few topics and these are still surrounded by many uncertainties. More in-depth analyses for specific areas of policy could make a useful contribution to the policy debate.

- The risks of irreversible changes, extreme events and other surprises have received too little attention in research for these crucial factors to play a major role in the assessments. However, these potential trends and events can have far-reaching implications, incurring huge costs for society.
- What changes can be made in production and consumption and how can such changes be brought about? An important gap in all four assessments is that they mainly examine technological solutions related to production and ignore potential measures and policy options related to consumption.
- How are the desired transitions and trend reversals in society to be achieved? Questions related to governance and the issue of how change can be brought about should be given much more attention in future assessments.
- Finally, future global assessments would benefit from a stronger relationship with regional, national and local analyses, because policy actually takes shape at those levels. This requires an exchange between people with specific local knowledge and those with knowledge on a global scale. One important challenge is to combine qualitative insights from the local and national levels with model-based, global knowledge.

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Four global assessments have painted a concurrent picture of the world's major challenges of environmentally sustainable development

Global targets for development and the environment will not be achieved if current trends are to continue. Analyses in IPCC Climate Change 2007, UNEP Global Environment Outlook 4, OECD Environmental Outlook to 2030 and the IAASTD Agriculture Assessment all show that swift action must be taken by all countries, worldwide, to achieve the internationally set targets.

From the assessments, land use emerges as a new theme for international policy, as the competition for land is growing. The assessments infer that many of the solutions are already known and that possible measures are theoretically affordable. This report analyses two important areas that warrant global attention: 'agriculture, food and biodiversity' and 'energy, climate and air pollution'.

While producing this report, and with the findings of the four assessments in mind, we considered the specific roles that the Netherlands and the EU potentially could take on to constructively add to finding policy arrangements for the global challenges described. What are we good at and which cards do we hold?

As to ourselves, the Netherlands Environmental Assessment Agency has gained substantial experience in producing global environmental outlooks. Hopefully, our contribution to these assessment processes helps to make international discourse on key issues of sustainable development increasingly concrete.

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