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Beyond Climate

Options for broadening climate policy

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Abstract

In this study ways are explored to increase the policy coherence between the climate regime and a selected number of climate relevant policy areas, by adding a non-climate policy track to national and international climate strategies. The report assesses first the potential, synergies and trade-offs of linking the climate regime to relevant other policy areas, including poverty reduction, land-use, security of energy supply, trade and finance and air quality and health. Next the possibilities to mainstream climate in those policy areas are explored. After this the question is answered how a 'non-climate' policy track can be made part of the current adaptation and mitigation efforts within UNFCCC and its national implementation. Lastly, the question is answered how national and international policies can contribute to the implementation of the non-climate policy track. The reports concludes that the non-climate policy track offers a lot of potential to enhance the implementation of climate beneficial development pathways to decrease the vulnerability of societies for climate change and/or result in less greenhouse gas emissions.

Keywords: climate change policy, sustainable development, mainstreaming, adaptation, mitigation

Rapport in het kort

Dit onderzoek verkent wegen om de beleidscoherentie tussen het klimaatbeleid en een aantal klimaat relevante beleidsterreinen te versterken. Dit kan worden gerealiseerd door een niet-klimaat beleidsspoor toe te voegen aan nationale en internationale klimaatbeleidstrategieën. Onderzocht zijn het armoedebestrijdingsbeleid, landgebruik en landbouw, de voorzieningszekerheid van energie, handel en financiering, en luchtkwaliteit en gezondheid. Het rapport analyseert het potentieel en de mogelijkheden voor synergie en uitruil van het verbinden van klimaatbeleid met deze beleidsterreinen. Op deze manier is een overzicht gemaakt van de meest veelbelovende opties om klimaat te integreren. Vervolgens is nagegaan hoe een niet-klimaat beleidsspoor onderdeel gemaakt kan worden van het huidige adaptatie en mitigatiebeleid binnen de UNFCCC en nationaal klimaatbeleid. Tot slot is de vraag beantwoord hoe nationaal en internationaal beleid kan bijdragen aan de implementatie van het niet-klimaat beleidsspoor. Het rapport concludeert dat het niet-klimaat beleidsspoor een aanzienlijk potentieel heeft om de implementatie van klimaatveilige en klimaatvriendelijke ontwikkelingspaden te versterken, met als uiteindelijk doel de kwetsbaarheid van samenlevingen voor klimaatveranderingen te verminderen en minder broeikasgasemissies uit te stoten.

Trefwoorden: klimaatbeleid, duurzame ontwikkeling, beleidsintegratie, adaptatie, mitigatie

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Executive summary

The study described here has succeeded in looking beyond the current climate policy framework for options to enhance policy coherence in dealing with climate change at national and international level. The analysis carried out focused on exploring possibilities for enhancing the effectiveness of the climate regime in two ways: 1) by establishing linkages between these policy areas and climate change policies and 2) by mainstreaming climate change into other policy areas.

Introduction

Though climate change is increasingly recognized as a significant problem in both developing and industrialized countries, it remains remote from the core of national and international policy-making. Many climate-relevant decisions are taken in different policy areas without actually taking climate change into account. This lack of support has resulted in questioning and re-thinking the Climate Convention (UNFCCC) as sole vehicle for developing policies for dealing with climate change, especially as negotiations for an eventual post-2012 agreement are nearing. Looking beyond the UNFCCC context seems attractive for a variety of reasons. Increased policy coherence by integrating climate change concerns into other policy domains could contribute to the effectiveness of the climate regime, may contribute to building trust between parties in the UNFCCC and may open up new possibilities for reaching agreement in the international negotiations through issue linkages. In addition, the broader involvement of countries may be achieved.

It is also increasingly recognized that climate change needs to be an intrinsic part of sustainable development. By linking climate change to core interests and (sustainable) development goals of countries, the effectiveness of climate change policies could be enhanced, while this linking may also help to make climate change policies more acceptable to both industrialized and developing countries. The focus would then be on 'making development more sustainable, that is 'climate friendly' and 'climate change proof' by including climate change concerns in development goals and policies.

The climate and non-climate policy track

Besides the UNFCCC and the national implementation of climate policies, an additional strategy may need to be developed as part of national and international climate policies. This study distinguishes between the 'climate policy track' and what is labelled as a 'non-climate policy track':

- the 'climate track' refers to climate policies that reside under the UNFCCC and its implementation, while
- the 'non-climate policy track' is defined as policies that contribute to realizing climate goals through other policy areas and focus on increased policy coherence and mainstreaming climate change concerns in relevant policy areas.

The study explores the opportunities for the non-climate policy track to integrate climate concerns into these other policy areas, i.e. 'mainstreaming climate change'. These policies can be implemented at local, national and various international levels. The appropriate level of action depends on the specific questions at hand in a policy area. A combination of policy agendas would probably first have to be accepted on the national level before really move forward to the international level.

General conclusions

The analysis of the five policy areas, i.e. poverty, land-use, security of energy supply, trade and finance and air pollution and health, covered shows considerable potential for addressing climate change through actions that can be taken to realize primary policy objectives in other policy areas. Although not included in the report, other policy areas may carry similar potential and be worth investigating e.g. technology development and water. The reason why a 'non-climate policy track' may succeed is that outside climate policy many policies and measures can be taken to realize specific policy goals that happen to be beneficial from a climate adaptation or mitigation perspective or help to prevent the risks of unfavourable developments.

The need for policy integration within the environmental domain and external integration of environment in other societal domains has long been recognized, but progress has been limited. The question here is why the

climate potential in other policy areas has not yet been captured. This has to do with linkages with other policy areas being underdeveloped for environmental policies and, especially, climate change policies. Reasons for this are bureaucratic inertia (compartmentalization, lack of capacity and lack of incentives) and vested interests, but also the complexities that arise when combining policy agendas.

The next question is how the non-climate policy track relates to current adaptation and mitigation policies through UNFCCC and its national implementation? The answers to this question show differences in emphasis. With regard to adaptation policies this report suggests that a non-climate policy track needs to be a crucial component of any national and international strategy to decrease the vulnerability of humans and ecosystems to climate change, particularly in the short term. Climate change needs to be integrated in all relevant national and sector planning processes, given the fact that climate change impacts are inevitable. Especially within developing countries, this is of great importance for development planning and development assistance.
For mitigation policies this report concludes that target setting, timetables and instruments and mechanisms for mitigation need to be established through the climate track if environmental goals and targets are to be guaranteed (e.g. realizing the EU climate target). The non-climate track issues will be essential for implementing an international mitigation strategy. It draws the attention to targeting (alternative) policies and measures that are attractive because they can be taken on the basis of non-climate concerns, but at the same time, also climate friendly.

Implementing the non-climate track as part of national and international strategies could start immediately and relatively independent of the UNFCCC. Progress through a non-climate policy track may help to generate momentum for the UNFCCC negotiations. This could help to build confidence between Parties if action beneficial to climate is taken in other areas without a formal linkage to UNFCCC. To start with, a broader awareness of the importance of climate change and the opportunities climate policies may also offer is needed in other policy areas. Next, political will and a sense of urgency to include climate concerns in these policy areas are required. This is why it is important that the way climate policy could be beneficial to other policy objectives is further substantiated and more broadly understood. Climate policy needs to be regarded as an issue that can be dealt with, while realizing primary policy objectives and maybe even offering opportunities for doing so. Then, if sufficient political will is present, mechanisms for implementation could be installed.

The key requirement for an effective non-climate policy track would be co-ordination between different policy areas to achieve policy coherence. A major issue is how climate change can become part of the core of policy-making at the different policy levels. The report identifies a number of policy options to improve the institutional and organizational inter-linkages between the climate regime and other regimes. These vary from the development of common fora, Memoranda of Understanding, mainstreaming measures, specific measures in other regimes and specific climate change measures. Improved coordination might be realized in the following ways:

- Within the UNFCCC context, e.g. in the design of the convention. This includes measures taken within the UNFCCC aimed at minimizing contradictions and maximizing synergies with other regimes (such as pre-empting investment disputes through a proper design of the CDM, and improved co-operation with the multilateral environmental agreements). Furthermore, reporting obligations, analogous to the 'national communications' under the UNFCCC could be part of the instrumentation.
- Between the climate change policy area and other policy areas, through a legal mandate with Memoranda of Understanding. The conclusion of a Memorandum of Understanding with the GEF, ICAO and IMO and WTO provides a formal legal mandate for co-operation, and may address the political bottlenecks with regard to climate change in these policy areas. Other options would be the streamlining of existing obligations under various treaties and the establishment of common fora for co-operation, such as a possible International Partnership on Sustainable Energy Policy. Institutionalized co-operation may enhance the synergies between the climate change and other policy areas.
- Through other policy regimes by mainstreaming on a voluntary basis. This includes the mainstreaming of climate change concerns in policy areas directly affected by or having a direct effect on climate change, such as FAO and UN Habitat policies and foreign direct investment strategies. Specifically, climate

change adaptation concerns could be mainstreamed into the development policy of the developed countries and the major banks.
- Mainstreaming is also important at the national level. Inter-ministerial task forces could make a significant contribution in this sense (by exchanging information, creating consistency in national policy on climate change, understanding the various aspects of climate policy, etc), although these forces tend to carry less authority or political weight than ministries.

On the international level, several organizations and conventions are already looking into climate change. The IEA, for instance, clearly links security of energy supply to climate change mitigation goals. The Convention on Long-Range Transboundary Air Pollution is looking into up-scaling models on air pollution to cover global problems and is considering CO_2 in its protocols. The United Nations Convention on Combating Desertification and the Convention on Biological Diversity are represented in a Joint Liaison Group with the UNFCCC, to which also the secretariat of the Ramsar Convention is an observer. On the national/ supranational level, the EU is looking into synergies between air and energy policy. In national environmental departments, policy areas are often combined into one work unit.

Analysis of climate relevant policy areas

The study aimed at approaching the climate change problem and solution from the viewpoint of a number of climate-relevant policy areas. Figure ES.1 gives an overview of the interrelated areas covered in this report. The policy areas reviewed extensively in the report are indicated in white. While these areas are not explicitly reviewed, they certainly show a clear link to the other policy areas. Furthermore, they are relevant to climate change (indicated in blue). The question asked here is 'whether', 'if' and 'how' climate regimes and other policy areas can be linked in a productive manner, so that other policy areas will also contribute to realizing climate goals and vice versa.

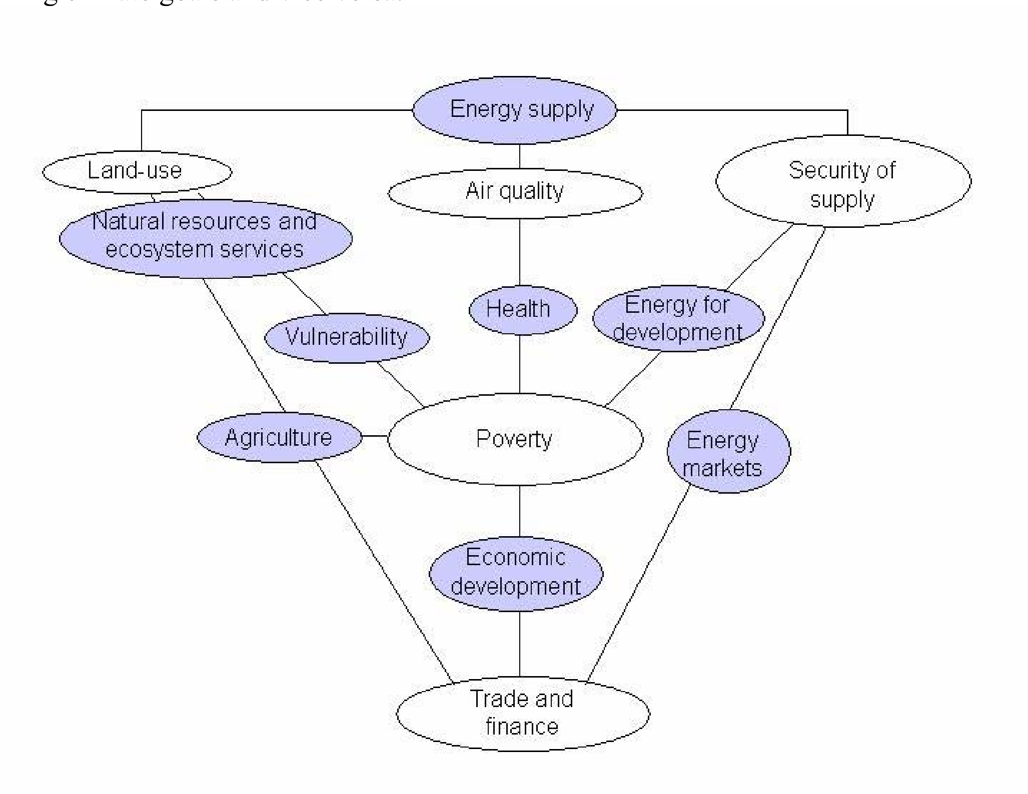

Figure ES 1 Chapter (white) and inte-linked themes (blue) assessed on their synergies, trade-offs and options for policy integration with climate change

A sustainable livelihood framework was used to elaborate the relationships between climate change and poverty reduction. This framework could be used as a basis for the formulation of poverty reduction strategies, and for integrating vulnerability assessments and adaptation measures in these strategies. Synergies may be obtained through proper selection of strategic entry points for adaptation to climate change programmes. Such entry points are provided by the following three closely related areas: (1) reduction of the vulnerability of livelihoods; (2) strengthening local capacity (institutions, skills, and knowledge) and reducing sensitivity (of in particular production systems to climate change), and (3) risk management and early warning. Development planning mechanisms such as those underlying processes in Poverty Reduction Strategies appear to be suitable for mainstreaming adaptation. There is already experience from which 'best practices' could be drawn to help achieve this goal.

The analysis of land use and climate change highlights land-use systems as carriers of essential functions and providers of basic needs to both industrialized and developing countries partly shaped by climate. The resilience of current land use systems can be improved by including climate change and climate variability in current land-use policies. But also when designing new forms of land use or when working on rural development, programs aiming at long-term sustainability incorporating climate change and climate variability can reduce vulnerability and loss on investment. Such strategies would also help reduce poverty through more productive agriculture and sustainable forestry. For vulnerable areas and groups, extra efforts will be necessary to adapt to changes in climatic conditions.

From the perspective of security of energy supply, a growing tension can be noted between the growing energy and fossil fuel needs, on the one hand, and the need to reduce CO_2 emissions and the limited number of countries that control the resources, on the other. Reducing energy dependence (through improving energy efficiency and diversification of energy sources) and ensuring energy supply security (by establishing links with the supplying countries) are national objectives in many countries. This is hard to arrange on a supranational level, although some groups of countries co-operate via organizations such as the International Energy Agency. Climate change mitigation is usually not considered a means to increase the security of energy supply. To meet the energy demand many regions cannot do without fossil fuels, so it will be necessary to at least reduce the negative impacts of their use. Using technologies that do not compromise the interests of the fossil-fuel exporting countries, such as CO_2 capture and storage or hydrogen production could improve international relations while helping to mitigate climate change.

Environmental policies aimed at incorporating the negative environmental external effects of production processes could affect trade flows towards more sustainable production. The analysis of trade and finance indicates that trade policies offer limited opportunities to enhance climate policy. The analysis has identified the areas of subsidy reform in agriculture and energy as being crucial to using the trade and finance regimes to address climate change. A proposal thus arising is to design a 'double-switch' approach that moves towards rewarding farmers/land-owners for services related to nature conservation and land stewardship. Resources released from subsidy removal could be used to compensate OECD farmers and finance a system of green payments i.e. payments that stimulate farmers' participation in nature conservation and land stewardship. A Grand Bargain is proposed for the energy sector. The vision behind this arrangement is that if OECD countries were to remove and ban fossil fuel subsidies, and assist non-OECD countries in their energy subsidy reform through financial and technology transfers, they would require non-Annex-I countries to take certain obligations.

Air pollution causes severe health problems in both developing and industrialized countries, and in both there is much room for improvement of air quality. There is usually more support for measures against air pollution than for climate change mitigation. Taking the greenhouse gas impacts of air quality measures into account is essential for success. There is also potential for synergies in air pollution and climate change policy, especially in the technological measures taken, because the main causes of both air pollution and climate change lie in burning fossil fuels. Policy harmonization was found necessary to capture synergies, but fully integrating the two policy areas was not considered viable because the time scale and location of impacts, and effects of measures will make the formulation of common goals and targets almost impossible. However, structural integration of air and climate policy could be achieved by including ozone and soot in international climate agreements or in non-climate agreements. These substances directly link air and climate problems.

The non-climate policy track as part of the adaptation and mitigation efforts

For adaptation to climate change it is concluded that a non-climate policy track would be a crucial component of any policy effort to decrease the vulnerability of humans and ecosystems to climate change, in particular, in the short term. Climate change needs to be integrated into all relevant national and sector planning processes, the sooner the better, given the fact that climate change impacts are inevitable. Especially within developing countries, this is of great importance for development planning and assistance. Adaptation measures are often highly synergetic with poverty reduction, sustainable land-use and a general reduction of vulnerability to climate extremes. Therefore in terms of conflicting policy interests, mainstreaming of adaptation is unlikely to cause problems, although it has to be recognized that especially developing countries will generally find it difficult to take up new issues in their priorities.

With respect to operationalising the climate and non-climate track, attempts can be made to secure funding of climate change adaptation under the climate regime, and at the same time to improve mainstreaming climate risk management into development plans. Substantial commitment to fund adaptation measures from Annex I countries would be needed if funding adaptation under the Convention were to cover a substantial part of the costs. Mainstreaming climate change into other development processes and risk management is thus also needed. Opportunities for additional funding can also be found outside the Convention. Linking the UNFCCC with other conventions and institutions could be improved, although resources for funding under other conventions are likely to be even more limited. Linking up to risk-management practices in national sectors as well as multilateral donor institutions would appear viable, since the reduction of weather-related natural disasters is gaining attention. Enhanced financing for disaster preparedness from UNFCCC funds and disaster relief funds could be an option for the short term in meeting the most urgent needs. Adaptation measures strongly interact with the policy areas of poverty and land use, for which the priorities need to be incorporated into whatever adaptation policy is agreed.

The conclusion on mitigation policies is that targets and timetables for mitigation need to be established through the climate track, if environmental integrity is to be guaranteed (to realize the EU climate target, for example). The non-climate track issues will be essential for implementing a national and international mitigation strategy. It draws the attention to targeting (alternative) policies and measures that are attractive because they can be taken on the basis of non-climate concerns and are, at the same time, also climate-friendly.

The analysis in this report focuses particularly on so-called bottom-up approaches to defining future climate mitigation commitments and the linkages with other policy areas. Such types of commitments are not based on quantitative emission targets as in the Kyoto Protocol, but on policy measures. It can thus be expected that these will allow more linkages with other policy areas than the top-down approaches based on emission reduction targets. Such bottom-up policies are likely to become more important in post-2012 climate regimes than at present, as the group of countries with mitigation commitments may be extended to developing countries and become more diverse. In examining the strengths and weaknesses of bottom-up instruments for international climate policy making, it is concluded that they do not seem to offer a full alternative to a climate regime defining quantified emission reduction and limitation targets. This is because they provide little certainty about the overall effectiveness of climate policies.
However, they do offer particularly interesting opportunities for additional components of a future climate regime and for defining contributions of developing countries to mitigation and for enhancing the integration of climate policies in other areas of policy making, promoting sustainable development.

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1. Introduction

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1.1 Background: Climate change and sustainable development

It is increasingly recognized that climate change needs to be an intrinsic part of sustainable development. By linking climate change to core interests and development goals of countries, climate policies can contribute to the sustainable development of countries and regions. This linking can also help to make climate policies more acceptable to both industrialized and developing countries. The implication here is that linkages need to be established between development and climate change that focus on *'making development more sustainable'* by including climate change concerns in development goals and policies (Munasinghe et al., 2003).

A major challenge for national and international policy-making, however, will be to ensure that the combination of economic, social and environmental policies provide the conditions for sustainable development. Many climate-relevant decisions are taken in different policy areas without actually taking climate into account. Integrating climate change concerns into other decision-making processes will contribute to making development more sustainable. A relevant example for developing countries are formed by the Millennium Development Goals (MDGs) that aim at halving poverty and hunger by 2015 (United Nations Development Declaration, 2000) The links between climate and poverty alleviation are obvious. Climate change impacts will hit the poorest people in developing countries hardest and could seriously hamper the realization of long-term development goals. For European countries, another example is the Lisbon Strategy of the EU, aimed at making Europe the most dynamic and competitive economy of the world[1]. Efforts to stimulate technological innovation to realize a hydrogen economy, for instance, could clearly form part of the Lisbon strategy.

From a climate perspective, the sustainable development challenge is to realize development pathways that will result in economies with low greenhouse gas emissions and reduce the vulnerability of countries to climate change impacts. Low-emission development pathways and mitigation will limit the occurrence and magnitude of climate change. The need for reduced vulnerability and adaptation, based on the fact that climate change is already occurring or bound to occur, will therefore require measures to respond to climate changes and their impacts. The principal objective of mitigation activities is to reduce the levels of greenhouse gases in the atmosphere so as to avoid a discerning influence of humans on the climate. Additionally, adaptation refers to the adjustments in practices, processes or structures to take changing climate conditions into account, to moderate potential damages, or to benefit from the opportunities associated with climate change (IPCC, 2001).

[1] The Lisbon Strategy is a commitment to bring about economic, social and environmental renewal in the EU. In March 2000, the European Council in Lisbon set out a ten-year strategy to make the EU the world's most dynamic and competitive economy. Under the strategy, a stronger economy will drive job creation alongside social and environmental policies that ensure sustainable development and social inclusion.
Http://europa.eu.int/comm/lisbon-strategy/

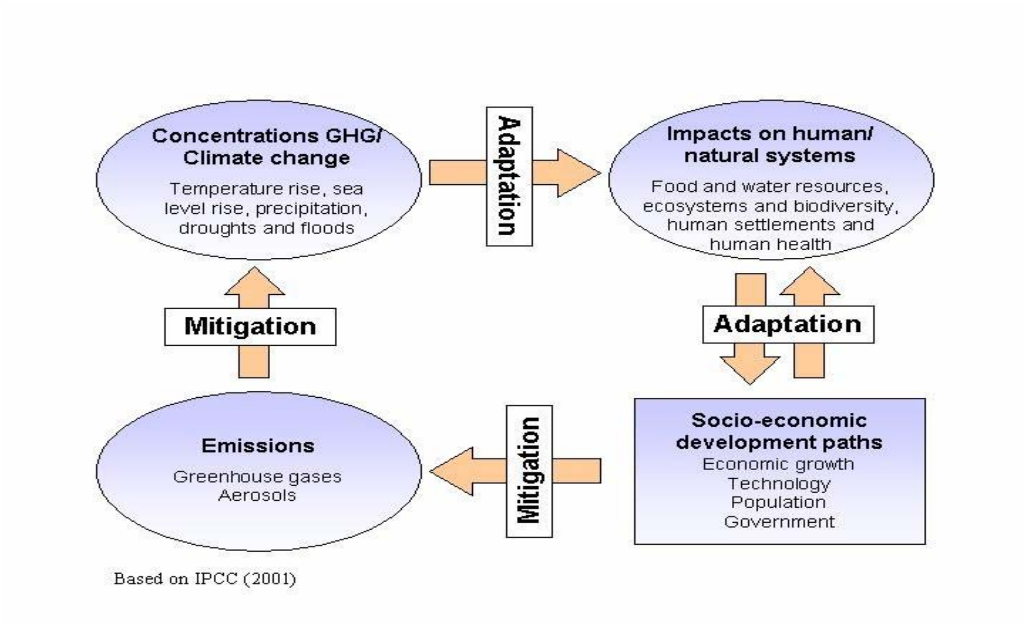

Figure 1.1 An integrated framework for climate change (based on IPCC, 2001)

How do (sustainable) development pathways relate to climate change mitigation and adaptation? Figure 1.1 shows the inter-linkage between socioeconomic development paths (driven by the forces of population, economy, technology and governance), the associated levels of greenhouse gas emissions resulting in the enhanced greenhouse effect, and the impacts on human and natural systems. These impacts will ultimately have effects on socioeconomic development paths and, in this way, complete the cycle. Any development path will affect the natural systems; examples here are land-use changes for agricultural and urban use. Clearly the two domains interact in a dynamic cycle characterized by significant time delays. Both impacts and emissions, for example, are linked in complex ways to underlying socioeconomic and technological development paths. Adaptation reduces the impact of climate stresses on human and natural systems, while mitigation lowers greenhouse gas emissions. Development paths strongly affect the capacity to both adapt to and mitigate climate change in any region. In this way, adaptation and mitigation strategies are dynamically connected with changes in the climate system and the prospects for ecosystem adaptation, food production and long-term economic development (Munasinghe, 2002).

Currently, there is a gap between, on the one hand, the increasing complexity of global problems such as sustainable development and climate and, on the other, the institutional capacity of governments and international organizations to deal with these complexities (UNEP, 2001; Rischard, 2002). Policy guidance and specific mechanisms to integrate environmental (including climate) considerations in developmental policies remain weak and there is a continued reluctance on the part of some international institutions to cooperate with others (UNEP, 2001; WSSD Plan of Implementation, 2002). Improved coherence between different agendas and between all levels of decision-making could strengthen policy-making for sustainable development. Institutional design options under discussion vary between harmonizing existing policies and organizations, the creation of a world environment organization, and going beyond the UN system of countries making agreements by including civil society, industry and other relevant parties.

A critical question, however, is the extent to which agendas should be combined. Can environmental problems be addressed without reference to poverty reduction and increased well-being? For many countries, development problems and environmental problems are so interlinked that they cannot be dealt with separately. To others, solving environmental problems should not be delayed by combining them with too many other issues. The IEA for one acknowledges that '(…) while policy integration is needed at all levels, the climate change negotiations process should not necessarily have to be merged into a broader sustainability agenda. Mitigating climate change requires urgent and specific action. Its solution cannot be made dependent on solving all other present needs' (IEA, 2003). From a theoretical perspective, Gupta (2002) discusses the taxonomy of possible institutional reforms from different theoretical perspectives. She concludes that institutional design is not a question of the best architectural option, but that multiple pathways are necessary to achieve more effective (global) governance for sustainable development.

The study reported here will be looking beyond the climate policy agenda to see how policy coherence can be achieved in national and international polices dealing with climate change. In both developing and industrialized countries, the climate issue is observed as being remote from the core of national and international policy-making. This lack of support has resulted in questioning and rethinking of the UNFCCC as the sole vehicle to develop policies for dealing with climate change. There is also an increasing interest in broadening the scope of a new round of international climate policies and agreements (including informal mechanisms and partnerships) beyond the UNFCCC and its national implementation. Looking beyond the UNFCCC mandate might be attractive, since increased policy coherence and climate change integrated into other policy domains can contribute to the effectiveness of the climate regime, can help to build trust between parties in the UNFCCC, and may open up new possibilities for negotiations through issue linkages.

1.2 Scope and objectives

The overall objective of this study is to create insight into the possibilities for enhancing the effectiveness of the climate regime by relating it to other policy areas. This translates into the questions of 'if' and 'how' climate regimes and other policy areas can be linked in a productive manner, so that other policy areas will also contribute to realizing climate goals and vice versa.

The following climate-relevant policy areas will be discussed:

- poverty alleviation;
- land use, forestry and agriculture;
- security of energy supply;
- international trade;
- finance and subsidies and
- air quality and health.

The selected themes were identified as being important by the Taskforce on the Kyoto Protocol, an interministerial group of policy-makers working on international climate policy in the Netherlands. It is, however, impossible to look at these policy areas in a strictly isolated terms (see white areas in Figure 1.2). The interlinked issues will also be discussed throughout the report (see blue areas in Figure 1.2).

The aim of the study was to identify options that contribute to realizing other public policy objectives at the core of country interests and, at the same time, to moving towards a low emission development pathway or reduced vulnerability for climate change. If 'external integration' (i.e. from the perspective of climate), increased policy coherence and integrating climate concerns is to be taken seriously, this may require a new component in the international climate strategy. Besides the climate track (through the UNFCCC and the national implementation of climate policies), an additional policy-making track will need to be developed that focuses on increased policy coherence and mainstreaming climate change concerns in relevant policy areas. This study explores the opportunities for such a strategy and will further be referred to as the 'non-climate policy track'.

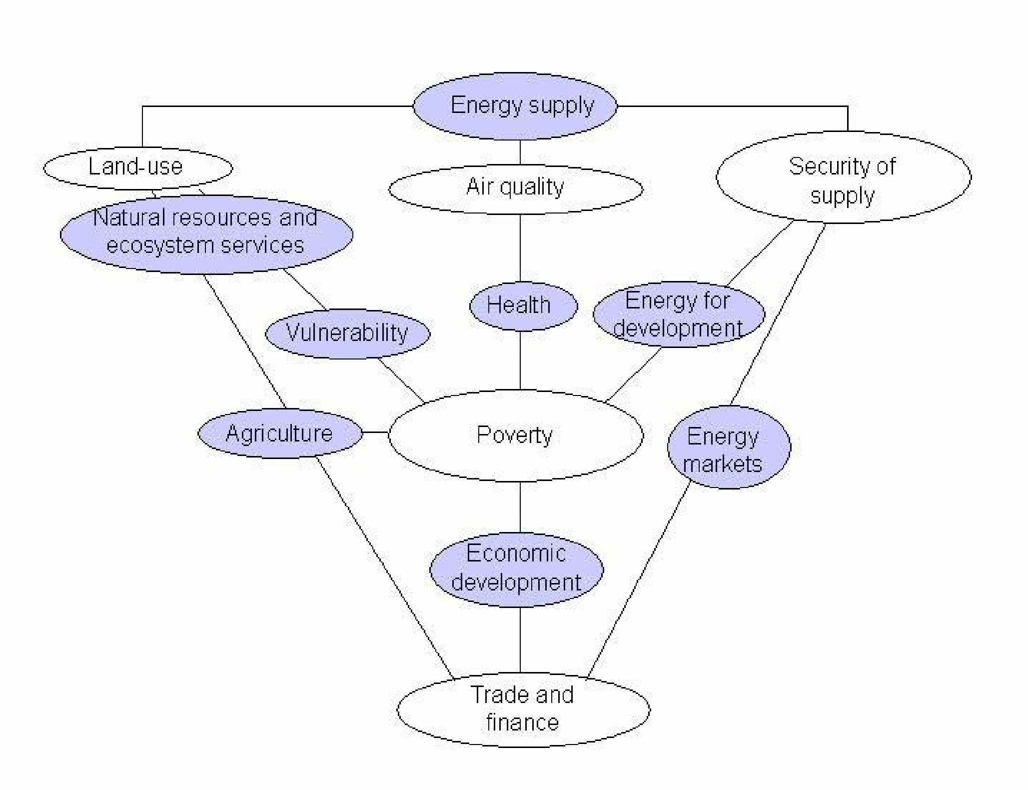

Figure 1.2 Chapter (white) and interlinked themes (blue) assessed on their synergies, trade-offs and options for policy integration with climate change

Specifically the study was set up to:
- Assess the potential, synergies and trade-offs of linking the climate regime with a selection of other climate-relevant policy areas.
- Explore possible policies and measures to mainstream climate concerns in other policy areas.
- Explore implications for the (post-2012) climate regime of strengthening mainstreaming.

Analysis in the study includes both developing countries and industrialized countries, with emphasis differing according to the policy area. Relevant cross-cutting issues to be addressed throughout are technology development and cooperation, financial means and mechanisms necessary, country groupings and implementation issues.

1.3 Research questions, methodology and set-up

The study reported here is an assessment of findings in the literature. Although the focus is on peer-reviewed literature, relevant 'grey' literature was also taken into account.
The research questions, following from the objectives in section 1.2, are cited below:
1. In what way do the respective policy areas *interact with climate change* and what are the technical and/or policy options for exploiting possible synergies and dealing with trade-offs?
2. What are the *most promising options and concrete policy recommendations* for addressing the respective policy problems and, at the same time, encouraging low emission economies (mitigation) and increasing resilience to climate change (adaptation)?
3. How can a non-climate track be taken up in climate change *adaptation and mitigation policies*?
4. How can *(inter)national policies* contribute to mainstreaming climate change in other policy areas?

A common approach is found in Chapters 2-6, which, first of all, describe the problem and the physical relation to climate change in terms of impacts and interaction in the respective policy areas. These are called factual or 'issue' interlinkages. Examples are linkages between inseparable issues, for example, that deforestation negatively affects global warming or, the other way around, that global warming may negatively affect agricultural output in many regions.

After providing this relevant background information for the policy issues covered in Chapters 2-6, we present a broad set of possible policy options that also deals with climate concerns. Each chapter will look at its specific policy areas and interaction with climate change. Subsequently, these chapters will be linked with other chapters by identifying common ground within the themes. Finally, a set of criteria is used to evaluate the options (see Table 1.1. for a summary).

Table 1.1: Criteria[2] for assessing the climate-related policy areas, excluding the contribution to the respective policy areas themselves and the climate-change contribution (mitigation or adaptation)

Criteria	**Policy area per chapter that applied the criterion**
Environmental - Impact on other environmental issues (e.g. waste, biodiversity and air pollution)	Land use (Chapter 3), Security of energy supply (Chapter 4) and Trade and finance (Chapter 5)
Political/institutional - Contribution to other development goals - Compatibility with UNFCCC - Contribution to increased trust between parties - Room for negotiations and reaching a compromise - Acceptability for crucial countries/country blocks - Robustness within different equity principles	Poverty (chapter 2), Trade and finance (Chapter 5) and Air pollution (Chapter 6)
Economic - Cost-effectiveness - Cost certainty as contributing to willingness to pay	Security of energy supply (Chapter 4), Trade and finance (Chapter 5) and Air pollution (Chapter 6)
Technical - Ease of implementation and other barriers - Contribution to transition (of long-term, promising) technology paths technology paths	Security of energy supply (Chapter 4), Trade and finance (Chapter 5) and Air pollution (Chapter 6)

This analysis results, first, in identifying a selection of the most promising options of benefit to the policy areas covered in the study. These options will also contribute to a low-emission economy or reduce the vulnerability to climate change. They will meet other relevant criteria as well: for example, implementation, cost-effectiveness and political acceptability. These options are suggested to warrant further attention because of their role in making other policy areas work in a climate-conducive direction.

Chapters 7 and 8 explore the relation between the non-climate policy track and current adaptation and mitigation policies. Special focus is on including and strengthening adaptation policy in the future climate regime and on bottom-up options for defining and differentiating possible post-Kyoto mitigation commitments and alternative post-2012 climate mitigation policies. Chapter 9 evaluates the policy interlinkages through which these policy areas can be combined. Institutional and organizational linkages, and normative and political linkages are identified. Institutional and organizational interlinkages refer to interlinkages between political institutions, or synergistic or conflicting interlinkages between different organizations. Normative interlinkages are linkages between different standards of expected behaviour of political actors. The political interlinkages represent the strategy of individual countries –or of negotiation facilitators such as conference chairs – to link issues in an attempt to generate a larger bargain. This can be either observed in actual negotiations or as a political proposal. Such interlinkages are not central to this report but represent a modest attempt to identify a few possibilities in this direction.

[2] The definition of evaluation criteria is based on a number of recent studies, notably Torvanger et al. (1999), Berk et al. (2002) and Höhne et al. (2003). Like in Höhne et al. (2003), a general distinction is made between environmental, political, economic and technical criteria. Here a subset of criteria has been selected on the basis of a more elaborated list of criteria in Den Elzen et al. (2003). These criteria are discussed in the literature in the context of a future mitigation regime. This limits their applicability for evaluating policy options for which adaptation and the linkage with other policy areas is also a part. Hence, several modifications have been made.

The set-up of the report is shown in Figure 1.3. In chapter 2-6 the climate relevant policy areas will be discussed in Chapters 2 to 6. These are specifically poverty (Chapter 2), land use (Chapter 3), security of energy supply (Chapter 4), trade and finance (Chapter 5) and air pollution and health (Chapter 6). Adaptation and mitigation are addressed in Chapters 7 and 8, taking into account the relevant outcomes reported in Chapter 2-6. To address the international law and institutional dimensions of linking different policy regimes, Chapter 9 looks into interlinkages between the different policy domains. Chapter 10 rounds off the report with the synthesis and overall conclusions.

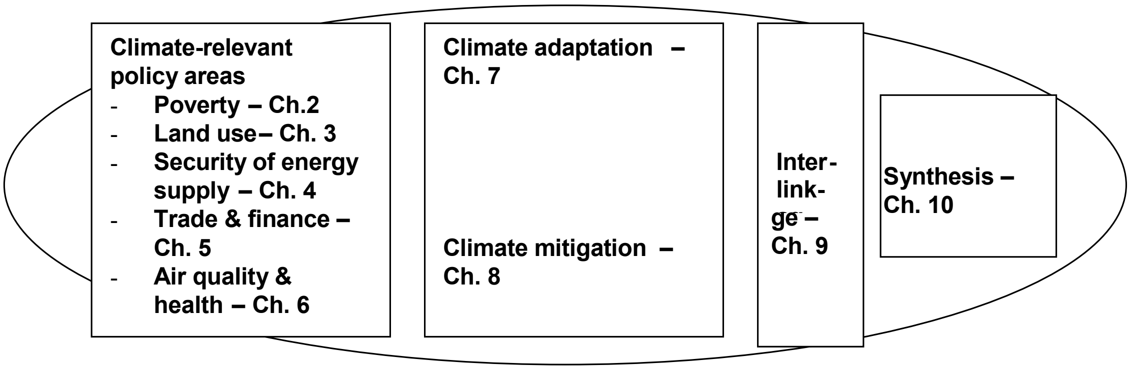

Figure 1.3 Set-up of the report

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2. Poverty and climate change

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Abstract

The main aim of this chapter was to review climate change mitigation-poverty and adaptation-poverty links, and to identify options within the development agenda to deal with poverty reduction and climate change. First of all, certain aspects of poverty with particular reference to the Third World, were examined, e.g. the multifaceted nature of poverty, factors by which it is being affected, and its prevalence, including developments over time. Poverty reduction strategies and the role of foreign aid were then discussed, and the use of instruments such as Poverty Reduction Strategy Papers (PRSPs) considered. Relationships between climate change and poverty described here should be understood in the wider context of the framework defined by the dynamic interactions between human and natural systems, socioeconomic development paths, and climate change. Although mitigation and adaptation are both key concepts to which reference is made, particular attention is given to the impact of climate change on poverty and the need for adaptation in line with the priorities of the Least Developed Countries (LDCs). Evidence presented for the dramatic impact of climate change on poverty, given the vulnerability of the poor and potential poor, calls for drastic adaptation policies and measures. Approaches in response to this impact have been made, in which the role and use of certain instruments and mechanisms in this connection, and the experiences gained, are briefly reviewed. We have used three country cases, Bangladesh, Mali, and the People's Republic of China in our review. The study concluded among other things that a strong need exists for mainstreaming climate change adaptation into poverty reduction programmes and strategies, while furthermore the importance of the Sustainable Livelihood (SL) framework in the formulation of these programmes and strategies, as well as in vulnerability, risk and adaptation assessments was emphasized. It was recommended, more specifically in the context of Dutch/European policy, to consider promotion of the SL framework based IUCN approach - complemented with elements from other approaches - as a promising basis for poverty-reduction oriented adaptation programmes and strategies.

2.1 Introduction

The main aim of this study is to assess the scientific insights into the potential for dealing with climate change concerns by mainstreaming policies and measures within several policy areas. This should take into account both negative consequences as well as possible climate gains with respect to mitigation and adaptation. This chapter will address the above issue with respect to poverty reduction; considering the high priority given by developing countries to poverty eradication, several specific questions will be answered.

In Section 2.2 we will review certain aspects of poverty, its nature, the factors which affect it and its prevalence, including developments over time. The results from this, which refer to the Third World in particular, underscore why, in terms of policy, priority is being given to poverty eradication/reduction and the formulation of programmes and strategies in this regard. 'Section 2.3 reviews poverty reduction strategies, including the role of foreign aid, and instruments such as Poverty Reduction Strategy Papers (PRSPs). An understanding of this will be required in order to assess whether sufficient scope can be found to mainstream climate change concerns.

Section 2.4 deals with the relationships between climate change and poverty, which should be understood in the wider context of the framework constituted by the dynamic interactions between human and natural systems, socioeconomic development paths, and climate change. Although mitigation and adaptation are both key concepts to which reference will be made, particular attention will be given to the impact of climate change on poverty and the need for adaptation, in line with the priorities of the Least Developed Countries (LDCs).

The dramatic impact of climate change on poverty is due to the vulnerability of the poor. This calls for a drastic reduction in the vulnerability of the poor or drastic adaptation policies and measures. In view of the apparently strong relationship between poverty and adaptation, efforts should be made to try to integrate adaptation measures into poverty reduction programmes. However, poverty alleviation efforts all too often fail to consider vulnerability to climate changes and adaptation to the forthcoming climate change.

Section 2.5 reviews proposed poverty alleviation approaches that take climate change into account, the role and use of certain instruments and mechanisms in this connection, and experiences gained. For this, use is made of three country cases, Bangladesh, Mali, and the People's Republic of China. Section 2.6 concludes this chapter with general conclusions and policy recommendations.

2.2 Aspects of poverty

In recent years, national governments, multilateral agencies and bilateral agencies have made the reduction and eradication of poverty the prime focus of their programmes (AusAID, 1997; DFID, 1999; UNDP, 1999; NZAID, 2002). At the same time, it has been recognized that a new approach to poverty reduction will be needed if the Millennium Development Goal of halving the number of people with a income of less than one dollar a day by 2015 is to be achieved. The dimensions of poverty are wide and complex and the realities of poverty vary between regions, countries, communities and individuals (UNDP, 1999).

2.2.1 Nature of Poverty

To understand the deprivations poor people face, it is essential to understand local contexts and how external forces influence these. Distinguishing between rural and urban areas is one useful way of emphasizing differences between local contexts and the forms poverty takes. According to the World Bank (2001c) an understanding of poverty is needed that:

1. recognizes the differences between rural and urban populations;
2. acknowledges that where people live and work, and other aspects of their environments, affects the scale and nature of their deprivation, and
3. recognizes the common urban and rural characteristics that cause or influence poverty, while tempe-ring generalizations because of the diversity of urban and rural locations.

In rural areas, most livelihoods depend on access to land and/or water for raising crops and livestock or to forests and fisheries. Rural poverty has many forms. A 1992 study of rural poverty identified six categories of rural populations at the greatest risk of poverty:

- smallholder farmers;
- the landless;
- nomads/pastoralists;
- ethnic/indigenous groups;
- those reliant on small/artisanal fisheries;
- internally displaced/refugees.

Many poor rural populations fall into more than one category. The causes of poverty differ between categories. In addition, the extent to which rural poverty is affected by crop prices varies considerably, from areas where self-sufficiency is the norm to areas where almost all production is for international markets, and where the extent of poverty is very much influenced by international prices and trade policies (Satterthwaite, 2001).

In recent years, poverty assessments have indicated the world's poor as living in rural areas with a quality of life lagging far behind those living in urban areas (World Bank, 2001c). Despite increasing urbanization and a wide range of poverty reduction programmes, the number of rural poor in most countries continues to grow. More than half of the rural poor and three-quarters of the poor in the LDCs are smallholder farmers. Landless labourers constitute a greater proportion of the rural poor in countries where agriculture is more commercialized and linked to world markets. For instance, landless labourers constitute 31% of the rural poor in Latin America and the Caribbean compared to 11% in Sub-Saharan Africa (Satterthwaite, 2001).

An important aspect of rural poverty is the lack of services such as schools, healthcare, and access to credit. The links between poor health and poverty are strong, because most rural poor lack easy access to health services while facing multiple health risks in their home and work situations. Most rural dwellers lack services because they live too far away from the facilities that provide the services.

Urban poverty is equally complex. According to World Bank estimates based on its 'one-dollar-a-day' income poverty line, there were some 500 million poor urban dwellers in the year 2000. In the urban sector, millions of poor families now reside in 'squatter' settlements. Many urban poor find their livelihood in the informal sector, where the absence of microfinance markets limits access to affordable credit for working capital, housing or other purposes. Poverty in developing countries was largely in rural areas. However, this is changing as societies urbanize and the rural poor move to urban areas in search of greater economic opportunities or because they have lost their land or livelihood.

The scale of urban poverty is often underestimated (Satterthwaite, 2001). Nearly three-quarters of the world's urban population now live in Africa, Asia, and Latin America. In Latin America, most poverty is now urban. In Africa the number of poor people in rural areas is still larger than that in urban areas. On the other hand, the continent's urban population is larger than that of North America. A high proportion of Africa's urban population lives in poverty as well.

Most government statistics on urban poverty are based on poverty lines that are too low with respect to the cost of living in cities (Satterthwaite, 2001). The World Bank estimates for the scale of urban poverty are an underestimate, because in many cities one dollar per person per day does not cover the costs of essential non-food needs. Large cities have particularly high costs for non-food essentials such as public transport, education[3], housing[4], water, sanitation and refuse collection[5], healthcare and medicines (especially where there is no access to a public or NGO [non-governmental organization] provider and private services must be purchased)[6], and childcare (especially when all adults in a household are involved in income-earning activities (Satterthwaite, 2001)). There are concerns that the rapidly growing cities of developing countries, especially those in Africa and Latin America, are causing huge environmental problems and are fostering social and physical insecurity while lacking traditional social support systems (OECD, 2001).

In addition, a multiplicity of laws, rules, and regulations on land use, enterprises, buildings, and products mean that most of the ways in which the urban poor find and build their homes and earn an income have become illegal.[7] There are important links between the extent of deprivation faced by low-income households and the quality of their government. Where infrastructure and services, such as water, sanitation, healthcare, education and public transport, are efficient, the amount of income needed to avoid poverty decreases significantly. Where government is effective, poorer urban groups benefit from the economies of scale that urban concentrations provide for most forms of infrastructure. But where government is ineffective and unrepresentative, the living conditions of poor urban communities may be as bad or even worse than those of the poor in rural areas. Large, highly concentrated urban populations with no access to water or sanitation and a high risk of accidental fires, live in some of the world's most threatening environments (Satterthwaite, 2001).

2.2.2 Incidence of poverty

A per capita consumption of $1 a day represents a minimum standard of living, yet in 1999 less than 1.2 billion people (or 23.2% of the total population of developing countries) lived on less than this, compared to nearly 1.3 billion in 1990 (Table 2.1). In middle-income countries a poverty line of $2 is closer to the practical minimum. In 1999, an estimated 2.8 billion people (or more than half of the world's population) lived on

[3] Even where schools are free, related costs for uniforms, books, transport and exam fees make it expensive for poor households to keep their children in school.

[4] Many tenant households in cities spend more than one-third of their income on rent. Households that rent or are in illegal settlements may also pay high prices for water and other services.

[5] Payments to water vendors often claim 10-20% of a household's income. Tens of millions of urban dwellers have no toilet in their homes, relying on pay-as-you-use toilets or simply relieving themselves in open spaces or plastic bags.

[6] Many low-income households also spend considerable resources on disease prevention, for example, purchasing mosquito coils to protect family members from malaria and other mosquito-borne diseases.

[7] A law may criminalize the only means by which half a city's population earns a living or finds a home. If applied unfairly, regulations can have a major negative impact on the poor in the form of large-scale evictions, harassment of street vendors, exploitative patron-client relationships that limit access to resources, corruption, and the denial of civil and political rights.

less than $2 a day compared to 2.7 billion in 1990.[8] The numbers living on less than $1 and $2 a day will continue to rise in Sub-Saharan Africa, whereas the decrease in poverty will be greatest in East Asia and the Pacific. Yet if present trends persist, by 2015 the poverty rate measured at this higher line of $2 per day will have fallen from its 1990 level by no more than 41%.

In Africa, slow economic growth led to an increase in both the number and proportion of the poor during the 1990s. This was particularly the case for Nigeria (which accounts for nearly one-fourth of Sub-Saharan Africa's poor), where the number of people living in extreme poverty rose steeply following the reversal of the 1985 to 1992 reforms (UNDP, 2003). Africa is now the region with the greatest proportion of people living on less than $1 per day. By sector, urban poverty has grown faster than rural poverty as a result of the massive migration from rural areas to the cities. The incidence of urban poverty now matches that of rural poverty (UNDP, 2003).

Table 2.1 People living on less than $1 and $2 a day, 1990, 1999 and 2015 (projected)

	In millions			Percentage (%)		
Regions	1990	1999	2015[a]	1990	1999	2015[a]
People living on less than $1 a day						
East Asia and Pacific	486	279	80	30.5	15.6	3.9
(excluding China)	110	57	7	24.2	10.6	1.1
Europe and Central Asia	6	24	7	1.4	5.1	1.4
Latin America and the Caribbeans	48	57	47	11.0	11.1	7.5
Middle East and North Africa	5	6	8	2.1	2.2	2.1
South Asia	506	488	264	45.0	36.6	15.7
Africa	241	315	404	47.4	49.0	46.0
Total	1292	1169	809	29.6	23.2	13.3
Excluding China	917	945	735	28.5	25.0	15.7
People living on less than $2 a day						
East Asia and Pacific	1114	897	339	69.7	50.1	16.6
(excluding China)	295	269	120	64.9	50.2	18.4
Europe and Central Asia	31	97	45	6.8	20.3	9.3
Latin America and the Caribbeans	121	132	117	27.6	26.0	18.9
Middle East and North Africa	50	68	62	21.0	23.3	16.0
South Asia	1010	1128	1139	89.8	84.8	68.0
Africa	386	480	618	76.0	74.7	70.4
Total	2712	2802	2320	62.1	55.6	38.1
excluding China	1892	2173	2101	58.7	57.5	44.7

[a] Projected
Source: UNDP (2003), 'Human Development Report 2003'; World Bank (2003), 'World Development Indicators 2003'

In addition to low income (as indicated by people living on a less than $1 and $2 a day), illiteracy, ill health, gender, inequality and environmental degradation are all aspects of being poor (World Bank, 2004). Table 2.1 suggests that the world is generally on track to achieving the first goal of halving the proportion of people living on less than $1 a day. However, it should be realized that the 2015 projection assumes an average annual GDP per capita growth of 3.4% for all developing countries. Furthermore, if China is excluded, this goal will not be achieved anyway. The table also indicates that in East Asia and the Pacific (where many of the world's poor people live), the number of people surviving on less than $1 a day had already almost been halved during the 1990s. Yet, as noted in the Human Development Report (2003), human development is proceeding too slowly, and for many countries the 1990s were a decade of despair (UNDP, 2003). Some 54 countries are poorer now than in the 1990. A greater proportion of people are underfed, more children (especially those under five years old) are dying, and primary school enrolments are shrinking. All things being considered, the Human Development Index declined for more than 20 countries during the 1990s. The latest

[8] Preliminary estimates by the World Bank show that in 2000, there were 2.7 billion living on less than $2 a day.

World Development Report (2004) similarly notes the world is off-track in reaching the other goals for human development, namely primary education, gender equality and child mortality.

The above presentation on poverty incidence is based on an income criterion, with its obvious limitations. It reflects only one of the many dimensions of poverty, which also includes health, access to education, social inclusion, control over resources, dignity, and autonomy, for example.

2.2.3 Determinants of poverty at different levels

As many studies have emphasized (e.g. Ravallion, 1996; Pyatt, 1999; World Bank, 2000; Dasgupta, 2003), determinants of poverty are found at every level, from the individual to the global.

The most basic micro-level can lead to an explicit recognition of individuals, distinct from the households in which they live. Prices are an important unit of analysis at this level. In the literature, low wages and high prices are typical causes of poverty that affect both individuals (as they are assumed to be wage earners) and the households in which they live. Another point of analysis is the level of education. It is argued that households whose members are better educated have a higher standard of living. However, Pyatt (1999) argued that this does not necessarily cause an economy to develop. It could also lead to pervasive unemployment of the educated, due to the balance between education on the one hand and the creation of job opportunities on the other.

Table 2.2 Levels of aggregation for which causation can be identified

Level of aggregation	Substrata/policy areas
International	Trade policy
	International debt
Macro	Monetary policy
	Fiscal policy
	Governance (including roles of government, NGOs and private enterprise)
Meso	Socioeconomic groups
	Communities
	Production sectors
	Product and factor markets
Micro	Households
	Individuals

Source: Pyatt and Graham (1999), 'Poverty versus Poor'.

At the meso-level, factors in which the cause of poverty could be identified include the communities where people live, the productive sectors into which economic activity could be divided, and the markets through which goods and services could be exchanged. At this level, wages and prices are determined by the dynamics of supply and demand on the labour market.

Many of the mechanisms which operate at the meso-level represent a translation to the sectoral and local level of policies and attitudes that are set at the macro-level (Pyatt, 1999). These include political attitudes towards the role of the private sector (non-governmental organizations and business), to law and order, and to good governance, all of which affect poverty through their influence on investment and therefore growth. Otherwise, societies are built at the macroeconomic policy level, where monetary and fiscal policies are argued to affect the economic incentives. However, these policies might damage the chances for societies to eradicate poverty. For instance, in Sub-Saharan Africa many have argued that the intensive stabilization programmes initiated by the International Monetary Fund (IMF) and World Bank in the 1970s and 1980s are the main causes of poverty today (Pyatt, 1999).

Moving up to the international level, it is claimed that poverty can be analysed through trade policy and international debt. International debt (external debt) and the servicing of this debt are argued as being critical for any developing countries trying to finally eradicate poverty. It is also argued that international trade policy affects the poor who are, relatively speaking, smaller players who are considered to be price takers.

Therefore any changes in international trade policies also affect policies and strategies to alleviate poverty in national economies.

2.2.4 Key aspects of poverty: opportunity, empowerment and security

As argued above, a concept of poverty based on an income criterion is incomplete. The concept has to encompass deficiencies in more than just income or consumption terms. Therefore in the World Development Report of 2000/2001, the concept was recast in terms of (lack of) opportunity, security and empowerment.

Opportunities for the poor are largely material opportunities. A lack of opportunity stems from a lack of physical, financial or other assets, and exclusion from access to markets. In this respect, economic growth is considered to be crucial for generating opportunities for the poor; in fact, very few poverty analysts would dispute this need for growth as a necessary component of poverty reduction.

Three main studies have come to provide the basis for this economic growth-poverty reduction nexus. Dollar and Kraay (2002) examined the relationship between economic growth and the reduction of income poverty using data from 92 countries over four decades (DFID, 2002). This study concluded that the average incomes of the poorest fifth of society increase proportionately with the average incomes of the whole of society and that this premise holds across regions, income levels and growth rates. The findings from Ravillion (2000) focussed on inequality and used 117 household surveys from 47 countries (DFID, 2002). The study argued that there is no correlation between growth in average household income per person and the change in inequality. This suggests that the average incomes at different levels in society grow at roughly the same rate. Meanwhile, the incidence and depth of poverty tend to fall with growth in average incomes. In another study, Bardhan (1996) identified three channels through which economic growth benefits the poor:

1. expansion of the poor people's opportunities to engage in productive and remunerative employment;
2. policies that improve the allocative efficiency of resource use by reducing distortions in relative prices, exchange rates and trade policies, and
3. terms of trade movements in favour of agricultural commodities and the removal of restrictions on their trade. This contributes to poverty reduction if the sector consists mainly of small farmers who market their output, and if the wages of landless labourers do not lag behind the prices (DFID, 2002).

Lack of empowerment or the inability to influence or take control of decisions affecting them, impedes people's ability to escape from poverty. In particular, voicelessness and powerlessness are key aspects of poverty, often exacerbated by social barriers due to ethnicity, gender, age or occupation (DFID, 2002).

The lack of security is synonymous with vulnerability and is often defined as defencelessness and exposure to risks or shocks. Examples of these shocks include conflict, bad health, crop failure, market price fluctuations and natural disasters (DFID, 2002). Vulnerability refers to the preparedness for, impact of, and ability to recover from shocks.

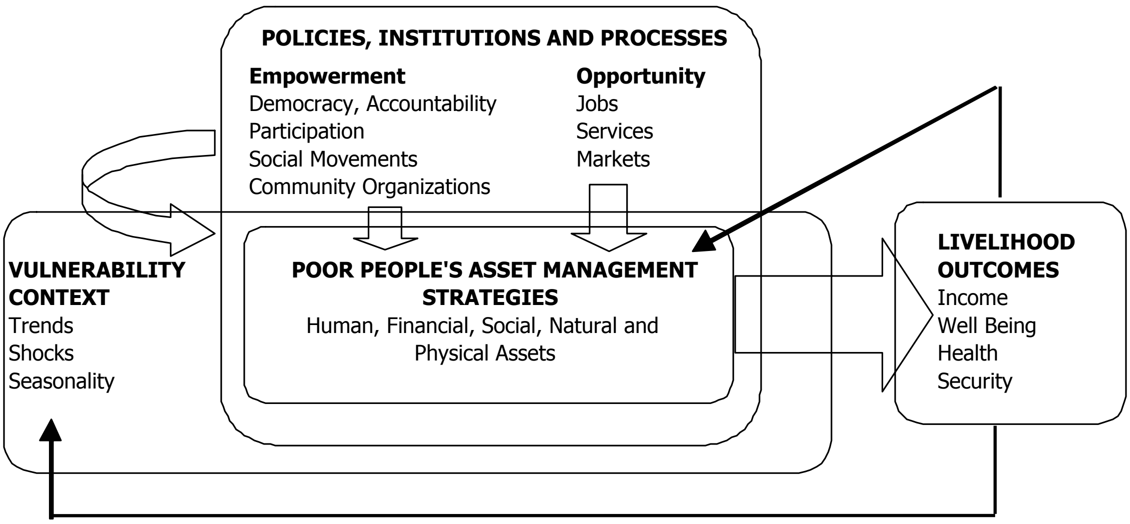
2.2.5 Concepts related to poverty: assets, livelihood strategies and vulnerability

A related set of concepts on which the framework of opportunity, empowerment and security is based stems from the participatory research on an individual's and household's experience of poverty. This set includes assets and vulnerability, livelihood strategies, and coping strategies.

A 'sustainable livelihoods (SL) framework'[9] is being used by some international agencies (such as DFID, CARE International, Oxfam) to put these concepts into practice and to provide a framework for poverty

[9] The SL approach or framework draws heavily on the Institute of Development Studies (IDS) work (Scoones, 1998) although it has been adapted to accommodate DFID's concerns and objectives (Carney, 1998). Other published frameworks are the IDS framework developed by Scoones (1998), CARE (Drinkwater and Rusinow, 1999), Oxfam (Carney, 1998), and Ellis (2000). UNDP has documented the SL approach but has no formal framework (Singh and Gilman, 1999; UNDP, 1999). The SL approach has been in-

analysis and policy formulation. In addition, the SL approach has been adopted by a number of government, non-government and multilateral organizations, such as the World Bank and the United Nations Development Programme (UNDP), as a basis for rural development research and practice.



Source: DFID (2002), 'Predicted Impact of Global Climate Change on Poverty and the Sustainable Achievement of the Millennium Development Goals,' Volume II.

Figure 2.1 The sustainable livelihoods framework

This framework is essentially an 'asset-vulnerability framework' (Norton and Foster, 2001). It can be generally applied in the sense that it caters for different kinds of vulnerabilities, including those related to climate change. Figure 2.1 shows how the SL framework is used for analysis. The framework starts with the premise that the asset status of the poor is fundamental to understanding the options open to them, the strategies they adopt to attain livelihoods, the outcomes they aspire to, the vulnerability context under which they operate (Ellis, 2000) and their coping strategies.

The UK Government's Department for International Development (DFID) distinguishes five categories of assets (or capital): natural, social, human, physical and financial (Carney, 1998). An analysis of assets is a review of what people have (and recognition of what people do not have) rather than an analysis of needs (Helmore, 1998). The asset analysis also considers how access to assets has changed over time, what changes are predicted, what has caused the changes, and how access and control of assets differs between social groups (Carney, 1998).

The concepts of empowerment and opportunities feed into the asset management strategies of the poor. In order to identify areas where restrictions, barriers, or constraints occur, and to explain social process that could impact on livelihood sustainability (Scoones, 1998), it is crucial to understand the structures or organizations, as well as processes such as laws, policies, societal norms and incentives. Institutional structures and processes affect the access to assets as well as their use and control. An understanding of structures and processes provides the link between the micro-level (individual, household and community) and the macro-level (regional, government, powerful private enterprise).

fluenced by a number of diverging themes. The concept of 'sustainable livelihoods' was first widely acknowledged when it appeared in the report of an advisory panel of the World Commission on Environment and Development (WCED) in 1987 and in Food Publication Report in 2000 (WCED, 1987).

In general, people's asset management strategies can be affected by events largely beyond their control. 'The vulnerability context firstly frames the external environment in which people exist' (DFID, 1999). The following may play a role in this connection:

1. trends in population growth;
2. the national and international economic framework;
3. natural resources and environmental degradation;
4. politics;
5. technology;
6. sudden shocks or events such as health problems, earthquakes, floods, droughts, conflict, and
7. agricultural problems such as pests and diseases, economic shocks, and seasonal vulnerability with respect to developments in prices, production levels, employment opportunities or health (DFID, 1999; Chambers and Conway, 1992).

Culture (including gender) and household dynamics can also cause risk and vulnerability (Cahn, 2002). At a secondary level, the vulnerability context is about how people adapt to and cope up with stresses and shocks.

Coping strategies, which refer to how poor people cope with adverse or worsening circumstances, are part of the vulnerability framework. They are argued to be important in reducing vulnerability and improving well-being. However, at times, coping strategies are also argued to follow a sequence, with an increase in damaging consequences and irreversibility[10] that undermine long-term development (DFID, 2002).

People choose livelihood strategies that will best provide them with livelihood outcomes according to the assets they have, the structures and processes that affect these, traditions and the vulnerability context under which they operate.

2.2.6 Key strengths and weaknesses of the SL approach

None of the elements in the SL approach are new. However, what is new is that the elements have been brought together to represent a holistic and realistic view of livelihood systems and to reflect poverty in its broadest sense. The SL approach is people-centred, designed to be participatory and puts emphasis on sustainability. Furthermore, the approach is positive in that it first identifies what people have rather than focussing on what people do not have. The SL approach recognizes various livelihood strategies; this approach can be multilevel, household, community and regional or national; it can also be dynamic. The SL frameworks are useful analytical structures that help practitioners and theorists to understand the reality of the poor and the complexity of rural life (Singh and Gilman, 1999; Farrington et al*.,* 1999). Furthermore, they may be instrumental in the formulation of poverty reduction programmes and strategies, as well as in the mainstreaming of adaptation measures in the latter.

The approach is still being developed and further benefits and disadvantages will emerge over time. However, concerns have been raised over what factors should be included in the conceptual frameworks. Equally important and just as controversial is the way in which the frameworks portray the relationships between the factors. One of the dangers is that because the reality and complexity of a livelihood system are represented in a simple and logical way, the relative importance of some factors and the relationships between the factors are lost. Another major concern is that the SL approach is too complex. Furthermore, some consider 'that the approach is overambitious and offers insufficient practical guidance on the way forward' (Carney, 1998). However, the complexity is in the holistic understanding of complex livelihood systems (Carney, 1998). The SL approach is not a blueprint for rural development, but rather an analytical framework that guides the thinking behind development planning and intervention. The SL approach is designed to work across sectors, which is what some multilateral institutions are attempting to do. However, it is argued that in reality most government institutions and organizations are operated and funded on a sector basis, tending to make cross-sector development difficult.

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[10] DFID (2002) outlined this to include cut down on consumption, drawdown on savings, borrowing from kin/neighbours, borrowing through moneylenders, intensification of labour inputs, selling off consumer assets, temporary migration, selling off producer assets, permanent migration, begging, prostitution and crime and disintegration of the family unit.

2.3 Poverty reduction and foreign aid

In general, doubt, if not outright scepticism, exists about the role of foreign aid[11] in the alleviation of poverty over the past 40 to 50 years.
In a review of the impact of aid on poverty, White (2001) referred to earlier work in this area carried out in the mid-1980s by Cassen et al. (1986), Riddell (1987) and Mosley (1987), and concluded that all found little reason to be positive about the impact of aid in this connection. With reference to recent work by Cox et al. (2000), he points out that three-quarters of the 70 odd poverty projects they examined had only a negligible or moderate impact on the poor. A Danish study (DANIDA, 1996) found more positive results, and stated that most interventions had positively affected livelihoods, though usually for fewer people than had been anticipated. Both recent studies conclude that poverty impact is highest when there is targeting, thus casting doubt on the stance that 'all aid is poverty reducing'. White concludes that when aid is targeted at the poor, it may directly assist them. Yet only a small proportion of aid is used in this way.

According to White, reviews have shown that despite the rhetoric, much operational work pays little attention to poverty. One of the various sources he used to provide evidence on this low priority was a World Bank review of its own poverty reduction strategy in Africa. This review found that poverty reduction is rarely a central or motivating theme in the business plan or country assistance strategy. Even if the operational cycle begins correctly with a poverty assessment, the poverty focus is often lost by the time a lending programme is implemented (World Bank, 1997).

White mentions several possible biases that may explain the lack of poverty focus, which include sector bias (sectoral allocations have generally not favoured the poor, with commercial pressures favouring import, technology and import-intensive projects) and project design bias.

On the more positive side, we refer to a recent study for the World Bank by Goldin et al. (2002), aimed at assessing the role of World Bank-supported development assistance in economic growth and poverty reduction. Using cross-country statistical evidence it concluded that development assistance has generally accelerated growth and poverty reduction, and its poverty-reduction impact has increased over time. Furthermore, the study found that large-scale financial aid can generally be used effectively for poverty reduction, where reasonably good policies are in place, and that the World Bank and other donors have acted on these findings by tailoring support to local needs and circumstances. Thus the balance of support has moved towards providing large-scale aid to those that can use it well, and focussing on knowledge and capacity-building support in other countries. By this criterion, donor financial assistance is targeted far more effectively at poverty reduction than it was a decade ago. As with overseas development assistance (ODA) in general, international development aid (IDA) allocations were too often driven in the past by considerations other than poverty reduction. And even where poverty was the focus, the Bank has often been overly optimistic about the prospects for reform, thereby contributing to the misallocation of aid Goldin et al. (2002).

Yet, despite the improvement in aid effectiveness, donor countries did not respond with an increase in aid flows; instead, aid levels fell. In real terms aid flows dropped substantially over the 1990s, and by 2001 these were 20% below the 1990 level in inflation-adjusted terms. With the growth in incomes in the rich countries

[11] Any money that benefits a developing country – grants, concessional loans, or non-concessional loans - from a governmental or quasi-governmental organization is considered foreign aid. The only exception is the use of credit from the International Monetary Fund, which is excluded unless otherwise noted. In some instances, foreign aid includes all money that would be classified as official development assistance, including military assistance, political development programmes, export promotion, debt forgiveness and non-concessional lending by all bilateral and multilateral organizations.

A measure of foreign aid is official development assistance or ODA. OECD-DAC defines ODA as those flows to countries on Part I of the DAC List of Aid Recipients (developing countries) and to multilateral institutions for flows to Part I aid recipients which are: (1) provided by official agencies, including state and local governments, or by their executing agencies and (2) each transaction of which is (a) administered with the promotion of the economic development and welfare of developing countries as its main objective, and is (b) concessional in character and conveys a grant element of at least 25% (calculated at a discount rate of 10%).

over the 1990s, aid levels expressed as a share of the donors' GNP fell even more sharply, from 0.33% in 1990 to 0.22% in 2000.

Table 2.3 shows the magnitude of ODA in per capita terms and as a percentage of GDP for recipient regions, comparing data for 2001 to those for 1990. Both the per capita and the percentage of GDP trend show the same pattern for all regions and confirm the conclusion above.

Table 2.3 Net receipts of Official Development Assistance by Region (US$)

	Per capita of recipient		Percentage of GDP	
Region	1990	2001	1990	2001
All developing countries	15	10	1.61	0.81
Least developed countries	33	20	12.92	8.45
Arab States	59	18	2.85	1.00
East Asia and the Pacific	5	4	0.77	0.32
Latin America and the Caribbeans	13	12	0.48	0.32
South Asia	6	4	1.18	0.84
Sub-Saharan Africa	34	21	6.13	4.55
World	14	10	1.28	0.77

Source: UNDP, Human Development Report 2003.

2.4 Poverty reduction strategy papers

The more recent interest in poverty reduction is in the context of the Millennium Development Goals (MDGs) and favours the development of poverty reduction strategies (PRS). This idea has been given a boost by the requirement to produce a PRS paper (PRSP) as a prerequisite for accessing debt relief under the Enhanced Highly Indebted Poor Countries (HIPC) facility. The PRSP model, although originally conceived in the context of the HIPC initiative, is now envisaged as the centrepiece for policy dialogue in all countries receiving concessional lending flows from the World Bank and IMF. It comes in two parts: the paper itself, drafted and owned by government, in their own preferred format; and the World Bank/Fund assessment of it, which accompanies the paper when it is presented to the boards of the international financial institutions (IFIs).

The aim is to encourage a locally owned participatory process for formulating and implementing a coherent poverty reduction strategy, financed from government and donor resources. As such, it provides scope for the introduction of an SL approach. A study by Norton and Foster (2001), which addresses questions related to the use of an SL approach in PRSPs, concludes the asset/vulnerability framework of the SL approach to have considerable potential for improving the PRSP process, in terms of the diagnosis, the design of the strategy, and the monitoring framework. It should also be noted that this conclusion is relevant with respect to the potential use of PRSPs (or for that matter, SL-approach-based PRSs, in general) as instruments for mainstreaming adaptation measures.

In line with the SL approach, Satterthwaite (2001) has stressed that poverty reduction programmes should respond to the diversity and complexity of local contexts. Interventions by outside organizations should be influenced by the knowledge and priorities of those who face deprivation. The effective functioning of institutions that protect the poor's civil and political rights and provide access to basic services should be ensured. According to Satterthwaite, one of the implications of this for international agencies is that they should develop greater capacity to support and work with local institutions that can tailor poverty reduction initiatives to local contexts in ways responding and accountable to the poor. This includes working with local governments as well as with local NGOs and organizations formed by the poor themselves. Furthermore, he argues that they should ensure that their own institutional structures and policy responses to poverty, recognize its multiple dimensions, including the distinctions and links between rural and urban poverty.

Over the last few years, there has been a significant accumulation of experience in the preparation and implementation of national poverty reduction strategies across all regions (IMF and World Bank, 2003). The implementation of PRSPs has shown some encouraging results at the national level. Among these positive results, the IMF and World Bank Report (2003) shows that:

1. the majority of PRSPs testify to the increased interest and involvement of parliamentarians in their formulation and a relatively significant role for the legislature is observed in the implementation, which is indicative of the broad government ownership of PRSPs;
2. the role of the participatory process is encouraging, as both trade unions and the private sector have been significantly involved in PRSP formulation.

Unfortunately, the above-mentioned review did not consider the translation of the PRSPs into local priorities.

An IFAD review by Longo (2002) on the PRSP process in Eastern and Southern Africa, concludes, with respect to the analysis of the content of the PRSPs, that:

1. most of the strategies contained in the PRSP are simply the sum of sectoral strategies and few countries have adopted clear and transparent criteria for the prioritization of the activities, and;
2. in relation to rural development, strategies tend to be agricultural rather than based on rural livelihoods, and in most cases a clear vision of an economic development path for the rural sector is lacking (for further details on this see Chapter 3).

As a result, there is no structured strategy leading to actions, which are neither prioritized nor sequenced.

In conclusion, it might be argued that the PRSP process is quite young, and although the results achieved in some countries are quite encouraging, there is still a long way to go in order to promote the basic principles of the whole process. PRSPs have been promoted as tools to set up multipolar dimensions, other than those of national governments and the donor community, to develop and implement poverty reduction strategies. One of the main objectives of the PRSP process is to bring the voice of the poor to the negotiating table and to involve all stakeholders in designing and implementing poverty reduction activities.

It is worth noting that countries may have a strategy for tackling poverty but give it a different name, such as Bolivia's 'National Dialogue'. Other strategy-making processes exist in addition to PRSPs, such as the National Strategy for Sustainable Development (NSSD), which every country should have in place by 2005. NSSDs are being prepared by countries in response to a commitment made by governments in Agenda 21 at the 1992 Rio Conference on Environment and Development held in Rio de Janeiro to adopt national strategies for sustainable development. The Organization for Economic Cooperation and Development (OECD) defines the latter strategy as a coordinated set of participatory and continuously improving processes of analysis, debate, capacity-strengthening, planning and investment, which integrate the economic, social and environmental objectives of society, seeking trade-offs where this is not possible (OECD, 2001). It is supposed to address the following key challenges: extreme poverty, political instability, environmental deterioration, population growth, HIV/AIDS and malaria, and marginalization from the global economy. There is a lot of similarity between the sustainability concerns of the SL approach and NSSDs (Norton and Foster, 2001). In fact, many have argued that PRSPs and NSSDs should be combined into a single, integrated framework for the sustainable eradication of poverty. This would address the economic, social and the ecological dimensions of poverty. Furthermore, where a PRSP has been made or is in progress, there should be no pressure to develop a separate NSSD.

The eradication of poverty continues to be a formidable challenge, irrespective of whether poverty is declining or not. As will be further discussed in Section 2.5.3, poverty reduction will become increasingly urgent and difficult because of the critical trends in the ecological and physical environment. Pronk (2003) lists these critical trends as global biodiversity, the change in the global climate, the increasing scarcity of basic resources such as water and energy, and distortions of the ecosystems. He also argues that these would certainly affect the poorest people as they live in the most vulnerable places. This should pave the way for a more formal and explicit inclusion of environment concerns in PRSPs, as poverty and environment links currently continue to be limited.

2.5 Poverty and climate change

2.5.1 Introduction

As observed in the introductory chapter, mitigation and adaptation are two main ways of responding to climate change. We will now consider both types of responses in relation to poverty. However, in so doing we will not address issues concerning the optimal mitigation-adaptation mix, as like Klein et al. (2003), we doubt whether it is sensible to refer to 'the' optimal mix. They argued that given the special characteristics of the problem - as well as the widely differing interests, values and preferences within and between societies - there is no single optimal mix of mitigation and adaptation. Furthermore, uncertainty about climate changes and socioeconomic changes strongly affects the outcome of any optimization exercise. As soon as new information becomes available, the optimal mix will change.

2.5.2 Climate change mitigation and poverty

Up until now mitigation efforts in the south have been relatively limited. However, climate mitigation benefits could arise from sound development planning. A review (Chandler et al., 2002) aimed at assessing the climate benefits of initiatives undertaken in six countries, including Brazil, China, India and Mexico, found that many of these efforts were motivated by common drivers: economic development and poverty alleviation, energy security, and local environmental protection, but were not undertaken for reasons of climate change. In other words, there are multiple drivers for actions that reduce emissions, and these produce multiple benefits. It was therefore concluded that the most promising policy approaches would be those that capitalized on natural synergies between climate protection and development priorities in order to simultaneously advance both.

The framework of the Clean Development Mechanism (CDM) of the Kyoto Protocol has been established to provide an opportunity to invest in projects in developing countries aimed at mitigating the impact of greenhouse gas (GHG) emissions. The CDM relies on two objectives:

1. to promote sustainable development for the host country, and
2. to provide emission reduction credits for the investor country.

The CDM is important because the ways in which CDM activities are undertaken (as a direct consequence of greenhouse gas abatement) may affect the poor and their vulnerability.

Richards (2003a) considered which kinds of projects have been found to offer the best prospects for 'win-win' positions in this regard, and reported that small-scale rural renewable energy projects appeared to offer the best prospect for poverty benefits in the CDM. Poverty benefits will be highest where rural households are connected with new energy sources, for example, via grid-connected biomass electricity production. The poverty benefits from this type of project may include increased income from enterprise development, access to clean water, improved health services and sanitation, security, education and gender benefits (as women and children spend less time collecting firewood and water). Improved wood stoves and microhydropower generation are other energy options with high poverty benefits. But the study observed the need for 'dedicated purchasing programmes' to ensure that such benefits are obtained.

According to a recent study by the Center for International Forestry Research (Smith and Scherr, 2002), community-level forestry is another high-potential area, even though forestry 'sink' activities in the CDM have been limited to afforestation and reforestation. Community-based restoration of degraded and deforested areas can be achieved trough through multiple-species reforestation and agroforestry (see also Chapter 3). However, such projects will have higher transaction costs and lower biomass productivity compared to industrial plantations, and there are still outstanding uncertainties about forest definitions and 'sink project modalities' (Richards, 2003a, p.8).

A recent study for OECD by Ellis et al. (2004), which reviews progress with the CDM, concludes that some types of project, such as renewable electricity generation, can have clear positive effects on local environmental pollution, economic development and employment, while also reducing GHG emissions. Several different types of project in other sectors can also have significant sustainable development benefits. On the other hand, it is also concluded that there is considerable variation in the sustainable development aspects of different types of project. Some degree of variation, reflecting different host country development and CDM priorities in approving projects is expected. In this respect, small-scale renewable energy and energy efficiency projects appear to account for a shrinking proportion of the CDM project portfolio, whereas projects related to landfills, coal beds, oil and gas production, cement production, and others that offer much cheaper emission reductions (but less obvious non-GHG benefits) are growing rapidly.

Wamukonya and Skutsch (2001) considered gender aspects and argue that in the definition of rules and programmes for CDM, women's participation should be actively sought and that technologies should be targeted towards this very important section of the population. There should be capacity-building programmes associated with this that consider the poor (and therefore also women and their roles in emission reduction and sustainable development) and therefore enable them effectively take part in these programmes.

In conclusion, the above findings suggest on the one hand that different types of CDM projects can be identified which have considerable potential to both mitigate and reduce poverty, but that on the other hand developments are taking place towards types of projects without those kinds of benefits. Expectations about contributions of CDM projects to poverty reduction must therefore be modest, at least for the time being. It should be realized, however, that the CDM has not been primarily designed to contribute to poverty reduction. This would require it to be reformed to focus more specifically on projects that have a strong sustainable development orientation in general, and a poverty reduction orientation in particular. Within the framework of the present CDM, host governments and investors involved in CDM projects can enhance this orientation by applying relevant project selection criteria to that effect.

2.5.3 Climate change impact on poverty: the need for adaptation

Changes in global climate are expected to lead to alterations in temperature and rainfall patterns at global, regional and local levels, resulting in variations in soil composition, sea level rises, increasing frequency of meteorological extreme events, high temperature episodes, floods and droughts. Both natural ecosystems and human society have different degrees of vulnerability to certain phenomena. Their vulnerability is closely related to their capacity to absorb, adapt to and/or mitigate the effects of the unusual events.[12]

Over the last decade, numerous studies have been published which point to the dramatic impacts of climate change on developing countries in general, and on the poor in these countries in particular (given the enhanced vulnerability of the poor to these phenomena). In this connection, Richards (2003a, p. 5) points out that climate change is predicted to deepen poverty both directly and indirectly. The direct impacts include the loss of life, livelihoods, assets, infrastructure, etc., as a result of climatic extreme events. For example, following Hurricane Mitch in 1998, 165,000 people in Honduras fell below the poverty line; the 'poorest' lost 18% of their assets, there was a 29% loss of crops, and 20% of hospitals and education centres were affected (World Bank, 2002). The indirect effect is due to the effect on economic growth; the continuing climate change variation is predicted to alter the sectoral origins of growth, including the ability of the poor to engage in the non-farm sector, as well as increasing inequality, and will therefore reduce the poverty elasticity of growth (ERM, 2002). This could nullify the pro-poor potential of macroeconomic policies, trade and private sector investment.

The Third Assessment Report of the IPCC (2001) defines the poverty impacts of climate change. The report confirmed that the poorest (countries and people) are most at risk[13], and has identified a range of poverty-related climate change impacts, including:

- Reductions in crop yields in most tropical and subtropical regions due to decreased water availability, and new or changed insect pest incidences. In Africa and Latin America many rain-fed crops are near their maximum temperature tolerance, so that even small climate changes are likely to result in a sharp fall in

[12] In the case of natural ecosystems that capacity is lower when the levels of structural fragility of those ecosystems are greater. In the case of societies, that capacity is linked to the existence of certain technology, infrastructure and economic and financial resources to cope with their vulnerability.

[13] Between 1990 and 1998, 94% of 568 major natural disasters, and 97% of all disaster-related deaths took place in developing countries. Another study has found that 35-40% of the worst catastrophes have been climate-change related (ERM, 2002).

yields; falls in agricultural productivity of up to 30% over the 21st century are projected[14], and marine life and the fishing industry will also be severely affected in some places;
- Such changes would have a major impact on food security, employment, incomes, and economic growth; for example, one study has predicted that a temperature rise of 2-3.5°C will result in a 9-25% fall in net farm revenue in India, and reductions in crop yields can be expected to lead to local increases in food prices;
- Huge displacement of people from coastal and densely populated low-lying areas like the Bangla, Mekong and Yangtze Deltas (inundation would also result in salinization of these fertile areas), while islands like Tuvalu, Kiribati, Anguilla and the Maldives could disappear;
- Exposure of millions of people to new health risks, especially from vector-based diseases like malaria and schistosomiasis, as well as water-borne diseases like cholera and dysentery. Malnutrition from the reduction in crop yields would increase the severity of these diseases. Health impacts are also likely to have an effect on growth;l e.g. a correlation between higher malaria incidence and per capita growth has been reported (ERM, 2002);
- Climate change will increase the frequency and severity of extreme climatic events like the El Niño related hurricanes and droughts. Pacific cyclones are predicted to increase by 10-20%. Poorer developing countries are most at risk, since they are more reliant on agriculture, more vulnerable to coastal and water resource changes, and have less financial, technical and institutional capacity for 'adaptation'. Africa is particularly susceptible due to the desertification process, declining run-off from water catchment areas, declining soil fertility, dependence on subsistence agriculture, the prevalence of AIDS and vector-borne diseases, inadequate governance mechanisms, and rapid population growth. South Asia shares many of these problems.

According to IPCC (2001), climate change impacts are now inevitable. Most mitigation scenarios show that even with deep emission cuts, the lead time for this to result in GHG stabilization is at least half a century. Social groups are 'vulnerable' when their livelihood systems are sensitive to modest climate changes, and they lack supportive institutions or social networks. Successful adaptation depends on such factors as local institutional arrangements, the availability of finance, information exchange and technological change. Given the irreversibility of climate change, one realizes that adaptation is almost as important as mitigation. Therefore, for many observers, 'adaptation' is the key poverty issue surrounding climate change. Richards (2003b) argues that some important North-South differences in priorities exist within the adaptation and vulnerability debate. In his view, the North tends to place more emphasis on disaster prevention and preparedness (DPP), e.g. early warning systems and contingency planning for droughts and floods. The South argues that given the irreversibility of climate change impacts, DPP is inadequate for short-term threats, and places more emphasis on disaster relief. The South's view is reinforced by emerging evidence of imminent threats, e.g. 44 glacial lakes in Bhutan and Nepal could burst their banks within five to ten years.

Table 2.4 below has been reproduced from Eriksen and Naess (2003). It systematically lists the main challenges brought by climate change impacts, and in particular, the social and environmental factors that are increasing vulnerability in developing regions of Africa (mainly Sub-Saharan Africa), Latin America and Asia (except Western Asia).

[14] Another recent study of agricultural vulnerability to climate change predicts that the 40 poorest countries may lose 10-20% of their basic grain growing capacity by 2080 due to water scarcity, while yields in temperate areas increase due to warmer temperature and higher carbon dioxide levels. China, the world's largest cereal producer, could experience a 25% rise in production (Fischer et al., 2002).

Table 2.4 Regional challenges in climate change adaptation

	Africa	Latin America	Asia
Social and environmental challenges	• Droughts • Floods and resulting landslides • Increased intensity of precipitation events • Extreme storm events and tidal waves • Reduced runoff and increased water stress • Disruption of water-dependent activities • International water management hampered by rainfall variability • Reduced hydropower production • Destruction of catchments and aquifers • Sea intrusion in deltas and coastal erosion • Arid and semi-arid ecosystems threatened • Possibility of reduced fish landings • Increased incidences of vector-borne diseases and reduced nutritional status • Reduced attractiveness of wildlife-based tourist destinations • HIV/AIDS • Poverty, high infant mortality rates and illiteracy • Weak institutions • Deteriorating terms of trade • Poor infrastructure • Expanding coastal cities	• Floods and resulting landslides • Droughts • Cold outbreaks/frosts • Heat outbreaks • Forest fires • Melting of glaciers • Loss of coastal land and biodiversity • Saltwater intrusion • Decreases in agricultural and livestock production in some areas • Potential user conflicts over water resources • Damages to infrastructure • Increased malnutrition • Increased geographic distribution of vector-borne diseases • Expansion of infectious diseases southwards and to higher elevations • Shantytowns in flood-prone and landslide-prone areas • National debt burden • Income inequalities • Deforestation, leading to reduced runoff and precipitation	• Droughts • Floods • Cyclones and intense rainfall events • Saltwater intrusion, erosion and flooding related to sea level rise • Coastal tourism, cities, infrastructure, fishing and agriculture threatened • Melting of glaciers • Hydropower and urban water supply affected by reduced stream flow and increased peak flow • Reduced area of boreal forests and changed distribution of rainforest and monsoon forest • Elevation shifts of mountain and upland ecosystems • Mangrove and tidal wetlands threatened by sea level rise • Bleaching of coral reefs • Increase in cardio-respiratory illness and mortality triggered by increase in heat-waves • Increased geographic distribution of vector-borne diseases • Increase in waterborne infectious diseases • Urbanisation • Industrialisation and related pollution • Poverty and income inequalities • Population pressure • Intensive land use, in particular in river basins

Source: Eriksen and Naess (2003)

Adaptive options can be divided into two tracks. One relates to the formulation of options addressed at dampening the effects of extreme events, such as hurricanes, major floods and severe drought. In this track, implementing early warning systems for extreme weather events is a possible solution. The other track refers to the options that cater for adaptation to gradual changes, such as coastal protection, and adjusting agricultural and forest management. As the vulnerability of countries decreases when national income increases, achieving economic development in a sustainable manner could also be regarded as an adaptation policy. Invariably, the countries most concerned about adaptation are those with limited resources that are economically, ecologically and socially vulnerable to the negative impact of climate change, and therefore have a low capacity to adapt.

2.6 Adaptation

2.6.1 Adaptation approaches

The previous section made it clear that as a result of present and future climate change, adaptation is inevitable for the most vulnerable groups in society. The debate has now moved on to questions concerning adaptation approaches. However, Burton and van Aalst (2004) stress that such questions cannot be answered generically. Adaptation is largely a location-based activity, and a great deal of it can and should take place spontaneously or autonomously within those sectors and by those people, communities and enterprises most directly at risk. Adaptation also differs greatly from sector to sector in terms of the necessary measures, policies, technologies and costs, so that broad prescriptions are inappropriate. Furthermore, the prioritization of adaptation options takes place in national policy contexts, which differ from case to case.

In general terms much emphasis is being placed on mainstreaming adaptation into strategic thinking on development and development cooperation activities, with particular reference to poverty alleviation (e.g. AfDB *et al*., 2003; Eriksen and Naess, 2003; Richards, 2003; Yaron and White, 2002). Climate change adaptation and poverty reduction agendas are argued having much common ground. Adaptive capacity-building actions (e.g. strengthening local institutional networks) are mainly the same as those needed for poverty reduction. Similarly, sustainable development (SD) policies aimed at improved governance and natural resource management are crucial for climate change adaptation. There is an urgent need to understand the additional vulnerability caused by climate change over other poverty-inducing factors, and then to realign current development policies and practices to account for this (AfDB et al., 2003).

AfDB et al. (2003) identify the following areas of action for all stakeholders, assuming that the main objective is to mainstream and integrate adaptation responses into sustainable development processes and activities:

1. mainstreaming adaptation into sustainable development;
2. continuing and strengthening assessment- and information-gathering;
3. engaging in the United Nations Framework Convention on Climate Change (UNFCCC) process;
4. ensuring synergies with other multilateral environmental agreements, and
5. external funding.

In identifying strategic entry points for adaptation measures and policies, Eriksen and Naess (2003) mention the following three, closely related, areas:

1. reducing the vulnerability of livelihoods;
2. strengthening the local capacity (institutions, skills and knowledge) and reducing sensitivity (of production systems in particular) to climate change, and
3. risk management and early warning.

The authors outline particular entry points that can be targeted for each area (see Table 2.5 below). These specific entry points concern both local and national planning and implementation measures. Synergies also exist between these entry points; for example, the strengthening of links between local institutions and government authorities contributes to an enhancement of both local capacity (and a reduction in sensitivity) and local livelihoods. Although Table 2.5 outlines key entry points, it does not represent a comprehensive list and therefore other areas might exist through which adaptation measures can be usefully implemented**.**

Table 2.5 Entry points for adaptation (examples)

Livelihoods	Local capacity and sensitivity	Risk management and early warning
• economic opportunities for the poorest, including seasonal migration labour • climate considerations in economic and infrastructural development • access to, and viability of, communal resources and biodiversity (including forest products) • processing and marketing of local products • health and education • the role of local knowledge in economic development • women's coping mechanisms, and the 'informal' based mechanisms	• integration between 'traditional' and 'modern' agricultural and pastoral technologies and management systems • linkages between local 'informal' institutions and authorities • diversity of crops, agrobiodiversity • integration of adaptation into government department activities • land use planning and infrastructure planning • seed and input distribution, in particular local seed varieties and inputs • local research on crops, livestock and economic development that are adapted to the local climate	• early warning systems • local disaster response strategies (national and local institutions) • natural resource management based protection (mangroves, water catchments) • the space of local climate information as well as meteorological and climatological capacities of national institutions • national adaptation plans and vulnerability assessments • coastal defenses, urban drainage and water supply, hydroelectricity, flood defences

Source: Eriksen and Naess (2003), Table 3, p.16

Focussing on World Bank operations, Burton and Van Aalst (2004) propose a Risk Management Approach in relation to adaptation. The approach includes compiling serious but selective assessments of the risks related to climate change. The application of the approach is based on the use of a set of tools that help to identify opportunities for climate risk reduction. Given that climate risks are so sector-specific and country-specific (or even location-specific), the identification and management of climate risks must form an integral part of a country's strategic planning and project development.

One of the tools that could be used in this context is a web-based Climate Risk Management Knowledge Base. Elements of this tool would include:
1. a database of climate risk information;
2. risk management methodologies, guidelines and checklists, and
3. good practice examples of risk assessments in operational contexts, and risk management elements being incorporated into projects, country assistance strategies and PRSPs.

Although it is being proposed within the context of World Bank activities, this approach clearly has a wider applicability.

IUCN et al. (2003) propose combining disaster risk reduction, natural resource management and climate change adaptation in an approach aimed at reducing vulnerability and poverty. The approach is strongly *bas*ed on livelihood, whilst considering adaptation as a process which is itself adaptive and flexible enough to address locally-specific and changing circumstances. Poverty reduction is the main goal of this process, as the capabilities and assets that comprise people's livelihoods often shape poverty as well as the ability to escape it. The main components of this framework will be presented below.

1. Understanding vulnerability: livelihood interactions
Identification of the main climate-induced vulnerabilities that affect poor communities; assessment of the adaptation measures that poor people already take; identification of barriers to action and enabling factors in the implementation of new policy measures; determination of the needs, priorities and capabilities of different stakeholder groups through participatory processes.

2. Establishing the legal, policy and institutional framework
Diagnosis of existing laws, policies and regulatory systems in relation to their effects on climate-induced vulnerabilities; definition of the institutional processes through which adaptation measures are implemented.

3. Developing a climate change adaptation strategy
Identification of potential reform measures and investment options to enhance the resilience and reduce the vulnerability of poor people to climate variability and change, and to enhance their access to ecosystem services.

In a study on climate change, in which it is recognized that the poor will be hit the hardest, Red Cross Netherlands (2003), identifies seven steps towards risk reduction. While some of these steps relate specifically to National Red Cross Societies, they lend themselves to generalization. The steps are:
1. carrying out of preliminary climate risk assessments;
2. assessment of priorities and follow-up planning;
3. raising of awareness about climate change and its possible impacts on vulnerable people. If climate change is identified as a priority, the next step would be to integrate climate change into ongoing education activities with local communities;
4. establishing and enhancing partnerships between experts involved in the preliminary climate risk assessments;
5. highlighting climate-related vulnerability with other players ;
6. documentation and sharing of experiences and information, and
7. the shaping of a global response to climate change through advocacy.

Table 2.6 explains how the aforementioned approaches relate to each other, and lists their similarities and differences. This table aims to clarify the components of the SL framework on which the various appro-aches are primarily focussed.

Table 2.6 Five adaptation approaches

SL FRAMEWORK COMPONENTS

VULNERABILITY CONTEXT	**POLICIES, INSTITUTIONS AND PROCESSES**	**ASSET MANAGEMENT STRATEGIES**
AfDB (2003) -continue and strengthen vulnerability assessment (current and future climate vulnerability); project assessment should include vulnerability of community, ecosystems, and socioeconomic sectors, and effects of the project. **E&N (2003)** -early warning systems; local disaster response strategies; natural resource management-based protection; local climate info; national adaptation plans and V&As, coastal defences. **B&A (2004)** -risk management approach - serious but selective assessment of risks; 'climate risk management knowledge base' which will form part of broader Vulnerability. and Capacity Assessment (VCA). **IUCN (2003)** -identification of the main climate-induced vulnerabilities that affect poor communities in different places. **Red (2003)** -preliminary climate risk assessment; highlight climate-change vulnerability with other players; assess priorities and plan follow-up; and raise awareness about results of risk assessments.	**AfDB (2003)** -mainstreaming adaptation into Sustainable Dev; strengthening information gathering; UNFCCC process; ensuring synergies with multilateral environm. agreements; external funding. **E&N (2003)** -integration of traditional and modern agricultural and pastoral technologies; links between local informal institutions and authorities; diversity of crops and agro-biodiversity; integration adaptation into government department activities; land use and infrastructure planning; seeds and input distribution; local research on crops. **IUCN (2003)** -combines disaster risk reduction and natural resource management by means of establishing legal, policy and institutional framework; establishment of climate change adaptation strategy. **Red (2003)** -establishing and enhancing partnerships; documentation and sharing of experiences and information; advocacy.	**E&N (2003)** -economic opportunities for poor, climate considerations in economic and infrastr. development; communal resources and biodiversity; processing and marketing of local products; health and education, role of local knowledge; women and 'ínformal-based' mechanisms. **IUCN (2003)** - relate climate-induced vulnerabilities affecting poor communities to the dynamics of their livelihoods and their asset base, with particular attention to environmental resources

Notes:
AfDB (2003) = AfDB et al. (2003) B&A (2004) = Burton and van Aalst (2004) E&N (2003) = Eriksen and Naess (2003)
IUCN (2003)=IUCN et al. (2003) Red (2003)= Red Cross Netherlands (2003)

From the table it can, first of all, be concluded that all approaches focus on one or more components of the SL framework. Moreover, they all contain the vulnerability component. Two approaches focus more explicitly on aspects of all three components, i.e. IUCN and E&N. The IUCN approach is comprehensive, and strongly based on livelihood. Therefore it might be considered one of the more promising options from a SL perspective. Yet the other approaches have been conceived within the same spirit and therefore partly overlap with and partly complement elements of the IUCN approach. Where elements overlap, their integration is worth considering.

For example, with respect to the vulnerability context, B&A (2004) and IUCN (2003) share the strategy of identifying or selecting risks that affect the poor through risk assessment. In the B&A (2004) approach, a climate risk management knowledge base forms part of a broader vulnerability and capacity assessment (VCA). Red (2003) suggests that after risk assessments, risk awareness-raising activities will be required. How society could manage these risk assessments can be seen in E&N (2003) which suggests early warning systems as well as local disaster-response strategies. In a similar vein, overlaps and complementarities between approaches exist for the other components, as can be seen in Table 2.6.

In conclusion, the IUCN approach – complemented with elements from other approaches - appears to be promising as a basis for poverty-reduction oriented adaptation approaches.

2.6.2 Mainstreaming aspects

In the discussion on mainstreaming climate change adaptation certain issues keep cropping up, often in conjunction with each other. These include the:
1. need for adequate vulnerability and adaptation assessments;
2. role of PRSPs and similar mechanisms in mainstreaming, and
3. participation of all stakeholders.

We will address some aspects related to these issues with the help of relevant case study material from Bangladesh, China and Mali. Although there are considerable differences between these countries, they were selected for having a number of climate change-related factors in common. These include:
1. their geography and agro-ecological features, with episodes of bad weather or extreme weather events, which make their vulnerability to livelihood shortages more pronounced;
2. a common and immediate impact of these features on the incomes of the people, which affects poverty incidence;
3. relatively pronounced vulnerability and adaptation assessments across these countries, and
4. common policies and efforts of stakeholders across these countries geared towards integrating climate change initiatives into national poverty reduction strategies.

Vulnerability and adaptation assessments

Vulnerability and Adaptation assessments (V&As) are methods for evaluating the potential impacts of climate changes and the possible adaptation strategies to cope with these. They are intended to be a proactive, rather than a reactive tool for facilitating strategic thinking around sustainability issues. The SL approach is argued to be useful for V&A assessment to the extent that climate changes can restrict or expand livelihood opportunities. In the same way, people will adapt their livelihood strategies in response to changing opportunities (Eriksen and Naess, 2003). Mention may also be made of the following tools and instruments.

The general IPCC Guidelines. (Carter *et al*., 1994) This framework, aimed at conducting V&A assessments, has demonstrated its utility. However, as it is primarily structured for determining impacts, it has its limitations. Firstly, it does not determine the vulnerability of a sector or a system. Secondly, the framework does not show any steps to involve stakeholders in the impact assessment processes.

The Adaptation Policy Framework (APF) was set up by the UNDP National Communications Support Unit. It is directed towards national climate study teams and policymakers, with its main objective to facilitate the incorporation of adaptation into a country's national development strategy. The APF outlines a stakeholder participatory process aimed at such incorporation. It emphasizes present climatic variability and extremes, and future climate change.[15] Its five steps include the scope of the project, assessment of current vulnerability, characterization of future conditions, prioritization of policies and measures, and preparation for adaptation.[16] For further details, see Chapter 7, Section 7.2.1.

Assessments of Impacts and Adaptations to Climate Change (AIACC) is a Global Environment Facility (GEF) funded initiative implemented by the United Nations Environment Programme and executed by the Global Change System for Analysis, Research and Training (START) and the World Academy of Sciences (TWAS). AIACC aims to enhance the scientific capacity of developing countries to assess climate change vulnerabilities and adaptations, and to generate and communicate useful information for adaptation planning and action.

During the last 5-10 years there has been an increase in the use of Strategic Environmental Assessment (SEAs) to address the weaknesses of the traditional environmental impact assessments. These weaknesses

[15] UNDP (2001) refers to this framework as the 'second generation' V and A framework, as it is more focused on policy than climate science. This is in contrast to the so-called 'first generation' V and A, which is focused on climate science.

[16] The framework is also argued to have its limitations. Firstly, the framework is characterized by a one-way feedback mechanism, as it takes inputs from stakeholders only. Secondly, the framework is not transparent with respect to the process involved in the identification of stakeholders. Thirdly, the data needed to carry out the assessment is limited. And fourthly, the maintenance of a standard assessment across developing countries is argued to be subject to uncertainties.

include its late application in the planning process, it being applied to just individual projects, and it often being detached from broader societal context (Dalfelt and Naess, 1997). SEAs on the other hand are intended to be a proactive rather than reactive instrument and to be applied early in the planning stage. As such they are a potentially powerful tool for facilitating strategic thinking around sustainability issues. In particular, SEAs could be an appropriate tool for assessing how sectoral policies, plans and programmes affect the vulnerability of beneficiaries, and particularly how these affects the ability of the poor to cope with climate variability and change (Eriksen and Naess, 2003).

A number of regions and countries, such as the Caribbean and Pacific Islands, and some African countries, have already completed the early stages of adaptation assessments. However, these assessments continue to be limited to just a few sectors, while there is a need to diversify assessments to a variety of different sectors. These could be chosen to provide a mixture of geographical areas as well as sectors (e.g. coastal zone management, disaster mitigation, water resource management, agriculture, etc) to provide lessons on what works best.

Apart from diversifying assessments into different sectors, Leary (2003) stresses the importance of looking at multiple scales such as different subunits within a region or community and cross-scale interactions.[17] Focussing on single scale may lead to misdiagnosed capacities, vulnerabilities and thresholds, and the prescription of ineffective adaptation actions. In addition, he emphasizes the importance of looking at multiple future scenarios, from both a socioeconomic and a climate viewpoint.

Mirza (2003) has suggested that lending agencies/donors could introduce mandatory V&A assessment/studies for relevant development projects in developing countries. This would be a significant step forward from the present arrangement of environmental impact analysis, which has not been practised since the 1980s.

According to AfDB et al. (2003), international support is important for creating an enabling environment in developing countries to carry out vulnerability assessments that are relevant to their needs and priorities. This could include strengthening the infrastructure for data collection and dissemination, and strengthening the capacity building for scientific and socioeconomic assessments, and the related policy analyses.

Vulnerability assessments and their integration into development policy and implementation is an evolving process. The incorporation of vulnerability assessments requires a strengthening of the human and institutional capacity in national and international development agencies, as well as appropriate civil society organizations to support the information and decision-making needs of individuals, and the realignment of institutional practices where appropriate. In recognition of the importance of increased knowledge sharing, some development agencies in their efforts to enhance this have created an open network called the Vulnerability and Adaptation Resource Group (VARG). A comparable initiative is the previously mentioned web-based Climate Risk Management Knowledge Base.

Appendix A provides information on the extent of vulnerability and the adaptation assessments of Bangladesh, Mali and China. In the case of Bangladesh, more thorough V&A assessments were made in major areas /sectors and at different levels (regional, national and local) than those of Mali, focussed on only a few sectors and concentrated at the local level.

In the case of China, V&A assessment studies have been comprehensive. The agriculture and water resources sectors have received considerable attention because land degradation due to mainly water and wind erosion is argued to be causing rural poverty. It was noted that about 90% of the remaining absolute poor live on moderately to severely degraded land.[18]

[17] This is contained in the Assessments of Impacts and Adaptations to Climate Change in Multiple Regions and Sectors (AIACC) project. This project incorporates 24 regional case studies in 46 countries throughout Latin America, Africa, Asia, and the Small Island States.

[18] Asian Development Bank (2003), Country Strategy and Program of People's Republic of China (2004-2006), ADB Manila. Philippines.

PRSPs and similar mechanisms
International and multilateral organizations have been focussing on the integration of climate change adaptation measures into mechanisms such as PRSPs and NSSD.

Recent reviews emphasize the importance of PRSPs as mechanisms for mainstreaming climate change policies and strategies (AfDB et al., 2003; Eriksen and Naess, 2003; Agrawala and Berg, 2002). In particular, the AfDB report has emphasized the need to go beyond the national level and to integrate climate adaptation into local level planning and implementation as well, following the extensive decentralization processes that are taking place in many developing countries.

Bojo and Reddy (2002) reviewed the integration of environmental concerns in 40 PRSPs. Their review addressed the following questions:
1. What environmental *concerns and opportunities* are identified in the PRSPs?
2. To what extent are poverty-environment causal *links* analysed?
3. To what extent are environmentally relevant policy responses, costed *actions,* targets and indicators put in place as part of the poverty reduction efforts?
4. To what extent has the *process* allowed for mainstreaming the environment?

In overall terms the review concludes that many PRSPs pay little to very little attention to basic issues of environmental health, natural resource degradation and vulnerability to environmental hazards.

Yet, the review also states that *good practices do exist*. There are several examples of PRSPs providing promising links, notably in the cases of Mozambique, Honduras, Nicaragua, Burkina Faso and Kenya (Bojo and Reddy, 2002). A large part of the report is dedicated to providing specific examples of good practices in this respect.

Other mechanisms for mainstreaming climate change include the National Strategies for Sustainable Development (NSSD) and National Environmental Action Plans (NEAPs). A United Kingdom House of Commons Report (2002) highlights the links between DFID's country assistance strategies and PRSPs, NSSDs and NAPAs. In fact, it is argued that PRSPs and NSSDs should be combined into a single, integrated framework for the sustainable eradication of poverty. This would address the economic, social and ecological dimensions of poverty. Where a PRSP has been made or is in progress, there should be no pressure to develop a separate NSSD.

Participation
Over the last 20 years, the participation of stakeholders has become a defining characteristic for good and effective governance. However, with regard to mainstreaming efforts, some argue that stakeholders' action plans are still limited. Appendix A provides details on the role of stakeholders in Bangladesh, Mali and China. In the case of Bangladesh, the role and success of stakeholders were mixed. The role of stakeholders in coastal resource management, freshwater management, agriculture, ecosystem and biodiversity as well as cross-cutting issues and research were regarded as successful. However, there was much less success in the health sector and in getting the interest of policymakers to mainstream climate change adaptation in their national development programmes. A similar pattern was also seen in Mali, where the role of stakeholders in sectors such as agriculture and water was relatively successful.

In the case of China, the activities of many stakeholders cover a wide range of environmental areas, including the development of renewable energy, the promotion of clean production, the construction of urban and rural social infrastructures for sanitation, the fight against land degradation, the prevention of global warming, participation in international conventions on the environment, greater facilitation of the use of market instruments, and the involvement of local communities in environmental management and policy and institutional changes.

Other
Burton and van Aalst (2004) point to a growing interest in the potential of public involvement and public-private partnerships in insurance with respect to natural disasters related to climate change. The World Bank

has already carried out some preliminary work in this area. They refer to initiatives that have sprung mainly from natural disaster areas and that have yet to be examined in terms of their relevance for climate change (Burton and Yohe, 2003). The link between climate change and extreme weather events is such as to warrant more attention for insurance in the climate arena, a seemingly obvious and unavoidable opportunity. It could be interesting for the World Bank and other international agencies and donors to explore this issue further, particularly with reference to its application in cases of vulnerable poor groups.
Wamukonya and Skutsch (2001) considered gender aspects of vulnerability studies and adaptation programmes, and argue that approaches which target poor population groups in general, should follow best practice in this field and use existing methodologies that already recognize and incorporate a gender approach.

2.6.3 Funding adaptation activities

Funding will be needed to support local level adaptation activities. Funding is also needed to help scale-up community coping strategies to regional and national levels. Funding can be obtained from various public and private sources at the national and international level. Chapter 7, section 7.3, provides a more detailed and systematic overview of this, as well as an evaluation of the various options (see Table 7.4). We therefore limit ourselves here to two points.

Firstly, the need for funding adaptation activities has been recognized by the UNFCCC, which created several funds during the second half of the sixth Conference of Parties (COP 6) held in Bonn, Germany in July 2001. This was followed at the seventh meeting (COP 7) in Marrakech, Morocco in November 2001, where it was agreed that these funds would be disbursed through the GEF.

The newly created funds include:
1. a Special Climate Change Fund to support adaptation, technology transfer, energy, transport, industry, forestry and waste management, as well as activities to assist developing country parties in diversifying their economies;
2. a Least Developed Countries (LDCs) Fund to support preparations of NAPAs, and;
3. a Kyoto Protocol Adaptation Fund to support concrete adaptation projects and programmes in developing countries that have become part of the Protocol.

This fund is to be financed from a share of the CDM projects.

Secondly, recognising that climate change adaptation is part of the development process, including poverty reduction strategies, has implications for the funding of adaptation measures as part of normal development cooperation programmes.

2.7 Conclusions and policy recommendations

General

In this chapter we have reviewed climate change mitigation-poverty and adaptation-poverty links, and have tried to identify options within the development agenda to deal with poverty reduction and climate change.
The review has made it clear that climate change adaptation needs to be mainstreamed into poverty reduction programmes. Adaptation has been indicated as not having been given high priority in development strategies. However, adaptation is urgently needed for the most vulnerable groups in society. Poor people in developing countries are particularly dependent on natural resources for their livelihoods. In a related vein, the poor are particularly vulnerable to shocks arising from environmental change, conflict and natural disasters. The general reduction in vulnerability is an indispensable element in implementing poverty alleviation strategies. There is therefore an important need to integrate adaptation into strategic thinking on development and development cooperation activities, and in particular poverty alleviation.

Secondly, the SL framework is considered to be instrumental in the formulation of poverty alleviation strategies; that it can also be instrumental in vulnerability, risk and adaptation assessments has also been argued. It should be realized, however, that this approach is still under development, being clearly sensitive to context and situation. As with any other tool, its success will depend on how well the approach and associated frameworks reflect the realities of life and on how sensitively, inclusively and competently the approach is used in practice.

The following possible synergies are relevant in the context of poverty reduction and climate change:
1. In relation to CDM projects it was found that small-scale rural renewable energy or fuel switch projects appear to offer the best prospects for poverty benefits. The latter will be highest where rural households are connected with new energy sources, for example, via grid-connected biomass electricity production. Within the framework of the present CDM, it is more generally recommended that both host governments and investors apply project selection criteria favouring projects that have a strong sustainable development orientation in general, and poverty reduction orientation in particular. As far as a post-Kyoto CDM framework is concerned, a redefinition towards an explicit focus of projects with a sustainable development and poverty reduction orientation is being recommended.
2. Strategic entry points for adaptation measures and policies, as identified by Eriksen and Naess (2003), are provided by the following three, closely related, areas:
   a. reducing the vulnerability of livelihoods;
   b. strengthening local capacity (institutions, skills, and knowledge) and reducing sensitivity (of in particular production systems to climate change);
   c. risk management and early warning.

Synergies also exist between these entry points; for example, the strengthening of links between local institutions and government authorities contributes to the enhancement of both local capacity (and reducing sensitivity) and local livelihoods.

Much emphasis has been placed on the need for proper identification, assessment and prioritization of vulnerabilities, risks and adaptation measures, and their subsequent integration in poverty reduction strategies and programmes. Reference was made to several approaches that have been proposed for tackling these issues. From a comparison of the various approaches, it was concluded that these all focus on one or more components of the SL framework. Moreover, they all share the vulnerability component. Two approaches, IUCN and E&N, focus more explicitly on aspects of all three components. The IUCN approach is comprehensive, and strongly based on livelihood. Therefore it might be considered one of the more promising options from an SL perspective. Yet the other approaches have been conceived within the same spirit and therefore partly overlap with the IUCN approach, and complement elements of it. The integration of certain complementary elements is worth considering. In conclusion, the IUCN approach -complemented with elements from other approaches – seems promising as a basis for poverty-reduction oriented adaptation approaches.

In view of the importance of identification, assessment and prioritization of vulnerabilities, risks and adaptation measures, and their integration in poverty reduction strategies and programmes, there is a need for international support. Such support will help to create an enabling-environment in developing countries, so that countries can carry out vulnerability assessments of relevance to their needs and priorities. This could include strengthening the infrastructure for data collection and dissemination, and capacity building for scientific and socioeconomic assessments, as well as for related policy analyses.

Funding is also needed for the implementation of adaptation measures and programmes. The UNFCCC Kyoto Protocol Adaptation Fund, and ODA, have been mentioned as possible funding sources. However, other sources could also play a role (see Chapter 7).

The PRSP process appears to be an appropriate mechanism for mainstreaming adaptation to climate change. The process is relatively young and still evolving. The review has mentioned 'best practice' cases of this process, the number of which is likely to grow in the future. Developing countries, donors and international agencies involved in this process should be encouraged to familiarize themselves with these cases.

In those cases were countries are required to prepare a PRSP as well as a NSSD, there should be no pressure to develop a separate NSSD when the PRSP has been made or is in progress. It has, furthermore, been recommended that PRSPs and NSSDs should be combined into a single, integrated framework for the sustainable eradication of poverty. This would address the economic, social and ecological dimensions of poverty.

International agencies and donors may consider a further exploration of public involvement and public-private partnerships in insurance for natural disasters related to climate change, particularly in relation to their application to vulnerable poor groups.

Specific recommendations for Dutch/European policy

- Poverty reduction should be made one of the most important areas for present and future non-climate track climate policy. As stated earlier, adaptation is urgently needed for the most vulnerable groups in society. Poor people in developing countries are particularly dependent on natural resources for their livelihoods and are very vulnerable to shocks arising from environmental change, conflict and natural disasters. The general reduction in vulnerability is an indispensable element in implementing poverty alleviation strategies. Therefore adaptation needs to be integrated into strategic thinking on development and development cooperation activities, particularly poverty reduction.
- The following actions should be prioritized in this connection:
  - Preference should be given to encouraging the development of poverty reduction strategies that are based on SL approaches, and the integration of vulnerability assessments and adaptation measures in these type of strategies.
  - More specifically, it is recommended considering promotion of the IUCN approach - complemented with elements from other approaches – as a promising basis for poverty-reduction oriented adaptation approaches.
  - It is also recommended that international support (ODA) be provided for the creation of an enabling environment in developing countries to carry out the activities required in this connection. Cases in point are strengthening the infrastructure for data collection and dissemination, and capacity building for scientific and socioeconomic assessments, and for the related policy analyses.
  - In addition, it is recommended that the options for making additional ODA available for the actual implementation of adaptation measures and programmes be explored.
- In relation to UNFCCC, the need for funds for the actual implementation of adaptation measures and programmes requires support for proposals aimed at widening the scope for funding adaptation activities through UNFCCC funds, particularly within the framework of poverty reduction strategies and programmes.
- Furthermore, with regard to the present CDM, it is recommended that, wherever possible, investor countries apply project-selection criteria to favour projects that have, in general, a strong sustainable-development orientation and, in particular, a poverty-reduction orientation.
- Recommended with respect to a post-Kyoto CDM framework is a redefinition more geared to an explicit project focus with both a sustainable-development and a poverty-reduction orientation.

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Appendix A

COUNTRY CASES: BANGLADESH, MALI, AND CHINA

Over the last decade a number of studies have been conducted on impacts, adaptation and vulnerability to climate change. These studies were carried out by the governments of Bangladesh, Mali and the People's Republic of China as well as by academic institutes, and research organizations. A number of these studies were carried out on a joint basis.

This presentation of country cases for Bangladesh, Mali and China has been derived mainly from the work of Huq et al. (2003).

I. BANGLADESH

A. Climatic situation

The climate of Bangladesh is characterized by high temperatures, heavy rainfall, frequently excessive humidity, and fairly marked seasonal variations. Although more than half the country is north of the tropics, the effects of the Himalayan mountain chain mean that the climate is more or less tropical throughout the year.

The country has an almost uniformly humid, warm, tropical climate. The mean annual rainfall varies widely within the country according to geographical location. There are two main periods of rainfall, with distinct sources of precipitation:
the western depression of winter rains, mainly from January 20 to February 25, when the rainfall is between 10 mm and 40 mm;
the pre-monsoon thunderstorms, known as the Nor'westers (North-westerlies), which begin on about March 10.

B. Vulnerability and adaptation assessments

Major ongoing studies related to climate change include:

1. Initial National Communication to the United Nations Framework Convention to Climate Change, conducted by the Bangladeshi Department of the Environment with financial support from GEF. The draft report of the National Communication is under review. It covers national impacts, adaptation and vulnerability, and mitigation potential.
2. Reduction of Vulnerability to Climate Change in the six coastal districts study, conducted by CARE Bangladesh with financial support from the Canadian International Development Agency (CIDA). The project will work with 6000 rural households to improve resilience and reduce vulnerability to climate change.

C. The role of stakeholders

Discussions with stakeholders (primarily sectoral planners and managers) in key sectors provided information on the likely sectoral impacts of climate change, and helped identify and prioritize (according to agreed criteria) suitable adaptations. The results were summarized, somewhat subjectively, by Saleem et al. (2003), as follows:

C.1 Coastal resource management: A major project on integrated coastal zone management planned with World Bank support allowed the project managers involved to readily see the usefulness of incorporating climate change issues into their programme planning (which they have now decided to do). This was therefore quite a successful mainstreaming exercise for the coastal zone development community.

C.2 Freshwater resource management: Water-sector planners could soon see the importance of climate change impacts on their national water sector plans. They have agreed to incorporate climate change adaptation into the 25-year water-sector plan under development.

C.3 Agriculture: Stakeholders involved in agricultural research were quite quick to see the importance of incorporating climate change considerations into their research programmes (especially for the development of drought and saline tolerant rice varieties). However, those involved in agricultural extension did not recognize the importance of adaptation measures for their work.

C.4 Human health: Attempts to gain the attention of stakeholders in this sector were reasonably high, but attempts to effect decision-making within the public health community met with less success. However, those involved did express a desire to do more work on the issue.

C.5 Ecosystems and biodiversity: Stakeholders involved in ecosystem conservation accepted that impacts on the Sundarbans forest were of major significance. They agreed to incorporate climate change impacts assessment into a major project being undertaken for the Sundarbans. However, attempts to engage with the stakeholders in other ecosystems were less successful.

C.6 Cross-cutting issues and research: Climate change and adaptation are relatively long-term problems that require research and a furthering of the knowledge base. National research capacities need to be enhanced so that the issue can be dealt with on an ongoing basis. Stakeholders representing the research community were quite willing to be involved in further work on the issue.

C.7 High-level policy makers: Engaging with, and getting the interest of, high-level policymakers (for example, those representing the Prime Minister's office, Finance and Planning ministries as well as legislators) was perhaps the least successful area. This group seemed least concerned about the impacts of climate change on the overall economy of the country and needs to be targeted more effectively in any future efforts to do more on adaptation to climate change in Bangladesh.

II. MALI

A. Climatic and economic conditions

Mali is a West African country bordered to the north by Algeria, to the west by Mauritania and Senegal, to the east by Niger and to the south by Guinea, the Ivory Coast and Burkina Faso. The economy is dominated by the agricultural sector, which is based on cotton (the principal export) and livestock, but gold also plays a major role. In terms of vegetation, Mali possesses a diverse ecology, contrasting forest formations with the shrub-covered savannah in the north and the drifts of forest to the west and south. In terms of climate, Mali typically has one rainy season per year with light rain throughout (between 200 mm and 1200 mm).

B. Vulnerability and adaptation assessments

The existing studies on vulnerability in Mali were conducted within the implementation framework of the UNFCCC and in particular the initial National Communication. These studies cover the water resources and agricultural sectors. Such studies are justified, given that the main occupation of the country's inhabitants is agro-silvo-pastoral in nature.

The study area is located in the upper valley of the Niger River, one of the main agricultural areas of the country. The objectives of the exercise were to:

1. evaluate the eventual consequences of climate change on yields of millet and sorghum in the area;
2. evaluate the socioeconomic impact of climate change, and
3. propose strategies for adapting to any climate changes that may ensue.

B.1 Agricultural sector: Studies were carried out using General Circulation Models or GCMs and simulation models involving crop growth. The GCMs were used to establish the possible climate scenarios, which were derived from reaction equilibrium experiments.

Two Crop Growth Simulation Models were used to assess climate change impacts. The first one was the MAIN model developed in collaboration with the Centre for Agro-biological Research in the Netherlands. This model was calibrated using agro-meteorological data obtained from the study area. Scenarios involving temperature increases of one, two, three and four degrees centigrade were used to develop the simulation models.

The second one was the Decision Support System for Agrotechnology Transfer (DSSAT) model, which uses simplified functions to forecast crop growth under the influence of certain factors affecting their yield, namely: genetic, climatic (sunlight, maximum and minimum temperatures, precipitation), soil properties and agricultural practices.

B.2 Water resources sector: This aspect was studied using the analogue method, in addition to expert judgment and simulation models. It considered:
1. 1995 as the reference year;
2. 1961-1990 as climatologically normal;
3. 2025 as the temporal horizon, and
4. The Niger basin at Mopti to be the study area.

C. The role of stakeholders
Efforts undertaken to mainstream adaptation to climate change into the national planning and activities of the various sectors were relatively successful for the agricultural sector, which already has a long history of working on drought-prone agriculture. It was moderately successful in the area of energy, but little success was realized in other sectors (such as water resources) and at the national policy-making and planning levels.

III. CHINA

A. Climatic conditions
China is rich in biological resources. Plant cover and soil formation in China follow distinctive latitudes and belts. However, over the last few years, indicators of unsustainability were noted; these include water loss, soil erosion, floods, saline and alkaline soils, and weed and pest damage. Each year various kinds of natural disasters account for about 10 million tons of yield loss. Grass planting and afforestation have decreased the incidence of water loss and soil erosion. At present, projects and biological measures are being undertaken to reduce the losses due to natural disasters. Floods occur in the regions surrounding the Great Rivers, droughts in western China, water loss and soil erosion near the Yellow River and pest damage in all agricultural regions.

B. Vulnerability and adaptation assessment
Comprehensive studies have been conducted on the impacts, adaptation and vulnerability to climate change on coastal resources, agriculture, grasslands or livestock, water resources and forest. A regional study (which includes China, Laos, Myanmar, Thailand, Cambodia and Vietnam) entitled ‘Southeast Asian Vulnerability to Water Resource Changes and Extreme Hydrological Events’ is being conducted by the AIACC. This focusses on water resources and associated sectors.

Agriculture: Due in part to the importance of agriculture in China, vulnerability assessments were done more in this sector than in any other. These assessments were generally more detailed and extensive than other analyses, examining the vulnerability of numerous specific crops and cultivars under a variety of climate change scenarios.

Water resources: While most of the vulnerability analyses of water resources focussed on run-off (the proportion of precipitation on land that ultimately reaches rivers or lakes), other factors were also considered such as water supply and demand, flooding and drought, river salinity, water quality, irrigation and hydroelectric generation.

C. The role of stakeholders
The role of stakeholders in mainstreaming climate change adaptation needs to be strengthened. Up till now, there are two areas where the role of stakeholders can be clearly seen. Firstly, in the area of the legal and policy framework for environmental management the national stakeholders are amending and awaiting the adoption of the Air Pollution, Prevention and Control Act, the Anti-Desertification, Environment Assessment Act, the Clean Production Promotion Act, and the Grassland Law and Water Act. Secondly, public and local community involvement in environmental management is present and increasing.

3. The role of land use in sustainable development: options and constraints under climate change

A Verhagen, GJ Nabuurs and J Veraart (Plant Research International, Alterra, Wageningen UR)

Abstract

Agriculture and forestry contribute to economic development in terms of income generation and employment. Although agriculture and forestry are no longer the main drivers of the rural economy in industrialized countries, in most developing countries they have traditionally been, and still are, the key livelihood strategies for people living in rural areas. Therefore the sustainable development paths in such countries are laid out differently, depending on the regional setting, ongoing societal and political processes and the stakeholders. In developing regions, the services supplied by natural resources will then be able to help to lift the rural poor above the poverty line. Sustainable development is not only dependent on the production of food and fibre, but also on environmental functions such as carbon sequestration, water supply and biodiversity. In this review industrialized countries were now seen to be seeking new ways of producing food and fibre, with great emphasis on non-wood forest products. Climate change has an overarching effect on these processes. In developing countries, it can hamper sustainable development (e.g. through extreme weather events), but in industrialized countries, policy makers and land managers will have the capability to respond adequately to climate change. As development does not automatically lead to cleaner products and production processes, policies should promote the transition to more sustainable production systems.

3.1 Introduction

Natural resources are the basis of existence in both industrialized and developing countries. In developing countries, a large number of people are directly dependent on the natural resource base and are forced into exploiting, and even overexploiting, the natural environment. In industrialized countries only a small number of people are directly dependent on natural resources, but they are forced to use these in an unsustainable manner. In both cases, society depends on services provided by natural and managed ecosystems. Yet, because only a small number of people in industrialized countries depend on the natural resource base for their livelihood, this link is hardly acknowledged.

The chapter focuses on the role of land use (agriculture and forestry) in sustainable development. Society determines which goods and services are needed, and land use is the reflection of these needs. Land use is placed in the context of economic development, environmental policies (in particular, climate change) and sustainability. This is done for both industrialized and developing countries. In industrialized countries agriculture and forestry are no longer the main drivers of the rural economy. However, in most developing countries agriculture and forestry have traditionally been, and still are, the key livelihood strategies for people living in rural areas. In both situations sustainable development not only depends on the production of food and fibre, but also on environmental services such as carbon sequestration, water supply and biodiversity conservation. Land use systems can damage or destroy these environmental services and in so doing undermine future needs and development.

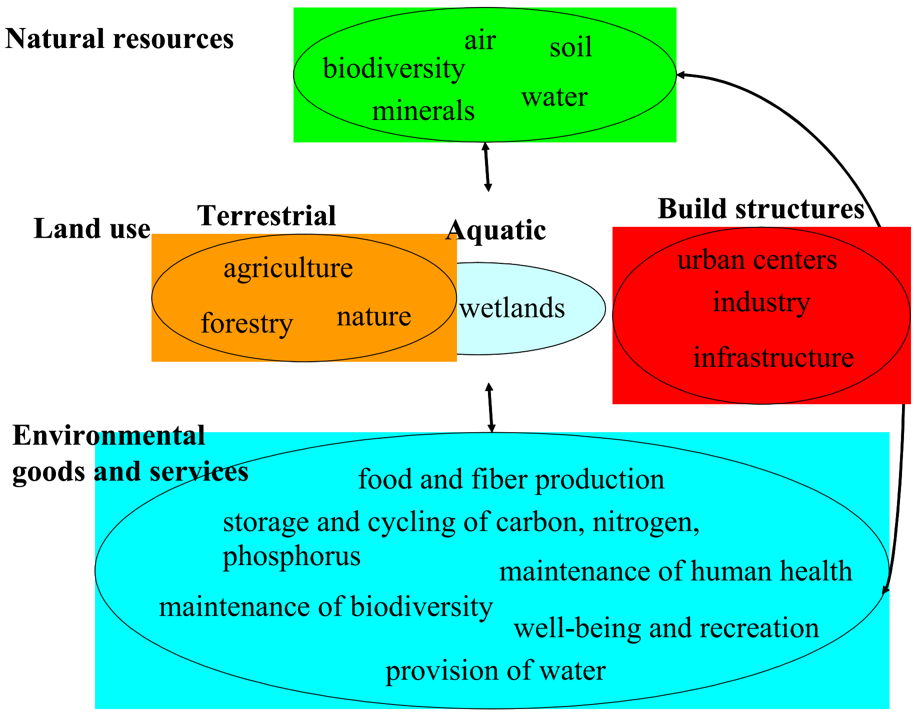

Figure 3.1 Links between natural resources, land use, and environmental goods and services

Land use is both an agent and victim of climate variability and long-term climate change. This double nature is reflected in climate policies by taking into account both adaptation and mitigation measures in response to climate change. The reduction of land-use-bound greenhouse gas emissions and coping, or adaptation, are clearly stated in the United Nations Framework Convention on Climate Change (UNFCCC). How specific countries try to improve their overall development can also affect their capacity to mitigate or adapt to climate change.

International conventions are intergovernmental treaties that bind signatory governments. Such conventions are crucial instruments in addressing global problems like energy, deforestation, population growth and climate change, and could form a first step to the global governance of the environment.

The fundamental differences in infrastructure, economic and human capacity, socio-political systems and environmental awareness between industrialized and developing countries need to be borne in mind when considering the implementation of adaptation and mitigation policies for land use practices and rural development in future climate policy. Land use and rural development programmes aimed at long-term sustainability can benefit from taking climate variability and climate change into account. Including the additional information on climate change and climate variability may help to target already scarce resources more efficiently. Extra efforts to adapt to changes in climatic conditions will be necessary for vulnerable areas and groups.

The key issues in this chapter are:

i. to assess in what way development options within agriculture and forestry are supporting or obstructing climate policies;
ii. to assess synergies between international environmental conventions (notably the Convention to Combat Desertification, Ramsar and the Convention on Biological Diversity) in the field of land use, and international agreements on sustainable development.

This chapter is organized as follows. In the first few sections we discuss the status of the global natural resources, the role of agriculture and forestry in development and how climate change will impact these sectors and the natural resource base. Which groups and regions are particularly vulnerable is also generally assessed. The subsequent sections look at the link between land use and climate policies. In Section 3.5 we will also explore how several international environmental agreements interrelate to the objectives of the UNFCCC. The chapter concludes with a discussion on policy guidelines and recommendations that serve both land use and climate policies. The role of finance and subsidies, for example, in the context of the World Trade Organization (WTO), and how these can contribute to agricultural and climate policies are discussed in Chapter 5. The human dimensions, e.g. poverty and the policy context of adaptation, are provided by Chapters 2 and 7, respectively.

3.2 Interactions between land use and environmental goods and services

The United Nations Food and Agriculture Organization (FAO) (www.fao.org) and the World Resources Institute (www.wri.org) regularly produce reports on the status of the world's ecosystems. More recently (2001) work on a global assessment was started via the Millennium ecosystem assessment (www.millenniumassessment.org) on the basis of the literature, data and models, with the aim of providing decision-makers and the public with scientific information on the consequences of ecosystem change for human well-being. Most studies portray a future in which we will not be able to sustain human life, unless a transition to more sustainable ways of using the earth's natural resources can be realized.

According to FAO's (2002) latest estimate, there were 815 million undernourished people in the world in 1997-1999: 777 million in the developing countries, 27 million in the countries in transition and 11 million in the industrialized market economies. Progress in combating hunger and undernourishment has been very uneven, with parts of Africa, Central Asia, Latin America and Eastern Europe lagging behind the rest of the world.

Recently, the Millennium Development Goals were put forward in an ambitious global agenda to eradicate extreme poverty and hunger. The targets set for 2015 aim to halve the proportion of people living in extreme poverty and hunger. The Millennium Development Goals have gradually become the guide for international policies (Davidson et al., 2003). In Asia and the Pacific, the percentage of undernourished people has been halved since 1979-1981. In Sub-Saharan Africa, by contrast, the incidence of undernourishment has declined only marginally over the same period. Considering the rapid population growth in this region, this means that the total number of undernourished people in Sub-Saharan Africa has increased significantly. In Latin America and the Caribbean, the incidence of undernourishment is lower than in Asia, but progress over the last two decades has been slower. The Near East and North Africa region has the lowest incidence of undernourishment, but has seen no reduction over the last two decades (FAO, 2002).

Food production has more than kept pace with global population growth over the last decades. This has mainly been achieved through intensification. The irrigated area has increased, and the use of purchased inputs (e.g. fertilizers) and new technologies has grown in order to increase production per hectare. The expansion of agricultural land has slowed down over the last few decades. Whereas the increase in cereal production has slowed down, the quantity of livestock products has increased with consumption patterns. The relative amount of meat in diets increases with an increase in income and living standard. In general, increased food production in both developing and industrialized countries has come at a cost. In developing countries, natural resources, soil and water are exploited, undermining the very base of these production systems via the loss of soil fertility and soil erosion. In industrialized countries environmental problems are related to high-input levels that result in nutrient and pesticide leaching. The combination of high inputs and technologies clearly has consequences for the sustainability of agro-ecosystems. Crop choice and management practices change in response to policy signals, market signals and technological developments. All of these drivers can be used to divert aspects of resource depletion and degradation.

3.2.1. Soil

Soils are non-renewable resources that provide the basis for agricultural development. Esrawan et al. (2001) report that the productivity of some lands has declined by 50% due to soil erosion and desertification. In particular, marginal land in arid and semi-arid regions is already under pressure and large areas are strongly degraded (Esrawan, 2001).

Only about 3% of the global land surface can be classified as prime agricultural land and this is not found in the tropics. Approximately 11% of the land area must feed the six billion people today and the 7.6 bilion expected in 2020. Desertification is evident on 33% of the global land surface and affects more than one billion people, half of whom live in Africa. Besides soil erosion and desertification, fertile land is also lost due to urbanization. Towns and cities have been founded near fertile areas that could provide the food needed to feed the population. The expansion of urban centres inevitably leads to the loss of agricultural land (Ramankutty et al., 2002).

Soil organic matter plays a crucial role in stabilizing soil structure by providing a rooting environment for plants, and the storage and release of water and nutrients. Soil nutrient depletion is a silent or creeping disaster, and may result in an irreversible destruction of the soil. Soil organic matter (carbon) management is a key factor in combating land degradation in mineral soils. In organic or peat soils, degradation is strongly linked to water table management. Drainage of peat soils results in the oxidation of organic material. Where fire is used for land management, large quantities of peat (carbon) can be lost.

3.2.2. Water

Water stress is an indication of the amount of pressure put on water resources and aquatic ecosystems by users. A typical measure of water stress is the annual 'withdrawals to availability ratio'. Water stress increases when either water withdrawals increase (in relation to population and economic growth), and/or water availability decreases (due to pollution or climate change) (Kabat et al., 2003).

In developing countries, a level of severe water stress indicates an intensive level of water use, which is likely to cause rapid degradation of water quality for downstream users and absolute shortages during droughts. Also, in both developing and industrialized countries, a level of severe water stress indicates strong competition for water resources between municipalities, industry and agriculture during dry years. In most studies, severe water stress appears mainly in arid areas of the world, but also occurs in the more humid drainage basins of the world.

A United Nations study (UN, 1997) revealed that one-third of the world's total population of 5.7 billion lives under conditions of relative water scarcity and 450 million people under severe water stress. However, the UN figures are based on national-level totals, ignoring the fact that spatial differences occur. Vörösmarty et al. (2000) showed that if these in-country differences were taken into account, four times as many people – 1.8 billion – would live in areas with severe water stress. Using a global water model and projections of climate change, population growth and economic growth, they concluded that this number would have grown to 2.2 billion by the year 2025, this being attributable to a combined effect of population growth and climate change.

Shiklomanov (2003) applied a comprehensive assessment framework to assess the state of the world's water resources. The study focuses not only on the present and future situations, but also includes estimates of water withdrawals and consumption over the last 100 years (Figure 3.2). The agricultural sector is responsible for 84% of water consumption, while figures for domestic, industry and reservoirs are 4%, 2% and 10%, respectively.

Agriculture is the world's biggest water consumer. Natural variability in rainfall, temperature and other weather conditions are among the main factors influencing variability in agricultural production and food insecurity (FAO, 2001), making climate variability the farmers' 'greatest challenge today'[19]. Since 1950, diversions for domestic use and industry have been rising in number, but they are still low in comparison to agriculture. Water shortage is, in general, associated with a decrease in water quality, which is more critical for domestic than for agricultural use. The impact of water shortages on domestic water use will therefore be more critical than for agricultural water use.

In the same study, Shiklomanov projected water withdrawal and water consumption for each sector in 2025. For agriculture, water withdrawal is projected to rise to 3200 km^3 and the consumption to 2300 km^3 from

[19] http://www.fao.org/NEWS/1997/971201-e.htm

2600 km^3 and 1800 km^3, respectively, in 2000. Total withdrawal for all sectors is projected to be almost 5500 km^3, compared with less than 4000 km^3 in 2000.
In terms of spatial distribution, the dryer regions in the northern hemisphere already consume a very high proportion of their water resources (Figure 3.2). The very high population growth expected in these regions, particularly in China, India and Pakistan, is therefore very alarming.

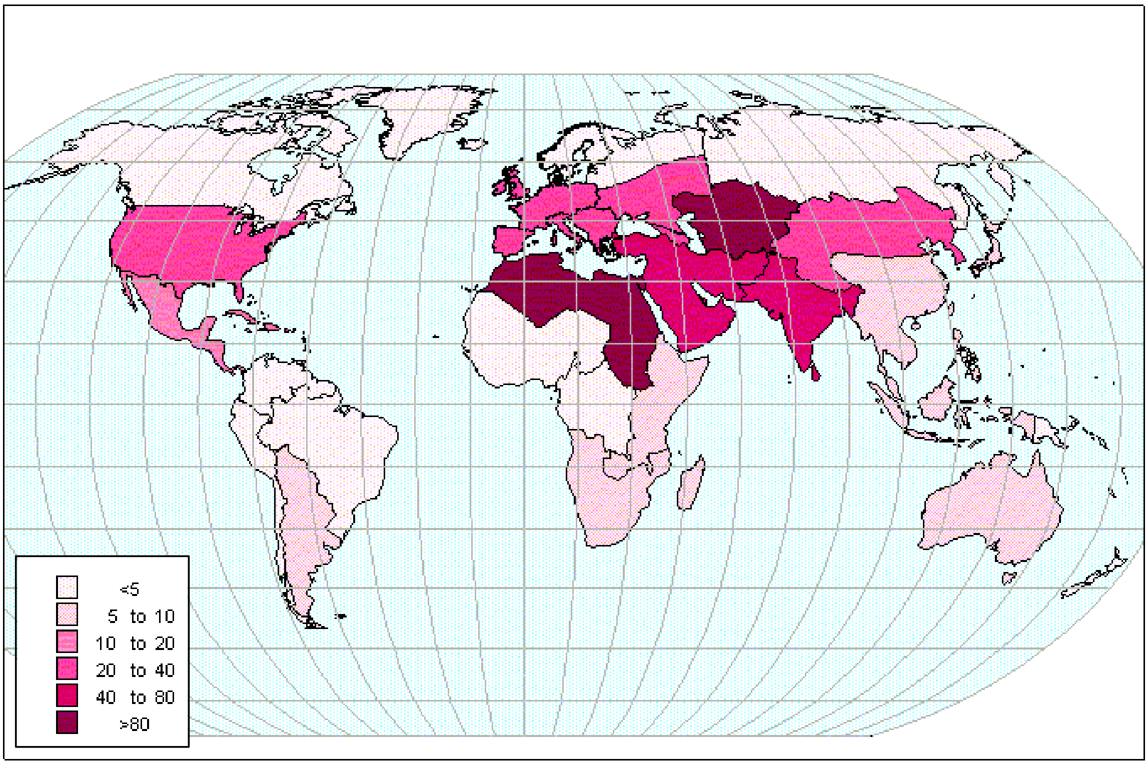

Figure 3.2 Percentage of water consumption from total water resources by natural-economic regions of the world in 2000 (Source: Shiklomanov, 2003)

It is also interesting to put the above figures and estimates on future demands in the context of the world's available water resources. Rodda (2001) presents 'Scenarios for World Water Resources and Demands', in which estimates of world water resources are compared with global demand for water. Starting at a lower range of the estimates of available world water resources of about 25,000 km^3 per year, this study shows that in 2000, almost 5000 km^3 of available water had already been lost due to pollution, and that this loss will continue to occur at an increasing pace. In about the year 2040, progressively increasing global water demand will meet a decreasing curve of water availability (corrected for pollution losses) at roughly 12,000 km^3 (Rodda, 2001). From 2040 onwards, the global demand is projected to exceed the availability. Impacts of climate have not been considered in these projections.

3.2.3. Biodiversity in relation to agriculture and forestry

Biodiversity underlies all ecological goods and services, as it provides the basis for food- and fibre-production systems. The largest losses of wild biodiversity are the result of habitat destruction and fragmentation, which are mainly related to the conversion of the natural vegetation for agriculture and other purposes.

Agriculture has used the genetic diversity in crop and livestock species to enhance food production. However, the biological diversity in agricultural crops and livestock breeds is also the result of adaptation to environmental conditions. Beside the natural environment, economic, social and cultural factors also played a role in the diversification of agricultural crop and livestock. Changes in agricultural production only resulted in a decline of agro-biodiversity when most traditional crop varieties were replaced by modern high-yielding varieties.

The distribution patterns of many plant and animal species are to a large extent determined by climatic parameters. Changes in these parameters will result in changes in the distribution of most species, as well as changes in distribution and abundance of pests and diseases. How agriculture and forestry will be affected by these changes is still uncertain.

Globally, forest cover comprises some 3.87 billion ha, of which almost 95% consists of natural forests and 5% of plantations (Figure 3.3). A large proportion of the natural forests consist of semi-natural managed forests often found in temperate and boreal regions. In these regions forest area has stabilized and forest biomass is often increasing. Tropical deforestation and degradation are negatively affecting the availability of forest goods and services.

The estimated net annual change in forest area worldwide over the past decade (1990-2000) was -9.4 million ha, representing the difference between the estimated annual rate of deforestation of 14.6 million ha and the estimated annual rate of forest area increase of 5.2 million ha. The causes of forest degradation vary. There is a global trend towards greater reliance on plantations as a source of industrial wood. The development of a significant global plantation estate is quite recent; half of all plantations in the world are less than 15 years old. Asia has led plantation establishment globally, with 62% of all forest plantations having been located in that region since 2000. Other significant developments include rising private sector investment in plantations in developing countries, increasing foreign investments in plantations and arrangements whereby communities or small landowners produce trees for sale to private companies.

3.3 Climate

Climate is not a peripheral question for agricultural or forest development. Today, the natural variability of rainfall and temperature are already among the main factors causing the variability in agricultural production, which, in turn, is one of the main factors causing food insecurity.

The IPCC (2001) has stated that developing countries are vulnerable to climate change, because they generally:
- have a relatively large share of their economy in climate-sensitive sectors (e.g. agriculture and forestry);
- are inhabited by people already weak as result of poor nutrition or a poor health infrastructure;
- are located in drought and flood-prone marginal production areas.

On the basis of model studies, the IPCC concluded that the impacts of climate change on agriculture are predominantly negative, although there might be short-term minor increases in crop yields in a few areas (IPCC, WGII). This is confirmed by Fischer et al. (2002) who found that developing countries consistently face a substantial decrease of wheat production potential, according to all scenarios for the 2080s (in the order of 15–45%); wheat is virtually disappearing from Africa. Wheat-production potential is decreasing in South Asia (20–75%), Southeast Asia (10–95%), and South America (12–27%). They further find that the situation in sub-Saharan Africa is of concern. For example, Sudan, Nigeria, Senegal, Mali, Burkina Faso, Somalia, Ethiopia, Zimbabwe, Chad, Sierra Leone, Angola, Mozambique, and Niger lose cereal-production potential for of the climate models, across all the emission scenarios. In contrast, Zaire, Tanzania, Kenya, Uganda, Madagascar, Côte d'Ivoire, Benin, Togo, Ghana, and Guinea all gain cereal-production potential. China, the world's largest cereal producer, gains substantially, up to 25% for three of the GCM climate models and all emission scenarios. For India, the second-largest cereal producer, Brazil, and Thailand, results vary according to climate model. Argentina gains production potential by up to 25% for two of the climate models and loses in the other two climate models. South Africa substantively loses production potential for three climate models and all emission scenarios (Fischer et al., 2002).

The consensus is that the marginal areas like arid and semi-arid regions in the tropics are going to be hit hardest by climate change, whereas some gain in production is expected in the temperate zones. The arid and semi-arid regions are already among the most vulnerable areas because of the poor natural resource base, notably high rainfall variability and low soil fertility. The capacity of agriculture to adapt to climate changes depends on factors such as population growth and distribution, the quality of the natural resource base (especially soil and water), farm technologies, crop varieties (biodiversity), access to inputs (fertilizer and water), access to markets and crediting schemes.

The effects of climate change on biodiversity are unclear. However, in a recent paper in nature by Thomas et al. (2004) an extinction risk related to climate change of between 15-37% was estimated. It is clear from phenological data series that some changes are already occurring (Natuurkalender; IPCC, 2001b). The rate at which the changes occur will be a crucial factor. In general, mobile species are better equipped to respond to these changes, whereas species like coral and most plants will experience more difficulties in adapting.

It is expected that wild plant species will have to migrate in order to survive the changing environmental conditions. Whether plants will be able to find suitable new environments will depend on many factors. Shifts in agro-ecological zones will result in species moving away from their region of origin. With the shifts of agro-ecological zones, shifts in the abundance and occurrence of pest and diseases in agricultural and forest systems are likely to take place.

Sea level rise and the associated saline water intrusion is a serious threat to the densely populated coastal areas. The security of people living in these areas and their agricultural production systems are both in danger.

3.3.1. Extremes

Human-induced and natural disasters such as war, conflicts, drought, floods and hurricanes continue to threaten development and destroy years of development in many developing countries. Developing countries lack the means to be prepared for such events and to rebuild livelihoods in their aftermath (FAO, 2001). The predicted population explosion in conjunction with a possible deterioration in environmental and social conditions is an alarming scenario for agricultural production, especially for the semi-arid regions that are already under pressure.

The European report by the EC's Joint Research Centre in Brussels revealed that the prolonged heat spell in 2003 caused crop yields to drop across Southern Europe. For example, high temperatures and water shortages cut maize and sugar beet yields in Italy by one-quarter, and wheat yields fell by one-third in Portugal. However, yields rose in Northern Europe, which was been affected by drought. For example, the warm weather helped increase sugar beet yields by one-quarter in Ireland and by up to 5% in Denmark and Sweden. Yields of oilseed rape, or canola, rose by 12% in Finland (New Scientist, 2003). Destruction of forest habitats by fires was another important impact of the 2003 droughts.

3.4 Vulnerable groups and regions

The impacts of climate variability affect everyone, and there are few places in the world that will not be affected by long-term climate change if temperatures rise by more than 2^{o}C. However, there are major differences in the capacity to cope with those impacts, depending on where they occur. Many different agencies and individuals have contributed to the development of assessment techniques for vulnerability to climate change and, to a lesser degree, climate variability. Olmos (CCKN, 2001) has prepared a summary of the resulting plethora of terms (impact potential, resilience, sensitivity, responsiveness, adaptability, adaptive capacity and vulnerability). We have confined the discussion on this by keeping in mind the definition of vulnerability given by IPCC (2001): 'the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. It is, amongst others, a function of the character, magnitude and rate of climate variation to which a system is exposed, its sensitivity and its adaptive capacity'.

About 70% of the world's poor live in rural areas. Many development programmes have had the objective of reaching the rural poor. Agriculture is the main livelihood strategy of the rural poor, and addressing poverty in rural areas means addressing agriculture and forestry. Survival strategies of the rural population are diverse and include on farm and off farm activities, forest, saltwater and freshwater products. One strategy is seasonal migration to and from the cities. Despite considerable uncertainty about the scale and rate of urbanization, it is predicted that in the foreseeable future, all of the world's population growth will occur in urban areas (Cohen, 2004).

3.5 Embedding climate change mitigation and adaptation in sustainable development plans

From the previous sections it is clear that natural resources in the rural areas (forests and agriculture) cannot provide sufficient income and employment opportunities to support sustainable forms of development. Therefore policymakers face the challenge of facilitating a process that allows the rural poor to cope with climate change impacts and which uses adaptation opportunities to enhance livelihoods. At the very least, such an approach should ensure that climate change does not lead to a worsening of the situation of the rural poor.

In general, where too many people depend directly for their livelihood on natural resources, overexploitation often follows. Offering economically viable opportunities for the sustainable management of natural resources should therefore be at the core of any rural development planning. In some regions agricultural development that enhances and stabilizes production levels can be seen as a development pathway. In some regions payments for environmental services such as carbon and biodiversity could create income and job opportunities. In fact, such payments are already being made in the form of agro-environmental payments in the EU, but also in countries such as Costa Rica.

Clearly, environmental services and increased agricultural outputs alone will not be enough to provide the economic boost needed. Other activities crucial for development such as small-scale industrial enterprises, agricultural production and tourism also need incentives and supporting policies. We will now focus on some issues related to the exploitation of the natural resource base.

3.5.1. Rural development based on agricultural production

Considerable efforts are being made to improve land and water management, and agricultural production, in both industrialized and developing countries. In all cases, improving the agricultural economic position is crucial for the success of climate change policies. Policies cannot substitute markets, but can provide stability and the context for revenues from land use with acceptable risk levels. In many countries the adequacy of legal frameworks for the management of land and water, and the strength for implementing arrangements are crucial success factors. However, the legal frameworks are often not good enough to bring about the wise management of the natural resource.

Policies should create incentives and be supportive towards sustainable livelihood strategies. This approach should include investing in people and resources (see Chapter 2). Good management of the natural resource bases requires an integrated and synergistic resource management approach that embraces, locally, appropriate combinations of the following technical options (adapted from Penning de Vries, et al., 2003 and UNCCD, 2004):

- Soil and crop management:
  - build up soil organic matter and related biological activity to optimum sustainable levels (for improved moisture, infiltration and storage, nutrient supply and soil structure);
  - prevent soil erosion via soil organic matter management and revegetation;
  - deploy integrated plant nutrition management;
  - improve crop management by using better seeds, effective weed control and integrated pest management;
  - introduce risk-reducing strategies e.g. early warning systems.
- Water management:
  - improve rainwater management to reduce run-off, thereby lessening the risk of moisture stress during dry spells while reducing erosion;
  - protect and restore freshwater resources.

- Land management:
  - reclaim severely degraded cultivated land, where appropriate (i.e. if technically feasible and costeffective);
  - implement sustainable pasture, forest and livestock management;
  - stimulate conservation of in-situ biodiversity of both wildlife and origin species of agricultural crops.
- Research and technology:
  - stimulate efficient use of input;
  - design/redesign farming systems;
  - introduce new technologies;
  - introduce new species and varieties with a capacity to tolerate salinity and/or aridity;
  - educate farmers;
  - provide alternatives to slash-and-burn agriculture.

The aforementioned options must be seen in the context of a constantly changing agricultural environment. Responding to changes in consumer demand, global market prices and environmental degradation is nothing new. Recent developments in agriculture aim to produce more on less land while optimizing inputs, e.g. fertilizers. Precision agriculture allows for a fine-tuning in space and time, so as to reduce the negative impacts on the environment and at the same time allow for high production levels. In greenhouses the production environment is to a large extent independent of climate, ecology and geography. Completely cutting or reducing the ties with the natural environment is a logical step in agricultural development. Technological development is a crucial element in agricultural transitions.

Agricultural intensification can reduce pressure on natural areas, provided the changes in the production process such as increased inputs of fertilizers are fine-tuned to the development and needs of the crop (Wood and Lenné, 2004).

Non-food crops with added value such as energy and raw materials are interesting options from a perspective of sustainable development and climate change. The production of non-food crops, e.g. for industrial processes and as biofuel, will create new options for farmers and the substitution of fossil fuels will lead to reduced emissions of greenhouse gasses. When moving to a bio-based economy, the area cultivated with non-food crops may increase dramatically. Depending on local resources and price levels, this will open new options for rural development. As with other cash crops, competition for land with food crops is a concern for food-insecure areas.

Crop breeding and, more recently, genetically modified (GM) crops contain the promise of stable production levels with low inputs of pesticides and herbicides. Biotechnology will also open up possibilities of production on degraded lands (saline conditions) and options to absorb external shocks (droughts, floods). The downside of the technological fix is that it may exempt land managers and policymakers from actions to reduce the negative impacts on the natural resources.

Pests and diseases are an important factor in the success of agriculture. Both pre-harvest and post-harvest losses from birds, insects, pathogenic fungi and bacteria, for example, are high. Oerke et al. (1994) indicated a 42% pre-harvest loss of the attainable yield for eight major crops for 1988-1990. Reported post-harvest losses related to insects and fungi vary considerably, but are in the order of 10-30%. Pests and diseases do not just affect product quantity but also product quality and may even result in toxicities. Agriculture will have to respond to changes in the abundance and distribution of pests and diseases. Chemicals are commonly used to combat diseases (pre-harvest and post-harvest). The effects of climate change on altering pest and disease patterns and on food quality are poorly understood.

In addition to food and fibre, agriculture also provides several environmental goods and services. Carbon and, at a local level, water are two of the goods and services valued in monetary terms. As the unsustainable use of the natural resource base mostly leads to short-term economic gains, financial incentives to stimulate the protection and wise use of these bases are urgently needed (see, for example, Bio-rights).

3.5.2. Forestry

With an estimated annual global stemwood harvest of 3.4 billion m^3, the main purpose of managing forests continues to be the production of fibre. Half of the global harvest is still non-commercial fuel wood, the most most important source of energy worldwide. Despite large increases in processing efficiency in the industrialized world, harvests have remained at a constant level. Thus the efficiency increases have just coped with the rapid consumption increases. Consumption is expected to continue to increase, and will be fastest in the new EU accession countries and in countries such as Brazil, China and India. The global wood market is mainly continental-regional: i.e. the main trade takes place within continents. Compared to other (temperate and boreal) timbers, the international trade of tropical timbers is, relatively speaking, very low.

Forestry provides very little employment, both in developing and industrialized heavily-forested countries. In this sense, forestry cannot add a lot to the sustainable economic development of rural populations. However, there are sustainable development opportunities related to the forest sector that are closely related to both mitigation and adaptation:

- Management:
    - The most important functions of the natural forests in developing countries are biodiversity, carbon conservation and carbon regulation. Schemes that mitigate climate and fulfil these functions can be designed;
    - Increased planting of plantations is needed to take the pressure of the natural forests;
    - Most deforestation in the tropics is caused by land use changes, not by commercial timber harvesting. Farmers need to be provided with alternatives;
    - In industrialized countries, commercial harvesting in managed forests must remain possible;
    - Management of forests in industrialized countries will increasingly shift towards a ‘closer to nature forestry’, this holds for options for adaptation to climate change;
    - Selective logging schemes are hardly practised today; implementation and control are needed.
- Research and technology:
    - Forestry and agriculture are closely interrelated in developing countries; education of farmers is needed here;
    - Increased processing efficiency in developing countries is urgently required and will take pressure off the forest;
    - Non-wood forest products can become a large driver of sustainable development in both industrialized and developing countries.
- Certification:
    - Certification of tropical timbers is needed (with associated changes in management) in order to improve the trade position;
    - The CDM mechanism (afforestation and reforestation) can help to combat deforestation and desertification. It can also help to generate fuel wood supply in the future and take pressure off the natural forest
    - Functions of forests are becoming more distinct in a geographical sense, with strict reserves in one location and intensive monoculture plantations in another.

Biomass energy from short rotations can alleviate many problems in both developing and industrialized countries. It can improve the financial sustainability of farmers, improve regulation functions and mitigate soil degradation. Furthermore, it reduces the use of fossil fuels. In industrialized countries it will also restore the close relationship between forestry and agriculture.

3.5.3. Financial mechanisms

Micro-credits, and insurance are important tools for providing a safety net and options for investment that are crucial in the alleviation of poverty. Both formal and informal finance systems play an important role for small-scale entrepreneurs. Economic growth is crucial in generating opportunities. Limited access to physical and financial assets will hamper economic development (Chapter 2).

The relation between insurance, banking, asset management and sustainable development is perhaps not obvious. Most response types, such as food aid, relate to crisis situations without considering the long-term impact on the natural resource bases.

Hazel (2004) states that in relation to climate change, risk management interventions need to be designed in such a way as to assist farmers to manage risk more effectively and to improve their productivity and incomes, but without distorting incentives in inappropriate ways. The experience with feed subsidy and debt relief programmes has had mixed results. While they have helped protect incomes and food security in drought years, they have had negative impacts on the way resources are managed. Better alternatives could take the form of area-based rainfall insurance, particularly if offered by the private sector, and the development of more accurate and accessible drought forecasting information (Hazel, 2004). Other mechanisms at the national level include the 'debt for nature swaps', an agreement in which a proportion of a country's debts are written off in exchange for a commitment by the debtor country to undertake environmental protection projects.

3.6 Synergies and conflicts between conventions on land use and climate change

The challenge posed by the intricate interrelationships of land use, climate, biological diversity, drought and desertification on the social, economic and environmental fronts has been recently been exemplified in many countries. Also amply demonstrated has been a clear convergence of objectives among the three Rio Conventions, the United Nations Convention to Combat Desertification (UNCCD), the Convention on Biological Diversity (CBD) and the United Nations Framework Convention on Climate Change (UNFCCC), see also Chapter 9. The strategic approaches that the various interested parties have pursued up to now, particularly at the individual country level, need to more firmly converge (UNCCD, 2004). Moreover, there is also a need for parties to focus on a broader framework that includes a complex set of issues enveloping desertification and land management, biological diversity, climate change and socioeconomic development.

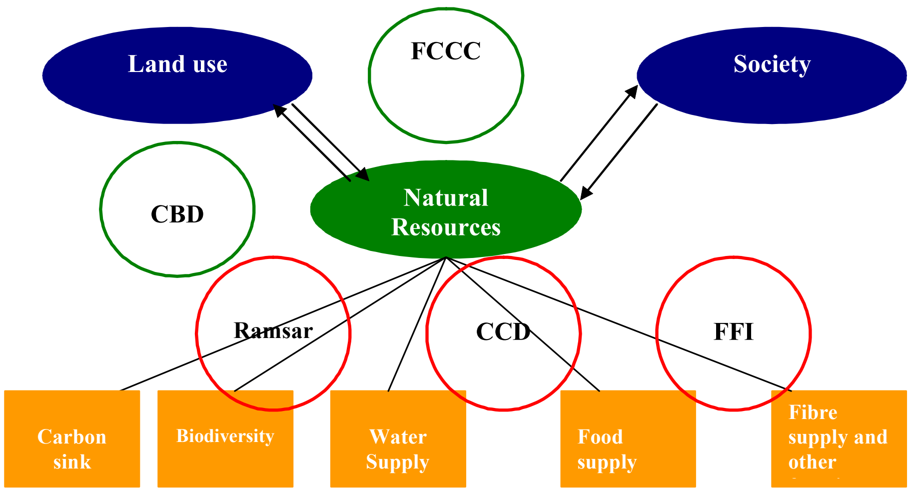

Figure 3.3 Interrelationships between Land use Natural resources and Environmental conventions. CBD - Convention on Biological Diversity, FCCC - Framework Convention on Climate Change, CCD - Convention to Combat Desertification), UNFF - (United Nations Forum on Forests)

Figure 3.3 shows the relationship between the conventions and environmental goods and services. The Ramsar, CCD and FFI convention are related to specific types of ecosystems, i.e. wetlands, drylands and forests, while the FCCC and CBD conventions look at specific environmental problems (i.e. climate change and biodiversity conservation). A more detailed description of these conventions can be found in Section 8.2.

3.6.1. Links between land use and the Convention on Biological Diversity

In Article 1 of the Convention on Biological Diversity the contracting parties have agreed to the following: 'Conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding' (CBD, 2004). The contract ing parties of the CBD have also agreed to work on a large number of issues that would help in meeting this objective.

Measures in CBD: synergies and constraints with UNFCCC

The need for the rate of climate change to be reduced to allow ecosystems to adjust is recognized within the UNFCCC. Measures such as the conservation and sustainable management of coastal zones (Figure 3.4), forests and other ecosystems can contribute simultaneously to both the UNFCCC and the Convention on Biological Diversity.

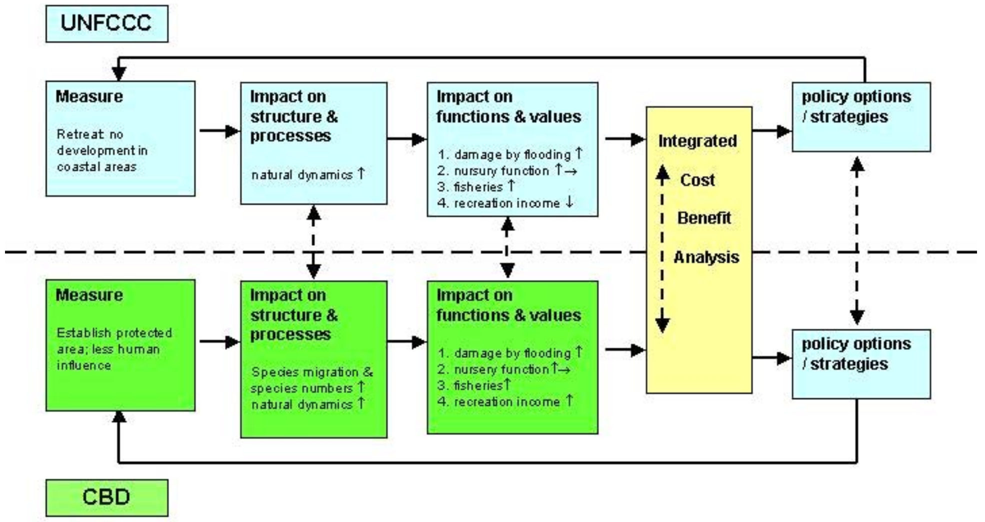

Figure 3.4 Synergies between measures in coastal zones from a CBD and UNFCCC perspective (Source: Bucx et al.*, 2002)*

Nature conservation measures related to UNFCCC objectives (adaptation)

- Reduction of habitat fragmentation by the establishment of refuges, parks and corridors to allow migration of species (IPCC, 2001). Habitat fragmentation poses barriers to migration by reducing the possibility for species to adapt by moving as the climate changes. Habitat fragmentation may result in small isolated populations with low genetic diversity. These are more vulnerable to extinction, especially if genetic diversity is also reduced so that the populations have low genetic adaptability
- Use of captive breeding and translocation (IPCC, 2001);
- Conservation of ecosystems (CBD, 2004). Ecosystem degradation, which may result from unsustainable use of ecosystem components, pollution, pest outbreaks or changes in fire regimes, can decrease the resilience of ecosystems to climate change. Addressing such exacerbating factors may be an important component of adaptation to climate change.

Nature conservation measures related to UNFCCC objectives (mitigation)

- The UNFCCC promotes the sustainable management, conservation and enhancement of ecosystems, e.g. forests as sinks of greenhouse gases. There is no unique relationship between the biodiversity and carbon sequestration of an ecosystem (CBD, 2004). However, some forest types are net sinks, while others are sources. Unmanaged forests have more biodiversity and more carbon than managed forests such as plantations. Recent evidence (Chambers et al., 2001; CBD, 2004) suggests that the amount of carbon sequestered by 'old-growth' forests as opposed to managed forests is higher than first thought. Nevertheless, in the absence of major disturbances, newly planted or regenerating forests will continue to take up carbon for 20 to 50 years or more after establishment.

- The restoration of wetland basins through the re-establishment of aquatic vegetation, as well as soil carbon restoration in riparian zones and uplands that may be cultivated, is another important element of an integrated strategy to address climate change.

The synergies between nature/biodiversity conservation strategies and adaptation measures to climate change are mostly positive (see Box 3.1). However, adaptation strategies to climate change within other sectors, such as agriculture or water management may alter biodiversity conservation. For example, dams could be seen as a technical adaptation option to cope with future water scarcity. However, the building of dams could also further block migration routes for many fish species and change shallow water or semi-permanent aquatic habitats into permanent deepwater habitats (World Commission on Dams, 2000).

Box 3.1. It pays to be prepared for climate change
Vietnam is one of the most typhoon-lashed countries in Asia. Every year, an average of four seaborne typhoons and many more storms wreak havoc on this low-lying country. Planting and protecting mangroves will help protect the coastline from current extreme events and future climate change as well as conserving biodiversity. Since 1994, the Vietnamese Red Cross has planted 12,000 hectares of mangroves, at a cost of US$ 1.1 million. The benefits are enormous for the coastal zone ecosystems, economy and people: the project has helped reduce the cost of dyke maintenance by over US$ 7 million per year. Lives, possessions and properties have been saved from floods. And an estimated 7750 families have benefited from selling the crabs, shrimp and molluscs that mangrove forests harbour.
Source: World Disasters Report, 2002, International Federation of Red Cross and - Crescent Societies.

Mitigation options may have positive or negative impacts on biological diversity, depending on the specific characteristics of the case concerned. Further, there may be other non-carbon impacts on sustainable development, besides impacts on biodiversity, which might need to be taken into account. For example, converting non-forest land to forest would typically increase the diversity of flora and fauna, except in situations where biologically diverse non-forest ecosystems (such as native grasslands) are replaced by forests consisting of just one or a few species. The inclusion of additional activities such as reduced grazing, forest management practices such as reduced impact-logging and increased rotation time, and agroforestry could provide incentives for the conservation and sustainable use of biological diversity. However, without screening certain other additional land uses, land use changes and forestry (LULUCF) activities (such as fertilization of natural ecosystems defined by their low-nutrient status or irrigation of water-limited natural ecosystems) could lead to negative impacts on biological diversity.

3.6.2. Links between land use and the convention to combat desertification

Desertification means land degradation in arid, semi-arid and dry sub-humid areas as a result of various factors, including climatic variations and human activities (UNCCD, 2004). It involves the loss of biological or economic productivity and complexity in croplands, pastures, and woodlands. Desertification is mainly caused by climate variability and unsustainable human activities. The most commonly cited forms of unsustainable land use are overexploitation, overgrazing, deforestation and poor irrigation practices (UNCCD, 2004). Seventy per cent of the world's drylands (excluding hyper-arid deserts), or some 3600 million hectares, are degraded (UNCCD, 2004). Desertification has its greatest impact in Africa. Two-thirds of the continent consists of desert or drylands. While drought is often associated with land degradation, it is a natural phenomenon that occurs when rainfall is significantly below normal recorded levels for a long time.

Measures in CCD: Synergies and constraints with UNFCCC

Over the course of time, dryland ecology has become attuned (autonomous adaptation) to the variability in moisture; plants and animals can respond to it rapidly. People have learned to use the dryland's natural resources with age-old strategies such as shifting agriculture and nomadic herding. However, in recent decades these strategies have become less practical due to changing economic and political circum stances, population growth and a trend towards more settled communities. Following the CCD convention 'combating desertification' includes activities that are part of the integrated development of land in arid, semi-arid and dry sub-humid areas for sustainable development. When land managers cannot or do not respond in a flexible manner to climatic variations, degradation is often the result. Furthermore, the relatively low priority given to environmental protection within land use decisions often leads to desertification as well. There is increasing evidence that the climate is becoming more variable. However, whether this is due to to global warming is far from certain (Kabat *et al*., 2003). Measures to combat desertification are in part a strategy to cope with present-day climate variability but also a significant step towards coping with any further impacts of climate change.

Desertification and mitigation measures to climate change

Land-use change options to combat desertification could be combined with the enhancement of carbon sequestration (forestry). Some authors (Pandey, 2002) argue that agroforestry systems as options for climate change mitigation have more secondary environmental and socioeconomic benefits than other terrestrial mitigation options, such as reforestation or afforestation. Agroforestry systems have short-term, secondary environmental benefits such as helping to attain food security, securing land tenure in developing countries and acting as a corridor between protected forests (Pandey, 2002).

Desertification and adaptation measures to climate change

Climate change, drought and desertification should not be confused or used interchangeably (El Hassani, 2002). However, there are interrelations between the coping strategies for all of these issues. Most of the measures mentioned to cope with desertification (Table 3.1) have positive synergies with adaptation options to climate change. The most important interrelations are found between risk-reducing management strategies, water resources management and land-use change options.

However, not all countries have equal access to all of these options. Furthermore, the synergy between climate change adaptation and desertification measures depends on the socioeconomic and biophysical characteristics of a country. For example, the vulnerability to drought in different countries depends on the degree of exposure to aridity and the availability of drought management policies. Drought management is only beneficial as an adaptation option to climate change if it is regarded as a risk management process with an emphasis on monitoring and managing emerging stress conditions and other hazards associated with climate variability (El Hassani, 2002; see also Box 3.2). Drought management should not be regarded as a means of managing a temporary crisis.

Box 3.2 Dought relief programme in Morocco (El Hassani, 2002)

For the 2000 national drought relief programme in Morocco, the government initially budgeted a domestic fund of about $US 650 million for drought relief and preparedness activities over the 15-month period from April 2000 to July 2001. This was an important core fund which accounted for one-third of the whole annual investment budget of the country. The fund was disbursed as follows: 9.4% for the drinking water component, 19.4% for livestock feeding and sanitation, 60.5% for job creation in rural areas, 4.5% for stabilization of market prices of cereal grains, 3.8% for limiting forest degradation, 1.8% for the agricultural credit relief and the remaining 0.5% for communication and public awareness. There was also a pilot crop insurance subprogramme to cover the risk of cereal crop failure in the drought-prone areas of the country. Although this programme was relatively successful, it still managed drought as a 'temporary crisis', rather than as a 'risk management process'.

3.6.3. Links between land use and the Ramsar convention

The Convention on Wetlands is an intergovernmental treaty adopted on February 2, 1971 in the Iranian city of Ramsar. It has become popularly known as the 'Ramsar Convention'. Ramsar is the first of the modern global intergovernmental treaties on conservation and the wise use of natural resources. More than 1310 wetlands, covering some 111 million hectares, have been designated for inclusion in the List of Wetlands of International Importance.

Wetlands are broadly defined as a variety of shallow water bodies and high groundwater environments that are characterized by permanent or temporary inundation, soils with hydric properties, and plants and animals that have adapted to life in saturated conditions (Lewis, 1995). Wetlands are essential components of the environment. They provide support for the existence of aquatic and terrestrial wildlife, environmental goods (e.g. water, food) and services (such as flood attenuation and depletion of organic pollution). These are important services for many people worldwide, particularly the rural poor, who depend directly on natural resources or benefit from ecosystems. Providing water for the environment and for people are one and the same (Acreman, 2001). Indeed, the situation is often presented as a conflict of competing demand, as though it were a matter of choice between water for people and water for wildlife. However, since the United Nations Conference on Environment and Development (UNCED Conference) in Rio in 1992, it has become increasingly recognized that the 'environment' means far more than just wildlife, although the need to conserve biodiversity is widely accepted.

Measures in RAMSAR: Synergies and constraints with UNFCCC
The goals of wetland conservation and the wise use of wetlands are unlikely to be achieved without taking climate change into account. Wetlands are critically important ecosystems that provide globally significant social, economic and environmental benefits. Further, efforts to respond to climate change may have equally negative, and compounding, effects on freshwater and coastal zone ecosystems. Conserving, maintaining or rehabilitating wetland ecosystems can be a viable element to an overall climate change mitigation strategy.

Measures in RAMSAR: Synergies and constraints with UNFCCC (adaptation)
- Take into account wetland temporal and spatial global interconnections within current wetland management strategies. Wetland management approaches should incorporate a number of interconnected processes (migratory waterfowl and colonization/extinction events) that are, however, geographically or temporarily separated.
- Integration of wetland conservation within the region/watershed instead of the creation of highly protected natural reserves surrounded by non-natural territory (Amezaga et al., 2002). Wetland ecology is dependent on watershed surface run-off and groundwater discharge and the functional importance of neighbouring habitats. Therefore the water use strategy of the region/watershed should include the requirements set by the existence of a nature reserve. At the same time wetland areas should become a guarantee that the water resources are properly managed. A critical step towards achieving integrated water management will be addressing the conflicts created by the need to harmonize multiple necessities.
- It is generally understood that the most effective method for coping with the adverse effects of climate change is to remove the existing pressures on wetlands and to improve their resiliency.

These measures are, in a way, similar to measures to reduce habitat fragmentation as mentioned under the CBD convention (paragraph 3.6.1 of the CBD convention) on both a regional and a global level. There are a lot of positive synergies between adaptation measures related to direct climate change effects on ecosystems and those related to wetland conservation measures. However, adaptation measures within other sectors such as agriculture or water management could have negative impacts on goods and services from wetlands.

Measures in RAMSAR: Synergies and constraints with UNFCCC (mitigation)
- The restoration of wetland basins through the re-establishment of aquatic vegetation, as well as soil carbon restoration in riparian zones and uplands that may be cultivated, is another important element of an integrated strategy to address climate change.

Although wetlands are known to play an important role in the global carbon cycle, their full role is not yet completely understood. Wetlands play an important role in carbon and nitrogen storage, and are also natural sources of greenhouse gases (GHG) such as methane (CH_4) and sulphur dioxide (SO_2) (Sahagian and Melack, 1998). Wetlands are important reservoirs of carbon, representing about 15% of the terrestrial biosphere carbon pools (Bolin and Sukumar, 2000; Patterson, 1999). When boreal forests and some tropical forested wetlands are included as wetlands, this figure comes to about 37% of the terrestrial carbon pool (Bolin and Sukamar, 2000).

It is clear that drainage, conversion to agricultural use and degradation of wetlands will release large quantities of carbon dioxide and, depending on the peat, other greenhouse gases like N_2O and CH_4. A wetland's ability to store carbon is related to its hydrology and the associated level of the water table, its geomorphology and the local climate (Patterson, 1999; Sahagian and Melack, 1998). There are few opportunities to augment the accumulation of carbon in wetlands by improved management. Drainage of forested peatlands, largely concentrated in boreal regions, can significantly enhance tree growth, but the net ecosystem carbon changes are less clear; some studies report large net gains while others indicate large net losses of carbon to the atmosphere (see review by Zoltai and Martikainen, 1996). A more important mitigation measure, from the perspective of atmospheric CO_2, is the preservation of the vast carbon reserves already present in peatlands (van Noordwijk *et al*., 1997; Page et al.*,* 2002).

3.6.4. Links between land use and the United Nations Forum on Forests

The 2001 United Nations Forum on Forests (UNFF) was established to develop global forest policy and is expected to make recommendations for a legal agreement that will include definitions and measures for sustainable forest management (see also Section 8.2.3). These recommendations will build on past initiatives, including the International Tropical Timber Agreement, the Forest Principles adopted at Rio in 1992 and the work undertaken by the Intergovernmental Forum on Forests and the Intergovernmental Panel on Forests. The work of this Forum is complemented by the 1992 Convention on Biodiversity (paragraph 3.6.1)

The UNFF succeeded in carrying out a five-year period (1995-2000) of forest policy dialogue facilitated by the Intergovernmental Panel on Forests (IPF) and the Intergovernmental Forum on Forests (IFF). In order to achieve its main objective, UNFF main task is to facilitate the implementation of forest-related agreements, as well as acting as multistakeholder dialogues among governments and international organizations, including major groups, as identified in Agenda 21.

UNFF measures: Synergies and constraints with UNFCCC
No clear measures are advocated in the UNFF, but recommended areas for action were identified from the stakeholder dialogues:
- institutional measures, and
- measures to implement, monitor and evaluate national forest programmes in the context of sustainable development.

The UNFF panel encourages countries to work in these areas in such a way as to be consistent with national, subnational or local policies and strategies. Given this approach, it is clear that synergies can be reached when criteria for terrestrial sink projects, as mentioned under the UNFCCC, are incorporated within the national forestry programmes. Waterloo et al. (2003) identified eight generic criteria for CDM forestry projects after studying 14 sets of guidelines and criteria used by international organizations for forestry-related projects, as cited below.

1. <u>Additionality</u>: For claiming and receiving certified emission reductions (CERs) through a CDM project, it is necessary to demonstrate that the emission reductions obtained through such projects are additional to the ‘business as usual’ scenario in the country concerned.
2. <u>Project Framework</u>: This includes a comprehensive policy required for ensuring the implementation of a project as planned.
3. <u>Verifiability</u>: The implementation of a CDM project has to be monitored and controlled so as to ensure that the management and realization are in accordance with the planning.
4. <u>Compliance</u>: The host countries have to accept the CDM project voluntarily and these should take on board the local regulations and treaties, and be compliant with the provisions of all relevant international agreements (e.g. UNFCCC and CBD).
5. <u>Environmental sustainability</u>: Carbon sink projects should not have negative impacts on the environment or on the ecosystems and their functions and processes.
6. <u>Socioeconomic sustainability</u>: The activities undertaken by implementing a CDM project should not lead to negative impacts on the communities and people living around the project area.
7. <u>Sustainable Forest Management (SFM)</u>: The main targets of this criterion are the protection and conservation of pristine forests by preventing illegal harvesting and settlement. A second aim is to conserve and enhance the biodiversity by creating viable habitats and conditions for the species living there.
8. <u>Transparency</u>: The measures undertaken within the CDM project have to be comprehensible and understandable. The public should have access to results and impacts and have an insight into the project’s methodology and activities.

Adoption of these criteria serves the goals of both UNFF and UNFCCC by minimizing the risk of project failure, providing guarantees relating to the permanence of the sink (e.g. through socioeconomic and environmental sustainability), and ensuring additionality and eligibility to receive CERs.

The study focussed exclusively on certified emission reductions. It excluded the voluntary market and did not account for emission reduction that could be achieved via changes in forest management. So the adoption of these criteria also has a large impact on both the forest sink capacity (through forest land available for sink activities) and sequestration costs. The criteria reduce the scale of potential forestry sector CDM projects by a magnitude of about 3-5 (Waterloo et al., 2003). The costs of CDM afforestation/reforestation projects and forest conservation projects vary between countries but generally range between 4-10 US$ per tonne of carbon (US$/tC) when no criteria are adopted and 8-32 US$/tC when these criteria are enforced. The costs are lowest in African and some Asian countries, and highest in South American countries (Waterloo et al., 2003).

3.6.5. International conventions and land use: synthesis

From Table 3.1 it is clear that land use measures identified within the environmental conventions could have many positive synergies. Combining strategies to achieve the goals will provide a lot of countries with economic, social and ecological opportunities. We will focus on the links with the UNFCCC convention, drawing a distinction between adaptation and mitigation. The analysis is structured along four main categories of land-use related measures: land use change, technical measures to improve land use, capacity development and policy instruments, and integrated multifunctional measures.

It should be noted that most of the identified land use measures linked to environmental conventions (Table 3.1) are scale-dependent and may vary from individual households to local communities to catchments, as well as from national to international scales.

Table 3.1 Environmental Synergies and constraints between conventions

Measure (convention)	CCD	Ramsar	CBD	UNFCCC (climate potential) Adaptation	Mitigation
Land use change					
• provision of alternatives to slash-and-burn agriculture	+	0	0	?	+
• afforestation and reforestation	+	0	+/-	?	+
• introduction of agroforestry ecosystems	+	+/-	+/-	0	+
• reclamation of severely degraded cultivated land, where appropriate	+	0	0	+	+
• establishment of refuges, parks and corridors to allow migration of species	+	+	+	+	0
• restoration of wetland basins		+	+	+	+
Technical measures to improve land use					
• use of captive breeding and translocation in conservation	0	0	+	+	0
• introduction of new species and varieties with a capacity to tolerate salinity and/or aridity in agriculture	+	0	+/-	+	0
• better crop management using improved seeds, weed control and pest management	+	0	+/-	?	0
• better rainwater management to reduce run-off	+	+	+	+	0
• aero-seeding over shifting sand dunes	+	0	0	+	0
• narrow-strip planting, windbreaks and shelterbelts of live plants	+	0	0	+	0
• build-up of soil organic matter and related biological activity	+	+	+	0	?
Capacity development and policy instruments					
• risk-reducing strategies e.g. early warning systems for droughts	+	+	0	+	0
• education of farmers	+	+	+	+	+
• stimulation of conservation of in-situ biodiversity of both wildlife and origin species of agricultural crops	+	0	+	+	0
• taking into account the temporal and spatial global interconnections between wetlands	0	+	+	+	0
Integrated multifunctional measures					
• conservation of ecosystems (=protection against augmenting pressures)	+	+	+	+	+
• poverty reduction	+	0	0	0	0
• integrated water resources management	+	+	+	+	0
• prevention of soil erosion	+		+	+	0

Land use change

Terrestrial sink activities under the UNFCCC convention, such as afforestation, reforestation and agroforestry systems (Table 3.1) could have positive or negative synergies with the CBD and Ramsar conventions, depending on the specific characteristics of the case concerned.

The development of a shared framework with socioeconomic and ecological criteria serving the goals of UNFCCC, the CBD and Ramsar provides an opportunity for many countries. A shared framework will minimize the risk of project failure, provide guarantees relating to the permanency of the sink (e.g. through socioeconomic and environmental sustainability), and ensure additionality and eligibility. Further, there may be other non-carbon impacts on sustainable development, besides the impacts on biodiversity, which need to be taken into account. For example, agroforestry systems have short-term, secondary environmental benefits such as helping to attain food security, secure land tenure in developing countries, and act as a corridor between protected forests (Pandey, 2002; see also Chapter 2).

The measures mentioned in Table 3.1 also have positive synergies with respect to adaptation strategies. They may mitigate the intensification of the hydrological cycle and in this context act as an adaptation strategy with regard to the impacts of global climate change. Increasing the area of forest and wetlands will help to increase the water-retaining capacity of certain catchments. This will decrease the vulnerability to floods and soil erosion. These types of measures can become part of a shared framework for environmental conditions to implement land use measures.

A reoccurring issue within the UNFCCC is the financing of solely incremental costs. The convention intends to focus its resources on adaptation related to human-induced climate change (see also Chapter 7). Since some adaptation options will pay off in the short term, e.g. via a reduced vulnerability to current climate variability, funding responsibilities can become confusing. In such cases, adaptation funding can also been seen as normal development assistance (see also Chapter 2).

Technical measures
The technical measures listed in Table 3.1 have positive synergies with climate change adaptation policies, but are less important for mitigation options. For example, improved crop management and improved seeds could, in combination with weather forecasting, improve production stability. The downside of any technological fix is that it may exempt land managers and policymakers from taking actions to reduce the negative impacts on the natural resources.

Most technical and non-technical options need to be taken at the farm or plot level, as this is the level at which decisions are made. This should be taken into account when considering these measures as an option for climate change adaptation within a non-climate regime. Some of the technical management options mentioned (Table 3.1) are already routinely used within land use and water management to accommodate present-day climate variability. These will also contribute towards adaptations to any impact of enhanced climate variability and climate change. However, a single and universal adaptation approach or remedy does not exist.

Capacity development and policy instruments
A shared capacity development framework for land use management that considers all interlinkages between the conventions would be beneficial. There is a primary need to enhance knowledge on the ‘preparedness of land users’ to respond to droughts and floods, but also on active carbon management.

A comprehensive policy is required to ensure the implementation of a planned, sustainable land use management. Success or failure needs to be monitored and controlled to allow timely adjustments. This implies that the land use measures undertaken within all these conventions have to be comprehensible for international institutions, involved parties and other interested persons.

However, such strategies tend to introduce biases. For example, they favour ‘hard’ measures (e.g. sea walls) over ‘soft’ measures (e.g. institutional disaster preparedness) or the protection of natural areas/resources (e.g. mangrove forests in the coastal zones in South-East Asia) that provide natural protection against extreme events. This is not only due to the difficulties in monitoring the effects of land use management, but also because the co-benefits are difficult to quantify and attribute to a single activity.

Integrated multifunctional measures
Integrated strategies to conserve freshwater resources, prevent soil erosion and conserve ecosystems are often seen as a major solution within environmental conventions. The measures that enhance both ecological and human resilience in vulnerable settings are therefore crucial for mitigating the growing risk of climate change and climate-related disasters (floods and droughts). However, the need for integrated strategies to overcome sectoral and international institutional barriers should be borne in mind.

3.7 Conclusions and recommendations

Land use is an integral part of the climate-change policy arena. Climate change is intrinsically connected to all international environmental conventions. Working towards a more sustainable use of the natural resources is already the main aim of most environmental conventions. Both international and national policies should look for synergies that strengthen this objective.

Following the structure of this chapter we will start with policy options that contribute to the wise use of resources at the national scale and end with priorities for how international conventions can work together.

Four policy areas are defined:
1. policies aimed at conserving natural resources;
2. policies aimed at the sustainable use of natural resources;
3. trade and finance-related policies;
4. international conventions.

3.7.1. Policies that aim at conserving natural resources

Protecting areas is perhaps the most common strategy used to protect biodiversity and freshwater resources. Allocating functions to land and restricting the use to these functions, e.g. nature reserves, buffer zones and ecological main structures, has been applied with relative success in both industrialized and developing countries. However, allocation is often done top-down, with the result that the local populations are deprived of their land uses.

This strategy may involve buying land and/or compensating landowners, making it a costly option. When functions are allocated and habitats protected, other options are cut off, albeit sometimes on a temporary basis. Therefore strict conservation is not always the best option by far.

From a climate perspective, the conservation of ecosystems will mostly go hand in hand with the conservation of carbon in ecosystems. If it is not defined in a dynamic context, conservation could result in poor investments. Climate change will change the environmental conditions and so far it is not clear whether existing systems are resilient enough to respond to these changes. The protection of fragile ecosystems will be crucial to conserve biodiversity, but a dynamic and changing environment could overrule efforts made to conserve these systems in their current location.

3.7.2. Policies aimed at the sustainable use of natural resources

Many environmental interactions in agriculture and forestry take place at the field or plot level. Consequences of these actions can, however, be felt on higher scales as well. Surface water and groundwater pollution, soil erosion and climate change can all be directly linked to human activities on this low scale. For agriculture it is the farming system that provides the interface with policymakers. For forestry it is the silvicultural regime and its goals that provide the interface with policymakers.

Policies aiming at reducing the effects of land management can be either restrictive or stimulating. In Europe, for example, restrictive policies are used to regulate the use and application rates of fertilizers and pesticides in agriculture.

Policies that create incentives to stimulate desired behaviour by land managers are more difficult to define, as the relation to the measure and desired goal is not always direct. Policies should stimulate adaptive management and create a flexible approach that allows region-specific and location-specific solutions. This approach would generate a more diverse range of management options.

It is clear that a multifunctional approach to land use will enable an optimal mix of uses to be achieved. Under these mixes (for forestry: bioenergy plantations, long rotation forestry, employment, biodiversity, wood products, recreation, carbon sink, regulation function and protection function) real sustainable development can be a3chieved. These mixes can only be achieved locally by adapting the mix to local circum stances. The international conventions can provide a framework for this.

3.7.3. Trade and finance- related policies

Agriculture and forestry are economic activities, and in many African countries are the main economic activity, contributing to more than half of GDP. Price policies, such as taxes and subsidies for inputs and produce, can have a large impact on the direction and arrangement of production systems. On the global scale, the WTO defines the economic context, while, on lower scales, national and regional policies provide incentives to invest in agriculture and forestry. Economic policies are the main driver of many agricultural activities. The stimulation of fertilizer use or high production levels are common policies. Providing credits to farmers to help them survive through poor years and to enable them to buy the necessary inputs are also well-known mechanisms.

How the effects of natural disasters should be dealt with, in general, and in the light of climate change, in particular, is becoming an increasingly important issue. In both industrialized and developing countries, the management of risk through a combination of public and private capital is becoming increasingly expensive.

A clear danger of financial mechanisms and trade policies is that they may stimulate inappropriate land use and result in strong institutions that are difficult to change. Financial compensation requires a financial system that can reach the target groups.

3.7.4. Links International conventions

International conventions are intergovernmental treaties that bind signatory governments. The effectiveness of these conventions highly depends on the political weight and legal clout of these treaties. However, even when the convention is weak it may provide an important guideline for policy-making. International environmental conventions are crucial in addressing global problems such as energy, deforestation, population growth and climate change. These conventions can be seen as a first step towards the global governance of the environment.

Despite a large synergy between the goals of the environmental conventions discussed, combining the different conventions is not necessarily a logical step. At present, work on the various conventions is moving in more or less the same direction but at a different pace. This diversity allows for fast-moving tracks and successes.

The downside is that this diversity may result in complex agreements and structures, which in the worst case might even be counterproductive. Clarity on mandates and overlaps is urgently needed to avoid duplicate work and frustrating results (see also Chapter 2).

3.7.5. Cross-cutting issues

Monitoring will be required for all policy options to either compensate or stimulate land managers' actions. It is not always clear what should be monitored. A direct approach can be used for stimulating actions, as this is instantaneous. When effects are rewarded, results may be difficult to measure, as these may require longer timescales and, moreover, the relation between an individual activity and the result can often be difficult to establish.

Land managers are not necessarily the landowners. Legal and customary forms of land tenure and land rights can be a barrier to the implementation and operationalization of policy measures. Gender and political weight are important factors in this respect.

The enforcement of rules and regulations will require a strong government. A major concern is that widespread corruption will undermine the credibility of incentives to land managers, not only by diverting flows of money but also because these flows will stimulate corrupt behaviour. Financial institutions should be equipped to transfer money to land managers. This will need a clear administrative and regulatory environment as well as a credible enforcement.

3.8 Closing remarks

Climate change will underline the urgency of moving to a more sustainable use of resources, including the recycling and reuse of products. Closing the carbon and nitrogen cycles will become a guiding principle in rearranging production and processing chains. Economic growth is the main, if not the only, route to sustainable development and poverty eradication. Natural resources provide the basis for development in many developing countries. The use and conservation of these natural resources should be supportive of economic development and not hamper it. Sound management of soil and water is the core of sustainable land use.

With the globalization of consuming markets, consumers will increasingly determine the demand for products and how these are produced. Industry and producers can try to market production and pro-cessing strategies and methods. Policy can be aimed at stimulating the uptake of technologies and production methods through taxes and subsidies. In regions that contain biodiversity hotspots or have other values worth preserving, different incentives (e.g. agro-environmental schemes) are needed to maintain or enhance these qualities.

The effects of changes in regional development on economic, social and environmental aspects will need to be monitored and evaluated so that the development process can be adjusted or adapted.

Policy should encourage the transition to a sustainable economy. This can only be done in cooperation with producers, consumers and scientists. Because economic development does not automatically lead to cleaner products and production processes, policies should promote the transition to more sustainable production systems. Climate-related indicators such as emission profiles and vulnerability indices are part of a large group of sustainability indices.

In the long run, market processes will determine land use changes in the EU. In some areas agriculture and forestry can keep up with global competition and local pressures for land for non-agricultural uses. How this will contribute to or hamper climate goals is not clear. In regions where market failure results in undesired social (e.g. abandonment) and environmental (e.g. loss of biodiversity) effects, adjustment policies may be needed. From a land use perspective, the sustainable use of renewable natural resources is an interesting option for economic growth. A bio-based economic development will not only require restructuring of land-based systems such as agriculture and forestry but could also trigger other production systems, e.g. aquatic based ones.

The introduction of new technologies and changes in the processing of biomass, e.g. extracting half products for industry, offers new opportunities for food and fibre production. Changes in production and processing will require dramatic changes in system design and technologies.

Human activities are strongly linked to relatively small scales such as plots or fields. Policies aimed at the conservation or sustainable use of resources and policies that provide financial incentives, need to link to this scale. For land use systems it is the household level that provides the entry point for policy and man-environment interactions.

Strong institutions and political will are prerequisites for protecting and safeguarding global goods and services such as biodiversity, air, water and soil. Environmental conventions that promote the integrated management of natural resources form the basis for both global and local action.

The UNFCCC should stimulate local actions rather than focus on global-scale processes. Acknowledging and responding to the fact that climate change is only one factor that determines our future, can result in local initiatives that benefit local development and at the same time serve climate goals.

A more market-oriented economy requires a strengthened relationship between policy and business through commodity chains. Linking commodities to regional production areas will also place the responsibility for the sustainable development of such regions with the stakeholders in the commodity chain. An indicator approach in which climate-related aspects such as mitigation and adaptation are addressed, can be used to evaluate the sustainability of production and processing chains.

International agreements require a long-term vision on how to govern the global environment. One of the long-term goals could be combining the different environmental conventions. However, conventions should lead to actions. The Millennium Development Goals already provide a general framework with quantifiable usable goals. Synergies between conventions can be worked out in a regional context. Integrated approaches are needed. Combining processes that are already operational, should not result in lost time but should enable a fast-track approached based on the no-regrets principle.

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4. The Energy supply security and climate change

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Abstract

Security of energy supply (SoS) and climate change mitigation (CCM) both consider fuel mix and technologies. SoS and CCM objectives may be conflicting, so policies should be coherent. This chapter's objective was to find the preferred options and give recommendations for an integrated SoS and CCM policy. After a short introduction to security of energy supply and connections to climate change mitigation background information on the SoS policy field was presented. Energy dependency indicators both for today and the medium-term future (2025-2030), for six regions (EU, USA, Brazil, China, India and Japan) were subsequently described. The starting situation for each region is specific - a factor that will have to be addressed in policy development. SoS-enhancing measures mainly based on those currently applied in the EU, USA, China and Japan were then overviewed. CCM impacts were assessed and several other considerations that could make the measures more (or less) preferred options discussed. The assessment yielded a set of preferred policy options. Finally, several platforms to enhance coherent policy implementation were analysed. The main conclusion and recommendations were that integrating SoS and CCM asks for a policy package aiming at demand reduction, cleaner fossil fuel use, application of renewables (RES), and incentives for developments of new clean techniques. International cooperation and communication between fuel exporters and fuel importers will help to streamline their sometimes conflicting interests.

4.1 Introduction

There are many prevailing notions and definitions of the SoS concept. According to the Green Paper (Towards a European Strategy for the Security of Energy Supply (EU, 2000), for the well-being of a country's citizens and for the proper functioning of the economy, the main objective of an energy strategy should be to ensure the uninterrupted physical availability of energy products on the market at an affordable price for all consumers, whilst respecting environmental concerns and looking towards sustainable development. It is not a question of maximising energy self-sufficiency or of minimising dependency, but one of aiming to reduce the risks linked to such dependency. Energy resources that are being used right now must be taken into account in the debate. The EU itself relies heavily on fossil fuels such as petroleum (the dominant resource).[20]

In 2001 the total energy used by the world population amounted to over 420,000 PJ[21] or 10,000 Mtoe[21]. Around 80% of this energy is supplied by fossil fuels. In 2001 the combustion of this fossil fuel equivalent of 10 cubic kilometres of oil resulted in the emission of approximately 24 Gt of CO_2 (EIA, 2004), the main contributor to climate change.

Contrary to reducing greenhouse gas (GHG) emissions from fossil fuel use needed to prevent dangerous climate change, the demand for energy is still growing rapidly, being pushed by GDP[22] growth and population developments. Many countries in the world rely heavily on fossil fuel imports to fulfil their growing energy needs. Their first concern is to secure these fossil fuel supplies, rather than reducing negative impacts from fossil fuels or finding alternative fuels that do less harm to the environment.

Securing the energy supplies to meet the growing energy needs and, at the same time, reducing (the share of) fossil fuel use creates tension. The most cost-effective way to meet these growing demands would seem to increase the use of fossil fuels. However, this is increasingly thought to pose an unacceptable environmental burden.

Policies, whether they focus on securing energy supply or mitigating climate change, both affect the energy sector and the fuel mix. To ensure that SoS and CCM policies interact as positively as possible, a coherent view of both policy fields is needed and integrated targets and policies should be developed to meet both SoS and CCM objectives.

[20] Taken from europe.eu.int

[21] PJ = petajoule. Mtoe= Million tonnes of oil equivalents, 41.9 PJ equals 1 Mtoe. (Peta: 10^{15}, Exa: 10^{18})

[22] GDP = Gross Domestic Product

This chapter investigates the policy options contributing to both SoS and CCM objectives, starting from a security of supply perspective. Here, we present an overview of options for SoS policies (for the EU, USA, China and Japan) and how they affect the fuel and technology mixes. The criteria presented in Chapter 1 will help to rank the SoS measures to investigate the preferred policy options to meet SoS and CCM targets.

Methodology
A short introduction taken from several literature sources provides a framework for the study and discussion during the remainder of the chapter. The many views on SoS are discussed briefly. Subsequently we present an overview of quantitative energy dependency indicators from several literature sources showing the different starting points that regions have for policy-making. The overview shows the necessity of developing country-specific policies to meet SoS objectives. This is elaborated further in an assessment of current SoS policies in the EU, USA, China and Japan, based on official policy documents. This assessment produces three overviews, one for fuel-based policy options, one for demand-side policy options, and one for (renewable) technology options.

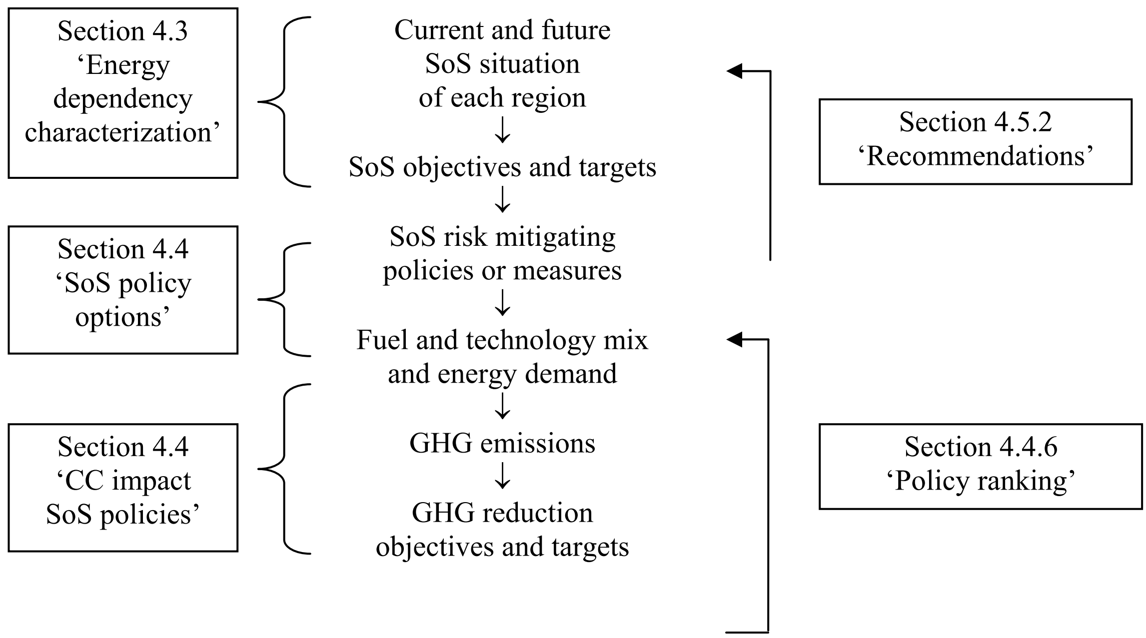
Evaluations of SoS and the environmental evaluation criteria (presented in Chapter 1) complete the SoS policy overviews. The scoring mechanism for evaluating SoS and GHG criteria are introduced and applied. Other criteria are assessed qualitatively. The scores for the SoS policies on the GHG criteria provide a means of ranking the most preferred policy options.

The chapter ends with a discussion and specific policy recommendations for integrating SoS and CCM policy and applying these recommendations and instruments to the selected country cases.

Scope
This study focuses on:
- strategic and long-term energy supply security risks and policies that have lasting effects on the fuel mix. Temporary effects of measures are assumed not to have significant structural impact on the fuel mix and GHG emissions (e.g. coal-fired power generation as backup facility in case of emergencies);
- the current policies of the four regions (the EU, USA, China and Japan);
- the current energy dependency situations of the EU, USA, China, Japan, Brazil and India;
- policy recommendations for integrating SoS and CCM objectives.

The assessment is qualitative, except for the energy indicators.[23] The following scheme shows the study approach and outlines this chapter. The steps and sequence follow the description given in the section.

[23] ECN is involved in EC FP6 project CASCADE MINTS (2004-2006). Among other activities, a case study was analysed that quantifies the impact of renewables on security of supply and climate change.



Before starting the analysis in section 4.3, we introduce the security of supply concept and several related issues in section 4.2.

4.2 Background to security of energy supply

4.2.1. Energy: a basic requirement for economic development

Security of energy supply is not an objective in itself. The Green Paper (EU, 2000) states the following higher goal when it defines the energy strategy objectives: 'for the well-being of its citizens and for the proper functioning of the economy'. Securing energy supplies means securing the supplies of an indispensable input in 21st-century societies.

For example, consider the situation in India, where the failing electricity supply is seriously inhibiting the development of the Indian economy. 'Although approximately 80% of the population has access to electricity, power outages are common, and the unreliability of electricity supplies is severe enough to constitute a constraint on the country's overall economic development.' (EIA 2003).

Energy carriers distinguish themselves from other commodity goods suppliers by the fact that their product is required as input for all activities and production processes. The essential nature of energy and the complexity of its transportation infrastructure makes securing energy supplies a far bigger issue than simply securing other commodity supplies (with the exception of water and food, for obvious reasons).

Section 4.3.1 shows that the GDP per head (often taken as a proxy for a country's development level) is highly correlated to the per capita energy use.

4.2.2. Dimensions of SoS

Historically, SoS has always referred to the safeguarding of oil supplies since the oil crisis in the early 1970s that first triggered the formation of the three-month IEA (International Energy Agency) oil reserves. Since then, many changing situations and a huge number of research reports have broadened the scope of the SoS concept. Today SoS covers a wide range of issues that include different timeframes, energy carriers, infrastructure, geopolitical relations, and market power in liberalising markets.

The following figure gives an impression of the dimensions of today's SoS (IEA 2002a; 2003a, Wood MacKenzie 1998, EU 2000, CPB 2004).

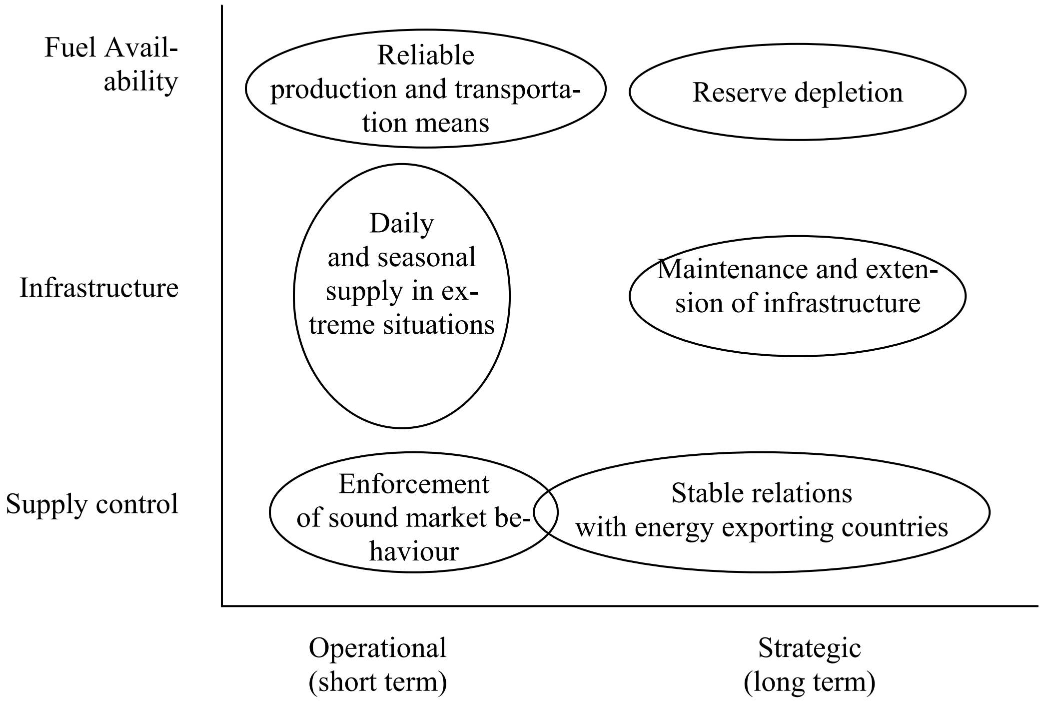


Figure 4.1 Security of supply issues

Real examples of issues (clockwize starting from lower left corner):
- sound market behaviour: bad regulation of the wholesale and retail electricity markets is supposed to be one of the major causes of the 'California crisis of June 2000' (Brattle, 2001);
  supply in extreme situations: a long period of extremely high temperatures led to 'Code Red' for electricity supplies in the Netherlands in August 2003 (www.energeia.nl);
- reliable infrastructure: contamination of the Bacton-Zeebrugge Gas Interconnector, July 2002, prevented the transportation of gas (www.interconnector.com);
- reserves depletion: in a few years the UK will be a net gas importer (reduced from almost total self-sufficiency over the past decade) (www.ukooa.co.uk/issues/economic/econ02/econ02_markets.htm);
- infrastructure extension: investment needs by the oil sector will total more than US$ 3 trillion over the three decades up to 2030 (IEA, May 2004);
- stable relations: an instable geopolitical environment led to the oil crisis in the 1970s.

The SoS perspective from an importer's point of view has been sketched above. Although one might think that energy-exporting countries have precizely the opposite interests to energy importing countries, this is not true in all cases. The interests of importing and exporting countries often coincide. Countries such as Russia (25% of GDP, EIA 2004) and Saudi Arabia (approximately 75% federal budget, 40% GDP, EIA, 2003) rely on energy-export-induced income for significant parts of their federal budgets and economic welfare. As the EIA (Energy Information Administration) states: 'Russia's economic growth over the last five years has been fuelled primarily by energy exports. (…) But this type of growth has made the Russian economy dangerously dependent on oil and natural gas exports'. The exporting countries also have security interests, the so-called 'Security of Demand'. When the exporting countries demand excessively high prices, are not reliable suppliers or impair their relations with importing countries, they may lose their major source of economic prosperity. Supplying countries also depend on the importing countries.

4.2.3. Effects of expression of risks

The expression of SoS risks refers, by definition, to a shortage in energy supplies. This may be either a relative shortage (mismatches in supply and demand inducing price increases), or a partial or complete disruption of energy supplies (also affecting prices, but with more dramatic social impact.). Oostvoorn (2003) analyses some of these direct effects of supply disruptions to major gas supply routes to the EU. This analysis focuses solely on supply disruptions. These disruptions affect the energy consumers that were supposed to receive the supplies. There are several ways to differentiate between these effects; one possibility is to split them into direct and indirect effects.

Direct effects are those that are immediately felt in our everyday lives when there is a supply disruption (when no stocks are available). Examples include economic losses due to halted production processes and hampered transportation possibilities. Urgent health problems occur when heating, cooling and cooking are not possible. The direct economic losses can be significant. A recent estimate (SEO 2003) of the economic loss due to a power outage in the Randstad region of the Netherlands was as much as € 72 million per hour during the day (the selling value of electricity being only € 1.6 million).

Indirect effects of disruption refer to those effects that are not immediately apparent. Examples include hampered economic growth, lost faith in the social or energy system and harmed relations between countries. The 1973 oil embargo induced a significant reduction in economic growth in the EU-15 countries in 1974 and a recession in the following year (Clingendael, 2004). A full quantification of indirect disruption effects is not available in the literature.

Although the economic costs resulting from supply disruptions can be huge, taking measures to prevent any possible supply disruption will generally not be cost-effective. The Dutch Central Planning Bureau (CPB) has published some assessments for the Dutch electricity market that confirm this (CPB, 2004). The costs of measures to prevent or manage disruptions must be balanced against the benefits of these measures. SoS policy is basically a matter of balancing costs and benefits and managing risks. Some countries sign 'solidarity agreements' to help each other in crisis situations (e.g. IEA, EU), but for most countries their national interests will prevail when approaching SoS issues. Platforms such as the IEF (International Energy Forum[24]) aim to balance the interests of all participating countries; both importers and exporters.

Section 4.3 provides an overview of energy security situations for six selected regions of the world, while section 4.4 discusses the available options for managing the risks, costs, benefits and impacts on GHG emissions.

4.3 Case studies on energy dependencies

A country's current situation with respect to its energy supply (and expected developments therein) has considerable consequences for the set of available and suitable policy options used to meet its SoS objectives. This section presents indicators for six regions in order to sketch the various energy supply situations. These regions are selected based on population size, CO_2 emissions, GDP (all for 2001) and the desire to show some geographical diversity[25]. The selected countries EU[26], USA, China, Japan, India and Brazil cover 54% of world population, 61% of world CO_2 emissions and 79% of world GDP.[27]

To obtain insight into the developments and future of energy situations, a number of studies are used that present numbers for different scenarios for the indicators considered here. The data used in this section are

[24] www.iefs.net

[25] IEA 2002b, CIA 2001, WDR 2003 pp. 234-235

[26] Data was not available for all EU-25 indicators so EU-15 data is sometimes used. When comparing certain data for EU-15 and EU-25, we see that the 10 countries that joined the EU on May 1, 2004 do not significantly alter the averages and developments. E.g. according to DG TREN 2003 the GDP per head for EU-25 is 87% that of EU15, and TPES per head for EU-25 is 95% that of EU-15 TPES.

[27] Russia ranks high on all of these indicators; however, as a big energy exporter with large oil and gas reserves Russia has no security of supply worries of an international dimension.

usually taken from the ‘reference scenario’ or ‘basic scenario’ values of studies implemented by institutions such as IEA and EIA. Sometimes the numbers could be used straightaway, on other occasions some processing was needed . The sources and the chosen numbers may be subject to discussion, but the magnitude of the numbers give good indications of what needs to be known for this analysis[28]. This study aims to distinguish trends rather than provide precize data for annual growth rates.

Data was not always available for all indicators for both EU-15 and EU-25 countries. When comparing certain data for EU-15 and EU-25, we see that the ten countries that joined the EU on May 1, 2004 do not significantly alter the averages and developments. (According to DG TREN 2003 the GDP per head for EU-25 is 87% that of EU-15, and TPES (total primary energy supply) per head for EU-25 is 95% that of EU-15.) As previously mentioned, we are looking for trends, not precize details.

4.3.1. Quantitative characterization of the SoS situation in different regions[29]

This section presents quantitative indicators, both for the entire world[30] and the six individual regions. The figures present data for the current situation as well as projections for 2025 or 2030 and cover security of energy supply aspects as well as CO_2 emissions. The first five figures present more general indicators such as population size, GDP and total energy use. Then two figures show the high correlation between energy use and population size and energy use relative to GDP. The subsequent two figures present numbers relating to energy use and CO_2 emissions, by showing fuel mixes, CO_2 emissions relative to GDP, to population and to TPES[31]. The figure thereafter shows the relative and geographical import dependencies per fuel per country. The last two figures present the fuel mixes for the industry and power generation sectors respectively.

Tables with more extensive data can be found in Appendix 1.

The first table shows world population development over the coming decades.

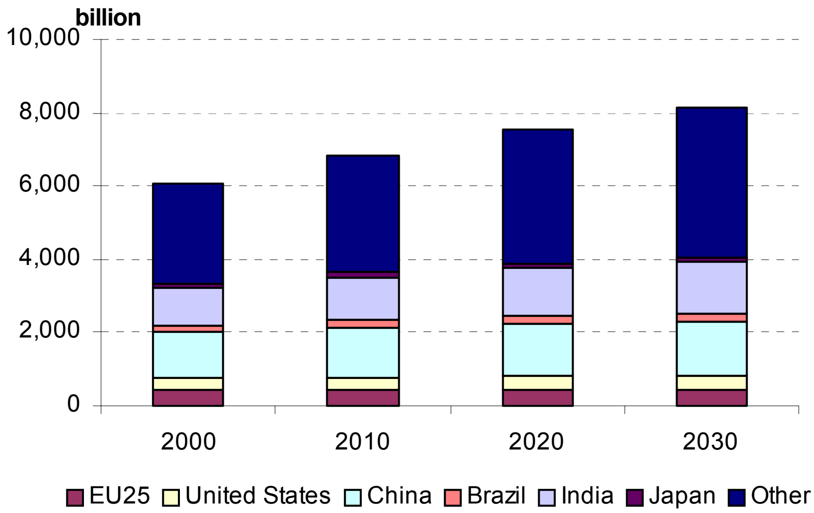


Figure 4.2 World population development with regional shares, 2000-2030 (UN, 2002; DG TREN, 2003)

[28] An indication for the spread of the projections: EIA’s low economic growth case energy consumption projection is 13% below the reference; the high economic growth case is 14% above reference.
[29] For another detailed approach to specify each country’s SoS risk, see Jansen, 2004.
[30] Data for the entire world is given as a reference and to help interpret the values.
[31] TPES: Total Primary Energy Supply

The figure shows that in 30 years the world population is projected to grow from 6 to 8 billion people, an increase of one-third. The share of the six regions considered decreases from 55% in 2000 to 50% in 2030.[32] The following figure shows the population development for each region separately.

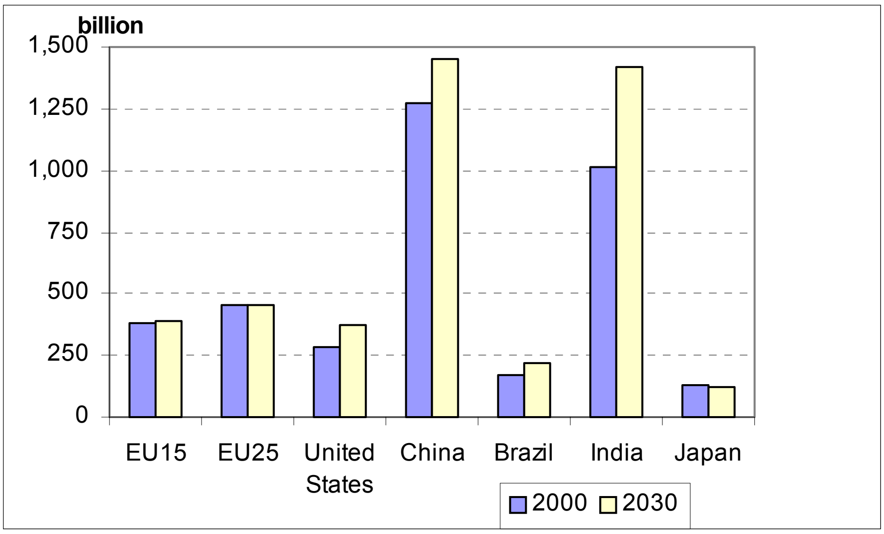


Figure 4.3 Regional population development, 2000-2030 (UN, 200; DG TREN, 2003)

The population growth rates vary considerably between the six regions. The populations of the EU and Japan are expected to stabilize (at 390 and 126 million respectively), whereas the populations of USA, Brazil, China and India will grow significantly. The increase in the Indian population is the largest (in both absolute and relative terms): plus 400 million to 1.4 billion (+39%). The second growth rate (+30% to 370 million) is for the US, and Brazil ranks third with +29% to 222 million. The Chinese population will grow by 14% to 1.45 billion people in 2030.

GDP is another measure of influence for energy use development.

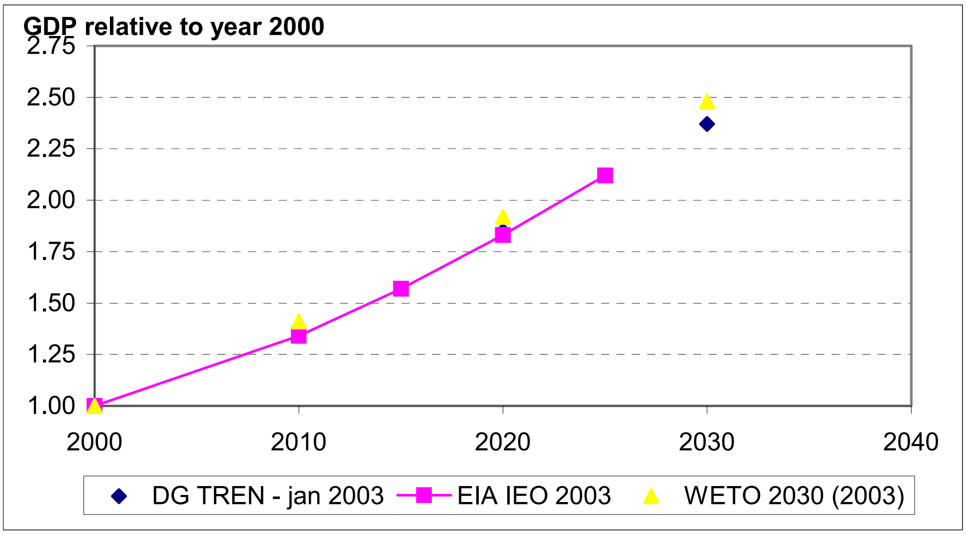


Figure 4.4 World gross domestic product development 2000-2030 (DG TREN, 03; EIA, 03; WETO, 03)

Although the three literature sources DG TREN, EIA and WETO (World energy technology and climate policy outlook) project figures in different prices and different basic years, their projected developments for the coming decades are in line with each other: World GDP in 2030 should be approximately 240% of GDP in 2000, (in real terms, i.e. purchasing power for the year 2000).

[32] For readability, we will not always use 'is projected to', but also 'will'.

The following figure shows how the division of GDP over the regions changes in the coming decades.

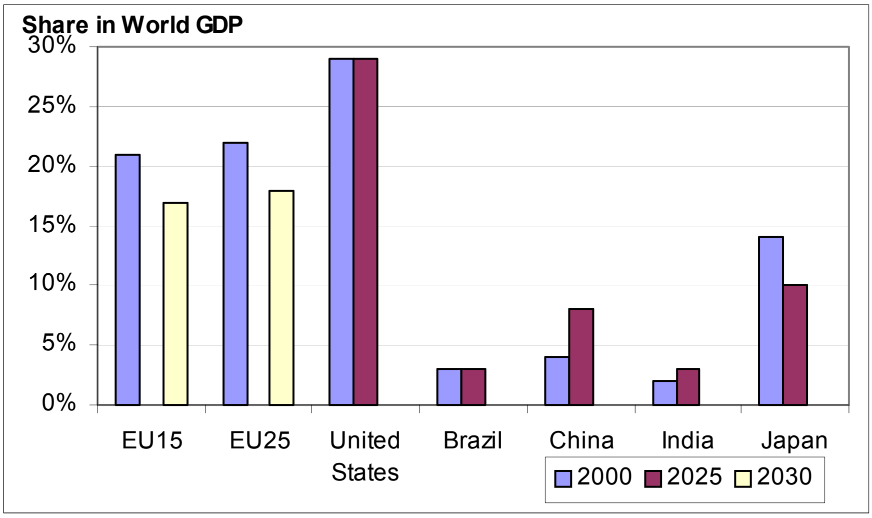


Figure 4.5 Regional domestic product development, 2000-2025/30. (DG TREN, 2003; EIA, 2003b)[33]

The percentage of worldwide GDP attributed to the EU and Japan will decrease and that of the USA and Brazil will stabilize. However, given the 140% expected increase in world GDP, all economies are projected to grow significantly. The GDP percentages for China and India grow significantly, but both GDPs remain modest in absolute terms. Even in 25 or 30 years time, the regional shares in world GDP will remain fairly stable.

The following figure shows the development of world energy use and the percentages for each region[34]

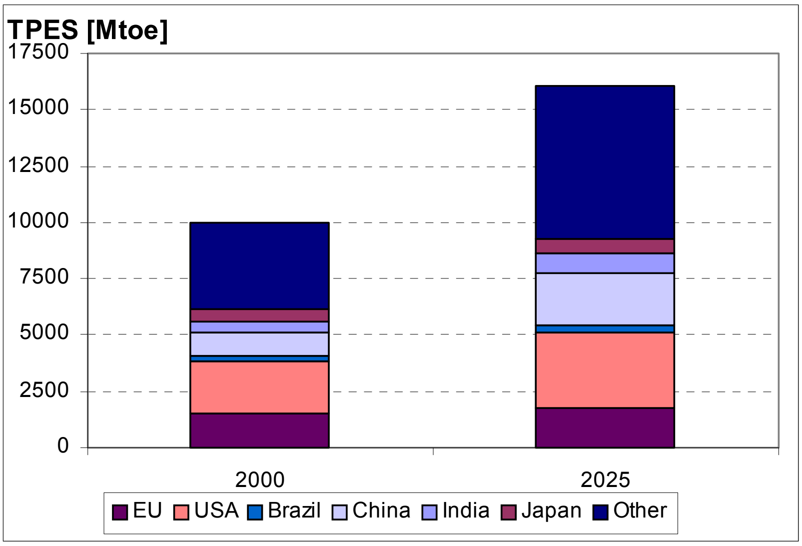


Figure 4.6 World energy use development, 2000-2025 (IEA2002b; EIA 2003b)

Worldwide energy use will increase by 60%, from 10,000 to 16,000 Mtoe (from 420 to 670 EJ). Usage in all regions will increase, but much faster in some areas than in others. Of the six regions the Chinese and US energy uses will increase most in absolute terms. The USA remains the largest energy user, consuming approximately 3500 Mtoe (146 EJ) in 2025. China becomes the second largest energy user, with over 2000 Mtoe (86 EJ), and pushes the EU into third place (1750 Mtoe, 73 EJ). Brazil doubles its TPES in 25 years to around 400 Mtoe (17 EJ) and India doubles its TPES to 800 Mtoe (34 EJ). Growth rates of the EU (+ one-sixth) and Japan (+25% to 700 Mtoe, 29 EJ) are more modest.

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[33] Note that in this figure, the EU GDP projection is for 2030, whereas for other regions these projections are for 2025.

[34] The percentages for different countries in 2025 differ considerably throughout the literature, but projections for the worldwide TPES are fairly consistent.

The energy use per capita indicates the possible impact of economie welfare on energy use, as shown in the following figure.

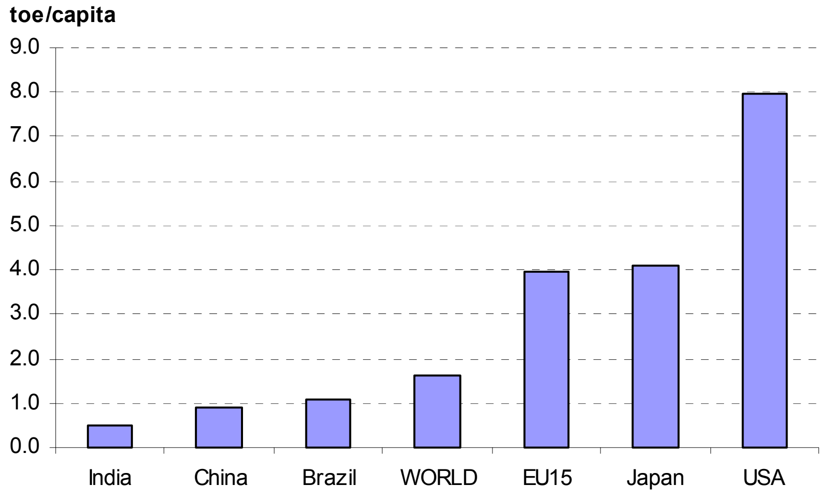

Figure 4.7 World and regional energy use per capita, 2001(IEA, 2002b)

With regard to per capita energy use, three countries (India, China and Brazil) stay well below world average (1.64) with respective values of 0.50, 0.90 and 1.07 toe per capita. EU-15 (3.94) and Japan (4.09) energy use per capita are around 2.5 times world average, whereas USA energy use per capita (7.98) is around five times the worldwide average.

The following figure shows the average energy input per economic output in tons of oil equivalents[35] per k$1995[36] (shown as 'Real' in the figure) and per k$1995 purchasing power parity (PPP), indicating the energy efficiency of a country.

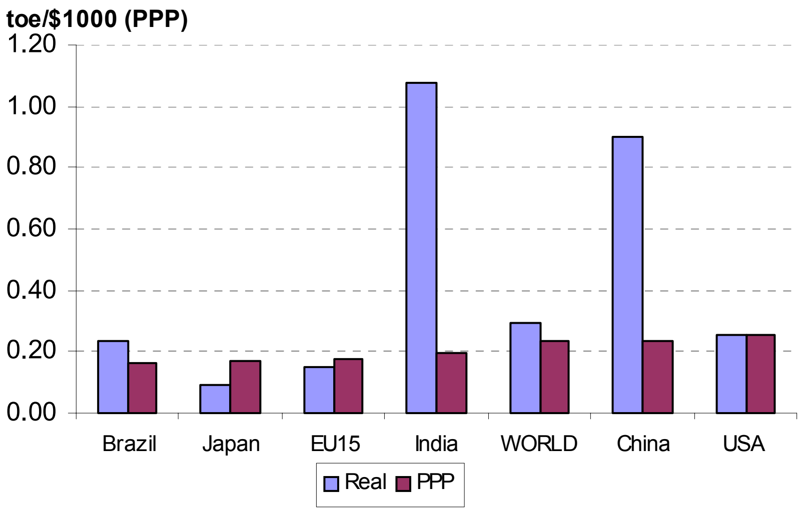

Figure 4.8 World and regional energy use relative to GDP, 2001[37] (IEA, 2002b)

[35] 1 toe = 4,297, roughly 7.5 barrels of crude oil.
[36] Per thousands of US$ at 1995 levels
[37] Note that both comparison bases yield very different figures, especially for developing countries. The explanation is that the purchasing power of the dollar (i.e. what can be bought with the local currency equivalent of one dollar) is usually higher in less developed countries. The energy input per PPP is more appropriate when translating 'what can be bought' into 'welfare' → to indicate the energy input needed to reach a certain welfare standard.

Brazil (0.162), Japan (0.167) and EU-15 (0.177) are the countries with the lowest energy intensities. India (0.196) has a higher energy intensity, but is still below world average (0.237). The Chinese value is very close to the world average (0.238). The value for the USA (0.254) is 7% higher than world average, which is quite remarkable for one of the most prosperous countries in the world. When we compare the energy intensity of the USA with the lowest value, that of Brazil, the difference indicates a 56% higher energy intensity in the USA than in Brazil.

Figures 4.7 and 4.8 indicate a relatively high energy intensity of the USA relative to population size as well as GDP.

The fuel mix shows the dependency of a country on different fuels. The following figures depict the actual fuel mixes in 2001 and projections for fuel mixes in 2025.

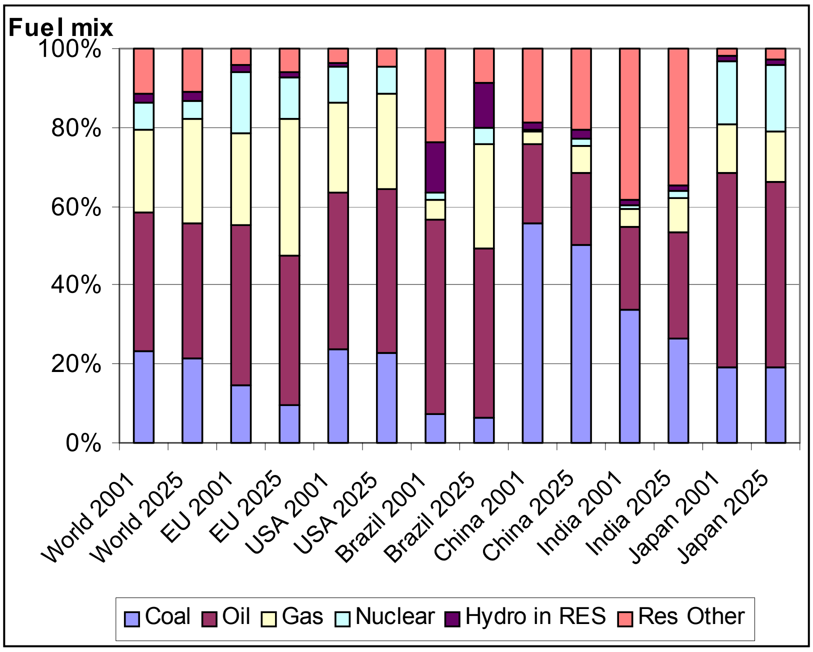

Figure 4.9 World and regional fuel mix development, 2000-2025 (IEA, 2002b; EIA, 2003b; DG TREN, 2003; WEO, 2002)

The current total fossil fuel share of the EU is 78%; the EU uses a relatively small portion of coal and more oil and gas, the nuclear and hydro percentages are larger and other RES (renewable energy supplies) smaller than world average values.

At 86%, the USA has a high fossil fuel share. All fossil fuels have high percentages. The nuclear share is also slightly higher than world average, while RES is much lower.

Brazil depends on oil for half its energy supplies. In spite of this large percentage, total fossil fuel use is quite low (61%); gas and coal shares are very low. Brazil has hardly any nuclear generation, biomass supplies[38] one-quarter of the energy, and hydro supplies the remaining 12%.

China's 80% share of fossil fuels mainly concerns coal (57%). China has a high percentage of RES (20%), mainly biomass[39].

[38] The oil crisis of the 1970s and trade balance problems were major incentives for Brazil to start biomass and biofuels programmes.

[39] Biomass in China and India is usually 'traditional biomass', i.e. fuel-wood, dung and agricultural residues for household applications.

At 39% biomass is the main energy supplier in India[39]. Coal ranks second with one-third of energy supplies. Oil supplies one-fifth, and gas, nuclear and hydro energy have very modest percentages. The total fossil fuel share is only 57%.
Japan relies heavily on fossil fuels (81%). Gas provides a modest 12%, and oil is also fairly high (49%). Nuclear power generates one-sixth of total energy. Japan uses very few RES.

Long-term outlook (2025) - In 2025 the EU is expected to use about the same percentage of fossil fuels as it did in 2000. Oil, coal and nuclear shares decrease and gas and RES rise.

The already high USA share of fossil fuels increases slightly; small shifts from coal to gas and oil. Nuclear energy generation and RES shares decrease.

Brazil still depends on oil for half its energy supplies, though the gas percentage is growing rapidly. The fossil fuel share rises to 70%. Biomass drops, while hydro stabilizes at one-eighth of TPES.

The use of fossil fuels is growing in China. The coal percentage remains high, but oil and gas will increase. The biomass share will be halved, and nuclear production will increase, but remain modest.

In India the coal percentage stabilizes at around one-third of TPES. Oil and gas shares increase significantly; biomass is reduced slightly, but stays above one-third of TPES.

Fuel percentages in Japan will be very similar to the current rates. The oil percentage decreases slightly, but the other fuels will fill the gap. Fossil fuels remain the major supply source with slightly more than three-quarters of total energy supplies.

Figure 4.10 below shows three CO_2 indicators relative to world averages. The indicators are CO_2 emissions per unit of energy, CO_2 emissions per unit of economic output and CO_2 emissions per capita.

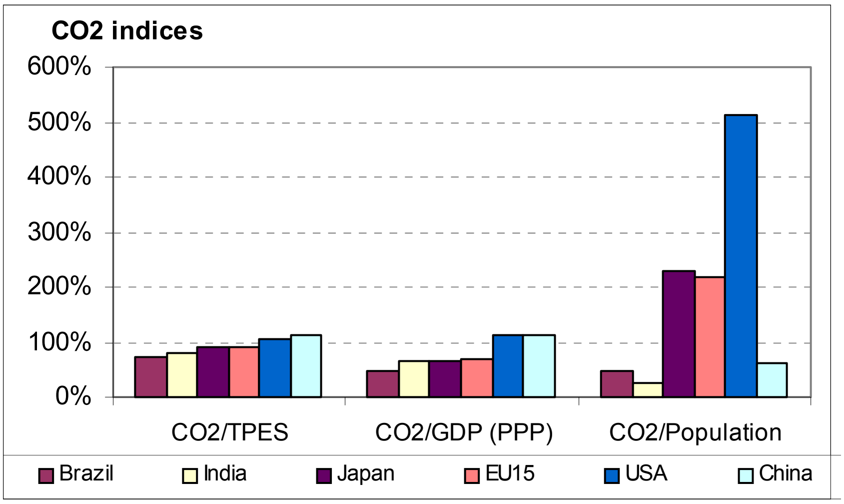

Figure 4.10 Regional GHG relative to TPES, GDP (PPP) and population, 2001(IEA 2002)

The six bars on the left present CO_2/TPES as a percentage of the worldwide average. All values are between 72% and 114%. The relationship between fuel mix and CO_2/TPES is very clear; the large hydropower share in Brazil ranks it first, with an overall score of only 72%. India ranks second (81%), probably due to the large percentage of biomass. The large percentages of fossil fuels in the USA and coal in China translate into scores of 106% and 114% respectively. The EU and Japan are in the middle with 91% and 92%, respectively. The other figures show similar picture as their TPES equivalents (Figure 4.7 and Figure 4.8), when adjusted for the CO_2/TPES nuances.

The following figure shows the geographical dimension of dependencies by displaying domestic production as well as the geographic origin of the imports by the EU, USA, China and Japan (all as a fraction of total energy use).

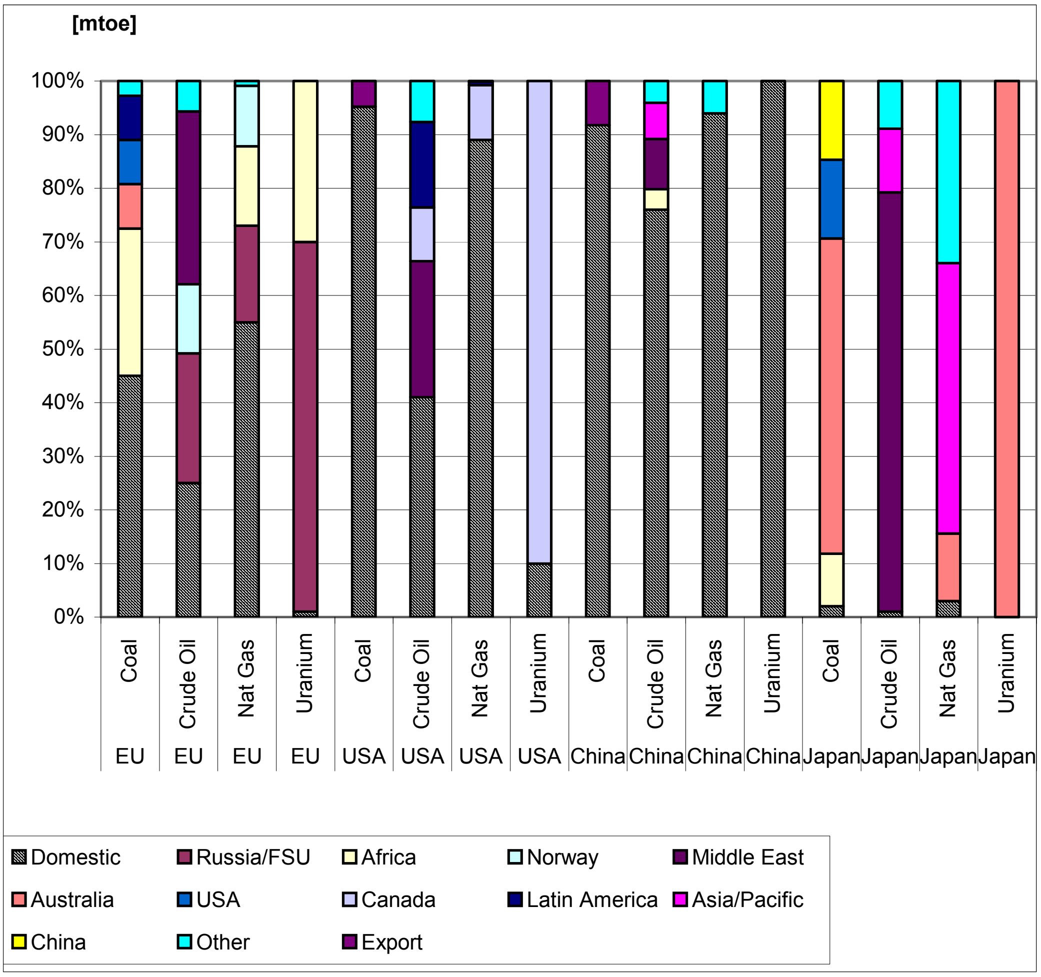

Figure 4.11 Relative and geographic import dependency per fuel per country, 2000 (Various sources)[40]

Of the 218 Mtoe (9.1 EJ) EU coal supplies, around 55% is imported, mainly from South Africa, but also from Columbia, USA, and Australia. Crude oil supplies are 620 Mtoe (26 EJ), 75% of which is imported. Around one-third of imports come from the Middle East. Other important suppliers are Russia and Norway. Of the natural gas (347 Mtoe, 14.5 EJ) used, 45% is imported. Russia supplies 40% of imports, African countries 33% and Norway 25%. The EU has no significant own uranium sources. The annual TPES of 232 Mtoe (9.7 EJ) requires that around 99% be imported, mostly from FSU (former Soviet Union) and African countries.

The USA has ample coal reserves and is a net exporter. There is significant domestic oil production, but also a large import volume (twice as much as Japan and China together). The oil import share is 59%. Over 40% of the imports originate from the Middle East, 25% are imported from Latin America and one-sixth from neighbouring Canada. The USA is almost self-sufficient in natural gas. However yearly imports of around 57 Mtoe (2.4 EJ) stem mainly from Canada (93%) plus some LNG (liquefied natural gas). Some 90% of uranium use is met by imports, mainly from Canada.

China is self-sufficient with regard to coal, and is even a net exporter. Around 25% of crude oil is imported. With 39% imports, around 10% of total use originates from the Middle East. Other supplies come from the Asia Pacific region (28%) and Africa (16%). Only 6% of natural gas is imported today (note that total gas use is limited). China is completely self-sufficient in uranium.

[40] Note that for completeness, several assumptions were made if the origins of supplies were not known. The exact data, as far as known, can be found in the appendix.

Japan imports at least 97% of its domestic fuel consumption. Coal imports add up to 98%, Australia being the main supplier (60%), though other suppliers include China, South Africa and USA. Crude oil is mostly supplied (79%) from the Middle East and 12% from more neighbouring countries in the Asia Pacific. Natural gas supplies originate from Indonesia (33%), 20% from Malaysia and 12% from Australia. Uranium supplies are probably all received from Australia. The high import share for fossil fuels is the main reason for the high fuel prices (IEA 2000).

India and Brazil are not incorporated into the global picture. India imports 70% of its crude oil, 9% coal, no gas (30% of all fossil fuels are imported) and probably some uranium. Brazil imports 20% of its oil, 84% coal, 44% gas, and 32% of all fossil fuels.

Fuel mixes of sectors can differ significantly from national averages, exposing some sectors more to external supply risks than others. The figures below depict the fuel mixes for industry and power generation. As transport's dominant fuel is petrol (90-95%) and heat generation is minor compared to power generation, these sectors are not included in the main text, but are presented in the appendix.

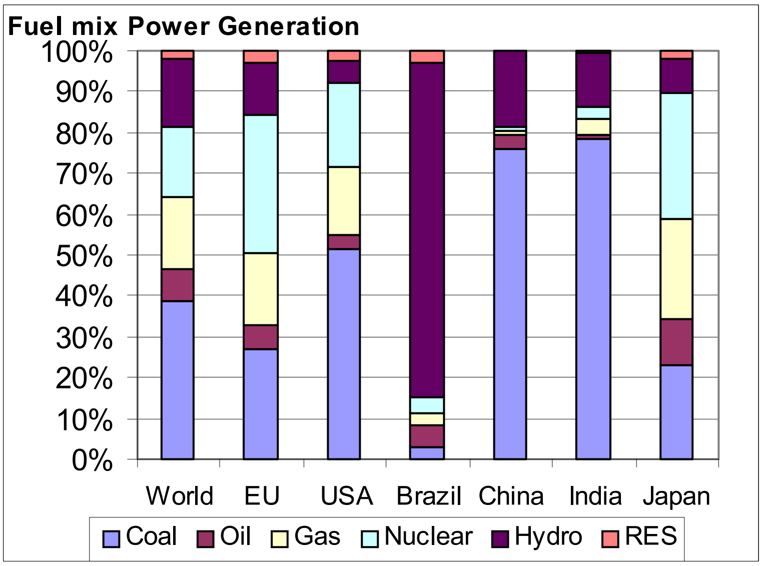

Figure 4.12 Regional fuel mix for the power sector (2001) (IEA 2002b)

Total 2001 world power output was 15.5 PWh[41], equivalent of 1333 Mtoe[42]. Coal is the major input, contributing 39%. Gas, nuclear and hydro rank close together as second, third and fourth respectively, contributing 18%, 17% and 17%. The remaining 10% stems mainly from petrol and some RES. The European power sector relies (for one-third) on nuclear production. Coal contributes slightly over 25%. Gas provides 18% and petroleum 6%, while fossil fuels account for 51%. The remaining one-sixth mainly consists of hydro and a small amount of RES. The USA produces around half its electricity from coal (51.3%), while nuclear provides 21% and gas 17%. All fossil fuels account for 72% of electricity production. RES, including hydro, have a modest share of 8%. In Brazil, hydro generates a considerable amount (82%). The remaining 18% is divided between the other fuels; the fossil fuel share is only 11%. In China, coal-fired electricity generation amounts to 75%. Hydro ranks second with 18%. The remaining 6% is produced by petrol, gas and nuclear. Total fossil fuels amount to 80%. In India coal also plays a dominant role in power generation, with just over 75%. Hydro accounts for 13% and the remaining 9% is divided between gas, petroleum and nuclear. The fossil fuel share is 83%. In Japan nuclear power has a high percentage (31%). The coal share is rather low with only 23%; oil (11%) and gas (25%) both have relatively high shares. Fossil fuels add up to 59%. Hydro and certain other RES account for 10%.

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[41] PetaWatt hour

[42] Allowing for conversion and transformation losses this equals around 3000 (Mtoe) in TPES.

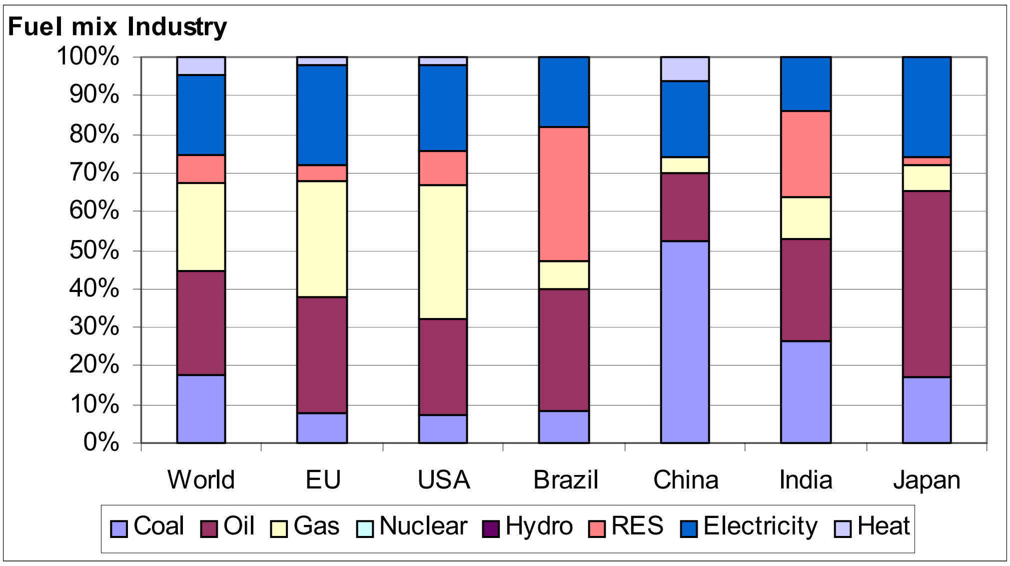

Figure 4.13 Regional fuel mix for the industrial sector, 2001[43]. (IEA, 2002b)

The worldwide coal percentage for industrial energy input is 18%, oil (petrol) 26%, gas 23%, electricity 21% and RES 7%. For EU industries the fossil fuels add up to 68%. However, as the power sector relies for 51% on fossil fuels, this sector adds 13% points (51% of 26%) to industrial fossil fuel input. So total fossil fuel dependency is 83%[44]. USA industries rely on gas for 33% of energy demand, for 25% on petrol, and for 25% on electricity. The total fossil fuel input is 84%.[45] Industries in Brazil use little gas (only 7%). The 35% share of other RES is remarkably high. The coal share is a modest 9% and petroleum 31%. Total fossil fuel share is slightly lower than 50%. Not surprisingly, China's industry uses a great deal of coal; over half its fuel input. Electricity has a 20% share. The total dependency on coal is 67%[46]. Other fossil fuel shares are much lower: petroleum supplies 17% and gas only 4%. The Indian petrol percentage equals the world average of 26%. Coal accounts for 27% and gas 11%. Other RES covers 22% and electricity 14%. Total fossil dependency is 75%. Japan's industrial sector has petroleum, electricity and coal as main inputs, i.e. 48%, 26% and 17% respectively. As electricity is 59% fossil fuel input based, total fossil fuel dependency is 88%[47].

4.3.2. Summary of the energy situation per country[48]

Summary for the European Union

The EU population stabilizes at around 390 million in 2030; GDP (in real terms) will double between 2000 and 2030 and energy use will increase by 16% to around 1750 (Mtoe) in 2025.

Fossil fuels remain dominant, with equal shares for gas and oil. Nuclear energy share will decrease and the RES share will increase slightly. The already high import dependency on oil will also account for gas and coal in the medium term. Power generation currently relies (for 33%) on nuclear production and (for 50%) on fossil fuels. The transport sector depends largely on petroleum (98%). Industrial fuel input is more diversified, but total fossil fuel dependency (including electricity from fossil fuels) amounts to 83%. The already high EU external dependency on fossils fuel supplies will increase significantly, as a greater share of a larger volume must be imported.

Summary for the USA

The population of the USA will increase by 30% to 370 million in 2030; GDP (in real terms) will double between 2000 and 2025 and energy use will increase by around 50% to 3,500 (Mtoe). The USA remains at the top of the list of energy users.

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43 Note that, per definition, energy carriers such as hydro and nuclear (uranium) are only input for power generation, so do not appear in the fuel mix for industry.

44 Coal 8% + oil 30% + gas 30% + power 13% + heat 2% = 83%.

45 (Coal 7% + petrol 25% + gas 35% + 0.72*23%) = 84%.

46 Directly 52.5% + indirectly via electricity 0.75 * 19.6% = 67%.

47 17% + 1% + 48% + 7% + 0.59*26% = 88%.

48 Some information is incorporated here that is not presented in the main text, but can be found in the appendix.

The current share of fossil fuels is relatively high and will remain high. The RES percentage is fairly low and will even decrease slightly. With regard to fossil fuels, the USA is (close to) self-sufficient for coal and gas. However oil consumption requires 60% imports. Only coal reserves are abundant. The power generation sector largely depends on domestically produced fuels. Transport is highly dependent on petroleum. The industrial energy input is more diversified, with a petrol share of 25% and total fossil fuel share of 86%. The already high external dependency of the USA on oil supplies will increase as the import share rises and needs to be obtained from regions further afield.

Summary for Brazil

The population of Brazil will increase by 30% to 222 million in 2030; GDP (in real terms) will increase by almost 150% to 2200 billion in 2025 and energy use will double to 400 (Mtoe) in 2025. Fossil fuels account for a small percentage of the fuel mix, but the oil share is 50%. Even with large uranium reserves, nuclear energy use is low, due to ample hydro capacity. Power generation relies for 82% on hydro. Transport depends on petroleum for slightly under 90%[49]. Industry energy input is more diversified, and less than 50% comes from fossil fuel input. The high oil percentage requires attention, but some literature sources (WETO, 2003) project that Brazil will become a net oil exporter in the coming decades.

Summary for China

The Chinese population will grow by 14% to 1.451 billion in 2030; GDP (in real terms) will almost quadruple in 25 years and total energy use will double to over 2000 (Mtoe). Coal is and will continue to be the dominant energy carrier, but the oil share will rise. Nuclear energy use will increase somewhat, but remain modest. The use of biomass stabilizes in absolute terms, so its share in TPES halves. Power generation relies for 75% on coal and 18% on hydro. The transport sector depends largely on petroleum (92%), and the industrial sector depends (for two-thirds) on coal as fuel input. The projected extra oil percentage will largely increase China's dependency on external oil supplies (given its limited domestic oil reserves).

Summary for India

The Indian population is projected to grow by almost 40% to 1.4 billion in 2030; GDP (in real terms) increases by 250% to 1800 billion $1997 in 2025. Total energy use will double to 800 (Mtoe) in 2025. Fossil fuels remain the dominant energy carrier; nuclear is a minor supplier and will remain so. The RES share drops slightly but will remain high. Power generation relies for 75% on coal and transport depends mostly on petroleum (over 98%). The industrial sector uses relatively large amounts of renewables. Low domestic reserves for gas and oil, combined with increasing shares in the fuel mix, result in increasing import dependency in the shorter term.

Summary for Japan

The population of Japan stabilizes at around 126 million; GDP (in real terms) will increase by 50% and total energy use will increase by around 25% to 700 (Mtoe) in 2025. The lack of domestic reserves forces Japan to import high volumes (> 95%) of all fuels. The nuclear energy share in TPES is 16%, more than twice the worldwide average. The RES percentage is low and is projected to remain low. Power generation relies on fossil fuels (approximately 60%) and nuclear power (around 30%). Transport depends on petroleum for 98%. Industry depends mostly on fossil fuels (88%), which is higher than other developed countries.

'Energy security issues are more critical in Japan than in most IEA countries owing to its isolated location and limited domestic energy sources' (IEA 2003). If any single country has experience in managing fuel import dependencies, it would be Japan.

4.3.3. Conclusions for energy dependency situations

The six countries/regions considered face a variety of energy dependency situations and developments therein. Populations will stabilize or expand and all GDPs are expected to increase. The lower the current GDP per capita, the greater the growth seems to be (Figure 4.5). Both population growth and GDP per capita growth push GDP upwards.

[49] In Brazil, ethanol is widely used as a transport fuel; www.eia.doe.gov/emeu/cabs/brazenv.html#ethanol.

With regard to fossil fuels, all considered countries/regions face significant and/or increasing import shares. (Even Brazil, which may become self-sufficient in oil, but not in gas. See Figure 4.11) All countries, albeit in differing degrees, face increasing external dependencies with respect to their (fossil) fuel use. Biomass use in China stabilizes, and will increase in India, though not fast enough to maintain its share in the fuel mix. It seems worthwhile investigating the possibilities of modern biomass applications replacing the traditional biomass share in the fuel mix.

The transport sector in any country is highly dependent on petroleum, usually over 95%. Even in Brazil, with its large-scale use of gasohol, petrol dependency is close to 90%. This overwhelming percentage exposes the transport sector to more SoS risks than other sectors. The fuel mixes for industry and power generation sectors show wider variation between countries. When a country has significant own resources of any fuel, the percentage of that fuel in industrial and power generation sectors is correspondingly high (e.g. coal in the USA, China, India.) The only two regions without major domestic fossil fuel reserves (EU and Japan) have high shares of nuclear power production (33%).

Japan's extremely high import of fossil fuels results in high domestic fossil fuel prices. This has therefore resulted in a relatively low average energy intensity and the high percentage of nuclear power production. However, it has not produced a larger share of renewables, which one might have expected (though Japan does not have considerable potential for renewables). With high fuel prices renewables should be competitive sooner, compared to other markets. The large proportion of hydropower in Brazilian power production makes its power sector non-dependent on fossil fuels, but dependent on weather conditions instead. Low rainfall can lead to power shortages, another example of the need to diversify energy supplies in any sector.

Energy supplies are a prerequisite for economic development and maintaining the current welfare standard. In any region, whether developing or industrialized, people will continue to evolve and become more prosperous. Fossil fuels are the most cost-efficient in the short term, but their negative impact on global climate cannot be neglected. The major fossil fuel reserves are located in just a handful of countries; so most countries, both industrialized and developing, will have to continue importing large amounts of fossil fuels. There is a lot of cash involved in these imports, and dependencies can be very high, often in countries in politically unstable regions. For developing countries the trade balance is often a troublesome issue. Modern RES (not just fuel wood, but also solar, wind, hydro and modern biomass applications) could greatly increase their access to energy supplies and thereby to a prerequisite for development, while simultaneously decreasing the amount of cash needed for energy imports.

This section has presented the different aspects of SoS that countries may face. The following section discusses the measures that countries may take to manage SoS risks and their impacts on climate change.

4.4 Security of energy supply policies and their impacts on climate change

4.4.1. Introduction

Governments in most countries consider SoS and CCM as separate policy fields. However both fields have a direct impact on the desired fuel and technology mix. Measures enhancing SoS objectives may conflict with CCM targets and vice versa. Therefore a coherent view of both policy fields is needed and integrated policies should be developed to meet both SoS and CCM targets.

The following figure illustrates this desired coherence in policy development. Both policy fields define their objectives and develop policies to achieve their objectives. Both affect the fuel and technology mix, though possibly in conflicting ways. The big blue arrow shows the level at which policy development should be integrated for coherent policy development while focusing on the objectives of both fields.

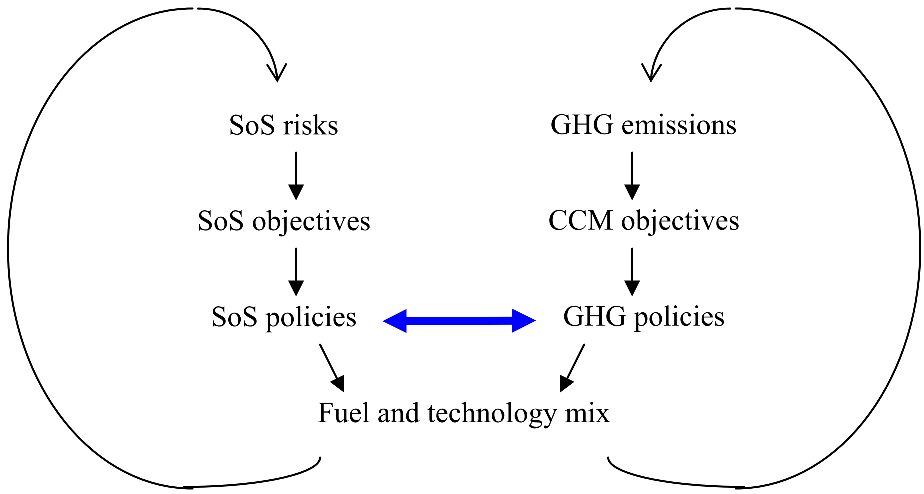

Figure 4.14 Suggested interaction level for coherent policy-making

This section provides an overview of existing SoS policies, targets and instruments in the EU, USA, China and Japan. A scoring mechanism is used to rank the different measures on both SoS and CCM aspects, and this ranking is performed in order to obtain a set of preferred policy options.

Section 4.4.2 starts by explaining the policy scoring mechanism. Section 4.4.3 presents and scores the Fuel-oriented SoS instruments. Section 4.4.4 gives some background on Demand-reduction-oriented policies, strategies and targets and introduces a demand-reducing measures-specific scoring mechanism. The last overview of measures, the Technology-oriented policies, strategies and targets (section 4.4.5) is preceded by an introduction of several technologies. Section 4.4.6 summarizes the Discussion and ranking of preferred options for integrated SoS and CCM.

4.4.2. Methodology

A scoring mechanism should address (some of) the previously introduced environmental, political, economic, technical and institutional criteria. The scoring mechanism presented here incorporates the impact on CO_2 emissions (an environmental criterion), other environmental considerations (such as the nuclear waste issue, air quality, biodiversity) and effects on the SoS situation (a political criterion). Other political criteria (e.g. agricultural policies, employment in mining, competition biomass and food production), economic (trade balance, investments), technical (viability of nuclear fusion) and institutional criteria are addressed in forthcoming paragraphs.

A worst-case SoS scenario would be a country that only uses one type of fuel, relying completely (i.e. for 100% of its fuel use) on imports that must be transported using unreliable means of transportation, where this fuel is provided by another single country, located in a highly politically unstable far away region, which itself has only limited reserves.

Criteria for security of supply

An SoS scoring mechanism should positively address moving away from the undesired situation. Jansen (2004) addresses these considerations using the following three terms: variety, balance and disparity. Following the basics of this approach, measures that positively influence:

- diversification of energy sources in energy supply;
- diversification of imports with respect to imported energy sources;
- long-term political stability in regions of fuel origin;
- the resource base in regions of origin;

will add to the SoS score in the following tables. The numbers 0 to 5 are used in the score; 0 indicating a negligible effect, 5 indicating a highly positive effect.

The climate change mitigation scoring mechanism
The CCM scoring mechanism is generally based on the impact of measures and instruments on CO_2 emissions that are exhausted during fuel combustion. Some measures and instruments are subject to scientific disputes concerning environmental considerations. Examples include nuclear waste, air quality, biodiversity and the impact that large-scale hydropower generation may have as a consequence of large flooded areas. These issues cannot be taken into account through the CO_2 scores, but will be addressed separately.

The scores are based on the CO_2 emission factors (see Table 'Energy content and GHG output of fossil fuels' in Appendix 1) of the respective fuels (the replaced fuel as well as the replacement fuel).

Table 4.1 CCM scoring mechanism

Energy source	When replacing			
	coal	oil	gas	biomass
Coal		- 1	- 2	- 4
Oil	+ 1		- 1	- 3
Gas	+ 2	+ 1		- 2
Biomass and biofuels[50]	+ 4	+ 3	+ 2	
Hydrogen (from gasification)[51]	+ 4	+ 3	+ 2	
Hydrogen (from electrolysis)[52]	+ 5	+ 4	+ 3	+ 1
Sun, wind, hydropower, geothermal power, ocean energy	+ 5	+ 4	+ 3	+ 1

The SoS and CCM scoring mechanisms are used in the following tables.

4.4.3. Fuel-oriented SoS instruments

The first table presents fuel-supply-oriented measures. The column 'Applied by' indicates the countries for which we have found policy documents or other evidence of existing activities. The columns SoS and CO_2 show the relevant scores, and the last column indicates other relevant criteria.

[50] Assuming biomass in a modern application, thus no traditional applications, e.g. fuel-wood
[51] Assuming coal gasification or methane cracking plus CO_2 storage
[52] Assuming renewable energy sources for electricity generation

Table 4.2 Fuel-oriented SoS policies, strategies and targets

Fuel	Targets, policies and instruments	Applied by				SoS	CO_2	Other criteria
Oil	Set up or enlarge oil stocks	EU	US	JP	CH	+ 2	0	
	Solidarity agreements with neighbouring countries	EU				+ 2	0	Political relations
	Monitor oil stock and supplies	EU				0	0	
	Diversify sources of oil imports		US	JP	CH	+ 4	0	
	Consumer-producer dialogues	EU	US	JP	CH	+ 3	0	
	Expand domestic recoverable oil reserves		US	JP	CH	+ 2	- 2	Vulnerable regions
	Financial involvement in other regions		US	JP		+ 2	0	Economic feasibility
	Build long-distance pipelines				CH	+ 2	0	
	Diversify energy mix away from oil			JP		+ 4	-1 / +2	
Gas	Investments in storage, long-distance pipelines	EU			CH	+ 2	0	
	Solidarity agreements with neighbouring countries	EU				+ 2	0	Political relations
	Monitor stocks and supplies	EU				0	0	
	Consumer-producer dialogues	EU	US			+ 3	0	
	Minimum share of long-term contracts	EU				+ 1	0	Liberalising E-markets
	Investment in LNG terminals and fleets of vehicles		US			+ 2	0	
	Diversify gas supplies					+ 4	0	
	Expand domestic recoverable gas resources					+ 2	- 1	Vulnerable regions
	Increase switch from coal to gas firing [53]				CH	- 1	+ 2	
	Cap domestic production for future SoS					+ 3	0	
Coal	Switch to domestically produced coal		US			+ 2	- 2	Air quality
	Multi-firing in addition to oil/gas	EU				+ 1	- 2	
	Subsidize domestic production	EU				+ 1	- 2	
	Relieve consequences of mine closures [53]	EU				- 1	+ 2	Employment
	Financial involvement in overseas production			JP		+ 2	- 2	
Nuclear fission	Keep nuclear option open	EU	US	JP	CH	+ 3	+ 2	Nuclear waste; non-proliferation treaty
	Target growth rate nuclear capacity	EU		JP		+ 1	+ 2	
RES General	Green electricity certificate trading system[54]					0	+ 3	
	Demonstration and pilot power plants	EU	US	JP	CH	+ 2	+ 3	
	Indicative targets for RES electricity	EU				+ 1	+ 3	
	Mandatory targets for RES electricity					+ 4	+ 3	Political support?
	R&D for promoting renewables	EU	US	JP	CH	+ 1	+ 3	
	Increase share of RES to significant levels					+ 4	+ 3	
	Develop RES-based distributed generation	EU	US	JP	CH	+ 4	+ 3	
RES bio-fuels	Targets for biofuel use	EU	US			+ 1	+ 3	
	Mandatory targets for biofuel use					+ 3	+ 3	Political support?
	Realize significant biofuels share in transport					+ 4	+ 3	
	R&D programmes, demonstration projects					+ 1	+ 3	
	Incentives for domestic biofuel production / use	EU				+ 1	+ 3	WTO, land use

The RES measures are grouped together in the table, but separate renewable options are presented in the technology measures overview.

The overview depicts several options that have a positive influence on both SoS and CCM. With respect to fossil fuels, moving away from coal or towards gas is always good from a climate perspective, but may not be advantageous from a supply security perspective as dependency on external supplies may be increased. There is a diversity of measures and instruments to increase the use of renewables; some have more positive impact on supply security than others. Among the various measures to encourage RES, the impact on supply security can differ significantly. The ranking of preferred measures is depicted underneath the overviews of demand-reduction and technology-oriented measures, based on the scores in the tables.

[53] This is actually not a supply-securing measure, but an environmental policy measure
[54] Only in some EU countries, ref: De Vries *et al*. (2003)

4.4.4. Demand-reduction-oriented policies, strategies and targets

Demand-reduction measures can be divided into those that discourage energy use and those that promote efficiency improvement. Several governments tend to discriminate (e.g. due to international competitiveness) when discouraging energy use, favouring the large industrial users over residential users. This is inconsistent with respect to SoS and CCM goals and also sends private citizens the wrong message. Some efficiency-improvement measures may focus on end-use devices, e.g. cars, aeroplanes or domestic appliances, while others promote efficiency in transport, conversion and transformation of energy. Demand reduction is usually a good way to reduce external energy dependencies. However it may contribute negatively to SoS aspects of variety, balance and disparity (e.g. when demand reduction is encouraged in such a way that the share of an already dominant fuel becomes even larger).

Effectiveness of demand-side measures

The degree to which a single energy-use reduction adds to SoS is arbitrary, however positive. The effectiveness of a demand-reduction measure is an indication for the impact on both SoS and CO_2 mitigation. The following table shows the effectiveness scores of demand-conservation measures; higher scores indicate a higher impact on both SoS and CCM.

Table 4.3 Categories of demand-reduction measures and related scores[55]

Category	Score
Legislative measures (informative)	+ 1
Information and education	+ 1
Voluntary agreements	+ 2
Fiscal measures, subsidies for R&D	+ 3
Fiscal measures, subsidies for end-use	+ 4
Legislative measures (normative)	+ 5
Miscellaneous measures (e.g. public transport promotion, or inconsequent measures of any kind relevant for energy reduction)	- 5...+ 5

Table 4.4 Demand-side policies

Objective	Targets, policies and instruments	Applied by				Score
Energy saving	Discourage electricity consumption in end-use sectors	EU				+ 4
	Lower energy taxes for high-volume consumers	EU				- 1
	Incentives for peak load reduction	EU				+ 1
	R&D to promote more efficient technologies	EU				+ 3
	Targets for savings on lighting		US			+ 1
	Monitoring programme demand-conservation measures	EU				+ 1
	Programmes for energy conservation			JP		+ 2
	Promoting public transport	EU		JP		+ 3
	Promoting modal shift towards inland and short sea shipping					+ 3
Efficiency improvement	Efficiency programmes for low-income households		US			+ 1
	R&D programmes for new technologies	EU	US	JP	CH	+ 3
	Efficiency programmes for vehicles	EU[56]	US	JP		+ 2 / + 5
	Efficiency labelling	EU		JP		+ 1
	Subsidies for appliances with good efficiency qualifications					+ 4

Several types of measures and instruments can be considered for energy conservation and efficient improvement. As the impact of demand reduction is definitely positive, demand-reduction measures are a 'must' in any policy package for improving SoS and CCM.

[55]Categories and scores are partly based on work in progress by Piet Boonekamp (ECN, involved in the Odyssee-MURE programme, www.mure2.com)

[56]Countries such as Germany and Austria have programmes for 2- or 3-litre cars, the 2 and 3 indicating the number of litres of diesel and petrol respectively that a car needs to drive 100 km. A large car manufacturer has developed a prototype diesel car that uses only 1 litre per 100 km (www.seriouswheels.com/top-vw-1-liter-car.htm)

4.4.5. Technology-oriented policies, strategies and targets

There are various kinds of technologies that may have significant impact on SoS and CCM objectives. Some technologies have been applied for several years, while others are still in the early stages of development, pilot or demonstration projects.

Before presenting the overview of technology-enhancing measures, this section provides some details and developments, and addresses certain other considerations for a number of technologies.

Table 4.5 Technology option: Nuclear fission

Option	Nuclear fission
Sectors	Power generation
Description	www.iaea.org
Issues	There is still no proper way to solve the nuclear waste problem; 'non-proliferation', waste product plutonium is used for nuclear weapons; huge environmental impact of accidents and incidents (Chernobyl, Sellafield); public acceptance; there is no consensus among politicians, see footnotes [57] and [58]

Although there are many political and scientific disputes regarding nuclear power generation, the advantages of diversifying energy supplies and the low CO_2 emissions of electricity production cannot be neglected. Given the scope of this study we therefore address nuclear energy as having a positive impact on both SoS and CCM, but note that it is beyond the scope of this study to assess all aspects of nuclear energy and make any final judgment. This would need more specific expertise and time for investigation.

Table 4.6 Technology option: Solar power

Option	Solar
Sectors	Power generation, transport, residential sector
Description	The two common technologies in solar power generation are Solar Photovoltaic (PV) and Solar Thermal. Solar PV is a direct conversion of light into electricity, while Solar Thermal produces heat that is used either directly or for power generation.
Issues	Thermal is mainly suitable in high solar-intensity regions, and costs € 0.16- 0.20/kWh (EC, 2002). PV costs € 0.52-1.20 /kWh (EC, 2002) which is around 6 and 18 times (respectively) as high as conventional options; when more than the generation itself is taken into account, then solar power generation can be cost-effective (see note below table). There is ongoing R&D to improve cost-effectiveness; public acceptance is usually high.

A study into rural household energy strategies in Swaziland (Lasschuit, 1994) compares PV lighting systems to electricity grid extensions. The study shows that solar power generation for villages with a few dozen households can be cheaper than grid extension when the distance is over 15 km. If the number of households increases to several hundred, a distance of 50-100 km would be break-even for grid extension and solar PV.

[57] The German opposition party attacks the 'Kernausstieg' (the policy of the current Bonds coalition to eventually close all German nuclear power facilities). The next conservative government is expected to stop the 'useless closure' (….). According to current plans the last German nuclear power plant will close in 20 years. (Powernews, 4-6-2004)

[58] The European Commission has approved the construction of a new nuclear power plant in Finland. (…) due to the growing demand for electricity in Finland and replacement of fossil fuels. Therefore the plant improves security and diversity of energy sources in Europe. (…). It will be the first new nuclear power plant to be built in the last 10 years. (www.utilities.nl, June 2004)

Table 4.7 Technology option: Wind power

Option	Wind
Sectors	Power generation
Description	Wind turbines are available in various sizes, generating power for anything from a single household up to small villages. Developments are moving towards larger wind turbines and large-scale offshore windfarms.
Issues	Costs € 0.04-0.07/kWh (EC, 2002). Wind energy can be cost-effective in several situations. Public acceptance of larger wind turbines and onshore windfarms is decreasing in heavily populated areas. The persistent but untrue myth that wind turbines kill hundreds of birds (Verhoef, 2003) does not help public acceptance either. High penetration of wind power in Denmark shows destabilising effects in the power network as a result of sudden weather changes.

Table 4.8 Technology option: Hydropower

Option	Hydropower
Sectors	Power generation, industry
Description	Hydropower is generated by flowing water driving turbines connected to dynamos.
Issues	Generating electricity from hydropower does not produce CO_2 emissions, but when applied on a large scale huge areas must be flooded, which may have negative environmental, agricultural and social consequences (see note below table).

Note on 'hydropower'

Flooding hydro dam areas may destroy nature and require major population relocation (e.g. 1.5 million people in China were relocated due to the Three Gorges dam). In Brazil, 'Flooding of delicate ecosystems and the displacement of indigenous people has led to strong opposition to new large-scale development projects' (EIA DOE CAB 03). Another possible negative consequence of large-scale hydropower facilities may be the lack of fresh water downstream of the dams:[59]. (Run-off river hydro does not have this problem.)

Table 4.9 Technology option: Hydrogen

Option	Hydrogen
Sectors	Power generation, transport, industry
Description	Hydrogen seems to be the perfect fuel. When burned, it is converted into water. There are several ways to produce hydrogen. Electrolysis using renewable electricity can be considered an RES. Other options, such as gasification of biomass or coal and steam-reforming of natural gas have various degrees of sustainability, for which capture and storage of the emitted CO_2 is a prerequisite.
Issues	Hydrogen can be used in several ways, e.g. as fuel cells (as an alternative for petrol and conventional vehicle engines), or as a buffer for electricity storage. Developments are currently at the demonstration project phase and economic feasibility is improving. 'The costs of hydrogen from fossil fuels with storage of the separated CO_2 are likely to be far less than producing hydrogen from water using carbon-free (renewable or nuclear) electricity or heat sources.' … Large-scale introduction will probably take several decades. (Williams, 2002)

In recent years Iceland has stated its ambition to take the worldwide lead in developing a hydrogen economy. An isolated geographical position, the absence of fossil fuel reserves and various natural sources of energy (e.g. geothermal energy and hydropower) put Iceland in an ideal situation to achieve this. The first public hydrogen filling station opened in 2003 and the country aims to be fully hydrogen-oriented by 2010.

59 www.interfax.com/com?item=Chin&pg=0&id=5671689&req=

Table 4.10 Technology option: Carbon dioxide capture and storage

Option	Carbon dioxide capture and storage (CCS)
Sectors	Power generation, industry
Description	CCS may be either a way to largely reduce the CO_2 emissions of fossil fuel combustion, or a prerequisite to producing clean hydrogen via coal or biomass gasification.
Issues	Current research focuses on reducing the energy required for CO_2 capture and compression. Estimates indicate that current state of the art techniques reduce the output of power generation facilities with one-sixth to one-third. (Jansen, 2003b); public acceptance (Shackley, 2004)

Table 4.11 Technology option: Biofuels

Option	Biofuels
Sectors	Transport sector
Description	Liquid fuels based on renewable biomass can have similar properties to the current transport fuels. For example, some biofuels can be mixed with diesel.
Issues	It is important for biofuel GHG balances that the whole production and logistics chain be sustainable. Energy inputs, use of fertilizers and pesticides may negatively affect GHG balances. Biofuels in transport are not always cost-effective with regard to CCM, compared to other CCM options. (Jansen, 2003b)

From a complete environmental perspective, using biomass (biofuels) in the transport sector would not be a preferred option. Using biomass in power generation is usually a more cost-effective option for GHG reduction (Jansen, 2003c). Restricted oil supplies, employment, a certain degree of self-sufficiency and a country's balance of payments may encourage the application of biomass as biofuels for transport. However this should be implemented side-by-side with biomass for electricity generation, not as an alternative.

In Brazil, bioethanol is a competitive transportation fuel. The Brazilian Alcohol Programme (PROALCOOL) to produce ethanol from sugarcane was established during the 1970s as a result of the oil crisis, and aims to reduce oil imports as well as to solve the problem of the fluctuating sugar prices in the international market. The programme has strong positive environmental, economic, and social aspects, and has become the most important biomass energy programme in the world (Coelho, 2004).

The following table presents technology-oriented measures. The scores for SoS and CO_2 are implemented using the previously presented scoring mechanisms. Other criteria were assessed in Tables 4.5 - 4.11.

Note that the table does not consider any cross effects of measures (e.g. the effect of CCS-enhancing measures on the economies for wind turbine investments), but simply judges the measures individually.

Table 4.12 Technology-oriented policies and targets

Technology	Policies and targets	Applied by	SoS	CO_2
Hydrogen	R&D production and storage	EU US	0 / + 5[60]	+ 2 / + 5[61]
	Develop infrastructure		+ 2 / + 5	+ 2 / + 5
	R&D fuel cells		+ 2 / + 5	+ 2 / + 5
	Roadmap for introduction and commercialization of fuel cells	US	+ 2 / + 5	+ 2 / + 5
CCS	CO_2 capture and storage	EU US	+ 4[62]	+ 2 / + 4 [63]
Nuclear fission	Safe and efficient 4th generation	EU US JP CH	+ 3	+ 4
CCGT[64]	Efficiency-improvement targets	US		
CHP[65]	Penetration targets	EU	+ 1	+ 1
	Efficiency-improvement targets	US	+ 1	+ 2
	Development of RES-based CHP		+ 1	+ 4
Solar[66]	Target growth rate or share of solar energy	EU JP CH		
	R&D		+ 1	+ 3 / + 5
	Production subsidies	[54]		
Wind	Targets for wind power	EU JP		
	R&D		+ 1	+ 3 / + 5
	Production subsidies	[54]		
Biomass	Targets for biomass-based power generation	EU JP CH	+ 1 / + 2	+ 2 / + 4
	Production subsidies	[54]		
Hydropower	Targets for hydropower	EU	+ 1 / + 2	+ 3 / + 5
	Hydropower certificates	[54]	0	+ 3 / + 5

These technology options are in various phases of their respective developments. Some options, such as solar, wind, hydro, nuclear, CCGT and CHP are already applied on a large scale. Another option, e.g. biofuels, is commercially available in a country like Brazil, but is only in its early development phase in the EU. Further research is needed to lower the costs involved in hydrogen and CCS. Of the most valuable options regarding both SoS and CO_2 impact (hydrogen and nuclear fusion) only hydrogen is already feasible under the prerequisite that the hydrogen generation is based on renewables or other CO_2-free processes.

The above assessments only rank possible options according to their SoS and CCM impacts. However, a discussion of other criteria is also required before an explicit ranking of preferred policy options can be given. This is included in the following section.

4.4.6. Discussion and ranking of preferred options for integrated SoS and CCM

Country-specific starting points have a significant impact on the preference order of measures and options. If a country is considering using hydrogen and has abundant coal reserves and a lack of arable areas, then the hydrogen-from-coal route has significant advantages over the biomass route. An option such as hydropower may have general advantages, but the geographical circumstances of a country may hinder the feasibility of its application.

This section reconsiders the options (with both SoS and CCM advantages) from the earlier overviews, and addresses (other) environmental, political criteria, economic, technical and institutional criteria. The options to be discussed (with positive scores for SoS and CCM) are:

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60 Hydrogen from fossil fuels will not decrease external dependencies, but hydrogen from biomass (particularly via electrolysis) will.
61 Hydrogen via electrolysis based on RES, or fossil fuels with complete CCS, receives a high score; otherwise lower.
62 Because it allows the continuation of coal use under a CO_2 constrained regime.
63 GHG score for CCS depends on the fuel that is (gasified and) combusted: gas, biomass or coal.
64 Combined cycle gas turbine.
65 Combined heat and power generation
66 Photovoltaic, as well as thermal.

energy demand-reduction measures, all RES, nuclear power, and fossil fuels in applications with CCS and natural gas (to replace coal or oil).

Energy demand-reduction measures
Energy demand-reduction measures score well on environmental and economic criteria, although energy suppliers may think differently about the economic criteria. But fossil fuel suppliers may also see the benefits of a more gradual increase in energy use, as this gives them more time to increase production and transportation capacities. Domestic energy-use reduction may also decrease pressure on government expenditures.

Natural gas prices for Russian domestic consumers are lower than the actual production-cost prices. The domestic prices are subsidized by the much higher export prices. From a macroeconomic perspective, selling prices that are lower than marginal costs cannot be defended, as consumers will use much more gas than is necessary from a social welfare perspective. Another social loss is induced by the significant losses (through leakage) of the natural gas pumped into the long-distance pipelines. Methane (the main component of natural gas) also contributes significantly to the GHG effect. Although the Russian natural gas reserves are abundant, reducing domestic demand (and therefore economic losses) will contribute to the long-term social welfare. A gradual increase in domestic gas prices to normal levels will stimulate the development and use of more efficient applications. This line of arguments also applies to the major oil producers.

Hydrogen
As previously described in section 4.4.5 the environmental performance of hydrogen is determined by the way it is produced. Hydrogen as an energy carrier must be produced from fossil fuels, biomass or water electrolysis. This last route (electrolysis) using renewables scores well, whereas the gasification route requires storage of the emitted CO_2 as a prerequisite for a positive score. With regard to the electrolysis route, it is probably more efficient to use the scarce renewable electricity directly (to meet the electricity demand) rather than making the energetically and economically unfavourable step towards hydrogen production. The gasification route is the most viable in the short term and fossil fuel suppliers might be more willing to take this hydrogen route rather than the other options, which are less easily combined with their export interests. Since both hydrogen production and CO_2 capture are still fairly costly processes, R&D should focus on cost reductions. International cooperation in these research fields may be beneficial for improving multilateral understanding and interests.

Renewables
Section 4.4.5 gives some background on several RES options. Although their performance on GHG emission reduction and air quality is positive by nature, some other criteria are less easily met in specific situations. For example, the negative impacts on the local environment and social structures of large areas flooded for hydro dams. An issue concerning biomass is contamination from heavy metals, which has very negative consequences for its environmental score. Another biomass issue concerns the availability of arable areas. When biomass resources need to be imported in order to replace imported fossil fuels, this may still add to diversity in energy supplies, but does not increase self-sufficiency or contribute positively to the balance of payments. The same applies to using biofuels in the transport sector. Solar energy is usually not cost-effective (except for isolated sun-drenched areas). Larger wind turbines are more cost-effective than their smaller counterparts, but in crowded areas there is considerable opposition to their domination of the scenery. Developing offshore windfarms requires higher investments per MW and raises other issues concerning marine life.

When the domestic situation allows for large-scale biomass production or major technological research, then renewables development and use may contribute to supply security, employment, economic and technological development and the balance of payments. Brazil is a specific example, which started in the 1970s with its biomass and biofuels programmes, not only to decrease its external oil dependency, but also due to balance of payment problems. Nowadays Brazil is the only country in the world where biofuels are cost-effective and used on a large scale in the transport sector. The USA pays around US$ 150 billion for their annual oil imports [67], which is solely for the transport sector. Fossil fuel imports account for around one-third of the US trade deficit. The current US trade deficit is a major concern to many economic analysts, as it is

[67] Import fraction 60% x daily use 19.5 million bbl/day * 365 days * price per barrel US$ 35 / bbl = 150 billion US$/yr

seen as a major destabilising factor in the global economy. Reducing oil use seems particularly beneficiary. US petrol prices (including tax) are among the lowest in the developed world, and average vehicle efficiencies are very low compared to other countries. Increasing the amount of RES, vehicle efficiency improvement and shifting tax pressure from labour to energy seem excellent ways of reducing the oil consumption. A similar reasoning illustrates the possibilities for African and Latin American countries with high debt positions to use biomass production as a means of reducing their oil dependencies, while stimulating their economies and improving foreign trade balances. Careful attention is needed to deal with competitive land use for food or energy crops. Food shortages would be an extremely undesired result of energy crop production replacing food production.

In Europe, the biofuels directive (EC, 2003) is assumed to create and save hundreds of thousands of jobs. Compared to other jobs in the energy sector (e.g. coal mining) sustainable biomass production is also a very healthy job. With regard to the transport sector, biofuels are an expensive option from a CO_2-mitigation perspective. For transport there are not that many other alternatives to petrol, besides efficiency improvement and CNG (compressed natural gas). A total balance of all the positive effects of biofuel production on employment, economy, trade balance, (exportable) technological knowledge and security of supply may favour the decision to undertake (at least partial) domestic production.

Nuclear fission
Nuclear fission remains a controversial option (see section 4.4.5 for various examples). There is still no proper solution to the problem of nuclear waste; the waste product plutonium is very dangerous if it falls into the wrong hands. Waste from renewable options is much easier to deal with. However as the advantages (from an SoS and CCM perspective) are clear, nuclear fission is included in the ranking.

Coal in applications with CO_2 capture and storage
Fossil fuels will almost inevitably be used extensively in the coming decades. Their abundant availability at low economic costs, plus the lead-time to realize alternatives on a sufficient scale, prevent a quick shift to other options. Given this inevitability, reducing the negative consequences through CCS is a necessity. CCS will probably be the cheapest way of reducing CO_2 emissions into the atmosphere for many years to come.

The subsidies paid for domestically produced coal in many European countries are an expensive instrument for enhancing SoS and employment. European cost prices are up to five times the world market price. A country such as Germany is very dependent on coal for its power generation. Coal subsidies result in low electricity production costs, leading to coal electricity imports in the Netherlands and therefore seriously harm the investment climate for the (mostly gas-fuelled, therefore cleaner) Dutch power generation sector. This seems contradictory to overall policy objectives.

Natural gas
One of the major reasons for China and India to use gas for power generation and transport in cities is the heavy local air pollution related to coal-fired power plants and diesel-based transport (see section 6.3.4). Natural gas would not be a sustainable option in the long term. However its rather low CO_2 content (compared to coal and oil) make it an optional bridge between today's fossil fuel economy and the future low CO_2 economy.

Oil and gas
With regard to fossil fuels, vulnerable regions are now entering the picture for expanding domestic fossil resource bases. Regions such as Alaska and the Dutch/German Wadden Sea, are of global significance for biodiversity and unique ecotypes. Some governments are more concerned with the environment than others, and shifts in political regimes can always take away the 'guarantees for life' previously given for not exploring in these vulnerable regions. To protect the vulnerable ecosystems, technologies should be developed to reduce the harm done in exploration and production activities. An example of such technologies is 'sideways drilling from the mainland'.

This discussion includes a wide range of issues. It illustrates the need for integrating policies for different fields. Before presenting conclusions and recommendations in the last section, we will summarize the previous scoring tables and above discussion in a ranking of policy options for integrated SoS and CCM policies.

The first column ‘Measure’ contains a general ranking. The second column briefly states the reasons why. As specific circumstances may reduce the available options or change the order of preference, the third column gives some explanatory remarks.

Table 4.13 Ranking of options

Rank	Measure		Reason	Comments
1.	Demand-reduction measures		Attractive from all perspectives	
2.	RES	Biomass (+ CCS)	Feasible sustainable production; widely available and applicable	Arable areas must be available; careful with food-energy competition; combining biomass with CCS may actually have a positive CO_2 balance
		Small-scale hydro, geothermal power	Minor impact on landscape	Only an option in specific geographical circumstances; much cost-effective locations are used already
		Wind	Generally cheaper than solar, proven technology	Feasible onshore or offshore locations must be available; intermittency limits application
		Biofuels	Main short-term RES petrol alternative	For the transport sector
3.	RES	Solar	Small-scale applicability, Generally rather expensive	Mainly in near-equator areas; intermittency limits application
4.	Nuclear power			From an SoS and CO_2 perspective
5.	RES	Large-scale hydropower		When limited negative impact on nature and social criteria
6.	Fossil fuels with CCS			Mainly for coal; feasible for gas but relatively expensive
7.	Natural gas		Lowest CO_2 content among fossil fuels	Replacing coal or oil As CNG in the transport sector

Hydrogen is not included among the ranked options. Hydrogen must be produced from fossil fuels, biomass or electrolysis of water. Since electrolysis needs electricity, these hydrogen production options are all included in the table.

The previous sections have analysed and ranked the available options for reaching both SoS and CCM goals. The following section provides conclusions and recommendations for policy development.

4.5 Conclusions and recommendations

Policymakers face the challenge of how to achieve both SoS and CCM objectives. Energy and the environment are related to many other policy fields. There is no single solution for achieving all objectives in these different fields. There is a need for a combination of various instruments and policies that apply on different timescales and geographical scales. Such a combination should contain instruments that focus on demand reduction, cleaner use of fossil fuels, the application of renewables, ongoing developments of technologies for new fuels (such as hydrogen and nuclear fusion) and improving existing technologies.

Climate change is not on many governments’ priority lists. Besides security of supply considerations, economic incentives (such as improving the trade balance and regional development and employment), as well as social considerations (air quality and health), or lack of public support for nuclear power generation may convince them that it is in their overall best interest to take measures that focus on both SoS and CCM targets. In many (but not all) regions SoS could be an extra argument for deploying climate-mitigating technologies. Real policy integration, however, does not appear to be in sight.

Before presenting the final recommendations we will briefly discuss some of the platforms that may be used to reach a coherent international policy framework in the following subsection.

4.5.1. Platforms for integrated policy development

Security of supply is initially a *national* interest, as are many of the related issues discussed in the previous subsection (4.4.6). Fuel imports and exports, the current climate change Kyoto Protocol and the Nuclear Non-Proliferation Treaty have clear international dimensions. It may be difficult to integrate a country-level interest into international agreements. However, some organizations and platforms may be useful for integrated policy development and reaching international coherency for SoS and CCM. Integration into other fields (e.g. economic development) is also possible.

Among the various international organizations there are several primarily focussed on energy. Examples include the IEF, OPEC and GECF (Gas Exporting Countries Forum). Although its name suggests a broader scope, and IEF represents importers as well as exporters, the IEF's[68] mission statement is very oil and gas oriented, and contains only one reference to 'renewables'. OPEC and GECF are organizations of oil and gas exporters. They may see renewables as a kind of long-term threat to their export positions. Inviting members of OPEC and GECF to participate in R&D aiming at cleaner use of fossil fuels (hydrogen, CO_2 storage) will be good for international relations and provides a means to allow the interests of both importing and exporting countries to run in parallel.

Multinationals (e.g. Q8, BP and Shell) are aware that for long-term survival they need to transform from being oil and gas suppliers, to become energy suppliers. They are all seriously involved in renewable energy businesses. These major producers and owners of oil and gas fields are also the parties that should apply CO_2 storage and produce solar panels, wind turbines, etc. Discussing the barriers for applying (experimental) techniques with these organizations and removing legal barriers may help them to improve the cost-effectiveness of CCM-advantageous techniques.

4.5.2. Recommendations

The aforementioned analysis, discussion and ranking have addressed various instruments contributing positively not only to SoS and CCM, but also to economic and technological development and other environmental issues (e.g. air quality). Coherent policies to achieve objectives in several policy fields can be hugely beneficial.

Reduce energy demand

Reducing energy demand decreases energy dependency and energy-related emissions. It is often a cost-effective and very synergetic option, and fits well into a long-term energy strategy, though lock-in effects should be regarded.

- Energy should be priced to reflect the economic costs as well as the externalities concerning its production and use. Countries such as the USA and Russia should consider the social and macroeconomic gains from raising energy taxes while simultaneously lowering labour taxes.

Energy supply

Energy is used in several important sectors: electricity generation, transport, heating and industry. The SoS issue is most pronounced in the transport sector. The main fuel for transport, oil, can only be extracted from a small number of countries. Transport is also the fastest growing sector for greenhouse gas emissions and a main contributor to urban air pollution (see Chapter 6). Switching from oil to less polluting transport fuels could produce triple dividends: higher security of supply, less air pollution, and structural mitigation of climate change.

Transport

Moving away from oil to other fuels suitable for transport (gas and biofuels), would be most appropriate in the near future, with biofuels and hydrogen in the longer term. The gas reservoirs around the world are also quite concentrated in distinguished areas. However, biofuel potential and the main fuel for producing hydrogen (coal) are fairly evenly spread around the world.

- Using gas for transport in densely populated areas should be encouraged, particularly in developing countries. The EU could support agreements on gas supply between Russia and Central Asia, India and China.

[68] www.iefs.net/iefs-mission.html

Technologies to use gas efficiently, both in transport and in electricity generation, should also be transferred more to developing countries, making it common practice. Mechanisms adapted from CDM could also be used after 2012. The gas-supplying countries could be pushed to aim for agreements where the fuel technology is also provided.

- The use of biofuels should be given priority within the EU. This provides opportunities for opening up new energy dependencies, and new markets, particularly in large developing countries (such as Brazil) and in the least-developed countries in Africa. Trade agreements to supply sustainably generated biomass or biomass products could even be supported by agreements on debt relief or adaptation in the least-developed countries.
- Hydrogen is produced from coal or from renewable sources: biomass gasification, specified solar panels, or renewable electricity. Coal is still by far the cheapest option, is present in abundance all over the world, and does not run the risk of being depleted within 60 years. Technology cooperation between the USA, the EU, Japan, and large coal-using developing countries (China, India, Brazil, Mexico, and South Africa), should enhance technology for CO_2 capture and storage and make hydrogen a climate-friendly option. This could be a viable route, particularly for heavily oil-reliant countries, notably the USA.

Electricity
The choice of fuels for electricity is more diverse than for transport and therefore provides more opportunities for securing energy supplies. Renewable energy could be beneficial for security of supply, but not in all cases. There are countries with hardly any potential for wind, solar or hydropower. This should be taken into account. Also, many renewable energy sources are intermittent or dependent (to some extent) on weather, which is a negative factor in security of energy supply.

- For many countries coal will remain the major resource for power generation. CO_2 capture and storage should be applied worldwide in order to prevent CO_2 emissions. By sharing technological knowledge (via the same methods as for clean hydrogen production) and stimulating the application of clean technologies (e.g. though integrated agreements that link removal of trade barriers to improved environmental standards) countries can be encouraged to behave in the world's best interest.
- Differing circumstances enable and require different options. Biomass is widely available, but its quality may vary significantly. Co-combustion of biomass in coal-fired power plants and biomass-based CHP are options available in the shorter and longer term, and may be extended with CCS. Information on biomass quality and technologies for quality measurements should be disseminated to prevent possible negative impacts through using biomass contaminated with heavy metals.

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Appendix 1[69]

Population; population development

Year Billions of people	2000	2010	2020	2030	Source
World	6071	6830	7540	8130	UN Pop. Prospects 2002
EU-15	379	388	390	389	DG TREN
EU-25	453	461	462	458	DG TREN
USA	285	315	344	370	UN Pop. Prospects 2002
Brazil	172	193	210	222	UN Pop. Prospects 2002
China	1275	1365	1429	1451	UN Pop. Prospects 2002
India	1017	1174	1312	1417	UN Pop. Prospects 2002
Japan	127	128	126	121	UN Pop. Prospects 2002

GDP development

Source	Year	2000	2010	2015	2020	2025	2030
DG TREN 2003		1.00	1.38	-	1.85	-	2.37
EIA 2003b		1.00	1.34	1.57	1.83	2.12	-
WETO 2030 (2003)		1.00	1.41	-	1.92	-	2.48

GDP Development per region

Region	Unit	2000	2010	2015	2020	2025	2030	Source
World	$ 1995 pps	41.2	57.1		76.4		97.5	DG TREN 2003
EU15	$ 1995 pps	8.5	10.9		13.6		16.9	DG TREN 2003
EU25	$ 1995 pps	8.9	11.4		14.5		18.0	DG TREN 2003
World	$1997	31.9	42.8	50.1	58.3	67.4		EIA 2003b
USA	$1997	9.4	12.5	14.6	16.8	19.3		EIA 2003b
China	$1997	1.1	2.2	2.9	3.9	5.1		EIA 2003b
Japan	$1997	4.4	5.2	5.7	6.2	6.7		EIA 2003b
Western Europe	$1997	9.3	11.7	13.1	14.7	16.4		EIA 2003b
Brazil	$1997	0.85	1.16	1.42	1.76	2.18		EIA 2003b
India	$1997	0.50	0.83	1.08	1.39	1.78		EIA 2003b

Energy and CO_2 indicators 2001

Indicators	WORLD	EU-15	USA	Brazil	China	India	Japan
CO_2 Emissions (Mt)	23,684	3209.88	5673.25	311.87	3112.64	1013.45	1132.31
CO_2/Population (tonne/cap)	3.88	8.46	19.84	1.81	2.43	0.98	8.9
CO_2/TPES (tonne/toe)	2.36	2.15	2.49	1.69	2.69	1.91	2.17
CO_2/GDP (PPP) (kg/$95 PPP)	0.56	0.38	0.63	0.27	0.64	0.37	0.36
TPES/GDP (toe/1000 $ 95)	0.29	0.15	0.25	0.23	0.9	1.08	0.09
TPES/Population (toe/cap)	1.64	3.94	7.98	1.07	0.9	0.51	4.09
TPES/GDP PPP (toe/1000 $95 PPP)	0.24	0.18	0.25	0.16	0.24	0.2	0.17
Population (million)	6103	379.44	285.91	172.39	1278.58	1032.36	127.21
GDP (PPP) per head[70]	100%	320%	452%	95%	55%	38%	354%

69 All values from IEA 2002b, unless indicated otherwise.
70 Deduced from other values in this table.

TPES and energy consumption per region

Country	Source	Subject	2000	2001	2025	2030
World	DG TREN 2003	TPES	9954			17,041
	EIA 2003b	Consumption	10,052		16,131	
	IEA 2002b	TPES		10,029		
	WEO 2002	TPES	10,089			16,302
	WETO 2030 (2003)	TPES	9953			17,213
EU-15	IEA 2002b	TPES		1495		
	DG TREN 2003	TPES	1499		1733	1781
USA	EIA 2003b	Consumption	2503		3505	
	IEA 2002b	TPES		2281		
Brazil	EIA 2003b	Consumption	228		415	
	IEA 2002b	TPES		185		
	WEO 2002	TPES	179			380
China	EIA 2003b	Consumption	931		2288	
	IEA 2002b	TPES		1156		
	WEO 2002	TPES	1162			2326
India	EIA 2003b	Consumption	319		690	
	IEA 2002b	TPES		531		
	WEO 2002	TPES	498			971
Japan	EIA 2003b	Consumption	548		683	
	IEA 2002b	TPES		521		
Japan, Australia, New Zealand	WEO 2002	TPES	653			823
Western Europe	EIA 2003b	Consumption	1685		2028	

Note the large differences for Brazil, India and China for 2000 and 2001 figures.

Fuel mix development per region (Mtoe)

Country	Year[71]	Energy	Coal	Oil	Gas	Nuclear	RES	Hydro in RES[72]
World	Growth	160%	146%	154%	198%	112%	152%	1.52
World	2001	10,029	2342	3507	2122	692	1366	221
	2025		3425	5418	4208	778	2082	336
USA	Growth	140%	133%	148%	149%	107%	139%	
USA	2001	2281	545	904	517	211	103	17
	2025		726	1339	768	225	144	
Brazil	Growth	182%	171%	177%	1133%	420%	112%	1.85
Brazil	2001	185	13	90	8.6	3.7	66	23
	2025		23	159	98	16	74	42.7
China	Growth	246%	228%	227%	610%	963%	278%	2.69
China	2001	1156	642	236	33	4.6	240	24
	2025		1461	535	204	44	667	64.1
India	Growth	216%	162%	262%	425%	350%	188%	2.84
India	2001	531	179	112	23	5.0	211	6.4
	2025		290	294	99	18	396	18.1
Japan	Growth	125%	124%	118%	129%	131%	164%	1.20
Japan	2001	521	100	256	65	83	16	7.2
	2025		124	303	83	109	27	8.7
W. Europe	Growth	120%	80%	111%	177%	79%	147%	1.03
EU	2001	1495	218	605	347	232	90	29
	2025		174	671	615	183	132	29.9

IMPORT DEPENDENCIES

[71] Growth rates deduced from EIA 2003b
[72] Hydro growth rates averaged from WEO (2002) 2020 and 2030 values, N/A for USA

Current import dependency by origin 2000

Region	Fuel	Import fraction	Reserves^	Source 1	Source 2	Source 3
EU	Coal	55%	60	South Africa	Columbia,	USA, Australia
EU	Oil	75%	2.5	Middle East (45%)	Russia	Norway
EU	Gas	45%	6.3	Russia (40%)	Africa (33%)	Norway (25%)
EU	Uranium	99%		Probably* Other FSU	Probably* Africa	
USA	Coal	- 5%	146	Self-sufficient		
USA	Oil	59%	3	Middle East (>40%)	Latin America (>25%)	Canada (17%)
USA	Gas	11%	4.7	Canada (93%)	LNG (6%)	
USA	Uranium	90%	2.7	Probably* Canada		
China	Coal	- 9%	72	Self-sufficient		
China	Oil	24%	3.4	Middle East (39%)	Asia Pacific (28%)	Africa (16%)
China	Gas	6%	1.3			
China	Uranium	0		Self-sufficient		
Japan	Coal	98%	0.5	Australia (60%)	China, South Africa, USA	
Japan	Oil	99%	0.01	Middle East (79%)	Asia Pacific (12%)	
Japan	Gas	97%	0.04	Indonesia (32%)	Malaysia (20%)	Australia (13%)
Japan	Uranium	100%	0.1	Probably* Australia		

^Reserves: Domestic reserves in (1000 Mtoe)

* Probable sources based on nearby regions that produce much more uranium than own use (BP Stats 2002, IAEA 2003)

Country	Fuel	Res. (1000 Mtoe)	Prod. (2001)	
Brazil	Coal	7.2	2.14	
Brazil	Oil	1.14	68.82	
Brazil	Gas	0.2	4.79	
Brazil	Nuclear	2.1	3.72	Probably self- sufficient
India	Oil	0.7	34.7	
India	Gas	0.6	23.2	
India	Nuclear		5.0	Probably some import
India	Coal		164.0	

Sector fuel mixes: industry and transport 2001

Region	Sector	TFC[73]	Coal	Crude	Petroleum	Gas	RES	Electr.	Heat
World	IND[74]	2201	17.6%	0.4%	26.4%	23.2%	7.3%	20.7%	4.5%
World	TRANS	1802	0.3%	0.0%	95.2%	3.0%	0.4%	1.1%	0.0%
EU	IND	320	8.0%		30.0%	30.0%	4.0%	26.0%	2.0%
EU	TRANS	319	0.0%		98.0%	0.0%	0.0%	2.0%	
USA	IND	403.8	7.3%		25.1%	34.5%	8.7%	22.6%	1.9%
USA	TRANS	609.2	0.0%		97.2%	2.4%	0.3%	0.1%	0.0%
China	IND	315.7	52.5%	0.7%	16.8%	4.0%	0.0%	19.6%	6.4%
China	TRANS	82.2	6.4%		91.7%	0.3%	0.0%	1.6%	0.0%
Japan	IND	122.9	16.9%	0.8%	47.5%	6.8%	1.8%	26.1%	0.0%
Japan	TRANS	96.1	0.0%		98.3%	0.0%	0.0%	1.7%	0.0%
India	IND	99.5	26.5%		26.5%	10.7%	22.4%	13.9%	0.0%
India	TRANS	44.6	0.0%		98.4%	0.0%	0.0%	1.6%	0.0%
Brazil	IND	66.7	8.5%	0.7%	30.9%	6.9%	35.1%	17.9%	0.0%
Brazil	TRANS	49.2	0.0%	0.0%	88.0%	1.0%	10.8%	0.2%	0.0%

[73]Total Final Consumption numbers (Mtoe), World TFC in 2001 was 6995 Mtoe, whereas TPES was 10,029 (according to IEA 2002). Thirty percent of all energy supplies are lost in transformation and conversion.

[74]IND = Industry; TRANS = Transportation sector; PG = Power Generation

Sector fuel mixes: power and heat 2001

Region	Subject[75]	Total	Mtoe	Coal	Petroleum	Gas	Nuclear	Hydro	RES Other	Electr.	Heat
World	PG (PWh)	15.5		39.0%	8.0%	18.0%	17.0%	17.0%	2.0%	-	
World	Heat (EJ)	12		37.0%	9.0%	49.0%	0.2%	-	5.0%	0.2%	
EU	PG (PWh)	2.6	224	27.0%	6.0%	18.0%	34.0%	13.0%	3.0%		
EU	Heat (EJ)	1.1	26	29.0%	8.0%	39.0%			22.0%	1.0%	2.0%
USA	PG (PWh)	3.86	332	51.3%	3.5%	16.7%	20.9%	5.2%	2.4%		
USA	Heat (EJ)	0.58	14	35.6%	13.2%	46.3%			4.9%		
China	PG (PWh)	1.5	129	75.9%	3.2%	1.2%	1.2%	18.4%	0.1%		
China	Heat (EJ)	1.53	37	85.3%	9.6%	4.2%	0.0%	0.0%	0.9%		
Japan	PG (PWh)	1.03	89	23.1%	11.3%	24.9%	31.0%	8.1%	1.6%	0.0%	
Japan	Heat (EJ)	0.02	0.2	2.8%	6.9%	53.6%	0.0%	0.0%	18.8%	17.9%	
India	PG (PWh)	0.58		78.3%	1.2%	3.6%	3.4%	12.8%	0.7%		
India	Heat (EJ)	-									
Brazil	PG (PWh)	0.33		3.1%	5.4%	2.6%	4.4%	81.7%	2.9%		
Brazil	Heat (EJ)	-									

Energy content and GHG output of fossil fuels

Energy carrier	Energy content (GJ[76]/ton)	Emission factor (kg CO_2 /GJ)
Crude oil, diesel, petrol	41 - 44	73 - 77
LPG	45	66
Natural gas	32	56
Lignite	21	101
Coal, other	27 - 32	94 - 103

The values are in line with IPCC 1995 (Spakman, 2003).

75 1 PWh (Petawatt hour; 10^12 kWh) ~ 86 Mtoe; 1 EJ (Exajoule; 10^18 joule) ~ 24 Mtoe.
76 Gigajoule, 10^9 Joule.

5. International Trade, Finance, Subsidies and Climate

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Abstract

This chapter deals with finance, subsidies and trade as important non-climate issues that can be analysed from a policy perspective, thus allowing policies to be framed that enforce the goals of the UNFCCC (UN Framework Convention on Climate Change) climate regime. Trade policies offer limited opportunities to affect the Kyoto goals. Only environmental policies aimed at incorporating the negative environmental external effects of production processes can affect trade flows in a sustainable manner. There is no barrier in the present WTO regime to do so. With regard to the future, a shift in high-carbon production from OECD to developing countries can be expected. This increases global GHG emissions and underlines the importance of getting the developing countries on board for future climate agreements. Finance is mainly concentrated on foreign direct investments (FDI) as these constitute the highest amount of long-term capital. Recent estimates of energy investments show that US$ 550 billion annual investments are necessary over the next 30 years. The financial requirements should be mobilized by increasing domestic savings in developing countries, i.e. through reforming governmental financial policies and the financial system, (more) privatization and liberalization of energy sectors, and attracting energy-intensive FDI. This produces problems for the climate regime targets. There are two opportunities to increase sustainability of FDI in the energy sector. First, reduce energy consumption and production through efficiency improvements. Second, switch from carbon-based to carbon-free or carbon-neutral sources of energy. It is possible to subsidize this switch (e.g. through export credit agency policies), but this chapter argues that such subsidies would be a waste of money as long as fossil fuel prices are kept artificially low by direct and indirect subsidies.

Two proposals have been formulated for subsidy reform, in agriculture and energy sectors. In the agriculture sector removal of OECD price support should form part of a broad 'double-switch' reform that moves towards rewarding farmers/land-owners for services related to nature conservation and land stewardship. Resources released from subsidy removal could be used to partially compensate OECD farmers, and another part for setting up a system of green payments. In non-OECD countries removal of input subsidies should be the main focus of subsidy reform. The elimination of agricultural subsidies in non-OECD countries would be rewarded by greater access to the agricultural markets of the OECD countries as high protection rates fall.

With regard to the energy subsidies a 'grand bargain' could be made through a connection to the Kyoto Protocol. If OECD countries remove and ban fossil fuel subsidies and assist non-OECD countries in their reform through financial and technology transfers, they could require (as part of the bargain) that, in return, non-Annex-I countries join the regime and accept national ceilings on GHG emissions. The deal should be worked out in more detail by taking into account different energy sources and groups of non-Annex-I countries. Coal subsidies in China and oil subsidies in oil-producing countries can be particularly worth the effort of setting out a 'grand bargain' in more detail. Forestry subsidies could also be included in such a deal.

5.1 Introduction

This chapter deals with international trade, finance and subsidies as non-climate issues that can be considered relevant for an international climate strategy. The three subjects - international trade, finance and subsidies - are linked to each other as shown in Figure 5.1.

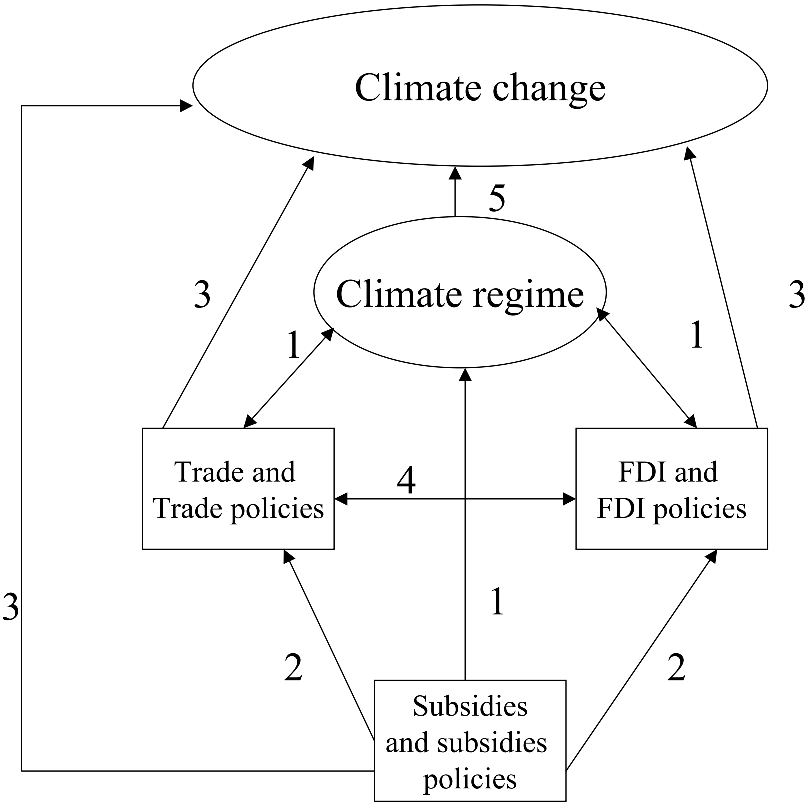

Figure 5.1 Relationships between foreign direct investment (FDI), trade, subsidies and climate issues

Figure 5.1 shows five basic effects. The first describes how the three relevant variables affect the climate regime (arrows numbered 1). For example, indirect fossil fuel subsidies artificially reduce the price of fossil fuels, which leads to greater consumption. To offset the resulting increase in carbon dioxide emissions, governments would either have to raise carbon taxes or adopt a more biting climate regime than in a situation without such subsidies. There is also an opposite effect from the climate regime to international trade and FDI. A higher carbon tax, for example due to a tough climate regime, affects the competitiveness of companies in countries with a pollution-intensive production structure.

The second effect concerns the indirect effects of subsidies on the climate regime through the other two variables – FDI and international trade (arrows numbered 2). Subsidies affect the price-cost structure and hence the size of trade and FDI flows.

The third effect runs from the three core variables direct to climate change (arrows numbered 3). International trade and FDI stimulate economic activity, (part of) which may contribute to climate change. Subsidies may also affect economic activities in a positive way and hence produce negative environmental effects that may contribute to climate change. Reverse effects (such as the impact of climate change on agricultural production and trade) fall outside the scope of this study, which is concerned mainly with the question of how FDI, trade and subsidy policies can be reformed such that they enforce or reduce the need for climate policies.

The fourth effect (arrow number 4) deals with the mutual effects of both trade and FDI policies. For example, the emergence of FDI goes together with changes from inter-company trade flows to intra-company trade flows, which also affects the structure of international trade patterns. These effects are also excluded, as they are not assumed to affect climate change and climate regime substantially.

The fifth effect (arrow number 5) shows the impact of the climate (Kyoto) regime on climate change. A more stringent climate regime reduces the probability of climate change. This effect is also not addressed in this chapter as we concentrate here on the non-climate issues.

Section 5.2 describes conceptual issues in which the relationship between the three subjects and climate change/policies are discussed. As background, section 5.3 reports some data on trade flows, FDI and subsidies (at both a global scale and that of industrial and developing countries). Section 5.4 discusses options on how trade, FDI and subsidies can be framed to enforce greenhouse gas (GHG) emissions (arrows numbered 1 and 3). Section 5.5 formulates possible (international) policy options based on a number of selection criteria, particularly economic, environmental, political and technical criteria. The role of international institutions is also discussed. The final section summarizes provides a summary, conclusions and recommendations.

5.2 Conceptual issues and definitions

5.2.1. International Finance

International finance consists of private and official financial flows. Private financial flows include all flows to the Balance of Payment capital account, i.e. both short-term and long-term investment capital. Short-term investment capital consists mainly of equity purchases and sales in the private sector and aims to make short-term profits in reaction to changing interest rates and share prices. Although the size of these flows has grown substantially over the last decade we do not discuss it here because its link with climate change is not obvious. Long-term investments, i.e. FDI patterns and long-term debt finance, are of more interest. FDI is defined as investment that involves a long-term relationship between the investor (parent company) and the affiliate. It consists of three components: equity capital, reinvested earnings and intra-company loans. FDI can take various shapes. Greenfields are investments in completely new capital stocks. Joint ventures are agreements between two or more partners to own and control a business. FDI through merger and acquisition (M&A) means that a company invests abroad by purchasing (a part of) an existing company in the host country. Long-term debt finance consists of the debt positions of (mainly developing) countries to private partners such as international banks.

Official financial flows include the official development assistance (ODA) and official aid (OA) provided by the donors of the OECD's Development Assistance Committee (DAC). ODA is provided to promote economic development and consists partly of concessional loans.

5.2.2. Subsidies

Subsidies are broadly defined as all measures that directly or indirectly keep consumer prices below market level and producer prices above market level, as well as leading to the reduction of producers' input costs. This means that subsidies are not only direct money handouts that can be found in government budgets, but also include monetary transfers to producers or consumers and are created through the market as a result of government intervention.[77]

Two types of economic policy intervention particularly stand out in this definition. By regulating domestic prices and keeping them below world market prices, governments support consumption. Subsidized consumer prices increase domestic consumption and this excess demand may induce additional imports and hence decrease foreign exchange revenues. Governments may also choose to subsidize production, e.g. by imposing minimum prices above market level. Producers expand supply and accelerate resource depletion, while public budgets are tapped to pay for the surpluses.

Apart from such interventions in market prices, governments employ a wide variety of policy measures to support consumption and production. Tax subsidies, such as tax exemptions, tax deferrals or reduced tax

[77] For a discussion of subsidy calculation methods based on this definition and the issue of benchmark choice in tradable and non-tradable products, see De Moor (1997), Steenblik (1995, 2003).

rates are particularly popular in OECD countries. Subsidies that aim to reduce the costs of capital or the financial burden of companies are also common. Governments provide loans at favourable interest rates or guarantee loans and overlook loans in default. Another form of support is the public provision of infrastructure and complementary services, with costs only partially recovered from users. The transport sector is a typical example of such subsidization. Table 5.1 shows a taxonomy as a practical tool in identifying subsidies according to their method of transfer.

Table 5.1 A subsidy taxonomy to identify public support: methods of transfer

Subsidy types	Examples
On-budget subsidies	
Budgetary subsidies	Direct subsidies, e.g. grants or payments to consumers or producers
Off-budget subsidies	
Tax subsidies	Support through tax policies, e.g. tax credits, tax exemptions, tax deductions, rate relief, preferential tax treatment
Public provision below cost	Infrastructure provision and complementary services, public R&D expenditures
Capital cost subsidies	Preferential loans, liability guarantees, debt forgiveness
Subsidies through the market mechanism	a) domestic-oriented, e.g. price regulation, quantity controls, procurement policies b) trade-oriented, e.g. import and export tariffs, non-tariff barriers

Source: Based on OECD (1998), De Moor (1997) and Van Beers and De Moor (2001)

Table 5.1 shows that subsidies are not restricted to direct financial support (i.e. a certain amount of money) provided by the government to consumers or producers. This type of direct, on-budget support is visible in government accounts. There is also a wide variety of off-budget transfers through the tax system, the price mechanism or other public and economic structures. Such policy interventions usually impose an indirect rather than a direct cost on the government. Off-budget subsidies also impose costs to society as a whole but these indirect costs are typically concealed.

Finally, external costs are explicitly excluded from the subsidy definition, or more specifically, the non-internalisation of external costs relating to water or air pollution, accidents or environmental damage. In theory, governments should intervene and introduce taxes or other pricing modes to internalise these external costs. Some authors argue that any failure to do so is also a subsidy (Myers, 1998). The present study does not include external costs in the subsidy definition, for two reasons. First, the non-internalisation of external costs refers to the lack of government policy, while subsidies (as defined above) arise from active government intervention. Second, there are significant differences in measurement and reliability; external costs are extremely difficult to valuate and involve large uncertainty margins, while estimates of subsidies are much more solid and reliable (Van Beers and Van den Bergh, 2001).

5.3 Relevance of trade, investment, and subsidies

5.3.1. International Trade and FDI

Table 5.2 provides some data on trade flows and average FDI flows. A first observation is that most trade and FDI flows originate from, and flow to, developed countries.

Table 5.2 Trade and FDI flows in the world (in billions of dollars). Share of world total in parentheses and italics

	Trade flows 2002		FDI flows: averages 1998-2002	
	Exports	Imports	Outflows	Inflows
Developed	3848	4268	802.2	693.4
USA	694	1,202	141.3	189.2
	(11.6)	*(18.5)*	*(16.3)*	*(20.4)*
EU	2449	2447	562.3	434.6
	(39.0)	*(37.6)*	*(64.8)*	*(46.9)*
Japan	417	337	29.6	8.0
	(6.6)	*(5.2)*	*(3.4)*	*(0.9)*
Russia and Eastern Europe	314	299	3.3	25.5
	(5.0)	*(4.6)*	*(0.4)*	*(2.8)*
Developing	2110	1943	62.4	207.6
Africa	140	135	0.7	11.9
	(2.2)	*(2.1)*	*(0.1)*	*(1.3)*
Asia	1620	1458	46.3	110.5
	(25.8)	*(22.4)*	*(5.3)*	*(11.9)*
Latin America	350	350	15.4	85.1
	(5.6)	*(5.4)*	*(1.8)*	*(9.2)*
World	6272	6510	867.9	926.6

Sources: International trade statistics 2003 for trade flows, World Trade Organisation; World Investment Report 2003 Statistical Annex, UNCTAD: pp. 249-256 for FDI flows. Number for EU includes intra-EU flows.

Total word trade flows are US$ 6272 and US$ 6510 billion for exports and imports respectively.[78] The average FDI for the 1998-2002 period was US$ 868 and US$ 927 billion.[79] Developed countries have an FDI surplus, i.e. they export capital, while the developing countries import capital, which is as expected. The USA currently forms the exception in the developed world, as it has more incoming than outgoing FDI. For comparison, the ODA inflow in the developing countries was US$ 52.3 billion in 2001, which is low compared to their FDI inflows.

5.3.2. Subsidies: food, energy and transport

Numbers on subsidies are presented in Table 5.3. Worldwide, public subsidies are some US$ 1065 billion annually, or 4% of world GDP. This equals the total GDP of all low-income countries in 1999 and is almost as much as the total foreign debt of Latin America, South Asia and Africa combined. OECD governments spend an annual US$ 725 billion on public subsidies, accounting for 3.4% of GDP. Although non-OECD countries spend far less on subsidies in absolute terms, the cost of US$ 340 billion is a heavier burden on the economy, consuming over 6% of GDP.

[78] The deviation between the two amounts can be attributed to the different valuing of imports (c.i.f.) and exports (f.o.b.).

[79] A difference exists between FDI flows and FDI stocks. Stocks are the net (depreciation-corrected) accumulation of all flows in the past. Measured as FDI stocks, this results in US$ 7122 billion for inward stocks and US$ 6866 billion for outward stocks.

Table 5.3 Annual public subsidies, 1994-1998, trade flows (mid-1990s) and FDI flows (average 1999-2000)

	Agriculture/fisheries	Energy	Road transport	Total (% GDP)
Subsidies (bln $)				
World	420	240	225	1065 (4.0)
OECD	345	80	200	725 (3.4)
Non-OECD	75	160	25	340 (6.3)
Subsidies (%)[1]	39.4	22.5	21.1	100
Trade flows (%)[2]	15.4	7.5	43.2	
FDI flows (%)[3]	0.1	8.1	11.5	

Notes: in % of global subsidies; 2. in % of global trade flows; 3. in % of global FDI flows
FDI energy sector = mining, quarrying, petroleum + coke, petroleum products, nuclear fuel + electricity, gas, water

Sources: Subsidy amounts and percentages: Van Beers and De Moor (2001) and OECD (2000); trade flow percentages; Van Beers and Van den Bergh (2001); FDI flows percentages: World Investment Report 2003: p. 192.

The three sectors (agriculture and fisheries, energy and road transport) constitute more than 80% of all global subsidies. Table 5.3 also suggests that the exploitation of the natural environment is heavily subsidized. Nearly 40% of all subsidies are for agriculture and fisheries. With an annual bill of US$ 400 billion, agriculture is by far the largest recipient of public subsidies. By far the bulk of the subsidies can be found in OECD countries, which spend US$ 345 billion a year on transferring agricultural support. The high level of OECD subsidies is a structural phenomenon, as it has existed since the early 1990s.[80] Most of the agricultural subsidies in the OECD countries come from the EU (US$ 142 billion), Japan (US$ 57 billion) and the USA (US$ 97 billion).

Agricultural support in OECD countries can be classified under one of four broad categories. The first is market price support, primarily through price guarantees and import tariffs. The second is direct payments, the bulk of which are based on area farmed (or not farmed) or the numbers of livestock owned by the farmer, and so-called ‘disaster payments’, which supplement farmers income when crops fail. The third category is indirect or direct support for farm inputs, such as fertilizers, farm credit and extension services. The fourth category covers general services, such as government expenditure in agricultural research and disease-control programmes (see also Chapter 3).

The energy sectors also receive large subsidies. Governments throughout the world spend approximately US$ 240 billion a year on subsidizing energy. Non-OECD countries – mainly developing countries - seem to give particular priority to energy support, as nearly half of all subsidies in the developing world are awarded to the energy sector. There is a typical difference between the type of support in OECD and non-OECD countries. Whereas public subsidies in non-OECD countries focus on supporting energy consumption, OECD countries mainly direct their subsidies towards energy production. These two categories have quite different economic effects. Consumer subsidies through low energy prices encourage overuse and waste, and therefore stimulate pollution. Underpricing also hurts energy producers, whose revenues and profits may be insufficient to replace and modernize existing equipment. The existence of old vintages of energy equipment, for example as used in many former centrally planned economies, causes an enormous waste of energy between production and consumption points. On the other hand producer subsidies encourage overproduction, since they reduce production costs or raise revenues artificially. Producer subsidies are usually accompanied by protection and quantity regulations that generate further distortions in the domestic economy.

Energy support is provided through a wide variety of policy interventions: direct grants to cover the operating losses of coal mines; support to low-income households to purchase fuels for heating and cooling; all sorts of exemptions from excise taxes for favoured energy users (such as farmers and fishermen); loans to producers at low interest rates; policies that allow public energy companies to earn a lower-than-market rate of return; limited financial liability for the nuclear industry and R&D support for nuclear fusion programmes; domestic purchase obligations for coal; deficit payments to mine-worker pension funds to compensate for the

[80] The agricultural subsidies of the OECD countries amounted to US$ 321 billion in 2000 and US$ 311 billion in 2001. This is a declining tendency but the amounts are still substantial.

costs of Black Lung Disease and early retirement; end-user energy prices at rates below market level; and the non-payments of tax bills and bail-out operations of public companies.

Table 5.4 Costs of energy subsidies per year, 1995-1998 (US$ bln)

	OECD countries	Non-OECD countries	Total
Coal	30	23	53
Oil	19	33	52
Gas	8	38	46
Subtotal fossil fuels	57	94	151
Electricity	a	48	48
Nuclear	16	negligible	16
Renewables and end-–use	9	negligible	9
Non-payments and bail-out[b]	0	20	20
Total	82	162	244
Per capita (US$)	88	35	44

Notes: a. Subsidies for electricity in OECD countries have been attributed to fossil fuels, according to the shares.
b. Subsidies from non-payments and bail-out operations have not been attributed to energy sources.
Sources: Van Beers and De Moor (2001) and IEA (1999).

Although the difference between consumer and producer subsidies matters from an economic viewpoint, it matters less for the environment, as most subsidies encourage the burning of fossil fuels in one way or another. Governments are effectively subsidizing pollution and global warming as more than 60% of all subsidies go to coal, oil and gas. Since power generation usually involves burning fossil fuels, adding subsidies for electricity raises this percentage even higher, to over 80%. Even nuclear energy, with all its risks to human health and the environment, receives more support than renewable energy.

In contrast to OECD countries, energy subsidies in non-OECD countries aim to support energy consumers by setting end-user prices below the world market level. These consumer subsidies amount to US$ 162 billion per year and are, again, mostly directed towards fossil fuels. The countries of the Former Soviet Union (FSU) and Eastern Europe account for US$ 89 billion of consumer subsidies, or US$ 220 per capita.[81] The OECD and the World Bank estimated the underpricing of energy in the early 1990s at US$ 250-300 billion annually.[82] In the post-Soviet era, the transition to a market economy forced governments to increase energy prices substantially, thereby cutting consumer subsidies. Currently, energy prices have come closer to world market levels (around 70%), which still implies subsidy rates of 30%. In most Eastern European countries, subsidy rates ranged from 16%-37% in 1995 and were even higher for fossil fuels.

Finally, large sums of public subsidies are given to road transport. The OECD region accounts for the bulk of government expenditure on roads, but expenditure by non-OECD countries on road transport has been increasing sharply over recent years, and will probably accelerate in the future as governments strain to keep up with the ever-increasing demand for road transport in developing countries. Road transport is most heavily subsidized in Japan and the USA. Road transport is less heavily subsidized in the EU, where excise taxes on motor fuels are higher.

[81] IEA (1999) evaluates energy underpricing in eight of the largest developing and transition countries. This IEA study includes estimates for China, India, Indonesia, Iran, South Africa, Venezuela, Russia and Kazakhstan for the 1997–1998 period. For other socialist countries, the subsidy estimates have been updated to 1995 levels by adjusting earlier World Bank calculations (see Larsen, 1994) for the changes in the percentage subsidy rates and the (negative) growth rate of commercial energy use.
[82] See Burniaux *et al*. (1992) and Larsen (1994).

5.4 Overview of present situation and possible options

5.4.1. International Trade and FDI

International trade refers to the part of production that is sold abroad. Production of commodities can affect greenhouse gas (GHG) emissions and thereby influence climate change. International trade theory prescribes that specialization according to comparative advantage leads to more efficient use of scarce resources. A sudden opening of trade between two countries formerly closed to each others' imports can boost both countries' productivity, probably leading to increased production and hence GHG emissions, at least in the short term. In the long term international trade reaps the benefits of scale economies. Bigger markets produce technological innovation and diffusion, and higher national income generates resources that can be used for environmental protection or remediation.

The channels through which the environmental quality variable is influenced by the trade flows are often unclear. Therefore the results found in the empirical studies are a composite of several partly counteracting effects. In order to shed more light on these channels it is necessary to decompose the effects of increased international trade into three categories: scale, composition and technique effects. Scale effects refer to the scale of production. More trade leads to greater economic activity and therefore to more environmental pressure through more pollution, use of energy, raw materials, transport services etc. The result is ceteris paribus, an increase in emissions and depletion of resources. The composition effect is a change in the composition of production and exports due to changes in relative prices as a result of (more) openness to trade. Countries tend to specialize in the production and export of commodities, the production of which makes heavy use of their relatively abundant production factors (Heckscher-Ohlin model). Increased openness to trade therefore leads to a shift towards capital-intensive goods in capital-abundant countries. In labour-abundant countries production will be shifted towards the labour-intensive goods. In the standard environmental economic literature, capital goods are automatically connected to pollution-intensive goods (e.g. Siebert et al., 1980; Van Beers and Van den Bergh, 1980). Although theoretically convenient, it is much harder to argue this for policy analysis. For example, gold-mining techniques in Brazil are more labour-intensive than those in South Africa but it cannot be argued that South African gold-mining techniques put more pressure on the environment than those used in Brazil.

Land-abundant countries such as Australia will specialize more in the production and export of land-intensive goods (e.g. agricultural production and resource extraction), whose environmental impact can be extremely negative. However, in order to give a sound judgment on the environmental impact it should be compared with the production it displaces (see also Steenblik and Coroyannakis, 1995).

The result of the composition effect on environmental pollution is ambiguous. The technique effect is caused by changes in technology and production methods provoked by openness to trade. This effect is also ambiguous and depends on many factors. For example, more trade increases growth and economic welfare. Higher income per capita means a stronger demand for environmental quality. This results in political pressure for more stringent environmental policy measures, which induces new production processes with lower per-unit pollution emissions. Openness to the world also means openness to modern technologies that are cleaner than production processes based on older technologies (e.g. compare the dirty production technologies used in Eastern Europe before 1989 with those in Western Europe during the same period).

The impact of trade on environmental quality is the composite result of these three effects, which are different between countries. For policymakers it is extremely important to know the magnitudes of these effects. If international trade results in stronger environmental pressure they to know what effect can be mainly held responsible for this and whether policy measures can be used to correct or compensate for it. As yet there are very few estimations of these effects. An exception is a recent paper by Antweiler, Copeland and Taylor (2002). They studied how openness to international trade affects sulphur dioxide concentrations in the USA and found a small positive effect. In other words: in this case, free trade is good for the environment. It is caused by pollution reductions due to the technique effects that dominate the increased pollution effect of scale and composition effects.

Outside the scope of Antweiler et al. (2002) it can also be argued that international trade is less damaging to the environmental quality than a situation without trade or self-sufficiency. Two examples illustrate this. Turkey used to aspire to self-sufficiency in wheat production in order to satisfy the hunger of its growing population. However, the environmental outcome was negative because it meant more domestic farming, even in ecologically fragile areas such as steep hills, which stimulated erosion. Another example is wood production in Indonesia. In the 1980s Indonesia was confronted with an export ban - and hence fewer export opportunities. The supply of logs for the export markets was therefore shifted to the domestic market, resulting in a huge drop in prices. The result was a more intensive use of logs per unit of output, given the lower efficiency levels of the local processing industry. The message is clear. Trade policies aimed at reducing trade are not necessarily environmentally friendly (Braga, 1991).

FDI also has links to climate change, particularly in the energy sector. However, a dominant theory on FDI has not yet been developed. The most important contribution is Dunning's eclectic approach, which distinguishes certain motives to invest abroad (Dunning, 1993). The following motives can be distinguished.
Market-seeking investments: these aim at providing goods for new markets. A special kind of market-seeking that may be relevant for small countries is *export-seeking investments*. These are investments that are not primarily focused on the market in the host country but on the markets of the host country plus the neighbouring countries in a certain region. The country's geographic location is important.
Strategic asset-seeking motives: these refer to investments acquired through mergers and acquisitions or joint ventures in order to tap into the strategic advantages of the foreign company acquired. The strategic goals consist of improving or maintaining the international competitive position of the investing company. A positive synergy is possible with local technological knowledge.
Efficiency-seeking investments: these are investments aimed at improving the efficiency of the production process in the entire multinational enterprise (MNE), not necessarily just the affiliates; these investments are made by MNEs that have previously invested abroad and, after a certain time, relocate their production and distribution facilities in order to take advantage of cost differences between countries.
Resource-seeking investments: investments with the special goal of achieving resources at a lower price in the host country than in the home country. These are vertically integrated FDI and are particularly relevant for investments in raw materials, e.g. oil and gas.

Resource-seeking investments put strong pressure on the natural environment. In developing countries with relevant natural resources the resource-seeking motive for FDI still plays an important role, although to a diminishing extent. Investments in LDCs (least developed countries) today are increasingly motivated by the market-seeking motive (e.g. China, Brazil, etc.). However, inward FDI in these LDCs mostly consists of resource-seeking investments flowing into the primary sector (UNCTAD, 1999). Resource-seeking FDI has the highest potential to contribute to negative environmental effects such as GHG emissions. Many FDI take place from a resource-seeking motive, particularly in the energy sector.

Mabey and McNally (1998) argue that evidence exists that certain resource- and pollution-intensive industries prefer areas of low environmental standards.[83] Although in individual cases it might be possible that pollution-intensive sectors perceive environmental costs as an important parameter in investment decisions, the general evidence from many empirical studies shows that FDI flows are not predominantly governed by environmental policy differences. Costs relating to environmental protection and pollution abatement account for only a small fraction of total investment costs and therefore do not play an important role in determining where FDI takes place (Kalt, 1988; Tobey, 1990; Levinson, 1996; Van Beers and Van den Bergh, 1997). MNEs originating from a 'high environmental standard' country may find it advantageous to adhere to their home-based environmental standards, for two reasons (Esty and Gentry, 1997). First, MNEs are clearly visible (e.g. Shell in Nigeria) and, together with their large scale of operations, form an attractive target for local enforcement officials and international environmental NGOs. Recognition of this high-profile position makes MNEs very careful in their overseas operations. Second, for reasons of efficiency, MNEs generally prefer to work with a common set of standards because operating in different countries with different envi-

[83] This is in contrast to Van Beers and Van den Bergh (1997) who found that in resource-intensive sectors environmental standard differences are of minor importance in investment decisions. The location of the resource is the dominant factor.

ronmental standards would imply differences in management practices, pollution-control techniques and training programmes. The costs of designing different production processes in different countries outweigh the costs of maintaining the high environmental standards of the home country (Knögden, 1979). This argument may be frustrated by host country policies to insist on elimination of the environmental aspects of the projects funded with overseas capital. An example is the funding of electricity projects in China (Esty and Gentry, 1997). There is a huge demand for power plants in the ever-expanding Chinese economy and Chinese politicians consider power shortages a threat to Chinese economic growth and hence to their political power, while increased pollution due to non-compliance with environmental standards is not considered as threatening. This is just one example, and a couple of case studies might shed more light on these issues. OECD (1998c) provides a number of such case studies, which unfortunately do not provide a clear and consistent picture.

The non-participation of many countries in the Kyoto agreement results in relatively lax environmental standards in these countries with regard to GHG emissions. Although no strong evidence exists of industries migrating to environmentally lax areas, the migration argument is often threatened by pollution-intensive industries. For example, in 1993 the US government tried to implement a carbon tax in the USA, which collapsed due to industries' complaints about losing their competitive advantage (Esty, 1994).[84] Despite the lack of scientific evidence, politicians may be vulnerable to such arguments.

Therefore, with regard to the non-compliance to the Kyoto Protocol by Annex II countries, it cannot be excluded *a priori* that FDI flows will be unaffected by it - especially if the non-compliance will last for a long time. An effort to include the non-Annex I countries (in the short term) in the Protocol or in a future climate regime would provide MNE investments with an additional incentive to maintain the higher environmental standards of its home country.

At this stage, an important observation is that the carbon intensity of OECD countries' GDP is decreasing, due to a change in the production composition. Most of the growth is occurring in relatively low-carbon sectors, such as services. High-carbon activities (e.g. many industrial production processes) are increasingly imported from non-OECD countries. GHG intensity of imported goods' production processes is higher than for OECD production processes and therefore replacing one unit of domestic OECD production with one unit of imported production increased global GHG emissions in 1995 by some 5% (Ahmad and Wyckoff, 2003). This implies that non-OECD countries, particularly developing countries, should participate in a future climate regime.

In the UN Framework Convention on Climate Change (UNFCCC) or Kyoto Protocol, the Clean Development Mechanism (CDM) provides an opportunity to reduce the danger of unsustainable FDI. Article 12 of the Kyoto Protocol establishes CDM and states that developing countries can benefit from (foreign) private and public project activities resulting in certified emission reductions (CERS). Developed countries can use the CERS resulting from these projects to meet their own quantified emission-reduction commitments under the Kyoto Protocol, starting in the year 2000. The idea is that, in a typical project, a developed country's government or private investor finances the construction of an environmentally clean power plant in a developing country in exchange for credit towards the developed country's emissions commitment. Especially if home-country governments can assure their MNEs that GHG emission reductions achieved through their plants in developing countries will be subtracted from the MNE's reduction obligations in the home country, this may also provide an additional guarantee for many MNEs to invest in developing countries with the same high standard of technology that they use in their home country. Further research is needed to investigate whether the CDM's contribution to sustainable FDI would be substantial.

A growing tension can be observed between sustainable FDI requirements and those for additional energy investment in order to cope with current trends in energy consumption. The IEA (2003) shows that - if current trends continue - US$ 16.5 trillion of investment will be needed in the energy sector over the next 30 years, or an average of US$ 550 billion annually. Some US$ 10 trillion is necessary for the electricity-

[84] These industry lobby groups always play an important role in blocking policy changes. For example, during the NAFTA (North American Free Trade Agreement) discussions at the beginning of the 1990s, many industry lobby groups argued that millions of jobs would be lost without mentioning that millions of (other) jobs would be created.

generation sector and the rest is required in equal proportions for the oil and natural gas sectors. Developing countries and transition economies will absorb 58% of the investment in the electricity sector, or US$ 319 billion annually. The financial means to fund these investments need to be mobilized from domestic savings and external finance.

Domestic savings are high in both OECD and East Asian countries, but relatively low in the transition economies (except Russia), of Africa and Latin America. The poor domestic financial infrastructure in many of these countries explains the low mobilization of domestic savings. Financial repression in many developing countries strongly inhibits the development of a sound domestic financial sector. Financial repression means the subsidization of domestic investors by keeping domestic interest rates artificially low through measures such as 'interest ceilings'. This increases demand for investment funds but reduces supply through savings and a clear shortfall arises between the investment requirements and domestic savings. A low interest rate results in financing low-risk projects, which are not necessarily the most efficient ones. Increasing real domestic interest rates by reducing or eliminating perverse government intervention in domestic financial markets in developing countries will mobilize more domestic savings and make them available for productive investment projects (see also McKinnon, 1991).

External finance is an alternative source that consists of official flows (aid and debt) and private flows (equity and debt flows). Table 5.5 shows the net long-term capital flows to developing countries and transition economies.

Table 5.5 Net long-term capital flows to developing countries and the transition economies (US$ billions in current-year dollars)

	1991	1995	1998	2000	2002
Total flows	124	261	337	238	207
Official flows	62	54	62	23	49
Aid	35	33	28	30	33
Debt	27	21	34	- 6	16
Private flows	62	207	274	214	158
Equity flows	*43*	*144*	*187*	*200*	*161*
FDI	35	108	180	174	152
Portfolio	8	36	7	26	9
Debt flows	*19*	*63*	*87*	*15*	*3*
Bonds	11	31	40	17	19
Bank lending	5	31	51	3	- 16
Others	3	2	- 4	- 6	- 6

Sources: IEA (2003), UNCTAD (2003), World Bank (2003).

Table 5.5 clearly reveals that net long-term capital flows to the developing and transitional economies increased substantially during the 1990s.[85] Private flows increased from 28% of total flows in 1991 to 73% in 2002. However the *total* inflow of more than US$ 200 billion is already insufficient to meet the required US$ 319 billion for the *energy sector* alone. At a global level, the FDI inflow was US$ 651 billion in 2002. The percentages of FDI inflows that went into the energy sector in the period 1995-2002 were 40% for the OECD (also due to privatization and liberalization of energy markets), but much lower (and declining) in developing countries and transitional economies. Since the total FDI inflows were boosted during this period, the energy-related investments in developing countries have lost importance.[86]

Future investments necessary to maintain and expand energy suppliers should be found in domestic savings and increasing FDI flows into the energy sector. Domestic savings need to be increased by improving the domestic financial markets in many developing and transitional economies in order to reduce financial repression. FDI flows need to be increased substantially as the investment requirements far exceed the FDI inflows in the energy sector. This requires more privatization and liberalization of energy sectors. Increasing

[85] Different values for FDI (as compared to the averages in Table 5.2) are due to differing definitions. In Table 5.2 FDI includes equity flows, reinvested earnings and intra-company loans. In Table 5.4, FDI only includes equity flows.
[86] Only limited data are available on FDI inflows per sector.

external finance to developing countries, particularly in the form of aid and official debt financing, is not a viable option as a substitute for domestic savings and/or private foreign capital. Budget problems in developed countries (USA budget deficit and EU stability and growth pact) and the huge debt positions, particularly of the African countries, block this option. However, public capital can be used in a smart way in private/public partnerships (PPP) so that it can generate private funds to finance energy investments. It is also possible to make energy investments more sustainable and to make them contribute to poverty reduction. EUEI (EU Energy Initiative, 2003) suggests that PPP can use public development capital to reduce risks that are prohibitive for the private sector to start investments.

If sufficient financial resources for energy investments were available and effectively transformed into more investments for traditional energy sources, a substantial increase in GHG emissions could be expected. Most of the investments would concern electricity, which is often generated from fossil fuels. There are two ways to achieve GHG emissions reduction. The first is through providing incentives to reduce energy consumption and production by technological process innovations that lead to more energy efficiency in production processes. The best starting point here is to reduce or remove many perverse energy subsidies. The second option is to support climate policies by mobilizing finance for non-carbon energy sources. Substituting renewable energy for fossil fuels would clearly contribute to a reduction in GHG emissions (Sonntag-O'Brien and Usher, 2004). Although policies that stimulate investments in renewable energy may be welcome, many carbon-producing energy sources are also subsidized. It simply does not make sense to subsidize carbon-free forms of energy while also subsidizing fossil fuels.

5.4.2. Subsidies

Subsidies are a government instrument to achieve certain policy goals. These can be broad, e.g. maintaining farmers' income, stimulating economic growth and poverty reduction. The effective achievements of these goals are valued positively in welfare terms.[87] In order to give a sound judgment on the welfare effects of subsidies it is necessary to weigh the positive effects of achieving the goals against the negative side effects (e.g. environmental effects) of subsidies. If the negative effects are greater than the positive effects then the subsidy is considered to be perverse.

OECD governments in Europe account for approximately US$ 50 billion of energy support and, in the USA and Canada, for another US$ 30 billion annually. OECD producer support is fairly persistent, for three reasons. First, most subsidies are hidden through tax breaks, cheap public infrastructure and price regulations; hidden subsidies cover the real costs of support. Second, high-income countries can more easily afford the deadweight losses associated with subsidization. Third, OECD countries are often willing to pay a high price for supporting domestic production, which policymakers often naively see as necessary in order to safeguard energy security or protect employment. In Europe, half the total subsidy bill of nearly US$ 50 billion is directed towards coal, particularly in Germany and, to a lesser extent, in Spain and the UK.[88] Total support per ton of coal production amounted to US$ 295 for Germany and US$ 85 for Spain in the 1990s (Van Beers and De Moor, 2001). There is a slight trend, at least in Europe, towards reducing subsidies. Coal support in the UK has been substantially cut, a process that started in the 1990s, and Germany intends to halve its coal support over the next decades. Many EU countries are planning to embark upon a process of deregulation, privatization and opening residential markets to competition by their energy sectors. Removing government subsidies would be a necessary element in this process. In North America, energy subsidies are mostly given through tax breaks and capital subsidies for fossil fuels. Nuclear energy is mainly subsidized through cheap public provision of goods and services and support for R&D, particularly in France, Japan and the USA.

Governments in developing countries subsidize energy consumption in the mistaken belief that it will generate economic growth and prosperity, particularly by boosting industrial development, and to improve the welfare of the poor. However, once they discover the errors of this strategy it is usually too late: the transitional gains trap makes it much harder to remove subsidies than to introduce them. Energy subsidies are considered necessary in order to avert possible barriers to growth. Another important motive for consumer sup-

[87] Subsidies can also take a form that is less welfare-enhancing or even welfare-decreasing, e.g. paying off friends.

[88] The figures not only include official support figures but also those public expenses that fall outside the formal definition of Producer Subsidy Equivalent (PSE), such as deficit payments to miners' pension funds, subsidies for early retirement schemes or adaptation aid to control water contamination.

port in developing countries is to provide the poorest population groups with cheap energy. For countries without efficient mechanisms for redistributing income, low energy prices are judged to be vital for helping the poor. However, public subsidies have proven to be rather ineffective in serving this purpose. Empirical evidence shows that the equity implications of energy price reforms are fairly modest: the maximum income loss is slightly over 3% and usually concerns low-income urban households. These groups depend largely on the use of commercial fuels. However, they are not typical for the poorest population groups, which are commonly rural households using non-commercial fuels. Petrol subsidies mainly benefit car owners – surely *not* a group of poor consumers.

Energy subsidies
Energy subsidies are ineffective in fuelling economic growth or in reducing the vulnerability of the domestic economy to external shocks. In fact, the analyses strongly suggest that energy subsidies hamper economic development. Eliminating both producer and consumer subsidies would provide better incentives for a more efficient resource allocation and would yield a negligible, or slightly positive, economic impact. Model analyses by the OECD at the beginning of the 1990s (Burniaux *et al*., 1992) suggested that the increase in global welfare would be in the order of US$ 35 billion if non-OECD countries were to eliminate the large amounts of support (mainly through price controls) that these countries were providing to energy consumers at the time. Real income for the world as a whole would have increased by 0.7% annually, while these countries' terms of trade with OECD countries would have improved by 0.5% per year. However, the distribution of this welfare gain would have been uneven, with several winners but also some losers. Most former socialist and developing countries would have seen their welfare improve, sometimes by as much as 20%. But the main loser would have been China, where the worsening in terms of trade would have resulted in an average real income loss of 0.7% a year. Other losers would have been energy-exporting countries, which would have suffered an estimated drop in real income of 5% annually. This latter effect can be attributed to reduced demand for energy putting downward pressure on energy producer prices. Case study evidence further supports the conclusion that reforming energy subsidies in developing countries benefits economic development. In most countries where energy price reform has been implemented (Colombia, Ghana, Indonesia, Turkey and Zimbabwe), GDP growth has been higher than before the reforms. Indeed, energy price increases tended to be complementary to economic recovery, according to Hope and Singh (1995). The results have been reconfirmed by the IEA (1999). Removing consumer subsidies in eight large non-OECD countries produces efficiency gains and promotes economic growth totalling 0.7% of GDP.

Energy subsidies are also environmentally damaging as most are directed towards fossil fuels. OECD (1997) calculations show that global subsidy removal could reduce CO_2 emissions by around 10% worldwide. CO_2 emissions by former socialist and developing countries would drop by 7%. In the OECD region, subsidy removal may reduce CO_2 emissions by up to 250 million tonnes. For specific countries such as the USA, OECD (1997) has calculated that the environmental gains of reducing subsidies range from 40-200 million tonnes of CO_2. Anderson and McKibbin (2000) confirm these findings; their analysis of removing global coal subsidies points to reduced global CO_2 emissions of 8% in 2005.

Table 5.6 Economic and environmental effects of removing consumer energy subsidies, 1997-1998

	Subsidy rate (% ref. price)	Efficiency gain (in % GDP)	CO_2 reduction (in %)
Russia	33	1.5	17
China	11	0.4	13
Iran	80	2.2	50
India	14	0.3	14
Venezuela	58	1.2	26
Indonesia	28	0.2	11
Kazakhstan	18	1.0	23
South Africa	6	0.1	8
Total	21	0.7	16
% Non-OECD	–	–	10
% World	–	–	5

Source: IEA (1999)

The IEA (1999) adds to the robustness of this result by concluding that, at the time of its analysis, removing consumer subsidies in eight large non-OECD countries would cut their CO_2 emissions by up to 16%, or nearly 5% in terms of global emissions (see Table 5.6). Although these reductions would *not* be enough to achieve the goal of stabilizing CO_2 emissions at their 1990 level, it is a firm step towards complying with the GHG reduction targets set in Kyoto. Removing energy subsidies could also produce multiple benefits by reducing other emissions such as methane, NO_x and SO_2. Eliminating fossil fuel subsidies would level the playing field thus allowing a more successful penetration of carbon-free energy forms by making the latter more competitive.

Agricultural subsidies

The original intention of agricultural support was to provide and maintain farmers' incomes. However, OECD subsidies are neither effective in serving this objective, nor are they very efficient. The OECD (1995) has calculated the transfer efficiency ratio of market price support at 0.2, which means that every US$ 5 of support generates only US$ 1 in additional farm income. In other words, US$ 4 out of US$ 5 leaks away to suppliers of inputs and owners of fixed assets, especially land. Additionally, most of the 20% of the subsidy that does reach farmers goes to the largest agricultural producers, who are usually also better off in terms of farm income. In the USA, more than one-third of direct payments (at the beginning of the 1990s) went to the 5% wealthiest farms, while only 17% went to small farms (OECD, 1995).

Considering their negative impacts on the natural environment, equity producer subsidies encourage farmers to increase output in order to raise their income. This results in an increasing demand for land and hence an increasing pressure on the natural environment. As available agricultural land tends to be fixed, a rising demand for land leads to higher prices. This in turn encourages farmers to start using existing land more intensively by applying more chemical fertilisers and pesticides. Efficiency gains have to be achieved and farmers tend to switch to monoculture to achieve economies of scale. However, monoculture generally contributes to soil exhaustion and reduces fertility, and therefore to a greater vulnerability of crops to diseases. More pesticides are needed to control diseases.

Agricultural subsidies contribute to climate change (arrow 3 in Figure 5.1) by generating elevated levels of nitrous oxide (N_2O), mainly from over-fertilised soils, and methane (CH_4), mainly from rice culture and the feeding of ruminants. CO_2 (cultivation under glass) is also important at a national level.[89] It may be less relevant at a global level, since additional CO_2 due to energy use in greenhouses can be offset by reduced emissions due to fewer transport movements, as greenhouses are located closer to consumers.

Farmers in many OECD countries receive administered prices for their harvests that are considerably higher than the prices for equivalent quality produce sold on world markets. This producer price subsidy gives OECD farmers an incentive to expand supply. In a few countries this overproduction is purchased (at ele-

[89] See VCNI (2001) *Guidelines Environmental Performance Indicators for the Chemical Industry: the EPI method (version 1.1)*, Report by the Working Group on Environmental Performance Indicators.

vated prices) by the government, which then spends yet more money to transport and store the surplus produce. The cycle continues by subsidizing the export of these surpluses to the world market. Dumping and subsidized exports depress world market prices, which further increases the need for producer price subsidies.

Subsidizing agriculture in OECD countries further distorts international trade and the natural environment in developing countries. The dumping of OECD surpluses pushes world market prices downwards and, as a result, agricultural products from developing countries cannot compete. In order to remain competitive small-scale farmers in developing countries have to move to cheaper soil and therefore have to use marginal and often ecologically fragile lands.

Furthermore, at home, farmers in developing countries face unfavourable treatment from their own national governments. In the first place, particularly in many African countries, farmers are obliged to sell their produce to state trading companies, which pay the farmers a price that is lower than the world market price, thus reducing the farmers' income.

Subsidies for irrigation, fertilizers and pesticides have been granted to compensate farmers. Again, however, a vicious circle of support emerges, as input subsidies are merely a means of reducing the damage introduced by other government interventions. Nor have these subsidies been very successful in securing food supply. Policy measures such as reducing producer prices impede the supply of agricultural crops and (environmentally friendly) investments in land and crops.

Transport subsidies
There are two main motives for subsidizing road transport. The first is to stimulate economic growth. Efficient transport can do this directly through time and cost savings and indirectly through a regionally efficient allocation of physical and human capital. However, the relationship works in both directions: growth of economic activity also increases the demand for transport. The other socially motivated reason for supporting transport is to provide access, particularly to low-income households, to enhance their employment opportunities. Transport subsidies are seen as a way to redistribute resources from high-income to low-income households.

In practice, road transport subsidies have proven to be rather ineffective in promoting economic development. User fees (usually in the form of excise taxes on petrol and diesel) that cover less than 100% and free parking provide a disincentive for the efficient use of private cars. Car use increases pollution and causes more traffic casualties. It also leads to congestion, which further aggravates pollution, and which also persuades policymakers to build more roads. A vicious circle is created. Congestion increases, particularly in and around cities, to which the typical government response is to build yet more roads. This negative cycle means that road transport subsidies eventually become economically and environmentally perverse. Indeed, the underpricing and subsequent overuse imposes all sorts of economic costs, commonly measured in terms of lost worker productivity. These economic losses manifest themselves in lost working days through pollution-based morbidity and premature mortality, and lost time and wasted fuel spent in traffic jams. For developing countries in particular, underpricing also deprives governments of the resources necessary to build and maintain a good-quality infrastructure.

Road transport subsidies are also ineffective in serving the social purpose of redistributing resources from high-income families to poor households. Subsidies for infrastructure in developing countries almost always disproportionately benefit high-income households. In the case of road transport, subsidies go to the wealthier population groups – i.e. to car owners. In Algeria, for example, the wealthier receive almost four times more subsidized transport services than the lower income groups. In Hungary this ratio is even lower, at approximately 1.3.

5.5 (International) policy options and role of international institutions

5.5.1. International Trade and FDI

Trade-oriented and climate-oriented policies interact with each other. Trade liberalization leads to a change in the pattern of production in a way that may affect GHG emissions. On the other hand, the climate regime aims to increase production costs of GHG pollution-intensive industries, which affects economic competitiveness. Some national governments may attempt to protect sensitive industries (i.e. those that the government deems to be important for employment or energy security) by exempting exports from taxes or taxing competitive imports. Such reactions provoke a counter-response at the WTO by affecting trading partners.

Pressure will be high on national governments that ratify the climate regime to protect their sensitive sectors, particularly if substantial parts of the world (probably Australia, Russia, the USA and the developing countries) choose not to participate in the climate regime. This therefore means that a Kyoto Protocol that is not implemented around the world will:

- not result in optimum GHG emission reductions;
- but will also create the potential for trade conflicts within the WTO framework.

An important fundamental difference between the Kyoto Protocol and the WTO trade regime is that the former aims to correct for *market failures* and provides national governments with maximum flexibility to use economic instruments in order to influence individual behaviour. In contrast, the WTO trading system aims to minimize and provide remedies against *government failures* – i.e. distortions and welfare losses generated by protectionist behaviour. Consequently, the trade regime works best under a multilateral framework in which national governments reduce their national powers.

However, cohesion between trade and climate regime is possible for a number of environmental policy instruments such as GHG taxes (Charnovitz, 2003; see Chapter 9 of this volume). A GHG tax would be an appropriate instrument to address a market failure such as GHG emissions. It would reduce the demand for energy, promote more efficient technologies, and lead to cleaner energy replacing less-clean energy. If the prices of coal and oil were increased by a GHG tax on the carbon content of fuel, this would cause a switch to natural gas renewable energy and, in some countries, nuclear power. A carbon tax would be an efficient way to reduce emissions, because each individual energy user could compare its own costs, including tax, with its revenues. The same effect could be achieved by issuing tradable GHG emission permits. If the Kyoto Protocol is not implemented, an alternative route would be to impose a GHG tax on GHG-intensive energy production and consumption. This would be a policy that addresses both environmental criteria (mitigation) and economic criteria (i.e. efficient from a welfare-economic perspective). However, a problem exists if political criteria on GHG tax policies have to be applied. Although some countries might opt for such a tax others might not, and it would not be surprising if the latter group included the same types of countries as those currently experiencing difficulties in accepting the Kyoto Protocol.

In the WTO trade regime, applying the principle of national treatment, such a tax would be allowed as long as all national governments treat domestic and foreign products alike. Countries would not be allowed to provide a tax rebate to energy-intensive exporters. From a climate regime point of view, this WTO rule is favourable for reducing GHG emissions because giving tax rebates to energy-intensive exporters would make the GHG tax less effective.

Another instrument is known as the border tax adjustment, i.e. a tax on domestic energy input of an imported product. Such border tax adjustments are allowed under WTO rules as long as they are concerned with specific contents, e.g. harmful chemicals incorporated into imported products. However, such a case based on the energy content of a product, which is technically much more difficult to measure than, for example, chemical contents, has never been tested in front of a WTO Panel.

With regard to finance, a distinction should be made between adaptation and mitigation (see also Chapter 7). Finance for adaptation should be mobilized from several public and private sources. Chapter 7 elaborates the following sources as potentially relevant: UNFCCC funds, the Global Environment Facility (GEF), Development Assistance (DA), Non-compliance funds, Type II Agreements, disaster preparedness, insurance and disaster pooling, public finance (including public-private partnerships) and FDI, which may be particularly relevant because of the size of the amounts involved. Adaptation will result in increasing investment costs, which can reduce FDI inflows in countries with high adaptation costs. Although governments can attempt to remain attractive for FDI through financial support in order to cover adaptation costs, such opportunities are limited. Many adaptation projects have to take place in developing countries. From the (often developed) home country it may be possible to use government policies on bilateral investment agreements to positively influence the behaviour of multinational companies with regard to bearing adaptation costs in the developing host country. Further research is necessary to determine whether this method would be successful.

As far as pollution-intensive FDI is concerned, the pace of energy investments, particularly in developing countries, is not keeping up with increased energy demands. This creates an opportunity for more FDI in developing countries' energy sectors. In order to make FDI flows more sustainable, it will be necessary to change the structure of FDI investments away from oil and coal and more towards natural gas, renewable energy and, perhaps, nuclear power.

At the national level export credit agencies might be used to influence technology exports such that they contribute to mitigation. Schaper (2004) argues that export credit agencies might achieve this by offering export credit products that are tailored to the needs of renewable energy technologies or technologies for low-carbon energy sources (see also Maurer, 2002). Project sponsors developing projects under the CDM mechanism would profit substantially from these products. This is just subsidizing alternative low-carbon energy sources, and effectiveness will be limited as long as high-carbon energy sources (such as fossil fuels) are also subsidized.

The most important way to overcome the barriers to investing in renewables is:
- to remove the government failure of support for fossil fuels; and
- to eliminate the market failure of external effects concerning fossil fuel GHG emissions, such as by levying taxes on the carbon content of fuels.
- Increasing the prices of fossil fuels could be a significant first step in increasing the expected revenues from investments in low-carbon and no-carbon fuels and therefore making them more attractive to the private sector.

The removal of fossil fuel subsidies should start before anything else because – as argued by Van Beers and Van den Bergh (2001) – introducing GHG taxes in a world with environmentally harmful subsidies produces less than optimal results. Basically governments could be tempted to introduce GHG emission charges that would be too low. Therefore the most important policy question left is: how to eliminate subsidies, particularly in the agricultural and energy sectors (see also Anderson, 2004).

5.5.2. Subsidies

Subsidies affect the environment through three main channels (see OECD, 1998a and b, and Van Beers et al., 2002). Firstly, subsidies produce economic effects as they increase the level of activity in the subsidized sectors. The second channel produces higher levels of emissions such as greenhouse gases (arrow 2 in Figure 5.1). Thirdly, they increase damage to the environment, which needs to be addressed, at additional cost, through stricter environmental policies (arrows 3 and 5).

When evaluating the impact of subsidies, three criteria are relevant:
- policy effectiveness;
- economic efficiency;
- environmental and social implications.

Subsidies are ineffective if they fail to achieve the desired results. They may even be counterproductive if they undermine the intended policy objectives (e.g. energy tax rebates for energy-intensive industries). Support policies are considered efficient when they serve the policy goals at the lowest possible cost; alternatively, they are inefficient if they incur unnecessarily higher costs. If subsidies adversely affect the environment or equity and outweigh the positive effects of support, they are called perverse.

Agricultural support reform

The reform of OECD price-support policies is the most important recommendation for subsidy reform in agriculture. Using the annual OECD reports, the costs and effects of agricultural subsidies should be demonstrated more vigorously to politicians, policymakers, consumers and taxpayers in OECD countries. For political and economic reasons many governments feel that it is necessary to compensate farmers. This may take the sting out of the public debate and isolate the most forceful opposition. Furthermore, *removing OECD price support should be part of a much broader reform towards rewarding landowners for services to improve the environment, nature conservation and land stewardship.* Obviously, such a ‘double-switch’ reform should ideally be pursued at OECD level. The economic implications could then be kept to a minimum, while the resources generated from subsidy removal could be partly used to compensate or buy out OECD farmers and partly to set up a system of green payments. Paying farmers and other landowners for environmental services could provide an alternative income opportunity; they would then have a choice between traditional food production and production more geared to nature conservation.

In non-OECD countries, subsidy reform should primarily focus on removing input subsidies. Raising prices to at least cover the full costs of supplying fertilizers and pesticides could be accommodated through special (micro) lending facilities. It would also require improved performance of the domestic financial sector. Eliminating agricultural subsidies in non-OECD countries could be rewarded through improved access to agricultural markets in OECD countries. Table 5.7 shows that sufficient economic potential exists for offering compensation options in the OECD countries.

Table 5.7 Simulated economic costs and benefits of reducing all crop support rates by 10% (in millions of US$)

	European Union	Japan	USA
Farmers income	- 1726	- 1184	- 241
Profits of input suppliers	- 448	- 321	74
Consumer surplus	367	1828	- 686
Taxpayer costs	2615	897	1218
Total	808	1220	365

Source: OECD (2001)

A 10% reduction in crop support would lead to a loss of farm income At the same time, taxpayers in the EU, Japan and the USA would benefit, as would consumers in the EU and Japan. The total effect would be positive, which implies that the benefits of reform are higher than the costs, and therefore that there are opportunities for the winners to compensate the losers, i.e. the farmers. For example, EU farmers can be compensated through the tax system, although such compensating mechanisms should be temporary, for other reasons. In Japan, a temporarily higher indirect tax on food could be introduced to skim the consumer surplus in order to compensate farmers.[90]

Reforming the world’s largest subsidy should be at the top of the global subsidy reform agenda. There have been many attempts to negotiate an international agreement on agricultural support. In fact, the Uruguay Round Agreement on Agriculture (AoA) was finally signed in 1994 after ten years of negotiation, as part of a number of other agreements that together formed the Final Act of the Uruguay Round of multilateral trade negotiations.[91] The objective of this agreement was to bring agricultural trade under the full disciplines of the multilateral trading system. In so doing, it was hoped that trade in agricultural products would eventually become more market-oriented. It focused on measures to reform agricultural trade and domestic agricultural policies, mainly through increasing market access, reducing price support policies in developed countries and

[90] Consumers would *not* pay higher prices than before, because the tax would replace the existing elevated prices maintained by high tariffs.

[91] Apart from trade in agricultural products, the Uruguay Round Agreements also contain agreements on trade in industrial products, textiles and clothing, services, Trade Related Intellectual Property Rights (TRIPS) and Sanitary and Phytosanitary Measures (SPS).

reducing export subsidies. The AoA created a precedent for evaluating domestic policies and imposing binding subsidy-reduction commitments in an international context.[92] However, despite this precedent, the actual impact of the Uruguay Round on the size of agricultural subsidies in developed countries has been rather limited.

One way to launch agricultural subsidy reform would be to allow reductions in OECD agricultural support to count towards official development assistance (ODA) and hence enable OECD countries to reach their official target of devoting 0.7% of GDP to development assistance. It might be argued that this measure would only have cosmetic value, as OECD governments have already officially committed themselves to this target. However, the OECD as a whole has so far never reached the 0.7% target, but could do so if the removal of agricultural subsidies could be counted as ODA. Furthermore, the associated opening up of OECD markets would probably benefit developing countries far more than most current development assistance.

Energy support reform
Energy reform aims to de-couple subsidies from production in OECD countries and from consumption in non-OECD countries. The former involves specific tax reform, the removal of price protection and the liberalization of the energy sector. NGOs could instigate reform by assessing a country's energy policy and exposing perverse energy subsidies. The Green Scissors campaign in the USA is a good example of different types of NGOs collaborating to improve transparency and expose wasteful public energy policies. OECD governments could further enhance and accommodate the transition by retraining employees in the energy sector and by providing compensation. If support is deemed necessary for employment reasons, direct employment subsidies are more cost-effective.

In non-OECD countries, raising energy prices should go hand in hand with direct income support targeted at the poor (such as fuel coupons, vouchers or credit options), possibly financed through a special IMF lending facility. Governments may further consider liberalizing the energy sector and actively involving the private sector in this transition.

There is an excellent political opportunity within the UNFCCC for striking a 'grand bargain' between the north and the south by linking energy subsidy reform to a meaningful participation by developing countries in the climate regime. A very important issue regarding a future climate regime is the involvement of the non-Annex-I countries, mainly developing countries (see also section 5.4). Their involvement is absolutely essential in controlling climate change, as GHG emissions are expected to continue increasing in developing countries, perhaps for a long time. Some Annex-I countries, in particular the USA, have indicated that they would ratify the Kyoto Protocol only after non-Annex-I countries have also made commitments to reduce GHG emissions. On the other hand, many developing countries claim that the current situation is mainly the result of past growth in industrial output and associated emissions in OECD countries, and therefore these nations have the prime responsibility to reduce it.

Removing energy subsidies may cause a breakthrough in this stalemate by demonstrating real progress by Annex I countries and obtaining the commitment of non-Annex-I countries. The OECD countries should remove and ban subsidies for fossil fuels *thereby accepting a worsening of their competitiveness towards non-OECD countries*. They should also assist non-OECD countries in their reform, through financial support and technology transfer. In return the non-Annex-I countries should join the Kyoto Protocol regime and accept national ceilings on GHG emissions.

[92] With regard to market access, non-tariff border measures are replaced by tariffs that provide substantially the same level of protection. Tariffs resulting from this 'tariffication' process, as well as other tariffs on agricultural products, are to be reduced by an average 36% (developed countries) and 24% (developing countries), with minimum reductions for each tariff line being required. Reductions are to be undertaken over six years (for developed countries) and over ten years (developing countries). The least developed countries are not required to reduce their tariffs. Domestic support is to be reduced by 20% (13.3% for developing countries, with no reduction for least developed countries) during the implementation period. Export subsidies are to be reduced to a level 36% below the 1986-1990 base period level over the six-year implementation period, and the quantity of subsidised exports reduced by 21% over the same period. For developing countries, the reductions are two-thirds of those of developed countries over a ten-year period (with no reductions applying to the least developed countries).

This strategy offers benefits to all parties:

- OECD countries would take a significant step forward in realizing their Kyoto targets;
- non-OECD nations would benefit from financial and technology transfers, which would lead to more sustainable energy use in these countries;
- the international trade implications would be minimal;[93]
- lower GHG emissions would result from both the removal of fossil fuel subsidies and global participation to control climate change.

Frankly speaking, such a 'grand bargain' could indeed provide a good opportunity to get fossil fuel prices right, but the concept needs to be worked out in more detail. As the non-Annex-I countries are not a homogeneous group, further research is necessary to investigate which groups of countries deviate from each other with regard to GHG emissions and amounts of direct and indirect energy subsidies. The bargain can be detailed further for different energy sources. For example, Van Beers and De Moor (2001: p. 51), based on an IEA (1999) report that during the second half of the 1990s the energy subsidy rates (for coal) in China would be 40%, while this rate for all energy sources combined is only 11%. The focus in China should be directed towards coal, as this country contributes substantially to global CO_2 emissions. Some 27% of the net change in global CO_2 emissions between 1990 and 2000 can be attributed to China. It also appears that subsidy rates in oil-producing countries are very high. Since most complaints from developing countries about OECD fossil fuel subsidies come mainly from petroleum-exporting countries,[94] this might offer a deal between OECD and the oil producers. The main concern of the oil-producing developing countries relates to coal subsidies. This is symbolic, as removing them would not have a significant negative effect on their exports, and might even increase as oil may be substituted for coal. Therefore a deal on OECD coal subsidies with oil-producing countries, in exchange for abolishing their own subsidies on oil and natural gas, might make sense.

Another aspect that may need to be integrated is the removal of forestry subsidies. Forests are carbon sinks - i.e. they have the potential to sequester carbon. The Kyoto Protocol allows countries to employ sinks for realising national GHG emission targets. Vice versa, cutting down forests releases carbon (see Chapter 3) and therefore deforestation leads to more carbon emissions. Some forestry subsidies – mainly government expenditure on road building that is not recovered through stumpage fees - are therefore counterproductive in any policy to fight climate change and global warming. Forestry subsidies can be doubly environmentally perverse as:

- they contribute to excessive forest clearance and biodiversity losses; and
- they aggravate climate change.

From a climate change perspective, it is essential to include the removal of forestry subsidies in the 'grand bargain' on energy subsidies. While governments will miss some income from logging royalties, bringing sinks into the CDM would give national governments in forest-rich countries the incentive to stop subsidising forest clearance and yet still receive financial resources, this time for maintaining and preserving forests. These financial resources are potentially very large, as the following figures illustrate. Estimates of the economic value amount to an average of US$ 2500 per hectare, 25% more than the value of timber production (Pearce, 1995). In absolute terms, Myers (1998) estimates the carbon sink function of forests at US$ 3700 billion a year, compared with the US$ 400 billion earned through commercial logging.

[93] Compare, for example, Burniaux et al. (1992), Shah and Larsen (1992) and Anderson and McKibbin (2000). See also the discussions on the impact of energy subsidies in section 5.5.1.

[94] I am grateful to Ron Steenblik, who raised this point in one of his comments.

5.6 Conclusions and recommendations

5.6.1. Conclusions

This study presents an overview of the importance of non-climate issues (international trade, FDI and subsidies) for the climate regime. Its main aim is to show how FDI, trade and subsidies policies can be reformed such that they enforce or can be substituted for climate policies.

Trade flows are difficult for national governments to influence due to WTO rules. An important difference between the Kyoto climate regime and the WTO trade regime is that the former aims to correct for market failures (and therefore requires national governments to use their economic instruments), while the latter tries to minimize and provide remedies against government failures such as protectionism. However, cohesion between trade and climate regime is possible, particularly regarding GHG taxes and border tax adjustment.

A data scan shows that FDI flows and stocks, as well as subsidies, are considerable – especially compared with the ODA flows. Therefore policy initiatives affecting FDI and subsidies could have potentially more impact on GHG emissions than ODA flows.

The relationship between investment flows and the climate regime is characterized by two problems:

- a huge amount of investments in the energy sector is necessary in order to maintain economic growth; and
- these investments should be put into energy sources with low GHG emissions.

Recent estimates on energy investments reveal that the energy sector will require annual investments of US$ 550 billion over the next 30 years. The financial means to fund these investments will have to be mobilized through domestic savings and external finance.

Domestic savings, particularly in developing countries, must be increased by eliminating financial repression by government policies. FDI flows need to be increased substantially, as the investment requirements far exceed the present FDI inflows in the energy sector. This requires more privatization and liberalization of energy sectors in developed countries, but also especially in developing and transition countries.

Increasing external finance to developing countries, in particular through aid and official debt financing, is not a viable option as a substitute for domestic savings or FDI. Budget problems in developed countries (the USA budget deficit and EU stability and growth pact), as well as the huge debt positions of the African countries, block this option. However, public/private partnerships can be used to mobilize sufficient private foreign capital and to influence the sustainability of FDI in the energy sector. Smart subsidies can provide a high leverage for private capital. Further research is necessary to clarify and detail these issues.

The quantity of the necessary investments says nothing about their sustainability. The expected huge investments in fossil fuel sectors will increase GHG emissions and run counter to the aims of the Kyoto Protocol. Two policy prescriptions are relevant aimed at increasing the sustainability of FDI in the energy sector. The first is to reduce energy consumption and production through technological efficiency improvements. This means that more funds should be invested in R&D for making consumption less energy-intensive. The second is to switch from carbon-based to carbon-free or carbon-neutral sources of energy. As a substitute for fossil fuels, these would clearly contribute to reducing GHG emissions. The policy prescription here is to reduce or remove many perverse energy subsidies. It makes no sense to subsidize alternative energy sources while at the same time continuing to subsidize fossil fuels.

Recent estimates show that, on a global scale, more than US$ 1000 billion annually is provided for subsidies. Some 80% of these can be found in the agricultural, energy and transport sectors. Many of these subsidies do not (or barely) achieve their goals and produce negative effects on the natural environment. Reducing or eliminating these subsidies would reduce environmental damage and barely affect the goals for which these subsidies were originally intended. There is room for ‘grand bargains’ to be struck, particularly in the agricultural and energy sector.

In the agricultural sector, removing the OECD price support should form part of a broad 'double-switch' reform that moves towards rewarding farmers/landowners for services relating to nature conservation and land stewardship. Resources released from subsidy removal could be partially used to compensate OECD farmers, and partially used to set up a system of green payments. Subsidy reform in non-OECD countries should primarily focus on removing input subsidies. Eliminating agricultural subsidies in non-OECD countries would be rewarded by greater access to the agricultural markets of the OECD countries, as high protection rates fall.

With regard to energy subsidies, the 'grand bargain' could be made through a connection to the Kyoto Protocol. If OECD countries remove and ban fossil fuel subsidies – thereby accepting a deterioration of their competitive position towards non-Annex-I countries – and assist non-Annex-I countries in their reform through financial and technology transfers – they could require (as part of the bargain) that non-Annex-I countries join the climate regime and also accept national ceilings on GHG emissions. The deal should be worked out in more detail by taking into account different energy sources in groups of non-Annex-I countries. In particular, it could well be worthwhile negotiating a 'grand bargain' for coal subsidies in China and oil subsidies in oil-producing countries. Forestry subsidies could also be included in such a deal.

5.6.2. Recommendations

It is advisable to use finance and subsidies as non-climate instruments to achieve climate regime objectives, i.e. to reduce GHG emissions.

Specific recommendations for Dutch/European policy regarding 'trade, finance and subsidies' would be to:
- use public funds (e.g. export credit agencies) to reduce risks that prohibit energy FDI in developing countries. Low funding levels should still be able to achieve a high leverage;
- invest more R&D funds in studies for making consumption less energy-intensive;
- mobilize action or reduce/remove many perverse energy subsidies on fossil fuels in order to facilitate a switch from carbon-based to carbon-free or carbon-neutral sources of energy.

The EU could take the lead in suggesting a deal to remove energy subsidies. If the OECD or Annex-I countries remove and ban fossil fuel subsidies, thereby accepting a deterioration of their competitive position towards the non-Annex-I countries, in return the latter group should join the (future) climate regime. There is plenty of scope for working out such a deal for coal subsidies in China and oil subsidies in oil-producing countries. Further study is recommended to elaborate on such a deal.

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6. Air Pollution, Health and Climate Change
Synergies and trade-offs

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Abstract
Future strategies designed to address climate change must consider the interaction with air pollution, a severe worldwide problem, with its impact on health and ecosystems varying depending on the region. These two environmental problems, air pollution and climate change, are interlinked in atmospheric chemistry, emission sources, and technical and policy measures. The two problems also show trade-offs in temporal and spatial scales of impacts. The objective of this chapter was to explore the opportunities and pitfalls for integrating and harmonizing air and climate policy.

This chapter addresses three types of air pollution: acidification, urban air pollution (in developing and industrialized countries), and indoor air pollution in developing countries. Based on case studies the technical and policy options for air pollution abatement have been screened for their impact on climate change. Identified here are a 'minimal approach' for policy harmonization, where air policy does not hinder climate policy and a 'maximal approach', where the synergies between the two are optimized. The most promising options are identified then as those conforming to additional economic, political and technical criteria. Although there is much room for optimizing the policies in terms of cost reduction and cost-effectiveness, synergies have not yet been achieved automatically and better coordination is needed to move the combination of air and climate policy in the right direction. Policy integration would be the most advanced form of coordination to be implemented, with a minimal form of policy harmonization at the other end of the spectrum.

Structural policy integrating air and climate policy could be achieved by including ozone and soot in international climate agreements, provided the related science advances to a politically satisfactory level. Where there is no direct physical link between climate change and air pollution, policy harmonization could convince key countries in climate negotiations, such as the United States and China. The inclusion of CO_2 in the Protocols to the Convention on Long-Range Transboundary Air Pollution, or bonuses for air-pollution friendly CDM projects are possibilities. Policy interaction in these different fields should undergo a structured evaluation before these possibilities are implemented.

6.1 Introduction
Air pollution poses serious health threats to humans and impacts on ecosystems. Smog, indoor air pollution and acidification are worldwide problems but with local characteristics. The impacts extend over different timescales and distances. The major emitters of air pollutants are fossil-fuel-based energy production facilities, industry, and motor transport, with different substances in the air having different impacts. They can, for example, exert their influence on a local level, be transformed in the atmosphere to other substances or travel great distances. In some areas they can even induce local climate changes.

The impacts of air pollution are as diverse as its causes. The World Health Organization (2003) estimates that about 2.8 million people die each year due to indoor air pollution (over 500,000 in China alone). Another 500,000 deaths are due to outdoor air pollution. Several attempts have been made to express the damage due to air pollution in monetary terms. Estimates here may comprise everything from degradation of monumental buildings (expressed in the repair costs) to the loss of productive life years and the medical treatment of illnesses related to air quality.

Climate change is another environmental problem that has very different characteristics in terms of mechanisms, timescales, type of impacts and levels of scientific knowledge. However, it takes place in the same atmosphere as local and regional air pollution; furthermore, the cumulative impacts on health and well-being are estimated to be at least as severe as those for air pollution. Many air pollutants have the same emission sources as greenhouse gases, making it seem impossible to consider climate change completely independent of air pollution. Technological measures to mitigate air pollution often have an impact on climate change. Policy instruments designed to tackle one of the two problems may interact as well. Recent literature shows an increased interest in the interaction of climate policy and air policy, both in terms of cost co-benefits and the negative interactions of measures. In view of a future climate treaty, it will be relevant to evaluate the levels and characteristics of the interactions, the potential for synergies, and the potential players that might benefit in a climate change regime.

For this reason, we aim in this chapter at determining potential synergies between air pollution policy and climate change mitigation policy. Concrete policy recommendations should evolve from the determination of the air pollution and climate change synergies focussed on problems and interests in several regions. This chapter offers a discussion on questions underlying the determination in the table below.

Question	Discussion
What are the most pressing air pollution problems, the impacts on health, and the interaction with climate change?	Section 6.2 overviews the interrelation between air pollutants and climate change, the impacts and the technical and policy options to address air pollution.
What can be learnt from the most pressing air pollution problems and what is their interaction with climate change mitigation?	Section 6.3 examines four relevant cases: 1) transboundary acidification; 2) urban air pollution in industrialized countries; 3) urban air pollution in developing countries; and 4) indoor air pollution in rural areas in developing countries. The cases and the analysis will provide indications for successful policy in air pollution.
What is known about the interaction of measures and policies to abate air pollution and achieve climate change mitigation?	In Section 6.4, the technical measures and policy instruments will be examined in terms of their impacts on climate change mitigation. This will answer the question as to which policy regimes can be synergetic to both climate change and air pollution mitigation.
What opportunities and pitfalls can be identified in terms of policy and how location-specific are these?	Section 6.4 investigates a ‘minimal approach’ of not allowing measures in the field of air pollution to be at the expense of climate change, and a ‘maximal approach’, in which synergies occur, using the criteria mentioned in Chapter 1.
	Section 6.5 provides conclusions and policy recommendations.

6.2 Impacts, interactions, and abatement of air pollution

This chapter overviews the current situation with respect to the interrelated problems of air pollution and their physical interactions with climate change. The technology and policy options available to address air pollution are discussed, along with the costs of air pollution and policy, and some evaluations of cost reduction due to synergetic climate policy are given.

6.2.1. Air pollution: sources, impacts and physical interaction with climate change

In air pollution, problems of acidification, smog and indoor air pollution, the substances involved interact with other pollutants in a complex manner and play different roles in different problems. The impacts are also strongly dependent on physical conditions. A detailed analysis of the physical processes is beyond the scope of this report, but Seinfeld and Pandis (1995), WHO (2000) and IPCC (2001) have presented detailed overviews of the physical nature of the pollutants and the associated health and environmental impacts.

Figure 6.1 indicates some of the interactions. This figure indicates not only the diversity of substances and impacts, but also the extended action radius of the pollutants. Ozone, for instance, has impacts hundreds or even thousands of kilometres from the source (Holloway et al., 2003).

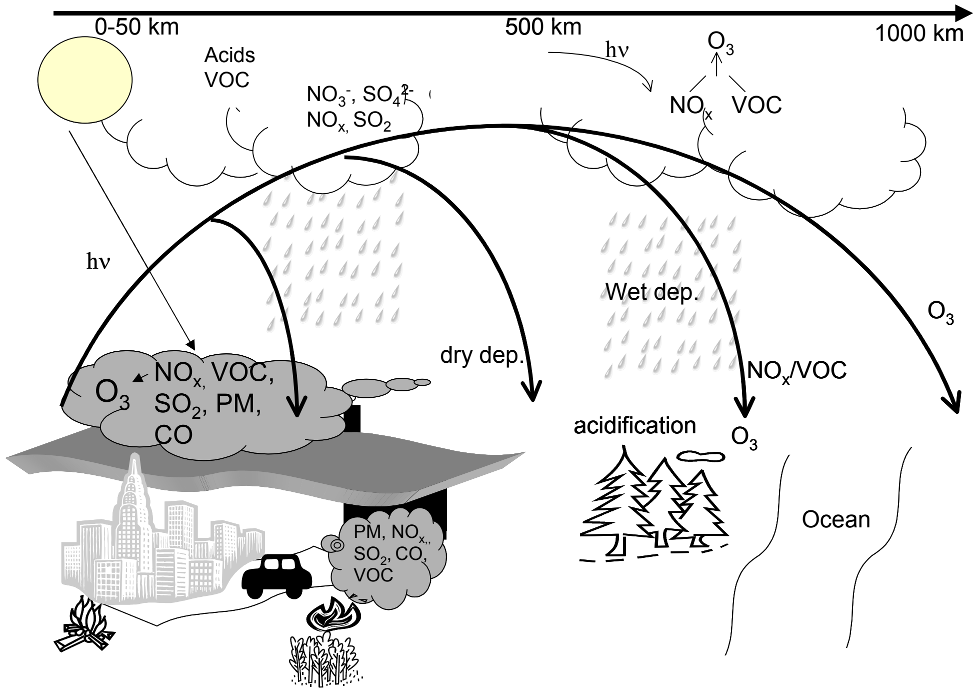


Figure 6.1 Interactions between pollutants, with the short-distance (urban air pollution), and long-distance (acidification) impacts indicated. The influence of solar radiation, some transforming processes, and deposition processes are also depicted

Air pollutants may have a direct or indirect influence on climate change, although the complex mechanisms involved in this are still not fully understood.

Table 6.1 Contribution of pollutants to air quality problems and climate change (Amman, 2004; IPCC, 2001)

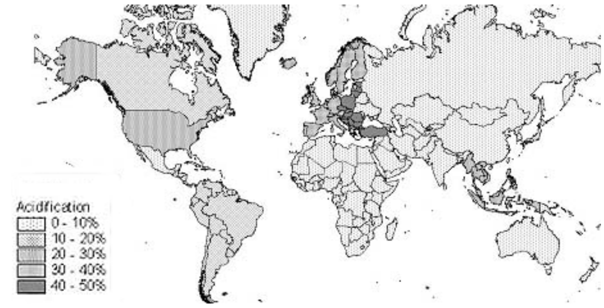
	NO_x	SO_2	NH_3	VOC	PM	CO	CO_2	CH_4	O_3
Acidification	x	x	x						
Health – PM	x	x		x	x				
Health – ozone	x			x					x
Health indoor				x	x	x			
Climate change – direct					x[1)]		x	x	x
Climate change – indirect	x[2)]	x[3)]	x[4)]	x[5)]					

[1)] Radiative forcing effect may be cooling or warming, depending on chemical nature
[2)] Precursor of nitrate particles, and effect on O_3 and CH_4; uncertainties large
[3)] Precursor of sulphate particles, cooling effect
[4)] Precursor of PM
[5)] Role in ozone formation

Climate change may also have an impact on air pollutants, enhancing or mitigating their effects, while processes affecting air pollutant concentrations may be modified due to temperature and humidity changes. For example, a 5°C rise in the surface temperature by 2100 would result in an 83% increase in ozone transport from the stratosphere to the troposphere (Jaxa, 2004), leading to an increased background concentration of O_3.

Health impacts of air pollution

Pollutant sources and environmental impacts differ from region to region. In general, acidification is worst in industrialized regions, whereas indoor air quality problems are particularly severe in developing countries. Urban air pollution is a problem in every region, though the seriousness of the impacts differs. Figure 6.2 and Table 6.2 overview impacts of the three problems for world regions. More quantified health impact indicators for each region in the world are given in Appendix A.



A

B

C

Figure 6.2a Impact of acidification: percentage of ecosystems affected (Bouwman and van Vuuren, 1999)

Figure 6.2b Health impact of urban air pollution: years of life lost per million urban capita (WHO, 2000)

Figure 6.2c Health impact of indoor air pollution: years of life lost per million capita (WHO, 2000)

Table 6.2 Regional impacts of air pollution (figures from Bouwman & Van Vuuren, 1999; WHO, 2000). The acidification data are from 1992, but according to the authors, the acidification impacts will not change substantially until 2015. The strong decreasing trend in acidifying emissions in Europe and North America of the last few years is levelling off. Developing countries show slowly rising emissions of SO_2 and NO_x. Actual numbers on the annual life years lost are probably higher due to ozone, which is not included in the WHO figures here.

Region	Percentage ecosystems where critical loads (med.) exceeded in 1992 due to acidification	Annual Life Years Lost per million capita (due to PM)		Remarks
		Urban smog[95]	Indoor air pollution	
North America	19	800	800	High sulphur emissions, smog, low energy efficiency
Latin America	11			Indoor air quality severe problem
Western Europe	35	1200	600	Emissions slowly decreasing but targets exceeded in most countries
EU Accession Countries	47			Emissions slowly decreasing in most countries
FSU/Central Asia	5			
South Asia	6	3200	8600	Urban emissions on the rise
ASEAN	21			
Africa	8	1900	57000	
Middle East	2	6300	19000	
East Asia	15	4200	2900	Urban emissions on the rise
Oceania	0			Very high per capita emissions

Table 6.2 shows that air pollution in general to be a global health problem, although the causes will need to be distinguished. The table makes a distinction between annual life years lost due to indoor air pollution and urban air pollution. Indoor air pollution is mostly a problem in developing countries, especially in Africa. The indoor air pollution health effects in the Americas and East Asia occur mainly in Latin America and developing countries such as China, but less in North America, Japan and Australia. Urban air pollution is a problem in both industrialized and developing regions, although the emission sources tend to change over time (see 6.3.6).

Sources of air pollution and climate change

Air pollutants and greenhouse gases or aerosols with a climate impact are known to be emitted from the same sources. Industry, power production and transport are common pollution sources for NO_x, SO_2, particulate matter and CO, with emissions mainly resulting from fossil fuel burning. In the case of particulate matter, significant contributions also arise from the combustion of other fuels, such as biomass.

Table 6.3 Anthropogenic sources of selected air pollutants and CO_2 (Sliggers, 2004; Erisman, 2003)

Pollutant	% Related to fossil fuel burning	Industry	Power production	Transport	Households
NO_x	95	x	x	X	
SO_2	80	x	x[1)]	X	
SPM	60	x	x	X	x
CO	?[2)]	x	x	X	x
VOC	30			X	x
CO_2	~90	x	x	X	x

[1)] Mainly from coal
[2)] No data available

As indicated in Table 6.3, CO_2 (the most important greenhouse gas) is also emitted as a result of fossil fuel burning, mainly in the same sectors. Addressing these sectors would, therefore, appear to yield benefits for both air quality improvement and greenhouse gas abatement.

[95] Numbers are per capita urban population, not the full region population.

Direct and indirect climate impacts of air pollutants
Several pollutants either directly or indirectly influence the climate, as shown in Table 6.2. Direct effects occur when the pollutant itself has a positive radiative forcing, therefore contributing to the greenhouse effect. Tropospheric ozone, a major air pollutant, is considered to be the most important greenhouse gas after carbon dioxide and methane (IPCC, 2001). Surface ozone concentrations are expected to rise by 40% by 2100 (Derwent et al., 2003), and will probably become a problem for both climate change and air pollution. Another major pollutant with a direct influence on climate is soot. The positive radiative forcing of soot had been known for some time (see e.g. Haywood et al., 1997), but the full extent of the smog resulting from soot only became visible after the alarming results of measurement campaigns. Publications on local climate changes as a result of air pollution followed after these campaigns. This happened, for example, in Mexico City (Raga et al., 2001), where the radiative forcing by soot is known to change climate and even extend towards the Gulf of Mexico and on the Asian Brown Cloud. Local climate change attributable to air pollution could include changes in the hydrological cycle, precipitation, warming or cooling and extreme weather events (UNEP and C^4, 2002). The extent of these changes is sometimes challenged (Srinivasan and Gadgil, 2002); nevertheless, the feature has had major impacts on the awareness of air pollution. Very recently, it was even estimated that as a result of the increased albedo due to soot trapping in snow and ice in the Arctic, one-quarter of the global warming over the past century could be attributed to soot emissions (Hansen and Nazarenko, 2004).

Sulphur dioxide can oxidize to form sulphate aerosols, which have a net cooling effect and might also induce local climate change. In China, for instance, a correlation was found between the south-moving monsoon and the SO_2 emissions (Xu, 2001). Air pollutants can also impact the residence time of greenhouse gases. The higher temperatures due to global warming and the other meteorological consequences of climate change can also affect the concentrations of air pollutants (UNEP and C^4, 2002). A detailed understanding of atmospheric chemistry is needed to determine the exact physical interactions of the two problems.

Similarities and differences between climate change and air pollution
The level of negative or positive interaction between climate and air policy, and therefore the feasibility of policy integration, should be seen in the light of different variables. The ‘common ground’ can be identified at five levels:
- atmospheric characteristics;
- emission drivers;
- impacts;
- technical measures;
- policy measures.

Table 6.4 details some notable differences in temporal, spatial and socioeconomic characteristics of climate change and air pollution.

Table 6.4 Differences in interaction levels of air pollution and climate change

Field of interaction	Variable	Air pollution	Climate change
Emission drivers	Economic growth	Decoupling with air pollutant emissions has been convincingly shown	Decoupling with greenhouse gas emissions has not been sustained
	Urbanization	Concentration of emissions	No real influence
	Technology	End-of-pipe technology aimed at effects	Mostly source-aimed technology
Atmospheric characteristics	Temporal	Short-lived substances	Long residence time
	Spatial	Local to transboundary movement of pollutants	Greenhouse gases spread globally. Only difference is between northern and southern hemisphere
Impacts	Temporal	Immediate impacts (health, ecosystems)	Delayed effects
	Spatial	Hot spots, mostly local effects	Global effects, geographical sensitivity
	Socio-economic	Depends on the problem but, in general, stronger for poor people in poor countries	Stronger for poor people in poor countries
Technical measures	Sectors	Energy production, transport, industry, households	Energy production, transport, industry, households, agriculture, land use and forestry, waste management
	Temporal	Implementation within 20 years	Implementation over the course of the century
Policy measures		Aimed at short-term results	Should be aimed at long-term transitions

A very important difference between air pollution and climate change is not only the delay of the impacts but also the timescale of the policy impacts. In general, the impacts of air pollution on health, visibility and ecosystems occur shortly after the problem has been caused. In climate change, this is notoriously different. The impacts of climate change are felt in the long term, as there is a natural delay in the response of the atmosphere to accommodate the temperature rise, and of the impacts of climate change on weather patterns. It should be noted that impacts in the far future and with measures that induce profound socio-economic impacts, such as climate change mitigation, inhibit the sense of urgency about a problem and are therefore less pressing on the policy agenda.

6.2.2. Policies and measures to address air pollution

A number of technical measures can be implemented to address the problem of air pollution. A technical measure is often tailored to address a specific substance or impact and, in some cases, may not be as effective as anticipated or may enhance other problems. Local circumstances determine the effectiveness of certain measures. Drawing a distinction between stationary and mobile emission sources is useful, as the technology and abatement options for these differ considerably.

Stationary sources

Stationary sources are relatively easy to regulate. Therefore the costs and effects of the measures needed are relatively well known, and many technologies are already commercially available. Sources of air pollution in the industry and electricity sector can be mitigated by (Wijetilleke and Karunaratne, 2002):

- Demand-side efficiency improvements: energy efficiency, process optimization, heat recovery and use (including heat pumps and storage), application of new process technology, improved combustion technology (clean coal technologies) and reduction of all pollutants resulting from energy production and industrial processes.
- Supply side improvements: application of alternative resources for energy production or industrial processes (nuclear or renewable energy sources or switching from coal to gas), reductions of acidifying agents, organic emissions, CO, and particulate matter. If availability of other fuels is a problem (see, for example, Chapter 4 on security of energy supply in this volume) or renewable energy is unavailable or not cost-effective, improvement of fuel quality is affordable and abates acidifying agents and particulate matter.
- End-of-pipe measures: targeted processes to reduce emissions of particulate matter, NO_x and SO_2 are well developed and regularly applied, especially in industrialized countries. Disadvantages are increased fuel use as a result of the extra installations, and the costs. Spraying of coal dust could reduce particulate mat-

ter and organic compounds. Relocating industries and energy production facilities away from urban areas will provide a temporary but not a sustainable solution.

The technologies mentioned do not anticipate air pollution abatement options that may become viable in the future. However, the scope for breakthrough technologies in end-of-pipe solutions for industry and electricity production appear to be limited, as they are already relatively mature (Wesselink and Wijngaart, 2000). There is still ample room for improvement in the fields of power production, renewable energy, energy efficiency and fuel cell technology.

In small stationary sources, such as heating and cooking in rural households, efficiency improvements by means of better cooking stoves, and a fuel switch from traditional biomass to gas or woodcokes would significantly reduce indoor emissions and health impacts. The emissions of volatile organic compounds from chemical solvents or petrol can be reduced by reducing the use of these chemicals, and by preventing leakage and exposure.

Mobile sources
In the transport sector there is considerable scope for an effective reduction of air pollutant emissions through better engines and fuels, but better transport management and end-of-pipe technologies are also possible. In particular, emissions of NO_x and soot can be addressed by:
- Engine efficiency and improvement: The mileage of cars can be increased through lighter cars, engine efficiency improvements (downsizing or new technology) and vehicle maintenance (World Bank, 2002). Alternative engines could be electric cars, and in the longer term, fuel cell cars (on low-carbon hydrogen);
- Transport management: Mass transit systems could be improved, in developing countries by preventing people from buying and using a private vehicle, and in industrialized countries by convincing people to refrain from using their cars. Traffic management and road improvement, in general, also contribute to a reduction in all pollutants;
- Fuel-change measures: Reformulating diesel and petrol to reduce sulphur content, and the end boiling point (Kojima and Mayorga-Alba, 1999), compressed natural gas (CNG) or liquefied petroleum gas (LPG) as the fuel replacing diesel or petrol in medium-clean technology vehicles, petrol replacing diesel;
- End-of-pipe measures: the use of a storage catalyst (for which a low S content in fuel is required) or active catalysts (SCR) as a buffer for engine-starting emissions (CONCAWE, 1999).

The policy instruments addressing air pollution can be broadly categorized into two groups: command-and-control measures, and market-based instruments, comprising, for example, legal delimitations of *transferable* polluter rights and other instruments affecting market prices such as tax and subsidy instruments. Box 6.1 provides a brief list of policy measures.

Box 6.1 Policy measures for air pollution control

Command-and-control instruments
- Mandatory technology and performance standards
- Non-tradable environmental permits.
- 'Voluntary' agreements
- Mandatory comparative (energy or pollutant) labelling
- Environmental reporting

Market-based instruments
- Environmental taxes
- An environmental subsidy, tax credit or a tax rebate
- A deposit-refund system
- A tradable pollution permit system

Current policy trends are to increasingly rely on market-based instruments – optionally in combination with command-and-control measures. Compared to the latter, market-based instruments provide more flexibility to the affected parties in complying with environmental regulation. Consequently, overall compliance costs may be appreciably less. Moreover, affected entities are 'incentivized' to pursue the reduction of polluting emissions across the entire range of the pollution they cause, whereas under command-and-control, the incentive to reduce pollution does not go further than the pollution standards in place. On the other hand, market-based instruments tend to impose high demands on institutional capabilities in terms of monitoring, verification and compliance enforcement. Moreover, if impacts of air pollution are highly localized, this will reduce the attractiveness of market-based control instruments, and hybrid market-based/command-and-control systems may need to be resorted to (see also Section 6.3.6).

6.3 Options for air quality improvement and climate change mitigation: four selected problems

Air pollution is a generic term that comprises several problems, each with its own characteristics. They all interact with climate change in a different way. This section selects four major air pollution problems and examines them in detail, focussing on options for abatement. The aim is to give examples of options for air pollution and climate change mitigation in different geographical and political areas that may have a pronounced synergy. The technology and policy options implemented in response to the different problems will be assessed for their climate change mitigation impact in Section 6.4. The cases are:

- large-scale, transboundary acidification: US and Europe;
- urban air pollution in industrialized countries: Los Angeles and London;
- urban air pollution in developing countries: Delhi, Mexico and Chongqing, and
- Indoor air pollution.

The relevance of these cases for climate change interaction is illustrated by their - preliminarily determined - interaction with climate change (see Box 6.2). Two of the air pollution cases are located in industrialized countries, and two are primarily located in developing countries. The distinction between industrialized and developing countries has been made for the two urban air pollution cases due to the different stages of policy they are at. Impacts on ecosystems (transboundary acidification) and impacts on human health (indoor and urban air pollution) are also presented. The next section briefly discusses climate impacts of air pollution policy in the four cases.

Box 6.2 Cases interacting with climate change

Transboundary acidification: With respect to acidification policy, the early reductions in NO_x and SO_2 were mainly achieved by end-of-pipe measures causing energy consumption - CO_2 emissions therefore – to rise slightly. Since acidifying emissions originate mainly from fossil fuel combustion, measures in the energy sector appear to be the most effective. When measures other than end-of-pipe regulation are considered, such as fuel switch, energy efficiency and switch to renewable energy, the climate effects will be positive.

Urban air pollution in industrialized countries: Transport remains the main source of urban pollution in industrialized countries. In general, the reduction of air pollutant emissions by end-of-pipe measures causes a rise in fuel use and therefore enhances greenhouse gas emissions. Measures in the transport sector that promote the use of zero-emission vehicles, enhance the use of public transport and promote energy-efficient measures provide a synergy with climate change mitigation measures.

Urban air pollution in developing countries: Measures to address SO_2 emissions of industry in the city can lead to less CO_2 emissions (mainly through fuel switch and efficiency improvement) but can also be negative in terms of industry relocation and increased transport demand for the workers in those factories. Emission standards and fuel switch usually benefit climate change mitigation, though the exact effects have not yet been quantified. Behavioural changes in transport are synergetic with climate change policy. The decrease in Chinese CO_2 emissions in 1999 and 2000, despite a GDP growth of 7-9%, were largely due to the fuel switch for electricity production in several large Chinese cities (Sinton and Fridley, 2000). This is a good example of a synergy in specific circumstances.

Indoor air pollution: The poor are the target group for indoor air pollution in developing countries. As most of the indoor air pollution is caused by lighting, heating or biomass cooking fuel, energy efficiency measures or a fuel switch for those activities usually leads to both better indoor air quality and reduced greenhouse gas emissions. These measures could also be cost-effective. Interaction with climate change may happen with fuel switching: e.g. use of diesel or gas instead of unsustainably obtained CO_2-neutral traditional biomass. In terms of the interaction between climate policy and policy to reduce indoor air pollution, there seems to be room for synergetic effects in the short term. The Clean Development Mechanism (see Chapter 2) could provide an opportunity for this.

6.3.1. Large-scale, transboundary acidification

Transboundary acidification has its main cause in fossil fuel use in industry, coal-fired power generation and fuel production in refineries, particularly the case if only SO_2 is considered. As these are all large stationary emission sources, the reduction of SO_2 emissions is relatively easy to regulate. However, there are various causes of NO_x emission, including diffuse and mobile sources that are difficult to manage (Erisman, 2004).

During the 1970s, the problem of acidification became so urgent and visible in Europe and North America that in 1979, around 40 countries adopted the Convention on Long-Range Transboundary Air Pollution (LRTAP). This Convention provides a framework for more detailed agreements on different substances. Under this framework, the '1985 Helsinki Protocol on the reduction of sulphur emissions or their transboundary fluxes' and the '1988 Sofia Protocol on the control of Nitrogen Oxides' were agreed upon, and entered into force (in 1987 and 1991, respectively). In general, the Protocols under the LRTAP lean very much on the command-and-control approach in policymaking. Most of them have either emission reduction targets including emission standards, or, at least, require relevant sources to make use of Best Available Technologies (BAT).

The 1985 Sulphur Protocol required Parties to reduce their SO_2 emissions by 30% by 1993 (base year is 1980). Most Parties complied with this requirement and kept their emissions stable in the years after 1993. As a follow-up on the 1985 Sulphur Protocol, the second 1994 Sulphur Protocol (the Oslo Protocol on further reduction of sulphur emissions) was agreed on and has already become effective. This Oslo Protocol is another example of typical command-and-control policymaking, since it has mandatory requirements for the sulphur content of gas oil and mandatory emission limits exist. However, in this Protocol, the tendency towards more market-based instruments is visible, as it includes a provision to introduce market-based instruments in order to achieve the targets more efficiently.

The 1988 Protocol on Nitrogen Oxides required Parties to ensure that emissions at the end of 1994 did not exceed the emissions in 1987. It also required Parties to establish critical loads and timing for emission reduction objectives. In addition, by 1993, the Parties had to have developed and applied national emission standards for major sources of NO_x, mainly by applying economically feasible BAT.

The most recent Protocol under the LRTAP is the 1999 Gothenburg Protocol to Abate Acidification, Euthrophication and Ground-level Ozone. This is unique among the LRTAP protocols in the sense that it is directed towards the effects of air pollution, rather than the emission sources. It does, however, set pollution effect-based ceilings for 2010 for four pollutants, including sulphur and NO_x. The implementation of the Protocol requires Europe to decrease its emissions of NO_x by 41% and the sulphur emissions by 63% compared to 1990. Most countries in the European Union are parties to the Sulphur and Nitrogen Oxides Protocols.

The United States plays an ambiguous role in the LRTAP. The country was a Party to the 1988 Nitrogen Protocol but not to the Sulphur Protocols. However, it decided to change the base year of the reduction target from 1987 to 1978 (LRTAP, 2004), which makes it essentially easier to meet the target.

The United States and the countries of the European Union follow a notably different approach. Whereas the European Union is an important driver behind the protocols under the LRTAP, the United States tends to follow its own policy, which is usually more market-based. Table 6.5 shows the effects of the different policies (based on Erisman, 2004 and UNECE, 2001). The approach of the European countries has generally been more effective in terms of reducing pollutants. However, this does not mean that this is due to the choice of command-and-control policy instruments. If in an emissions trading system, the cap, had been applied on a more ambitious level, this would also have been reflected in the policy achievements.

Table 6.5 The contribution of fossil fuel combustion to SO_2 and NO_x emissions, applied policy and actual effects on the emissions in the United States and Europe (Erisman, 2004)

		United States	Europe
Contribution of fossil fuel combustion to emissions	NO_x	94%	88%
	SO_2	95%	76%
Policy instruments		SO_2 emissions trading for power utilities NO_x performance standards	SO_2 direct emission regulation NO_x permit systems, emission standards
Policy achievements (Change in emissions 1990 - 1998)	NO_x	+1%	-21%
	SO_2	-18%	-41%

6.3.2. Urban air pollution in industrialized countries

The cities of London and Los Angeles are considered here. The causes of city smog in the USA are mainly stationary fuel combustion sources, road transport and industrial processes (EPA, 2003). In London, emissions were historically caused by concentrated industrial activity in the city (mainly causing SO_2 and soot), but most of the current air pollution problems are caused by transport. The meteorological conditions in the urban area, notably the wind velocity and the solar radiation, exert a considerable effect on the severity of the air pollution impacts. The wind can disperse pollution and the photochemical reactions, leading to tropospheric ozone formation, require sunlight.

The policy on how to address air pollution in cities depends on the nature and cause of the problem. The pollutant that is responsible for most damage in industrialized cities is thought to be particulate matter. A study carried out in the USA and in Europe shows, independently, similar numbers for the impacts in terms of mortality and hospital admissions as a consequence of air pollution (WHO, 2003), which means that there is a comparable health improvement incentive for air pollution abatement in both regions.

Los Angeles

Road transport is the main anthropogenic source of pollutants, both NO_x and particulate matter, in the city of Los Angeles. Road transport is also a fast-growing sector: the number of vehicle miles travelled each day in the Los Angeles area increased by 90% between 1982 and 2001.

Los Angeles, surrounded by mountainous areas and the Pacific coast, is often burdened by health-threatening pollution episodes. City, state and federal regulation is in place to abate emissions. The Federal Clean Air Act has the following basic elements: national ambient air quality standards for major air pollutants, hazardous air pollutant standards, state attainment plans, motor vehicle emissions standards, stationary source emission standards and permits, acid rain control measures, stratospheric ozone protection and enforcement provisions. (Alexis et al., 2003). The Act was first implemented in 1970 and last revised in 1990.

In 1996, the city of Los Angeles joined the US Department of Energy Clean Cities Program, which aims to enhance the number of Alternative Fuel Vehicle fleets in a number of different ways. However, this Program is unlikely to make a lot of difference to the total emissions because of its demonstration character.

Emissions of ozone precursors (NO_x) have declined, inclusive of a decline in ozone concentrations of about 50% in 1982-2001. Particulate matter concentration, the main cause of the health problems, are more variable and also more persistent. Though a downward trend can be observed between the start of the measurements in 1988 and 2001, it is a slow process, and the 2001 maximum 24-hour concentrations were the same as the 1995 concentrations.

London

In 1956, the first Clean Air Act was approved by the UK Government, which was later amended and extended into the Clean Air Act 1968. It limited pollution by smoke, grit and dust from domestic fires (by regulating the burning of solid, liquid and gaseous fuels), as well as industry (e.g. by controlling chimney heights). Regulation was therefore explicitly aimed at the causes of the Great Smog: particulate matter and

SO_2. Concentrations of these two fell from 280 μg/m^3 and about 400 μg/m^3 in the 1950s, respectively, to less than 20 μg/m^3 each in 2000 (Greater London Authority, 2002a).

In 1993, the Clean Air Act was revised to incorporate other environmental concerns, for example, regulation of the quality of petrol and diesel fuels. In 1995, this was all incorporated into a single Environmental Act, which introduced standards and objectives derived from the EU Air Quality Framework Directive on SO_2, NO_2, particulate matter, lead, CO and other substances (Greater London Authority, 2002a). Since the policy on air quality policy in the city was started 50 years ago, the contribution of transport to air pollution has surged and other pollutants have become more important. For example, road transport is currently responsible for about 35% of NO_x and 40% of health-damaging PM_{10} emissions (Greater London Authority, 2002b). This is why the Air Quality Strategy, with a specific focus on road transport, was launched in 2001. The following measures will be implemented:
- reduction of traffic load through investment in the public transport network, congestion charging, and appropriate planning;
- reduction of emissions from individual vehicles by targeting emission reduction from heavy diesel vehicles (buses, coaches, trucks, taxis), the deployment of newer, cleaner vehicles and technology, the introduction of cleaner fuels, investigating the introduction of one or more low-emission zones that would be inaccessible for most polluting vehicles, and, in the long term, increasing the take-up of zero-emission forms of transport.

With respect to the purchase of cleaner vehicles, the Strategy proposes providing incentives for the purchase of the cleanest, alternatively fuelled cars, the switching of vehicles for city services (such as police etc.) and the promotion the cleaner fuels.

Other targeted sectors causing air pollution are air transport (measures: offering alternative transport and technology improvements), heating of buildings (measures: improvement of energy efficiency and promotion of, for example, solar water heating) and the construction sector (measures: best practices to reduce dust emissions).

Table 6.6 Comparison of air quality and air quality policy in Los Angeles and London (World Bank, 2003)

		Los Angeles	London
Average annual concentrations (μg/m^3) in 2000	*PM*	38	23
	NO_x	74	77
Start of policy		1970	1956
Policy measures		– Industry control – Vehicle and fuel standards – Alternative fuel vehicles	– Industry control – Vehicle standards – Home fuel burning – Public transport – Alternative fuel vehicles
Policy effects		Gradual decrease of most important pollutants	– Prevention of extreme pollution episodes – Sharp decrease of pollutants

Although emission reductions in the two industrialized metropolitan areas are impressive, emissions still cause considerable damage to human health in those areas.

6.3.3. Urban air pollution in developing countries

The substances causing urban air pollution in developing countries are generally comparable to those causing air pollution in urban areas in industrialized countries. The differences are generally in the faster rate of economic development in developing countries, compared to the more gradual economic development and associated air pollution in industrialized countries.

A synopsis of Chongqing, Delhi and Mexico City

Chongqing has only just started to reduce air pollution. Compared with air pollution management in Mexico City or in Delhi, the Chongqing urban air quality policy is therefore in the least mature state. However, this policy has the potential to become more effective than the Mexican and Indian policies due to a more centralized government and the possibility of leap-frogging. This is illustrated by the considerable drop in SO_2 emissions within the space of two years as a result of a government decree. However, the transport sector, which is the polluter of the future, might be less susceptible to centralized policy incentives. It will take a long time before phase-out, emission standards, etc. have been implemented and are adhered to by the entire sector.

Delhi has recently switched all its public transport to compressed natural gas (CNG) and is currently building a metro system. In terms of traffic management, it has built a number of flyovers that streamline the flow of traffic in the city and therefore reduce air pollutant emissions from transport. Much industry has been relocated from the city centre. The emissions standards only apply to vehicles and not to industry. For old vehicles, inspection and maintenance programmes have been introduced.

Mexico City started relatively early with air quality policy, as the problems were extremely pressing due to the city's rapid development (ahead of the Asian cities) and the unfavourable geographical characteristics. For the past ten years, the city has restricted vehicle emissions through vehicle standards. Public transport (buses and taxis) use LPG as a fuel instead of gasoline, and the metro system has been improved to enhance the use of public transport as well. The city has implemented an integrated approach, where different sectors are used to improve the general environment in the city. Mexico City has not only relocated industry from the city core, but has also imposed emission standards on it. Even ecosystem restoration around the city is being enhanced as part of the air quality programme. Table 6.7 gives an overview of the measures taken in Mexico City, Delhi and Chongqing.

Table 6.7 Overview of measures taken by the cities of Mexico, Delhi and Chongqing

	Chongqing	Mexico	Delhi
Industry	– Power production fuel switch from coal to natural gas – Replacement of coal-fired boilers with cleaner fuels	– New standards for NO_x and VOC emission – Heat generation: End-of-pipe measures for NO_x reduction and gradual substitution of current plants with more efficient technology – Stricter fuel quality standards for combustion – Restructuring of fuel prices to favour more environmentally benign fuels (such as LPG, natural gas) – Use of prevailing tax incentives, and of international crediting programmes for financing the technology investments	– Industries directed to comply with emission and liquid effluent standards – Installation of meters for measuring emissions of particulate matter – Relocation of brick kilns outside Delhi – Closure of all (46) hot mix asphalt plants in Delhi – Closure of 168 hazardous industries in Delhi – Coal-fired power plants should switch to beneficiated coal – Gradually increase mandated use of fly ash in power plants
Transport	– Emission standards for motor vehicles – Inspection by obligatory annual tests, random tests on the road, remote sensing – Maintenance programmes – Training of technicians for emission testing and repair – Providing emission testing equipment in repair shops	– Use of the 'Hoy no circula' programme to modernize car technology by extending the travel restrictions for polluting vehicles – Increasingly strict standards for new and existing vehicles – Extension of the verification system – Progressive revision of the standards for fuels – Restructuring of surface public transport and reorganization of the transit system – Extension of non-polluting modes of public transport: metro, trolley buses and trains	In-use vehicles, e.g. fixing lifespan of all vehicles, phase-out of taxis older than 10 years in 2000, ban on alteration of vehicles by replacing petrol engines with diesel engines Traffic management, e.g. traffic management of most-polluted junctions and areas by synchronized signals and diversion of traffic based on air quality monitoring data, expansion and greater use of cycle paths, construction of by-passes and motorways Fuel quality, e.g. ban on loose 2-T oils at petrol stations, direction that two-wheelers and three-wheelers only obtain their fuel from pre-mixed fuel outlets, prevention of fuel adulteration, use of CNG in taxis, buses and extension to private vehicles.
Environment		– Reforestation and ecological restructuring of degraded areas – Urban planning aimed at better use of soils, recycling, and environmental protection areas	

In scarcely comparable cities, with different characteristics of morphology, meteorology, income, fuel mix, etc., it can generally be stated that sulphur dioxide (which mainly originates from traffic enhancement) is less a persistent problem than NO_x and suspended particles. It is thought that measures in the transport sector could have a considerable effect. However, as transport is very diffuse in source character, costly programmes of inspection and maintenance are required, as well a lot more planning than would be the case for the reduction of pollutants from stationary sources. A brief comparison is given in Table 6.8.

Table 6.8 Pollution characteristics, policy and effectiveness of three air pollution 'hot spots' in developing countries

		Chongqing	Delhi	Mexico City
Concentrations ($\mu g/m^3$)[96]	*PM*	147	187	69
	SO_2	340	24	74
	NO_x	70	41	130
Effects of policy		Sharp reduction SO_2	Start of decline in particulate matter, shift in air pollution from industry to transport sector	Reduction in SO_2, increase in number of days satisfactory daily AQS[97]

6.3.4. Indoor air pollution

Indoor air pollution is estimated to cause many more deaths and lost life years than outdoor air pollution. The fundamental differences with outdoor air pollution problems are that

- indoor air pollution is primarily a problem of vulnerable groups: poor women and children (who are often at home), who often lack influence in the policymaking circles;
- indoor air pollution is a problem associated with poverty, whereas outdoor air pollution is a consequence of economic activity and/or increased ownership of private motor vehicles. This is usually a sign of decreasing poverty.

In practice, most policy is not specifically aimed at improving indoor air quality. It is often a positive consequence of a more general programme to alleviate poverty by means of rural electrification and alternative fuel supplies, to reduce fuel wood consumption and combat desertification, or to improve local environmental conditions and promote renewable energy (Mika, 2002).

Cooking is the main cause of indoor air pollution in developing countries[98]. The dangerous compounds are usually particulate matter and CO. Measures that can reduce the emission of these substances are:

- the use of cleaner fuels such as low-propane gas and kerosene;
- the development of high-grade biomass fuels;
- improvements in stove design and better dissemination of stoves;
- improvements in housing (ventilation);
- improvements in environmental awareness and education.

Improved cooking stoves can reduce average $PM_{3.5-5}$ concentrations by 37-75% and CO concentrations by 54-77% near the stove during cooking time (Bruce et al., 2002; Patil and Dash, 2002).

There are some sporadic examples of targeted policy to address the problem of indoor air pollution. Some examples are:

- Around 3 million biogas plants and more than 22 million improved cooking stoves in India have been installed in rural and remote areas of the country, resulting in a saving of the equivalent of 21 million tonnes of firewood per annum (UNEP, 2003). The positive effects on health are unknown. However, one study estimates that in Uttar Pradesh, illness due to indoor air pollution results in economic losses of about 11 million US$ per month (Parikh and Biswas, 2002).
- The government of India also plans to electrify 18,000 villages in the country with renewable energy. Very much will depend on the form and usability for cooking in determining to what extent this policy will contribute to indoor air pollution reduction. Solar Home Systems (SHS) can be used for lighting and will reduce some pollution, but they are too small to cook on, and the use of firewood will continue if SHS are the only measures taken.
- The Durban Metropolitan Area in South Africa is planning an environmental action plan for indoor and outdoor air quality. The aim, however, seems to be outdoor air pollution, as most measures are in the field of vehicle emission reduction (see Durban Local Agenda 21).

[96] Source: World Bank estimates (World Bank, 2003); Particulate matter: 1999; SO_2 and NO_x: 1998. Annual average concentrations

[97] Air Quality Standards

[98] In industrialized countries, the main indoor air hazard is smoking

- Eskom, the South African electricity company, is implementing an electrification programme for improvement of indoor air quality in the townships. The measure aims to replace coal and wood as an energy source (Grida, 2003).

Top-down controlled programmes, for example, with emission standards for fuel and with cooking technology to reduce emissions, are not thought to be effective in reducing indoor air pollution. It is mainly a problem of the rural and uneducated poor. The question that needs to be asked is how these people, who are not susceptible to or eligible for government-controlled subsidy programmes, can be encouraged to improve their living conditions through cheap and simple technologies, and how these technologies can be made available to them. Unlike outdoor air pollution, this probably requires more in the way of capacity-building than inspection and maintenance programmes, as would be the case in outdoor air pollution.

It can be concluded that structural policy to address indoor air pollution is still in its infancy, which is surprising considering the magnitude of the problem. For some areas where indoor air pollution ranks second to malaria in terms of causes of child illnesses, it is about time that indoor air pollution is seriously addressed.

6.4 Linking air pollution and climate change

This section evaluates the mutual effects of the technical and policy options for air pollution reduction on climate change as discussed in the previous chapter. A method will be described that maximizes the synergetic effects of air quality and climate policy, and minimizes the trade-offs. The technical options will be discussed, followed by the policy options. Section 6.4.4 discusses the interaction with climate policy as a whole and identifies a minimal and a maximal approach for achieving synergy.

6.4.1. Cost-efficiency: an argument for policy integration?

Cost-efficiency is a major condition for the acceptability of emission reduction measures in both the areas of air pollution and climate change. It is therefore hardly surprising that the synergies in costs for air and climate policy have been evaluated extensively. The costs of air pollution can be expressed in different ways: in absolute terms, in costs per unit of product or in a percentage of GDP loss. For instance, according to Kojima and Mayorga-Alba (1998), the costs in some of the more industrialized developing countries of local air pollution has been estimated at between 0.5% and 2.5% of GDP and is expected to increase sharply. In the ExternE study (Rabl and Dreicer, 2002), the external costs of electricity production were examined on a systematic basis in terms of costs per kWh output. Externalities of coal power production were estimated to be up to 0.09 €/kWh, the main impact categories being public health and climate change. For oil and gas-fired plants, the figures were approximately 0.06 and 0.03 €/kWh, respectively, and for renewable and nuclear energy 0-0.01 €/kWh. These figures were included as 'benefits' in a cost-benefit analysis for air pollution or climate change policy integration. The hypothetical nature of these figures, however, (and the fact that costs of one impact may have other causes than electricity production alone) generates large uncertainties in cost-benefit analyses. Therefore the figures given below should not be seen as absolute reductions in costs for environmental policy, but should instead be treated as indicative figures on an aggregate level. Davis et al. (2001) evaluated the value of statistical life (VSL) found in Europe, Canada and the United States to be quite constant at around 3 million US$ (1990 value). For the unit Years of Life Lost, this would mean an approximate 83,000 US$ (1990 value) (Rabl and Spadaro, 2000). Under these assumptions, the figures given in Table 6.2 translate into costs for particulate matter in the United States alone into about 20 million US$ (1990 value). With regard to climate mitigation measures, Davis et al. (2001) recommend implementing measures aimed at reducing particularly small particulate matter. Reductions in coal combustion, industrial processes and diesel fuel combustion would be effective for both climate policy and the reduction of air quality-related health impacts.

RIVM (2001) performed a cost-benefit analysis of air policy and climate policy, which indicates that the current costs of air pollution damage far exceed the costs of climate policy (up to 2010). However, the costs of climate change will increase considerably over the course of the 21st century. The Regional Air Pollution Information and Simulation (RAINS) model has now been extended to include greenhouse gases. Ancillary benefits from air policy on climate policy can be estimated, and vice versa. It allows the cost-effectiveness of a large package of technical measures to be explored, taking into account both air pollution and climate change. Klaassen et al. (2004) and Sliggers (2004) have carried out evaluations like this with the RAINS model. Wieringa (2004) also highlights the economic potential and stresses that the integration of policy will be necessary to prevent shifts of environmental burden from one problem to another.

Though Wieringa (2004), Sliggers (2004) and RIVM (2003) provide interesting material on whether to implement policy against air pollution or climate change, the presentation of a case for policy integration that combines the costs of climate policy and air policy on a worldwide level would give specific information on the benefits of policy integration. Alcamo et al. (2002) argue that cost reductions of up to 40-55% in air quality policy can be achieved when integrating climate and NO_x/SO_2 policy. Van Harmelen et al. (2002) even conclude that measures for climate policy could reduce costs of SO_2 and NO_x reduction by 50-70% and 50%, respectively, up until 2100. Where technological learning only occurs in energy technology and not in NO_x and SO_2 abatement technologies (could partly be the case as add-on technology for NO_x and SO_2 reduction is already quite mature), it might be cheaper just to implement climate policy, since it can fully outweigh the costs for air policy under these conditions. For the United States, Burtraw et al. (2003) estimate the ancillary benefits in terms of avoiding investments in NO_x and SO_2 abatement to be 4-7 US$ per tonne of carbon (US$/tC) reduced, and the health benefits to be 8 US$/tC when a carbon tax of 25 US$/tC is imposed. If the carbon tax is higher (>75 US$/tC), the total benefits are greater but the money spent only on the climate component of the measures remains constant at about 12 US$/tC. This price is comparable to the current international market price for credits in the Clean Development Mechanism of about 4 US$/t$CO_2$ (about 14 US$/tC).

EEA (2004b) explores the ancillary benefits of the Kyoto Protocol and concludes that the benefits for the European Union in 2010 could be in the order of 12-14% for SO_2, 7-8% for NO_x, and 4 % for PM_{10} if the flexible mechanisms of the Kyoto Protocol are not used. More studies have been carried out in this field (Syri et al., 2001; Chae et al., 2003; Syri et al., 2002; Sliggers, 2004) and they all show drastic net reductions in costs.

Based partly on the above, Swart et al. (2003) and Swart (2004) plead for the integration of air and climate policy in the context of expanding the options of combining climate change and sustainable development targets. They also conclude that there is a lot of potential for synergy between the two areas, but that full policy integration is difficult due to the different natures of the problems. Little research has been carried out into translating the integration potential from the theoretical to the practical level. Fully integrating air quality and climate change policy could lead to maximal synergy, but could also encounter many practical barriers because the problems differ in their physical nature (see Section 6.2.1).

6.4.2. Interaction of air quality technical options and greenhouse gas emissions

Air quality → climate change

Table 6.9 gives a qualitative overview of the air pollution abatement options described in 6.2.2, evaluated according to a set of criteria. However, as mentioned in Chapter 1, environmental, political, economic and technical/institutional criteria are used in a way that fits the subject's needs. Again, we would like to point out that this is a very general assessment, and that outcomes of the evaluation are dependent on local circumstances and preferences.

Table 6.9 Climate evaluation of technical options for air pollution abatement as discussed in section 6.2.2

Technical option	Air quality impact	Climate change impact	Accep-tability	Cost	Ease of implemen-tation	Remarks
Fuel switch transport	++	+	0	+/-	+	Supply crucial
Engine technology	++	+/0	+	+	+	
Tailpipe controls	++	-[1)]	+	+	++	Fuel quality is vital
Reformulating fuel	++	0	++	+	++	Refinery emissions
Mass transit	+	+	+	++	+	High investment
Vehicle maintenance	+	+/0	++	+	+	Particularly developing countries
Vehicle scrappage	+	+	-	+	0	Particularly developing countries
Engine downsizing	++	++	-	0	-	High speed and strong engine popular
Electric/hybrid cars	++	++	0	-	?	Mid-long term
Fuel cell cars	++	++	?	-	?	Long term, clean H_2 production required
Traffic management	+	+	+	0/-	+	
Energy conservation (demand)	++	++	+	+/-	+	Many long-term options can be developed
Energy conservation (supply)	++	+	+	0/-	+	Often cost-effective in long term
Renewables	++	++	+/-	-	+	Long-term in particular
Nuclear	++	++	-	0/-	-	Public opinion differs across regions
Hydrogen	++	++	+/0	-	-	Clean H_2 source critical
CNG or LPG replacing diesel/gasoline	++	++	+/-	+/-	+	Supply and safety crucial
Gasoline replacing diesel	+	-	+	+	+	CO_2 increases
Fuel quality	++	0 [2)]	++	+	++	Life cycle impacts
Combustion technology	++	++	++	0/-	+	
Combustion process	++	0	+	0	+	
Flue gas treatment	++	-[1)]	++	+	++	Common practice
Industry relocation	+	0	+/-	+/-	+	Particularly developing countries
VOC mitigation	+	0	+/0	0	+/0	Sources are diffuse
Gas cooking stoves	+	+[3)]	?	+	+	Particularly developing countries
Reduce wood stoves in cities	+	+[3)]	0	?	-	Particularly developing countries
Forest fire management	+	+	++	+	0?	

If the indication is '0', a neutral result is expected when applying the criterion. 'Acceptability' refers to the general (public and private) initial response and perception of the measure. In the case of costs, a '+' indicates that the option is relatively cheap. 'Ease of implementation' indicates whether an option can be implemented in a relatively simple way and is already common practice.

1) The increase in energy consumption as a result of tailpipe controls and flue gas treatment is 1-3%
2) Radiative forcing of sulphate particles not taken into account
3) Assuming biomass is not harvested from sustainable sources

Climate change → air quality

In its Third Assessment Report (2001), the IPCC distinguishes different sectors for the implementation of climate policy. In this section, only those sectors identified in Table 6.3 as producing air pollution will be evaluated. The sectors are energy production, industry, transport, and household (mainly in developing countries). Table 6.10 highlights the air quality impacts of climate measures as identified by IPCC in the relevant sectors.

A distinction has to be made between industrialized countries and developing countries with respect to some of the options. Health damage as a consequence of air pollution in developing countries is often more severe than that in urban areas of industrialized countries with comparable economic activity. It is crucial that the air quality is improved from a very detrimental quality to a reasonable quality. Particulate matter poses the strongest health threats. Technical options to achieve this already exist and could be implemented in the short term. Policy can be designed in such a way that climate benefits are generated. If there are sufficient supplies, the introduction of alternative fuels in the transport sector is a promising option. CNG has proven to be successful in several cases already.

For industrialized countries, or countries where cleaner technology is already implemented, achieving further improvements with current technologies that are widely applied is more difficult. It might be that in the mid- to long-term, other approaches are necessary, which can be categorized as long-term climate change mitigating measures, to ensure a further decrease in air pollutant concentration. Sustainable energy production and lower-emission fuels are more than likely vital for achieving this. In this report, hydrogen cars and renewable or nuclear energy are only briefly mentioned. However, they have to be looked at more closely as they are unambiguously synergetic in the aims of air quality and climate change policy.

Table 6.10 Air quality impacts of climate change mitigation measures.

		Climate change mitigation measure	Air quality impacts	Remarks
Energy production		Conversion efficiency	+	
Energy production	Renewable energy	Photovoltaic	+	No emissions[1)]
Energy production	Renewable energy	Wind energy	+	No emissions[1)]
Energy production	Renewable energy	Biomass	0/-	Tailpipe controls for NO_x and heavy metals required
Energy production		Nuclear	+	
Energy production		Fuel switch coal → gas	+	Reduction in sulphur, NO_x and PM emissions
Energy production		CO_2 capture and storage	+/0	Decreases energy efficiency of the power plant, but capture of CO_2 enables end-of-pipe capture of pollutants
Transport		Hybrid electric cars	+	Motor efficiency improvements
Transport		Fuel cell technology	+	Low-emission technology
Transport		Technological efficiency	+	Less fuel use through efficiency increase
Transport		Fuel switch gasoline -> diesel	-	
Industry		Energy efficiency	+	Reduced use of fossil fuels in production processes
Industry		Material efficiency	+	First results from IPCC indicate large potential
Household sector		Fuel switch for local heating and cooking	+	Sharp reduction of indoor air pollutants
Household sector		Cooking stoves	+	Sharp reduction of indoor air pollutants
Household sector		SHS for lighting	+	Kerosene or gas replacement

A '+' indicates synergy, a '-' indicates that the climate option is contributing to air pollution

1) except for emissions from manufacture

It can be concluded that many technical measures to mitigate climate change are similar to those abating air pollution. Potential competing measures arise mainly in the technologies that cost energy to mitigate air pollutions. These are mainly end-of-pipe technologies in either the industrial or transport sectors. Conversely, the only point of focus in climate change policy that may interfere with air quality is energy production through biomass combustion. Biomass is notoriously rich in nitrogen compounds and even heavy metals, and is - compared to fossil fuels - relatively heterogeneous, leading to a higher risk incomplete combustion, and thus particulate matter. This could be relieved by applying end-of-pipe technology for air pollutants abatement, but this would decrease the energy efficiency and the financial feasibility of bioenergy.

6.4.3. Impact of policy instruments

Air quality ↔ climate change

The air quality policy instruments described in 6.2.2, and applied in one of the cases in Section 6.3, are discussed here in relation to their impact on climate change policy. The policy options are divided into mandatory environmental standards, other command-and-control instruments, and market-based instruments. As the same instruments can be applied to both climate policy and air quality policy, the interaction of instruments is thought to occur mainly in the technical measures. The impacts of climate policy instruments on air quality instruments is therefore not considered, since the synergies and trade-offs are in qualitative terms mutually interchangeable.

Table 6.11 Climate change mitigation evaluation of a selection of policy instruments for air pollution abatement as discussed in Section 6.2.2

	Policy option	Climate change impact	Remarks
Mandatory environmental standards	Air quality standards	0/-	Often, co-benefits will be small or negative as they highly depend on the technical options that are applied to comply with the standards.
	Technological performance standards	+/-	Interaction with climate change depends on the indicated or Best Available Technology
	Fuel standards	0/+	Co-benefits small
	Energy efficiency standards	++	Reduction in use of energy addresses the same cause which causes climate change
	Relocating industry	0	Total emissions do not change, possible decrease in ozone formation
Other command-and-control policy	Mandatory labelling and reporting of environmental performance	0/+	Measures improve the transparency of the industry and may have indirect positive effects on climate
	Traffic management	0/+	More efficient use of vehicles so less emissions. The GHG reduction of the associated more efficient use of fuel may be offset by increase in number of vehicles as driving becomes more attractive
	Mass transit system	+	Co-benefits if use of private vehicles is reduced.
Market-based incentives	Environmental taxes	+/-	Co-benefits depend a lot on type of tax: incentive may be to implement cheap end-of-pipe measures that decrease energy efficiency
	Subsidies, tax credit or tax rebate	+	Depends on target measure: e.g. subsidy for CNG or LPG will have positive climate co-benefits
	Emissions trading NO_x/SO_2	+/-	Incentive for cheap options, which often decrease energy efficiency
	Stimulation of public transport	+	Price incentives are given to replace the use of private vehicles

Table 6.11 indicates that there is potential for climate change benefits from air policy. The following general remarks can be made about this indication:

- Much of the maximising of the benefits is dependent on the technology chosen to implement the standard or to comply with the target. Since the co-benefits and trade-offs for specific technical measures are known and the policy effect can also be estimated, it is crucial that policy provides the right incentives.
- A sensible choice should be made between effect and source-aimed policy. Effect-aimed policy has the benefit of being very targeted, but inherently induces no incentive in other policy fields and therefore limits co-benefits for other problems. It can even cause trade-offs, for instance when end-of-pipe technology causes a rise in fuel use. Policy aimed at the source of pollution is generally more effective in terms of synergetic effects.

- In market-based instruments targeting one problem, e.g. air pollution, incentives are specifically directed to cheap emission reduction measures but without taking into account the likely increase of greenhouse gas emissions. Command-and-control instruments can be better designed so as to achieve the maximum benefits for air quality as well as climate change. A number of options that are more or less effective for reducing air pollution have low or no effect on climate change. These include the relocation of industries, fuel standards and fuel combustion technology.

Policy interaction could take place in the sense of the most cost-efficient policy instrument being chosen for one of the two problems. This, of course, means that the other problem is not mitigated in the most cost-effective way. In general, any policy instrument that has been designed to optimize the effect in one field will be less effective in the other (Sorrel and Sijm, 2003).

6.4.4. Synergies and trade-offs of air pollution and climate change mitigation

In Section 6.2.1 it was concluded that air pollution and climate change problems are different in terms of timescales; both in impacts and in the effects of measures. In general, the mitigation measures that achieve deep reductions in CO_2 emissions for climate change aim at transitions in the longer term. Most climate change mitigation measures provide structural solutions for air quality problems. If greenhouse gas emissions are reduced in the longer term (over more than 30 years), most air pollution problems will be automatically solved. A notable exception to this is indoor air pollution in developing countries, which is more related to poverty and access to technology than to the availability of affordable technology itself. In terms of technology, bioenergy is the only climate change mitigation technology that could seriously enhance air pollution, but this appears to be manageable with end-of-pipe technology for emission control, or even with CO_2 capture and storage, or with process improvements.

Points for attention
The cases in Section 6.3 have shown that the air quality problems and related health impacts of several important players in the climate negotiations could be resolved in a more structured and climate-friendly manner. With support from the literature, Section 6.4.1 showed that significant cost reductions in environmental policy implementation can be achieved by sensibly combining air quality policy and climate policy - also in the significant countries: the United States, the EU, India, and China. Structurally addressing indoor air pollution in poor areas has significant co-benefits in the fields of combating desertification, health improvement, and poverty alleviation. Finally, Sections 6.4.2 and 6.4.3 examined policies and measures in a more detailed manner, and we have learnt that there is a lot of potential for synergy between air quality policy and climate policy in the technical sense, but also for trade-offs in policies and measures in air pollution and climate change. The information provided so far contains important lessons for the design of air quality policy and climate policy:

1. The leading countries in the climate negotiations, in particular the United States, EU, China and India) could profit significantly from structural climate policy in the sense that their costs of air pollution (both policy implementation costs, and the costs of the impacts of poor air quality) would decrease. Using flexible mechanisms in GHG abatement will of course benefit the host country, but not the investing party.
2. All technical measures that increase energy efficiency have positive impacts on climate change mitigation and air pollution abatement. For climate change, efficiency is among the more attractive options in terms of costs and acceptability. For air quality, these measures are not usually the most effective in the short term and are therefore not among the first implemented.
3. Most tailpipe emission reduction measures reduce energy efficiency and therefore increase fuel use, by approximately 1-3%. This applies to mobile as well as stationary emission sources. In general, this efficiency loss (and therefore enhanced fuel use) can be compensated at low cost, but this could be done without the end-of-pipe measure as well and is therefore not real compensation.
4. Tropospheric ozone and soot are both contributors to climate change, and important air pollutants. Reducing their emissions has direct health and climate benefits. In industrialized countries, ozone is a very

important greenhouse gas and concentrations are rising. In developing countries, soot is thought to cause major health problems and local climate changes.

5. By enhancing energy production through biomass, climate policy can lead to increased emission of air pollutants such as NO_x, PM and heavy metals.

Bearing this in mind, the most promising options are determined in the framework of a minimal/maximal approach to synergy maximization.

Minimal and maximal approach

A ‘minimal approach’ to air quality policy without compromising climate change targets can be designed, based on the considerations of implementing only technical measures that have no ‘-' qualification for the interaction between greenhouse gas and air pollutants abatement in Tables 6.9 and 6.10. Also in the field of policy, negative interactions should be excluded. A ‘maximal approach’ consists of only ‘+’ qualifications in Tables 6.9 and 6.10.

Table 6.12 Minimal and maximal approach for technical measures to minimize trade-offs and maximize synergies for air quality measures and climate change mitigation. The maximal approach measures are naturally also part of the minimal approach

Sector	Minimal approach: no trade-offs	Maximal approach: maximal synergy
Energy production	Biomass replacing coal	Wind, hydro and solar energy
	Combustion process	Nuclear energy
	Fuel quality	Combustion technology
	CO_2 capture and storage	Fuel switch
Industry	Relocation	Energy conservation
	Fuel quality	Material efficiency
Transport	Fuel switch: diesel to biofuel	Reduction of transport need
	Traffic management	Fuel cell (on biofuel or gasoline)
	Fuel reformulation	Hybrid electric cars
		Fuel switch to CNG or LPG
		Vehicle maintenance and scrappage
Households	Improved stoves	Energy conservation

The additional essential criteria for the further success of technical and policy measures are assessed in the following section, and this leads to a set of most promising options.

Most promising options

The maximal synergy in the preceding table is only based on criteria for air quality and climate change. To identify the most promising options for combating both climate change and air pollution, other criteria are also applied (adapted from introduction):

- contribution to the transition to a sustainable energy supply;
- political and public acceptability;
- cost-effectiveness;
- compatibility with present policy and viewpoints.

If these criteria are applied to the minimal and maximal approach options, the following options are identified as the most promising:

- For the energy production sector, energy conservation is usually cost-effective and acceptable. Renewable energy production would be an ideal measure, but is often less cost-effective. In several niche sectors, however, renewables can compete with fossil fuel options. Both measures contribute to other policy fields and also to the transition to a sustainable energy supply.
- For industry, energy conservation and material efficiency appear to be most promising. In developing countries in particular, efficiency improvements in manufacturing industries could provoke cost-effective leaps in air pollutant reduction and could also enhance the viability of the local industry.
- The transport sector allows for a diverse range of measures. If in the mid-term or long-term clean and cost-effective technology for the generation and conversion of hydrogen is developed, this will contribute most to a transition to a sustainable transport sector. At present a fuel switch to CNG or LPG is cost-

effective and the compatibility with present policy and infrastructure is good. In addition, mass transit systems in large cities provide promising and sustainable opportunities but public support may be limited, especially in industrialized countries, where private transport has become an accepted privilege. For developing countries, vehicle maintenance (possibly together with scrappage programmes) could reduce pollutants in an acceptable manner.
- In households in developing countries, indoor air pollution is best addressed in a climate friendly way through energy efficiency in cooking stoves, and renewable or cleaner energy for cooking and lighting, preferably by (decentralized) renewable energy. The technology for this is simple, but implementation is difficult given the target group characteristics (low on resources and capacity, scarcely access to information or education). The overall capacity for immediate greenhouse gas reduction is low, but it is likely that future avoided emissions of developing regions are more substantial.

In terms of policy options, an even more complex picture prevails. Trading of pollutants other than CO_2 (e.g. NO_x) is unlikely to result in mitigation of climate change, as an emission trading system automatically aims for the least-cost option for the only pollutant addressed. CO_2 emissions trading is recommended as an instrument to regulate emissions in industry and power production, thus yielding air quality benefits (if NO_x from biomass is well abated). It is unlikely that renewable energy deployment will be enhanced by CO_2 emissions trading in the medium term because of low CO_2 prices.

Whether full policy integration or instead (less far-reaching) policy harmonization can be applied is a matter of debate. Integration is in principal more efficient, and should ideally be applied, but is subject to barriers that have been described in Sections 6.2.1 and 6.4.1. As there is little systematic and complete literature on the topic of policy interaction of air and climate policy instruments, this cannot be fully assessed in this report.

Policy integration could be viable in the area of direct links between climate and air quality in controlling the tropospheric concentrations of ozone and emissions of soot. However, climate change policy is more than ozone and soot, and so is air policy. Apart from a separate agreement on ozone and/or soot, a less integrated and more harmonized air policy and climate policy would still be needed.

6.5 Conclusions and recommendations

The level of synergy and trade-off between air pollution abatement and climate change mitigation depends on the common ground in terms of physical interaction in the atmosphere, the timescale of impacts and measures, the shared causes and the solutions to the problems in terms of both policies and measures.

Though climate change and air pollution share the same atmosphere, the substances responsible for climate change do not coincide with the most important health-affecting and acidifying agents, with the notable exceptions of ozone and some particulate matter, including soot. However, many air pollutants have indirect warming or cooling effects. Important differences are evident in spatial and temporal impacts: whereas air pollution is a local/regional and short-term problem, greenhouse gases affect the global and long-term climate. As a consequence, air pollution abatement induces more concrete policy efforts than climate change, even when the long-term impacts of climate change are considered to be extremely severe. As the sources of the most important greenhouse substances and the sources of air pollutants largely coincide, policy harmonization is possible and likely to be most effective at the technical and policy levels in addressing distinct sectors. Full policy integration would appear to be very difficult because of the differences in impacts of air pollution and climate change.

It is necessary to carefully weigh the policy effectiveness and interaction against the technological measures deployed with the aim of air pollution abatement. Model studies indicate that significant cost reductions can be achieved as a consequence of combining climate change mitigation and air pollution abatement. These model studies, however, assume optimal implementation of technologies that favour both air quality and greenhouse gas emission targets. Air pollution abatement over the past few decades has not had a significant impact on increasing or reducing greenhouse gas emissions. Only during the last decade has the fuel switch to reduce air pollution significantly mitigated CO_2 emissions in China.

On a global scale, it can be concluded that solving the air pollution problem to a satisfactory extent does not solve the climate problem. With a few exceptions, however, all climate change mitigation measures induce long-term benefits for air quality. To put it more strongly, the fuel-related air pollution problems would appear to be solved if the climate change problem were solved. The exception to this is indoor air pollution, which is (in terms of health impacts) the most severe and the least mitigated air pollution problem. Its causes originate in poverty and the lack of access to clean technology, and not in the general availability or appropriateness of technological measures.

To achieve maximum synergy, several 'most promising technologies' have been identified for the relevant sectors, based on criteria relating to the benefit for air and climate policy, cost-effectiveness, long-term contribution to transitions, public and political acceptance, and policy compatibility:
- *Industry*: Reducing energy demand and improving material efficiency;
- *Energy production*: More efficient fuel conversion, renewable energy (air pollution impacts from bioenergy need to be regulated separately);
- *Transport*: Fuel switch to CNG or LPG; long-term to hydrogen, increased use of mass transit, vehicle maintenance and scrappage (particularly for developing countries);
- *Households*: energy efficiency in cooking stoves, and renewable or cleaner energy for cooking and lighting, preferably from (decentralized) renewable energy (especially in developing countries).

Region and city-specific circumstances for these options need to be taken into account. The interests of regions and countries affect the view and the position taken in climate negotiations. For example, clean coal technology commonly applied in Europe may be a top priority policy in China or India.

Climate policy is most cost-efficient and cost-effective when implemented within a globally oriented policy framework. It is increasingly advocated that air pollutants also need to be addressed on a supernational level, possibly even globally. The interests of different countries could be combined into a single agreement, as benefits for air pollution may enhance the required international political acceptance for a climate regime. However, the full integration of air pollution and climate change policy appears to be limited by factors that arise from the physical nature of the problems, the timescales of impacts and solutions, and the level of urgency for different countries. For those areas where policy integration is not viable because of insufficient common ground, an enhanced degree of policy harmonization is strongly recommended, as this will enhance the support for climate policy.

To make this more concrete, the following policy recommendations are made for a post-Kyoto climate regime:
- Structural policy integration is only viable if there are direct physical links between problems. In air quality and climate change, this is the case for ozone and soot. A combined international agreement on reduction could be achieved for these substances, possibly with a credit system interchangeable for air quality and climate mitigation merits. It is likely that sufficient scientific progress will be made to support such an agreement.
- Policy harmonization – crucial because of the indirect links – could be maximized by choosing only the most promising options: energy efficiency and conservation, renewable energy and structural changes in modes of transport. Contributions to the transition to a sustainable energy supply would be the most appropriate for this. With respect to international climate policy instruments such as CDM and air pollution, criteria could be applied in the form of a 'clean air' standard, while ensuring no adverse air quality impacts, or even a fixed bonus or tax exemption on the credit price.
- Indoor air pollution is a policy area in its own right and should be tightly linked to poverty alleviation policy. More explicit recommendations in the field of poverty reduction and climate change (and the difficult choices this may induce between environmental and development priorities) are addressed in Chapter 2.
- The interaction of policies on the instrument level in air pollution and climate change has not been sufficiently investigated to give policy advice. Policy research aimed at clarifying the synergies and trade-offs in this field could help to develop international instruments that work both ways.

- Local circumstances, both physical and socio-economic, should be taken into account when addressing problems. The level of technical development, possibilities for financing and the energy intensity of the economy are important factors determining the effectiveness of measures. This is also addressed in Chapter 5.
- Climate policy is not an obstacle to economic development, as applied to both developing countries and industrialized countries, especially if it is combined with air quality policy. This study demonstrates that there is sufficient common ground for policy integration in some cases and policy harmonization in others, leading to benefits in both fields, and in principle, to broader support for a future regime stretching beyond climate.

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Appendix A: World Overview Air Pollution

Region	Acidification	Smog	Indoor	Air quality situation	Health impacts
North America (UNEP, 2003; EPA, 2000; NRDC, 2003)	X	x		*Acidification* Declining but very high SO_2 emissions due to coal power production; local and transcontinental acidification exceed critical loads; low energy efficiency; NO_x increasing with transport main source. *Smog* Slow decrease but high levels of in ozone and PM levels; tens of millions of US urban citizens regularly exposed to levels exceeding one-hour standard; transboundary problem: exchange between US and Canada of O_3 from NO_x in industrial plumes.	Despite decreasing air pollution levels the NA population is still faced with widespread exposure to PM, ozone, SO_2 (North-East), which has substantial health impacts: more than 120 million Americans live in areas where the air is unhealthy.
Latin America (UNEP, 2003)		x	x	*Smog* Severe problem in medium-sized cities and megacities (urbanization rapidly increasing), aggravated by unfavourable meteorological conditions; transport major cause with fleet increasing rapidly; power production, small and large industry and agriculture also important; problems extends to non-urban regions; forest fires. *Indoor air quality* Not known	Air pollution is blamed for 2.3 million annual cases of infantile chronic respiratory sickness and 100,000 cases of chronic adult bronchitis in the region; In São Paulo and Rio de Janeiro, air pollution is estimated to be responsible for 4000 premature deaths annually.
Western Europe (EEA, 1999; EEA, 2003)	x	x		*Acidification* Sulphur emissions have fallen by over 50% and NO_x by 8% in 1990s, however acid deposition still exceeds ecosystem critical loads in many countries. *Smog* Exceedance of O_3 health limits occurs occasionally in many cities and most member states, ground-level ozone increasing; safe level for crops and vegetation is exceeded in most countries; It is unclear which PM sources are most important; much attention is focussed on traffic and industry emissions of carbonaceous PM. Despite decreasing air pollution levels the European population is still faced with widespread exposure to PM and ozone, and sometimes also NO_2, which has substantial health impacts. Long-term rise in average ozone levels is observed which may have substantial health impact (despite decreasing peak levels).	*Acid deposition has affected vegetation on a large scale, ranging from decreased forest growth in the Netherlands to acid lakes affecting fish populations in Sweden.* The total cost of smog health impact is € 27 billion per year or 1.7% of the combined GNP of the three countries Austria, France and Switzerland.

Region	Acidification	Smog	Indoor	Air quality situation	Health impacts
Accession countries (EEA, 1999; EEA, 2003)	x	x		*Acidification* Acidifying emissions slowly decreasing with most countries below their path to reduction goals. However, still high SO_2 emissions, sometimes increasing NO_x due to rising number of vehicles; nitrogen deposition exceeds ecosystem critical loads on a large scale. *Smog* Power plants and energy-intensive industries major sources, often located near cities: winter and summer smog exposes a large population to poor air quality; AOT40 regularly exceeded but less frequent than in western Europe.	
FSU/ Central Asia (UNEP, 2003)	x	x	x	*Acidification* Gas is main fuel for power plants in Russia, transport increasing, low energy efficiency. *Smog* PM and ozone in cities exceed standards on a regular basis. *Indoor air quality* Exposure to PM and VOC due to biomass burning on a large scale.	
China (UNEP, 2003; Kojima and Mayorga-Alba,1998)	x	x	x	*Acidification* High SO_2 emissions due to power plants with outdated pollution control equipment, rapidly growing economy and energy consumption. *Smog* Megacities SO_2, PM *Indoor air quality* Major problem, high biomass use and low rate of rural electrification.	Around 0.28 million ha of forest land in the Sichuan basin of China are reported to have been damaged by acid rain
India (UNEP, 2003; Smith, 2000)		x	x	*Acidification* Emerging issue due to coal dependence, energy consumption expected to increase rapidly. *Smog* In cities, TSP, NO_x and SO_2 exceed safe levels for a large part of the year; motor fleet growing rapidly and poor road and vehicle maintenance; discussion about notorious haze over subcontinent (Asian Brown Cloud). *Indoor air quality* Policies in place for cleaner cooking fuels and stoves; 80% of households use biomass as fuel.	Indoor air pollution is blamed for 5-6% of the national burden of diseases in women and children in India.

Region	Acidification	Smog	Indoor	Air quality situation	Health impacts
ASEAN (UNEP, 2003)		x	x	*Acidification* SO_2 emissions high; local ecological impacts. *Smog* High PM/smog in cities, due to industry, vehicles, power production, households; forest fires in SE Asia also major impact *Indoor air quality* Widespread problem in rural areas	Levels of air pollution substantially exceed the international guidelines for air quality recommended by WHO.
Sub-Saharan Africa (UNEP, 2003)		x	x	*Smog* Urban centres: biomass/dung, kerosene, vehicle pollution, poor vehicle maintenance, industries; legislation developing in several countries. *Indoor air quality* Severe health impacts due to indoor pollution.	
M-E and North Africa (unep)		x	x	*Smog* Energy consumption and number of vehicles rapidly increasing; poor condition of vehicles and roads; industries contribute in urban centres; oil refineries and production sites and petrochemical industry main sources in M-E; heavy industry with outdated technology affects nearby settlements, trend towards cleaner technology; PM cause for considerable concern, partly from natural sources *Indoor air quality* Traditional fuels burned in households on a large scale cause bad air quality	
Oceania (Holper and Noonan, 2000)	x			*Acidification* Highest Annex I per capita SO_2 and NO_x emissions, despite low sulphur content in coal and oil *Smog* Summer smog occurs in large cities; poor energy efficiency in industry and transport.	

Appendix B: Brief policy data on Mexico City, Delhi and Chongqing

Mexico City

Table B.1 Policies and measures in the MCMA Programme (1995-2000) for improvement of air quality in Mexico (Departemento del DF, 1996)

Sector	Policies and measures
Industry and services	– New standards for NO_x and VOC emission – Heat generation: End-of-pipe measures for NO_x reduction and gradual substitution of current plants with more efficient technology – Stricter fuel quality standards for combustion – Restructuring of fuel prices to favour more environmentally benign fuels (such as LPG, natural gas) – Use of prevailing tax incentives, and of international crediting programmes for financing the technology investments
Transport	– Use of the 'Hoy no circula' programme to modernize car technology by extending the travel restrictions for polluting vehicles – Increasingly strict standards for new and existing vehicles – Extension of the verification system – Progressive revision of the standards for fuels – Restructuring of surface public transport and reorganization of the transit system – Extension of non-polluting means of public transport: metro, trolley buses and trains
Ecology and other	– Reforestation and ecological restructuring of degraded areas – Urban planning aimed at better use of soils, recycling, and environmental protection areas

Delhi

Table B.2 Policies and measures in Delhi (MoEF, 1997)

Sector	Policies and measures
Industry	– Industries directed to comply with emission and liquid effluent standards – Installation of meters for measuring emissions of particulate matter – Relocation of brick kilns outside Delhi – Closure of all (46) hot mix asphalt plants in Delhi – Closure of 168 hazardous industries in Delhi – Coal-fired power plants should switch to beneficiated coal – Gradually increasing mandated use of fly ash in power plants
Transport	<u>In-use vehicles</u>, e.g. fixing lifespan of all vehicles, phase-out of taxis older than 10 years in 2000, ban on alteration of vehicles by replacing petrol engines with diesel engines <u>Traffic management</u>, e.g. traffic management of most-polluted junctions and areas by synchronized signals and diversion of traffic based on air quality monitoring data, expansion and greater use of cycle paths, construction of bypasses and motorways <u>Fuel quality</u>, e.g. ban on loose 2-T oils at petrol stations, direction that two-wheelers and three-wheelers only obtain their fuel from pre-mixed fuel outlets, prevention of fuel adulteration, use of CNG in taxis, buses and extension to private vehicles.

Chongqing

Table B.3 Policies and measures in Chongqing (Zhou, 2001; Haq et al.*, 2002)*

Sector	Policies and measures
Industry	Power production fuel switch from coal to natural gas
	Replacement of coal-fuelled boilers with cleaner fuels
Transport	Emission standards for motor vehicles
	Inspection by means of obligatory annual tests, random tests on the road, remote sensing
	Maintenance programmes
	Training of technicians for emission testing and repair
	Provision of emission testing equipment in repair shops

7. Adaptation and funding in climate change policies

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Abstract

This chapter discusses the topic of adaptation in future climate change policy. Some climate change impacts are expected to be unavoidable and therefore adaptation is needed. Major questions in adaptation policy concern the level at which the policy should be shaped and coordinated within the UNFCCC or outside the Convention, and whether it should be financed under the UNFCCC, or from other sources. We propose that a two-track approach be followed that attempts to secure funding of climate change adaptation under a multilateral environmental agreement (MEA), but which also improves mainstreaming of climate risk management into development plans. It could be opportune for developing countries to agree on partial funding under agreed cost-sharing rules, rather than under complicated incremental cost calculations. Some practical experience in using simplified rules can be gained from pilots that have recently started under the GEF strategic priority on adaptation. Simplified rules for incremental costs and less attention to the issue of global environmental benefits would speed up the implementation process. However, substantial commitment to fund adaptation measures from Annex I countries would be needed if funding adaptation under the Convention were to cover a substantial part of the costs. Mainstreaming climate change into other development processes and risk management is also needed, and ample opportunities are available. Opportunities for additional funding can also be found outside the Convention. The linking of the UNFCCC with other conventions and institutions could be improved, although resources for funding under other conventions are likely to be even more limited. Linking to risk management practices in national sectors as well as multilateral donor institutions appears to be viable, since the reduction of weather-related natural disasters is gaining attention. Financing disaster preparedness from FCCC funds could be an option for the short term, in order to meet the most urgent needs. Adaptation measures have strong interaction with two policy areas (poverty and land use), for which the priorities need to be incorporated into whatever adaptation policy is agreed.

7.1 Introduction

7.1.1 Scope of the chapter

Climate change may seriously hamper economic, social and development prospects and could lead to problems such as acute water and food shortages, increasing poverty, impact on industry and increasing health hazards in these countries (IPCC, 2001). The human systems that are most vulnerable to climate change can be found in developing countries. The people most vulnerable to the adverse effects of climate change are the poor, and considerable efforts will be required to help them cope with the new circumstances (e.g. Mirza, 2003). The main responses to climate change are mitigation and adaptation. Mitigation includes the reduction of greenhouse gas emissions. Adaptation refers to the adjustments in natural or human systems in response to actual or expected climatic stimuli or effects. It is expected that even with considerable efforts to mitigate greenhouse gas emissions, some climate change impacts are unavoidable and consequent adaptation is needed (Parry et al.*,* 1998; IPCC, 2001). Both the UNFCCC and the Kyoto Protocol contain provisions for adaptation and the funding thereof. Adaptation is expected to be increasingly important in future climate policies.

The Kyoto Protocol Adaptation Fund, which will support specific adaptation projects and programmes in non-Annex-I Parties (i.e. developing countries) to the UNFCCC, is likely to start after 2008. Future climate agreements will need to include adaptation in a more fundamental manner than has so far been agreed. Adaptation should be considered within the framework of integrated risk management and sustainable development, since adaptation affects economic, environmental and social conditions, and vice versa. One of the important questions is how adaptation policies could be institutionally framed at the various levels: internationally, nationally and locally. For example, internationally this could be in a separate protocol, as some have suggested, or as an integrated part of a new treaty. At the national and local levels, sectoral policy and development planning relating to water resource management and coastal zone management could increasingly incorporate climate change adaptation.

The issue of funding adaptation strategies is particularly relevant for developing countries, since existing international funding arrangements are neither likely to be sufficient to cover the costs of adaptation, nor will they cover the costs of (residual) climate change impacts in developing countries. People and countries have always protected themselves against the impacts of climate variability and adaptation can therefore not be seen as separate from ongoing and future developments. In developed countries, the adaptation capacity of the various sectors is relatively high, and therefore implementing adaptation will mainly involve mainstreaming and financial planning – although NGO involvement in adaptation could still be improved (Rojas, 2004). This also leads to the question of who will (and who will not) receive funding for adaptation under the Convention. It is vital that clear rules and criteria be developed for allocating available international financial resources for adaptation. Opportunities involving the combination of international funds for adaptation with other sources, e.g. Official Development Assistance (ODA) and efforts such as funding coastal zone management, need to be explored. This chapter therefore explores possible funding rules for the Kyoto Protocol Adaptation Fund and looks at the potential for developing other sources of adaptation funding.

This chapter describes the current situation with regard to climate change adaptation and the resulting options for climate policies, both now and in the post-2012 period. We explore ways and means of incorporating adaptation into climate change policies, particularly regarding the issue of funding. A broad picture is drawn of the various options, both inside and outside the Climate Change Convention, focusing on the position of developing countries with respect to adaptation. We also study the levels at which (and institutions where) adaptation policies are developed, thus identifying the current and potential future sources for funding adaptation measures.

The objectives of this chapter were to:
- assess current policies with regard to adaptation, (integrated) risk management and sustainable development under climate variability and to investigate the potential for synergies between adaptation and mitigation, in order to arrive at recommendations for future policies (Section 7.2);
- discuss and evaluate promising options for climate change adaptation policies (Section 7.3). Besides options for incorporating climate change adaptation into post-2012 multilateral agreements, ways to mainstream climate change adaptation into existing institutions and current policies are of particular importance;
- assess options for funding adaptation costs, particularly for developing countries (Section 7.4);
- provide some conclusions and recommendations for adaptation policy (Sections 7.5 and 7.6).

7.1.2 What is adaptation?

In the definition used by the Intergovernmental Panel on Climate Change (IPCC), adaptation refers to ‘the adjustments in natural or human systems in response to actual or expected climatic stimuli or effects’. Adaptation can be planned (collective and state initiated) or autonomous/spontaneous (imitated by local actors or by natural systems). The possibilities for systems, regions or communities to adapt very much depends on their adaptive capacity[99]. Consequently, enhancing their adaptive capacity and capacity building would reduce their vulnerability. Adaptation varies according to the system in which it occurs, who undertakes it, the climatic stimuli that prompts it, and its timing, function, form, and effect (Smit et al., 2001). Developing climate policy is an iterative process, where policy responses are based on the effect of both mitigation and adaptation measures on the residual or net impacts (see Figure 7.1).

[99] “Adaptive capacity is the potential or ability of a system, region, or community to adapt to the effects or impacts of climate change. Enhancement of adaptive capacity represents a practical means of coping with changes and uncertainties in climate, including variability and extremes. In this way, enhancement of adaptive capacity reduces vulnerabilities and promotes sustainable development” (Smit et al., 2001).

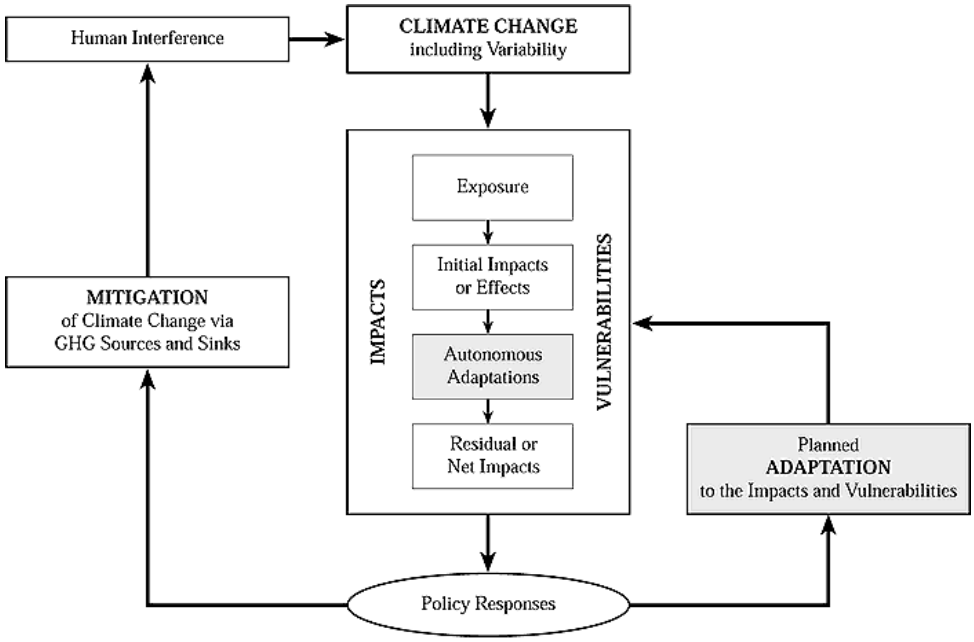

Figure 7.1. Processes of adaptation (from Smit et al.*, 2001)*

Most historic adaptation measures deal with alleviating negative impacts from extreme weather events. Studying the possible relationships between disaster reduction and adaptation therefore seems to be warranted, since linkages between adaptation and disaster reduction would require a close relationship with the disaster-preparedness and disaster-relief community. Past adaptation policies have mainly focussed on physical measures. Recently, however, more room has been given to 'soft solutions' in the form of non-structural measures or accommodation of weather extremes (e.g. 'Ruimte voor de Rivier', MinV&W, 2000; and 'Living with Risk', UNISDR, 2003; Gleick, 2003). Additionally, measures are not only designed and chosen on a cost-benefit basis, but also on social or cultural opinions of different stakeholders and political and individual preferences and interests.

7.1.3 Impacts and adaptation costs

The aggregate impact costs from climate change are estimated to be in the order of 2-10% of global GDP, depending on the degree of temperature change (Smit et al., 2001). However, there are differences in the regional, national and local impacts, and the distribution of impacts over different sectors. The total costs of adaptation are very difficult to estimate (e.g. Fankhauser, 1998), due to the dependency of vulnerability on local characteristics and changes in vulnerability over time. But to give an example, the total adaptation costs in the US have been estimated to be somewhere between US$ 69.3 and 335.7 billion (Ekins, 1996). It is estimated that global adaptation costs only comprise around 7-10% of the total global damage costs produced by climate change (Tol et al., 1998). Estimating the costs that occur during development and economic transition, and their potential for adaptation, is not addressed in current adaptation frameworks since most adaptation and impact studies assume economic equilibrium both now and in the future. However, the climate continues to change, as do the impacted systems (Aerts and Droogers, 2004).

Considerable uncertainties are involved in long-term adaptation planning. The impact and adaptation cycle is a dynamic process. The IPCC states that, in the short term, adaptation can result in substantial reductions in climate change damages, especially in the most vulnerable regions The optimum adaptation level minimizes the combined costs of adaptation and residual negative effects, with the most cost-effective steps taken first. Factors that affect adaptive capacity itself include institutional capacity, wealth, planning time, and scale (Tol et al., 1998). More research on the timing of adaptation is required. In this respect, Burton et al. (1998) point out that adaptation in socioeconomic sectors is easier when investments relate to activities with a shorter product cycle. For example, different cropping methods can be adjusted every year, but a forest has a life cycle of decades. Dams are even costlier to reconstruct in order to meet new climate conditions.

7.2 Adaptation policies

This section introduces adaptation policies in their various forms. First of all, we look at the UNFCCC adaptation policies. Secondly, we highlight current climate change adaptation policy outside the Convention. Thirdly, we discuss other multilateral initiatives that relate, or potentially relate, to climate change adaptation. Fourthly, we introduce the trade-offs and possibility of synergies between climate change adaptation and mitigation.

7.2.1 UNFCCC adaptation policy

Under the UNFCCC, national parties are obliged to both protect the climate system by mitigating greenhouse gas emissions, as well as combating the adverse effects of climate change (Article 4.1). Under the Kyoto Protocol (UNFCCC, 1997), all participating parties shall adopt measures to facilitate adaptation (Article 10 b). Moreover, 'the Conference of the Parties, serving as the meeting of the Parties to this Protocol, shall ensure that a share of the proceeds from certified project activities is used to cover administrative expenses as well as to assist developing countries that are particularly vulnerable to the adverse effects of climate change to meet the costs of adaptation' (Article 12.8). Three adaptation funds have been established under the UNFCCC (see also Section 7.3.1).

Technology transfer is explicitly mentioned in the Marrakech Accords (under the UNFCCC) to include adaptation technologies. Technology transfer is defined as 'a broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change' (Technical Summary in Metz et al., 2000), and can be reached through a combination of policies. The report lists important issues for all major sectors. Adaptation projects have thus far attracted limited interest from the Global Environment Facility (GEF) and other donors because the benefits of adaptation are primarily local, as opposed to benefits in greenhouse gas emission reductions, which are global. Moreover, adaptation technologies tend to cover site-specific issues and will therefore need to be designed and implemented keeping local considerations in mind, which could limit large-scale technology repetition. Strengthening technological, institutional, legal and economic capacities, as well as awareness-raising, are considered to be important for effective adaptation.

The UNFCCC envisages three stages of adaptation activities in non-Annex-I countries: Stage I (short-term) consists of planning, Stage II (medium-term) consists of preparation and Stage III (long-term) consists of initiating measures to facilitate adequate adaptation (including insurance and other adaptation measures). In order to facilitate the adaptation process, a number of tools have been developed such as the Vulnerability and Adaptation studies (V&A) in the National Communications, the National Adaptation Programmes of Action (NAPAs) and the Adaptation Policy Framework (APF, see below).

Table 7.1. Stages in UNFCCC adaptation activities (FCCC/CP/1995/7/Add.1 decision 11/CP.1.)

Stage	Stage I: Planning (short-term)	Stage II: Preparation (medium-term)	Stage III: Initiation (long-term)
Parties involved:	All	Particularly vulnerable countries or regions	Particularly vulnerable countries or regions
Activities:	Studies on possible impacts of climate change	Measures to prepare for adaptation, including:	Measures to facilitate adequate adaptation, including:
	Appropriate capacity building Identifying policy options for adaptation Identifying particularly vulnerable countries or regions	- Further capacity building - Developing Appropriate Adaptation Plans	- Insurance - Other adaptation measures

National Communications

The initial National Communications (NCs) to the UNFCCC were intended to provide information on greenhouse gas emissions and mitigation, a general description of steps (including impact and adaptation needs and measures), as well as a list of projects that could be financed. Current NCs identify a large number of adaptation measures in individual countries. The development of NCs (see also Section 7.3.1, under Special

Climate Change Fund) formed excellent capacity building projects and provided initial insights into adaptation measures and strategies. However, most underlying studies focussed on impacts and adaptation to medium and long-term climate change in specific sectors. They often looked at physical measures without considering other issues, such as the national policy perspective, adaptation to current climate variability and extreme events, cross-sector linkages, integrated risk management, sustainable development, livelihood systems and poverty. A full evaluation of financial, cultural, social, political, legal, institutional and other aspects of adaptation measures has not yet been implemented in most underlying studies.

With the APF being used for future studies and with the NAPAs (see below), adaptation can be expected to be covered more consistently in future NCs. The V&A assessments have so far only seldom led to adjustments in national and sectoral policy or implementation of measures. More attention should be given to coupling the assessment results to the relevant ministries (most notably agriculture, water, irrigation and coastal protection ministries), to create ownership. The less powerful environment ministries and meteorological departments currently carry out most of the V&A studies.

National Adaptation Programmes of Action

NAPAs are meant to address adaptation in the least developed countries, as well as to support the preparation of the National Communications by these countries. NAPAs should identify priority areas that address the urgent and immediate needs and concerns for climate change adaptation in the least developed countries. Chapter 2 discusses the contents of the NAPAs more extensively, as well as the relationship between the NAPAs, adaptation efforts and poverty alleviation in the least developed countries.

Adaptation policy framework

UNDP and GEF recently finalized an APF that can be used as guidance to implement adaptations at different scales (Lim et al., 2004). This framework is to be applied in UNFCCC Stage II and Stage III projects. The APF has four major principles, i.e.:

1. adaptation to short-term climate variability and extreme events serves as a basis for reducing vulnerability to longer-term climate change;
2. adaptation policy and measures are assessed in a development context;
3. adaptation occurs at different levels of society, including the local level;
4. the adaptation strategy and the process by which it is implemented are equally important.

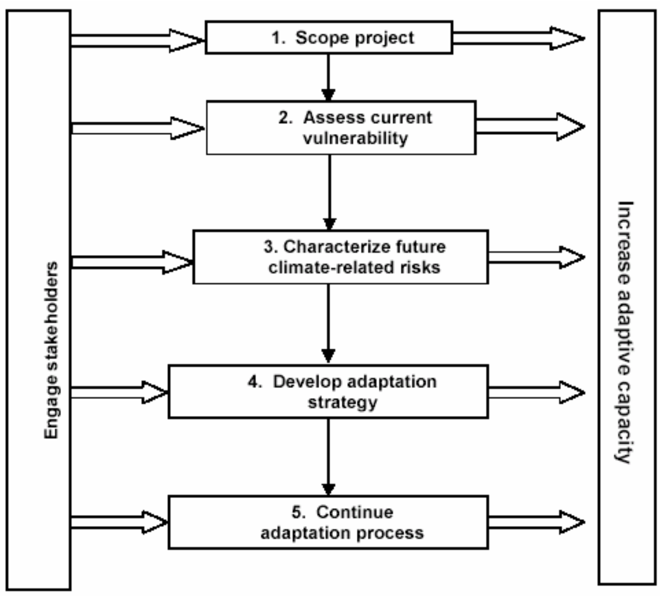

Figure 7.2 Basic components of an adaptation policy framework (from Lim et al.*, 2004)*

The APF process consists of five basic components (Figure 7.2), including the assessment of current vulnerability and the development of an adaptation strategy. It particularly focuses on the project level, rather than the global level, such as depicted in Figure 7.1. Linkages to other planning processes in various sectors and their funding mechanisms should be involved during all the stages. For example, risk management and its funding in other development processes should ideally be linked to climate change adaptation.

There are still a few challenges for actually using this framework in practice. Firstly, it is important to consider socioeconomic scenarios, although it may affect the uncertainty of the result (Yohe and Dowlatabadi, 1999). Secondly the costs of adaptation are rarely studied and even less is known about the benefits. Most studies focus on total damage costs, including adaptation, and not on avoided damages through adaptation (e.g. Zeidler, 1997). In addition, adaptation is an iterative process in which particular attention is paid to developing adaptation strategies and having experts and relevant stakeholders evaluate their effectiveness in a repeated fashion (Figure 7.1; Aerts and Droogers, 2004).

7.2.2 Sector-based national policies

Most countries have national and sector-based adaptation policies, in particular relating to disaster management. In some countries, sectors most vulnerable to climate variability already plan for future climate change. These are most notably the water resources sector (Kabat and Van Schaik, 2003), the agricultural sector (FAO, 2002; see also Chapter 3), the health sector, as well as integrated approaches in spatial planning processes related to urban areas, coastal zones and river basins. Maintaining safety is often an important concern, if not the most important concern. For example, water management plans relating to safety in the Netherlands over the coming decades have largely been based on anticipated changes in precipitation and river runoff, sea-level rise and consequent risks of floods and droughts (WB21, Tielrooy, 2000).

Adaptation technologies not only reduce vulnerability to anticipated impacts of climate change but also to contemporary hazards associated with climate variability and other pressures and developments, creating a clear incentive to start planning with climate change adaptation in mind. Adaptation could therefore be considered a ‘no-regret’ strategy because it has a purpose, both now and in the future. This has consequences for the available funding, especially in branches that explicitly or implicitly deal with adaptation from a national policy perspective, besides coastal zone management and river basin management, concern disaster preparedness and ad hoc relief. Pooling financial resources, as well as the (national) private insurance sector, mean that insurance arrangements between public and private partners become possibilities: particularly since many developments, such as improving and expanding infrastructure, are planned for many other reasons, and on the basis of many other rationales, besides reducing vulnerability to climate change *per se*. Funding opportunities are discussed in more detail in section 7.3. Efforts to prepare for disasters in developing countries are complemented by the work of multilateral organisations, bilateral activities and NGOs; these are discussed in the next section.

7.2.3 Other initiatives

Convention on Biological Diversity (CBD)

This convention focuses on both biodiversity conservation and human development. The situation in developing countries is explicitly reflected in the convention, which refers to the provision of new and additional financial resources, as well as access to relevant technologies, thus enabling developing countries to meet the agreed full incremental costs of implementing their commitments. Within the CBD, the GEF has been charged with the operation of the financial mechanism in order to make financial resources available to developing countries. This convention could potentially hold some benefits for adaptation, as the protection of habitats and reduction of non-climate pressures for example would increase the adaptation capacity of some ecosystems. However, at present, scientists as well as countries still need to recognize many of the linkages (Klein, 2001). Possible links to adaptation include reducing habitat fragmentation, using captive breeding and translocation and conserving ecosystems (see also Chapter 3).

United Nations Convention to Combat Desertification (UNCCD)

Potential links to adaptation include risk-reducing management strategies, water resource management and land use change options (see also Chapter 3). Additional obligations by the participating developed countries concern the relationship with developing countries, particularly with respect to providing financial resources and mobilizing new and additional funding (including from the private sector) to support and assist developing countries with implementation. Furthermore, developed country participants are to promote access (by developing countries) to technology, knowledge and know-how. The GEF acts as the financing source for the convention.

The UNCCD could potentially initiate some activities in mainstreaming climate adaptation into areas such as water resource management and restoration of degraded lands; activities that are related to this convention. This could also be interesting, since developed countries do provide some bilateral funding for implementing capacity building. Klein (2001) identifies the procedural and organisational linkages, the scientific and technological linkages, and the social and institutional linkages as potential options for synergies between the UNCCD and climate change adaptation. The UNCCD has a mechanism (called the Global Mechanism[100]), which aims at mainstreaming, establishing partnerships and funding implementation. Some links between the UNCCD and UNFCCC have been developed; for more details see Chapter 9.

United Nations Forum on Forests (UNFF)
The United Nations Forum on Forests, established in October 2000, aims to contribute to '… the management, conservation and sustainable development of all types of forests and to strengthen long-term political commitment to this end…'. The forum works as an international environmental process rather than functioning as a multilateral environmental agreement. The UNFF contains elements of forest management, but does not include any funding of implementation apart from voluntary contributions meant to support communication and dialogue. Sustainable forest policy could potentially contribute to adaptation by reducing the potential for erosion and flooding, while at the same time providing a habitat for other species. There are also possible links to mitigation, when carbon is sequestered in forests (see also Chapter 3). At the third meeting (UNFF3) held in May-June 2003, no progress was made towards implementing the Intergovernmental Panel on Forests (IPF) Proposals for Action, which dates from 1997[101]. Some sources indicate that issues such as national sovereignty and land tenure have hindered the establishment of a convention on forests (EC, 2003). Some NGOs are still aiming for a discussion on a legally binding agreement or forest convention. At this stage little support for climate change adaptation can be expected from the UNFF, either for policy or funding.

Convention on Wetlands (CoW)
The Ramsar Convention on Wetlands is '…an intergovernmental treaty which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources'[102]. Bergkamp and Orlando (1999) identified possible linkages between the UNCCC and the CoW. They describe four activities that could improve cooperation, i.e.:
1. promote linkages between the wetlands and climate change conventions;
2. predict and monitor the impacts of climate change on wetland areas;
3. the role of wetlands in adaptation to, and reducing the impacts of, climate change;
4. the role of wetlands in reducing greenhouse gas emissions.

Removing the existing pressures on wetlands, and improving their resiliency is considered the most effective method of coping with the adverse effects of climate change, although adaptation measures within other sectors (such as agriculture or water management) could have negative impacts (Chapter 3).

Type II agreements
This type of agreement consists of voluntary and non-binding partnership agreements between stakeholders, including governments, to achieve sustainable developments. They are additional to Type I agreements in the sense that they need not be negotiated at summits and do not need consent by delegations. The purpose of such agreements is to raise new funds for local developments by encouraging coalitions between like-minded stakeholders; this type of agreement was increasingly encouraged at the World Summit on Sustainable Development (WSSD) (see Gupta and Dorland, 2003). In principal, increased coalitions between various nations and stakeholders could hold potential for improving capacity building and joint policy of cross-boundary adaptation issues, such as coastal zone management and river basin management. However, it is

[100] See http://www.gm-unccd.org
[101] Available online at http://www.un.org/esa/forests/
[102] See http://www.ramsar.org/

still not clear whether Type II agreements will be widely used and how they will affect agreements that do include adaptation policy and funding.

Poverty-reduction strategies
Much of the multilateral cooperation and aid focuses on development. The Poverty Reduction Strategy Papers (PRSPs) attempt to structure development efforts needed to meet the UN Millennium Development Goals (MDGs) resulting from the World Summit on Sustainable Development. One of these goals is to halve poverty between 1990 and 2015. Incorporating some aspects of adaptation into poverty reduction would provide an option to help reduce the vulnerability of the poorest people. An analysis by Smith (2002) pointed to the fact that climate change may have an impact on the efforts to achieve the MDGs. The OECD climate adaptation project (Agrawala and Berg, 2002) seeks to link climate adaptation to the PRSPs[103]. Chapter 2 discusses more extensively the relationship between development, climate change adaptation efforts and poverty.

Disaster preparedness
Current policies to reduce the impacts from climate variability, particularly extreme weather events, tend to be reactive rather than proactive (e.g. IFRC, 2002; Bouwer et al., 2004). Instead of aiming to reduce vulnerability or prevent disaster, considerable effort is invested in reconstruction and rehabilitation. Such policies can be referred to as 'reactive adaptation': i.e. adaptation that takes place after impacts have been observed (IPCC, 2001). The reason is that disasters, just as climate change, are not regarded as immediate problems, and receive less attention than other (short-term) objectives. Organisations such as the Red Cross are also increasingly focusing on climate change as a threat, and argue that integrating risk reduction strategies into humanitarian and development strategies is essential for adaptation (Van Aalst and Helmer, 2004). Disaster preparedness is a 'no-regret' adaptation option that can be increasingly used in both national policy-making, as well as donor aid and development banking.

Other organisations that focus on risk reduction include the Provention Consortium[104] and the UN Strategy for Disaster Reduction[105] (UNISDR). The Provention Consortium aims to '…support developing countries reduce the risk and social, economic and environmental impacts of natural and technological disasters on the poor' and consists of '…a global coalition of governments, international organizations, academic institutions, the private sector and civil society organizations dedicated to increasing the safety of vulnerable communities and to reducing the impact of disasters in developing countries'. The consortium provides an opportunity to serve as a quick link to many scientific, governmental, as well as private organisations. The UNISDR '…aims to build disaster-resilient communities by promoting increased awareness of the importance of disaster reduction as an integral component of sustainable development, with the goal of reducing human, social, economic and environmental losses due to natural hazards and related technological and environmental disasters'. The UNISDR has set up a framework (UNISDR, 2001) for implementing disaster reduction, and its main objective is to mainstream disaster reduction into sustainable development and into national planning processes.

7.2.4 Synergies with mitigation
Synergies between adaptation and mitigation depend on the sectors in which the activities are undertaken, their scale (local and global benefits) and their financing. Mitigation mainly has benefits in the long term, and on a global scale, while benefits from adaptation measures become apparent in the short term and on a local scale. Furthermore, costs and benefits from mitigation are easier to calculate and compare, relative to the costs and benefits of adaptation measures, and decisions based on economic evaluation may therefore be difficult. Synergies may be intentional or unintentional. Mitigation is often regarded from the perspective of only one sector and can have both positive and negative effects for adaptation. Adaptation involves many more sectors and stakeholders, to whom climate is not of immediate concern. An example of a synergy is when reforestation or afforestation has a mitigating effect on greenhouse gas emissions resulting from the sequestration of carbon, but at the same time reduces vulnerability to flooding and erosion. An example of a trade-off between mitigation and adaptation policies is the transition from conventional fossil fuel use to cli-

[103] An overview of case studies is available at http://www.oecd.org/
[104] See http://www.proventionconsortium.org/
[105] See http://www.unisdr.org/

mate-neutral hydropower, perhaps also for purposes relating to security of energy supply (see also Chapter 4). However, from an adaptation perspective there may be an increasing dependence on precipitation and water availability, rendering a higher vulnerability (Arnell and Hulme, 2000). This particular trade-off problem, for example, is experienced in Nepal (see Agrawala et al., 2003). The adaptation perspective would have to be taken into account in mitigation policy, and vice versa.

The 'appropriate balance' between mitigation and adaptation will vary per country and over time, as local costs and conditions change, while many factors (non-linearity, long timeframes, global nature of the problem, etc.) complicate the assessment (Tóth et al., 2001). Klein et al. (2003) conclude that the most promising option currently appears to involve establishing links between adaptation and development policy and between mitigation and development policy. The challenge is to identify some desirable level and mix of climate policy and development policy. Some poverty-reduction strategies that are coupled to adaptation may have negative impacts on greenhouse gas emissions if these strategies are purely based on economic growth. For example, stimulating economic growth may lead to both increasing adaptive capacity and a transition from a rural society to an urban society, but at the same time may result in enhanced fossil energy use.

Developing rural electrification using biomass and other renewable energies is one of the key ways to meet needs at the rural level. In remote rural areas the provision of renewable energy may even become more cost-effective than conventional energy sources. However, to make such schemes sustainable, they need to learn from the last fifty years of experience. Reddy (1999) argues that these programmes fail when they are part of rural electrification programmes and are more likely to succeed when they are part of rural development programmes aiming to improve the physical quality of life (PQOL), the human development index (HDI) and poverty alleviation (See Chapters 2, 4, and 6). In other words, such programmes also need to encourage fuel-switch in households to more efficient cooking and heating methods. Where such programmes also succeed in empowering the rural poor they will also increase the resilience of the population to the eventual impacts of climate change.

Tropospheric ozone and soot are greenhouse gases and local air pollutants that have severe health impacts. These gases are presently not included in the Climate Change Convention, but should be (see Chapter 6). Reduction of these gases will not only reduce the concentration of greenhouse gases in the atmosphere, but will also improve human health, which in turn will contribute to improving human resilience.

7.3 Current and potential funding of adaptation

There are many ways in which adaptation measures can be financed. Current and potential future sources of funding for climate change adaptation include (in fairly random order):

- funds under the UNFCCC;
- the Global Environment Facility;
- non-compliance fund;
- Type II agreements;
- development assistance;
- public expenditures (including public private partnerships);
- disaster preparedness;
- insurance and disaster pooling;
- foreign direct investment.

7.3.1 Funds under the UNFCCC

According to the United Nations Framework Convention on Climate Change (UNFCCC, 1992), the Parties to the Convention should 'protect the climate system for the benefit of present and future generations of humankind, on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities' (Article 4.1). Accordingly, the developed country parties should take the lead in combating climate change and the adverse effects thereof. Moreover, the convention calls on the developed countries to provide the agreed full incremental costs (Article 4.3) of adaptation. The Conference of Parties (COP) will seek to mobilize financial resources (Article 7.2 h), but does not explicitly include the financing of adaptation. Thus, the convention does not include any legally binding quantitative commitments in relation to financing adaptation in developing countries. There are, however, legally binding non-measurable obligations to assist these countries, as stated in Article 12.8 of the Kyoto Protocol (see section 7.2.1).

The issue of adaptation measures and building adaptive capacity has been recognized by the UNFCCC. Several funds were created during the sixth Conference of the Parties (COP 6-bis) held July 2001 in Bonn, Germany. This was followed at the seventh meeting (COP 7) in Marrakech, Morocco in November 2001, where the mechanisms for disbursing these funds were agreed as being supplied through the GEF (see also Section 7.3.2).

However, the modalities of these three adaptation funds and the ways of contributing to the funds by the Parties to the Convention were not fully elaborated at COP 7. Priorities and funding criteria have to be established by the COP and the Meeting of the Parties with regard to programmes, priorities and eligibility criteria for funding adaptation activities. At COP 9 the European Union, Canada, Iceland, New Zealand, Norway and Switzerland together reconfirmed the earlier provision of US$ 410 million by 2005 (UNFCCC decision 7/CP.7) for the special climate change fund and the least developed countries fund. The three funds are discussed in greater detail below. The other activities are discussed in the section on the GEF.

Special Climate Change Fund
This fund will be used to finance the transfer of technologies (see below) in various sectors and to help developing countries diversify their economies. In particular, it aims to support adaptation, technology transfer, energy, transport, industry, forestry and waste management and activities to assist developing country parties diversify their economies. With regard to adaptation, it will support developing countries in preparing their initial National Communications to the UNFCCC (Stage I activities) and strengthening the implementation of adaptation activities relating to the National Communications or in-depth national studies (Stage II). Support is also provided for various activities relating to information networks, development and implementation of climate-related institutions development and implementing prioritized projects identified in National Communications, awareness raising and building (institutional) capacity for preventive measures, planning, preparedness for disasters and strengthening/establishing early-warning systems for extreme weather events. It could also fund implementation of adaptation measures. The funding criteria state that projects should be country-driven (based on national priorities) and aim for sustainable development. In the medium term (by 2005) it is expected that the Special Climate Change Fund will have a substantial part of the pledged US$ 410 million available for adaptation activities, although it is likely that ODA contributions will also be counted as part of this sum. The fund complements the climate change focal area funding under the GEF (see below).

Least Developed Countries Fund
This fund is implemented through the GEF and assists least developed countries to prepare and implement National Adaptation Programmes of Action (NAPAs, see Section 7.2.1). The fund has little more than US$ 10 million available for the preparation of NAPAs. Countries can apply for full-cost funding of up to US$ 200,000. The fund does not yet include the actual implementation of adaptation measures.

Adaptation Fund
This fund will be established as a trust fund under the GEF. It will finance the implementation of specific adaptation projects in non-Annex-I countries, including adaptation activities consisting of avoiding forest degradation, combating land degradation and desertification. The percentage and type of adaptation projects to be financed has not yet agreed. This fund is to be financed from a share of the CDM projects, in the order of 2% of certified emission reduction revenues, as well as by other sources of funding. The Adaptation Fund would have to contain considerable financial resources in order to provide the means for implementing adaptation measures.

Apart from the three funds mentioned above, a capacity building framework (extending earlier capacity building activities in developing countries) and technology transfer framework have been adopted in the Marrakech Accords. However, they have no financial mechanism of their own. Funding under technology transfer for adaptation is not considered additional to other funding sources, but should rather stem from conventional sources such as development assistance, public private partnerships, etc. Mansley et al. (2000) particularly mention the private financial sector as a potential source, since the sector recognizes that climate change could directly affect their business. However, Mansley et al. (2000) mostly discuss the financial needs for implementing environmental sound technologies (i.e. mitigation), and very little relates to the financing of adaptation. The capacity building framework should maximise synergies with other conventions and focus on vulnerability and adaptation assessment and measures (Gupta and Dorland, 2003).

7.3.2 Global Environment Facility

The Global Environment Facility (GEF) currently funds six focal areas that include biodiversity, water resources and sustainable development. It has approximately US$ 0.2 billion dollars per year to spend on climate change, which is complemented by some additional funding, such as public expenditures, ODA, loans, etc. The GEF is funding the full costs of capacity building and research activities in relation to adaptation under Stage I activities, using the funds from the Special Climate Change Fund (see also Table 7.2). While five Stage II activates have currently been initiated, it is unlikely that Stage III activities will be funded before 2008. However, under the GEF strategic priorities on adaptation, pilot projects have recently started that do implement adaptation measures.

The GEF will expand the activities (including capacity building and adaptation) as agreed in the Marrakech Accords. It could determine priorities by undertaking a global analysis of vulnerability and adaptation, and also allow countries to set their own priorities (Huq, 2002). The GEF also aims to mainstream adaptation into the other focal areas, most notably by looking into portfolios concerning topics such as biodiversity, international waters and land degradation (GEF, 2003).

Table 7.2 gives an overview of the UNFCCC/GEF funding relating to adaptation. The three adaptation funds are discussed in the previous section.

Table 7.2 Proposed framework by GEF for funding adaptation (from GEF, 2003)

Activities to be Funded	**Project Examples**	**GEF Trust Fund**	**LDC Fund**	**Special CC Fund**	**Adaptation Fund**
Stage I Adaptation within the context of national communications	V&A analysis	Enabling Activity (Full Cost)	N/A	N/A	N/A
Stage II Adaptation within the context of national communications	Prioritization, National policy/strategy development, Planning, Targeted research, etc.	Enabling Activity (Full Cost)	N/A	N/A	N/A
Stage II Adaptation beyond the context of national communications	Sector specific action plans, Barrier removal, Cost/benefit calculations, Regional climate models, Targeted research, etc.	Operational Programs (Incremental Cost)	N/A	UNFCCC to provide guidance	N/A
NAPAs	Preparation of NAPAs	N/A	Enabling Activity (Full Cost)	N/A	N/A
Pilot and Demo Projects	Implementation and testing of sector specific adaptation measures	Operational Programs (Incremental Cost)	UNFCCC to provide guidance	UNFCCC to provide guidance	N/A
Capacity Building	Observation systems, Monitoring of diseases and vectors, Disaster preparedness, Technology transfer, Public awareness, Improving climate information, etc.	Enabling Activity (Full Cost) Proposed Expanded GEF Support for Capacity Building Operational Programs (Incremental Cost)	UNFCCC to provide guidance	UNFCCC to provide guidance	Dependent on Kyoto
Concrete Adaptation Projects		UNFCCC to provide guidance	UNFCCC to provide guidance	UNFCCC to provide guidance	Dependent on Kyoto/ UNFCCC to provide guidance

Under the Strategic Priority Adaptation (SPA), which came into force on July 1, 2004, approximately US$ 50 million is available for adaptation pilots ('piloting an operational approach to adaptation'), which would mean actual implementation (Stage III) (GEF, 2004). Depending on the size of the project, the GEF will fund 100% (small grants) or less (for larger grants).

7.3.3 Non-compliance fund

The proposal by the Brazilian government at the COP 3 meeting in 1997 was for a fund in which fees would be collected from countries that do not comply with their mitigation obligations under the UNFCCC. All Annex I countries would share an emissions ceiling (30% reduction by 2020 relative to 1990) based on their share of responsibility for climate change. The funds would then be used for clean development; this inspired the clean development mechanism. But the funds could also be used to finance adaptation measures. However, such funds (based on non-compliance with mitigation obligations) would have to be negotiated through the UNFCCC process. Besides scientific difficulties, such as estimating the impact of individual countries on global climate (Rosa et al., 2003), direct coupling between non-compliance and payments would probably be an obstacle to the negotiation process.

7.3.4 Development assistance

The multi-agency paper on climate change (AfDB et al., 2003) has pointed towards climate change adaptation being incorporated into development assistance. The long-term effects of climate change on ODA are linked in at least three ways (Klein, 2001), i.e. the:

1. risk of climate change to ODA projects;
2. vulnerability to climate change of the community or ecosystem that is intended to benefit from ODA;
3. possible effects of the ODA project and its deliverables on the vulnerability of the community or ecosystem.

Moreover, risk assessment, vulnerability assessment and environmental impact assessments in ODA-funded projects could help reduce the vulnerability of these projects to climate change. However, the amount of development assistance is globally decreasing, making ODA an increasingly limited source for funding adaptation. Additionally, some part of ODA is in the form of loans, which add to national debts. Donor governments have often focussed on multiple interests in development assistance, including economic (e.g. contracts for their domestic companies) and geo-political (support for friendly political regimes) goals, which have not always been consistent with the sustainable development objectives of host countries. This has resulted in development aid, particularly tied bilateral aid, having a very mixed record.

The European Commission has identified adaptation as a relevant response strategy for most EU partner countries, using a set of indicators. However, most of the proposed assistance is limited to capacity building (joint research, knowledge exchange, etc.) rather than providing additional funding (EC, 2003). This would leave few possibilities of funding actual adaptation measures. Some scientists recognize that ODA can be better used to address the fundamental determinants of development and poverty rather than as a leading source of investment in environmentally sound and cleaner technologies (Radka et al., 2000) and climate change adaptation. This would also imply that ODA should not be used explicitly for adaptation or mitigation efforts. However, adaptation could be mainstreamed within ODA. The most important issue in this respect would be that, in addition to priorities for development and poverty reduction, long-term risk management and climate change objectives should also be taken into account. Additional financing of adaptation costs in ODA projects could come from the UNFCCC funds.

7.3.5 Public expenditures

Both public and private investments that are needed (e.g. in climate-related activities) are considerable. To give some indication: the investments needed for the water services infrastructure in developing countries, irrespective of climate change, are estimated to amount to approximately US$ 75 billion per year: a figure that is estimated to roughly double by the year 2025 (Table 7.3).

Table 7.3 Indicative annual required investments in water services in developing countries, in billions of US$ (from Camdessus and Winpenny, 2003)

	Present	2002-2025
Drinking water	13	>13
Sanitation and hygiene	1	17
Municipal wastewater treatment	14	70
Industrial effluent	7	30
Agriculture	32.5	40
Environmental protection	7.5	10
Total	75	180

Developed countries reserve finances for natural disasters (pooling), and also for investments in adaptation efforts, such as in water management and coastal protection. This makes it one of the largest potential funds for adaptation. However, developing countries are unlikely to make additional reservations for climate change adaptation. There is also a diverging trend between the incomes of developed and developing nations (World Bank, 2001), making this self-sufficiency of developing countries increasingly difficult. However, many options probably exist to mainstream adaptation into government planning processes and expenditures - at little cost. Within the climate change negations, some developing countries expect to receive full adaptation costs, but this is unlikely to happen. Therefore, for most countries, a major part of the funding will have to come from public expenditures, with additional coverage from UNFCCC funds.

Some authors have pointed to the potential of growing amounts of migrant remittances to contribute to development (e.g. Banuri, 2002). Examples include expatriate groups that mobilize resources for development projects, mainly aimed at schools, basic healthcare, micro-credit schemes and emergency relief. Governments may support such initiatives: e.g. the Government of Mexico will add two pesos to every peso that migrants contribute to local community development funds.

Public private partnerships (PPPs) between public institutions, private companies and NGOs at the national level have the potential to strengthen public (sustainable development) goals by making use of private efficiency and resources. If funds for PPPs are derived from development bank loans, regulations can be set for characteristics and goals of PPP efforts. However, most research on PPPs is limited to mitigation activities, and options for adaptation efforts should be explored (see also Chapter 9).

7.3.6 Disaster preparedness and relief

Disaster relief claimed funds from DAC[106] countries of US$ 4.4 billion in 1999, and 3.6 billion in 2000 (IFRC, 2002). In the past, disaster relief has mainly consisted of raising funds on an ad hoc basis. There is increasing awareness that reducing vulnerability and increasing preparedness are ways forward to reduce the long-term impact caused by natural disasters, while at the same time reducing the demand for foreign aid and relief. In particular, aid organisations such as the Red Cross have called for more disaster preparedness activities (IFRC, 2002).

The funding of disaster preparedness usually takes the form of ODA and development banking efforts, as well as efforts at the national government level. Disaster preparedness therefore offers an option for development banks and ODA institutions to reduce vulnerability, once risk management strategies are incorporated into larger development projects. This is also acknowledged by various institutions (e.g. IFRC, 2002; EC, 2003; Van Aalst and Helmer, 2004; Burton and Van Aalst, 2004). Current disaster preparedness projects include the Cyclone Preparedness Programme (CPP) in Bangladesh and the mangrove plantation in coastal zones such as Vietnam (see also the Box ‘It pays off to be prepared’ in Chapter 3).

7.3.7 Insurance and pooling

Most financial policies that deal with reducing the impacts from natural hazards tend to be reactive in character, in the form of relief aid and loans for rehabilitation and reconstruction. However, there are some exceptions. Insurance is explicitly mentioned under Stage III adaptation activities as an adaptation measure. The IPCC Third Assessment Report (TAR) (Vellinga et al., 2001) discusses both the challenges facing the financial services sector in the event of climate change, as well as the opportunities for both the sector and society as a whole to benefit from insurance and related products, by using them as a proactive means of covering the losses due to extreme weather events.

Financial services can support climate change adaptation, by absorbing part of the losses due to (weather-related) natural disasters, thereby reducing the need for disaster relief. But these services can also help to reduce vulnerability by setting standards for buildings, land-use planning, etc. (Hoff et al., 2003). Recent publications also underscore the potential for certain segments of developing countries, e.g. the water sector, to undertake steps to incorporate financial services products into development projects (Hoff et al., 2003; Bouwer et al., 2004). For example, Fox (2003) proposes promoting insurance schemes through development banking to reduce the impacts from flooding. Additionally, micro-credits and micro-insurance, often provided by local and small-scale institutions, could complement the more conventional financial market products. This is particularly true for the agricultural sector, where micro-credits and crop insurance can help to diversify income and create more resilience (see also Chapter 3 on land use).

The UNEP Finance Initiative[107] has created awareness among the financial services industry of both environmental and climate change issues. The initiative recently issued policy guidance for the industry on cli-

[106] Development Assistance Committee (DAC) of the OECD
[107] See http://unepfi.net/

mate change mitigation and risk reduction (UNEP-FI, 2002). Large (re)insurance companies, such as Munich Re and Swiss Re, are concerned with climate change, as it may affect their business, and they therefore conduct a considerable amount of research into weather-related natural disasters (e.g. Munich Re, 2004).

The UNFCCC has also considered the potential of insurance and other risk transfer products, and some have concluded that the UNFCCC could contribute here, e.g. by helping to manage funds for subsidising risk transfer (Linnerooth-Bayer et al., 2003). A similar construction to subsidize risk transfer in the form of insurance, using fees based on per capita emissions, was suggested by Bouwer and Vellinga (2002).

Risk management and funding of adaptation is also an issue for developed countries. For example, the funding of natural disaster costs in Europe could be dealt with at the European level. The European Commission has therefore proposed an EU-wide pooling mechanism to deal with disaster losses (EC, 2002). This pooling mechanism was established in response to the widespread flooding of Central Europe in 2002, in order to be able to efficiently respond to catastrophe losses that arise as a consequence of extreme weather events. This can be regarded as an adaptation measure, on the basis of solidarity between the various Member States, at a multi-national scale. At the national level, mechanisms like this already exist, for example the Federal Emergency Management Agency (FEMA) in the USA and the WTS (Disaster and Serious Accident Compensation Act) in the Netherlands. Some governments have chosen to contribute to insurance, for example by setting up reinsurance companies; this has been carried out in France.

7.3.8 Foreign direct investment

Financial flows from foreign direct investment (FDI) are potentially important for adaptation. One reason is that the amount of FDI in many countries is several orders of magnitude larger than the funds available for ODA. In 2001 the global amount of ODA was US$ 52.3 billion, while the global amount of FDI between 1998 and 2002 was, on average, US$ 207.6 billion (figures taken from Chapter 5). Ways could be found to influence investments and make them become relevant for adaptation, most notably through national policy. For example, climate risk reduction could be achieved if building codes and land-use regulations were applied to real estate such as hotel resorts in the coastal zone. This would become increasingly attractive to investors if such regulations were complemented by small amounts of subsidies provided by e.g. loans from development banks that compensate for the extra investments costs. More information on FDI flows can be found in Chapter 5.

7.4 Evaluation of options

The previous sections have presented the issue of climate change adaptation policy and possibilities for funding arrangements. This has led to the conclusion that there are a number of options available to bring adaptation policy forward in a multilateral context.

This section examines the range of adaptation and poverty reduction options that emerge from this chapter and from previous chapters. It also describes some directions for shaping adaptation policy and for funding of adaptation measures. Since poverty reduction increases the ability of people to adapt to climate change, this section also focuses on these options. Moreover, we also include some measures that have benefits for both mitigation and adaptation.

This section evaluates the policy options. Most importantly, we distinguish between a situation in which both adaptation policy and its funding are shaped under a new post-2012 agreement; and a situation in which there is no new agreement, and adaptation and policy are incorporated into other planning processes. This section discusses both options to some extent. Section 7.5 includes recommendations for future climate policies.

7.4.1 Range of adaptation options

Adaptation measures presented in this report include:

- Assessment of national vulnerabilities to climate change: In order to be in a position to help countries cope with the effects of climate change, a first step is an understanding of the key vulnerabilities of these countries (see also Chapter 2).
- Preparation of adaptation programmes within the context of sustainable livelihoods frameworks: A follow-up step is to develop national adaptation policies and programmes based on the key vulnerabilities and an understanding of the existing development programmes in these countries. These programmes then need to be integrated into the PRSPs and NSSDs in order to make them more effective (see Chapter 2).
- Policy measures to minimise the impact of flash floods; storms and droughts: Many of the impacts of extreme weather events such as flash floods, storms and droughts can be reduced by spatial planning tools (see also Chapter 3). The losses incurred from extreme events can wipe out all the savings of local people and their homes and livelihoods. Some collective insurance schemes against such extreme events can be developed, in which private and public sectors participate.
- Policy measures to deal with the increase in pests and climate variability: Climate change can lead to an intensification of pests and plant diseases. Measures to deal with these pests and diseases include spatial planning, public awareness and health and agricultural insurance (see Chapter 3).
- Health policy to focus on the increased risks of climate change to public health: Climate change may influence public health via increased vector borne diseases, reduced fresh water availability, increased temperatures, and there may be the psychological and other health effects of extreme weather events. There are also the negative side effects of tropospheric greenhouse gas emissions and indoor air pollutants (see Chapter 6).

The table below classifies the adaptation measures in terms of the issues discussed in the fore-going chapters. It lists possible policy instruments that are relevant for each measure and the anticipated benefits. For a complete picture of the adaptation and mitigation measures and related instruments, this table has to be read in conjunction with Table 8.1 in the following chapter.

Table 7.4 Adaptation measures, policy instruments and benefits

Adaptation measure	**Mitigation measure**	**Policy instrument**	**Benefit**
Poverty			
Studying national vulnerabilities		Research, assessment	Reducing poverty and vulnerability; integrating vulnerability and poverty programmes in development programmes
Adaptation programmes		Developing NAPAs with best practices, early warning systems and disaster preparation and relief Mainstreaming in: - national policy - development cooperation (PRSPs, NSSDs)	
Land-use			
Minimise vulnerability to the effects of storms, droughts, floods		Spatial planning Early warning systems Insurance and reinsurance schemes	Reducing poverty and vulnerability (to risks to infrastructure, housing and life)
Energy			
Renewable energy services for consumptive (cooking and lighting) and productive (to improve efficiency of production) uses in rural areas, including grid connected biomass; if integrated into development plans and combined with productive as opposed to only consumptive uses can also increase the welfare and hence ability to cope with climate change		Spatial planning; Rural development policy Public awareness policy Rural markets selling energy efficient cooking and lighting devices	Increasing income and reducing vulnerability (to health risks)
Agriculture			
Increase in pests and climate variability		Early warning systems Insurance	Reducing economic vulnerability
Health			
Health policy to minimise the effects of higher temperatures, vector borne diseases, indoor air pollutants		Early warning systems Public awareness schemes Insurance Spatial planning	Improving health and earning potential; reducing vulnerability
Include tropospheric ozone and soot		Environmental policy	Improving health

7.4.2 Funding adaptation

The funding of adaptation is an important aspect of future climate policies. Figure 7.3 illustrates the interrelationship between some of the major funds and their importance. The size of the circles roughly indicates the relative potential importance for adaptation activities. Additional funds could come from the private sector, household and local community spending.

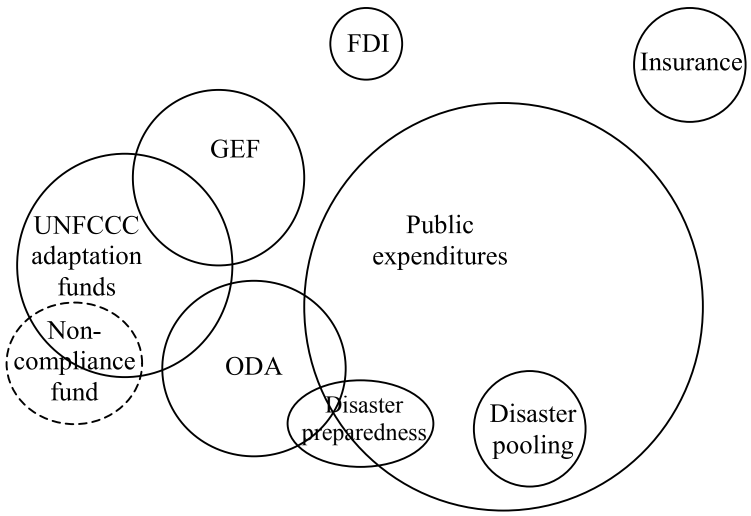

Figure 7.3 Interrelationship between different (potential) funds for adaptation in developing countries at the national level

Figure 7.3 clearly shows that the total size of the funds is limited, as many of them are interrelated and overlapping. Public finance is considered to be the most important source for funding adaptation in most developing countries, as government budgets currently allow for most of the investments in general infrastructure. Pooling for disasters and ex-post financing of disaster losses is part of public expenditure. For the least developed countries, the UNFCCC adaptation funds could support a considerable share of adaptation measures, if simplified rules and 100% funding of measures were available.

However, for more developed countries these funds are likely to be more limited. ODA and GEF funds largely overlap with the UNFCCC funds, since some developed countries could consider their UNFCCC contribution to be ODA. Other (non-climate) funds within GEF (e.g. CCD, CBD) could potentially contribute to adaptation, but probably only to a limited extent, where synergies with other MEA goals exist. FDI, as discussed earlier, is a significant source, but the potential to influence adaptation aspects is expected to be low. Insurance holds some potential to cover disaster losses, and also to aid the setting of standards and land-use regulations: but insurance will not fund any physical adaptation measures.

Table 7.5 shows the scores for different selection criteria (listed in Chapter 1) for the funding possibilities presented in this chapter. Environmental benefits are so dependent on the actual adaptation strategy, that they are not considered here. It should be noted that combinations between the different funding sources, in particular cost sharing, are likely to be the most promising paths for funding adaptation. Insurance is not considered as, although it may cover some of the disaster losses as well as providing incentives for disaster reduction, it does not provide funding for adaptation.

Table 7.5 Evaluation of options for funding adaptation in developing countries

	Selection criteria					Section
Funding options	Adaptation potential	Beneficial to development	Ease of implementation	Link with UNFCCC	Option for mainstreaming	
UNFCCC funds	+	+	+ [1]	yes	+/-	7.3.1
Non-compl. fund	+	+	-- [2]	yes	+/-	7.3.3
ODA	+/-	+	+/-	no, possible	++	7.3.4
Public expendi-tures	++	+	++	no	++	7.3.5
Dis. Preparedness	++	+	+	no, possible	++	7.3.6
FDI	? [3]	+	-	no	+	7.3.8

[1] Forum already exists (UNFCCC)
[2] Non-existent, may be difficult to establish (see main text)
[3] Unknown, needs to be assessed, but probably some potential

Table 7.6 attempts to point out the instruments that are available at the national level, the financing available at national level, and the potential for leveraging international funds for the different measures that are listed in Table 7.4. For a more integrated picture, this table needs to be read in conjunction with Table 8.4 that lists measures and instruments for mitigation in the following chapter.

Table 7.6 Measures and instruments at national and international levels

Measures	Policy instruments at national level	Financing at national level	Policy instruments at interna-tional level
Adaptation		*Benefits: Reduces poverty and vulnerability*	
Key vulnerabilities of countries	Research and assessment	National environmental and development funds;	GEF and Adaptation Fund; IPCC research
Adaptation pro-grammes in general	Developing NAPAs with best practices; early warning sys-tems and disaster preparation and relief Mainstreaming in: - national policy - development cooperation		GEF and Adaptation Fund; Development cooperation via PRSPs and NSSDs
Adaptation to storms, flash floods, droughts	Spatial planning; Early warning systems; Public awareness programmes Compensation	National funds National re-insurance funds, Local insurance funds	GEF and Adaptation Fund
Adaptation to pests and climate variability			
Adaptation to health risks			
Adaptation and mitigation		*Benefits: Improves wealth and health*	
Biomass electrification and renewable energy for remote villages	Spatial planning; Rural development pol-icy	Rural development funds; can be self-financing when combined with productive use of energy	CDM; JI
Include tropospheric ozone and soot	Environmental policy	National funds	GEF, emission trading where ap-plicable

7.4.3 Adaptation policy and funding under a new multilateral agreement

Adaptation faces a number of difficulties under the current convention (UNFCCC).

First, there is the difficulty of distinguishing between anthropogenic and natural climate change impacts. A particular aspect is the difficulty of distinguishing between local causes of impacts (political, socioeconomic, land-use changes) and global causes (climate change caused by greenhouse gas emissions). The UNFCCC agrees to cover the full incremental costs, or the costs that lead to global environmental benefits, and not the costs that lead to local benefits, which is particularly true for adaptation. Capacity building efforts and activities in relation to National Communications under the Convention are eligible for funding based on their full costs. The UNFCCC and the Kyoto Protocol/Marrakech Accords have provided a number of opportunities for carrying out vulnerability and adaptation assessments as mentioned under Stage I and Stage II activities.

However, the issue of incremental costs is likely to remain a very important obstacle for the actual implementation of Stage III activities, i.e. the implementation of adaptation measures. It is scientifically difficult (if not impossible) at this stage to determine impacts from anthropogenic climate change with sufficient certainty (Allen, 2003). Although this certainty is not required for the NAPAs, it would be required for actual funding of adaptation measures under the Convention. Some openings for partial and full-cost funding of actual implementation are given under the Strategic Priority on Adaptation of the GEF (see Section 7.3.2). It appears that the best way forward would be to use the Climate Convention funds to launch adaptation projects, providing full or partial funding of costs depending on the country, and the size and nature of the project.

Second, it is important to understand the current situation of adaptation policy and funding. Under the Climate Convention, there are currently no legally binding quantitative obligations to finance adaptation. The funds are voluntary contributions. Some thoughts have been developed on how to contribute to adaptation under the UNFCCC. For example, CAN (2003) has proposed differentiating between the efforts for mitigation and adaptation, in three parallel tracks, i.e.:

1. the current Kyoto track, with legally binding targets for emission reduction;
2. greening the decarbonisation track for developing countries not taking mitigation actions under Kyoto; and
3. an adaptation track for the most vulnerable regions (least developed countries and small island developing states) and countries.

The adaptation track would consist of parts of the Kyoto track (the three funds from the Marrakech accords). Others have suggested that a climate impact relief fund could be established by the UNFCCC, in order to deal with increasing demands for relief (Müller, 2002; 2003). While undoubtedly a need for disaster relief will always remain, particularly for residual or unavoidable climate impacts, studies show that disaster relief would be a less efficient use of funds than disaster preparedness or adaptation (see Section 7.3.6). If funding under the Climate Convention were used for relief purposes, it could result in a reduction of the total amount of funds available for adaptation. The Climate Convention intends to "…assist developing country Parties … to meet the costs of adaptation" (Article 12.8 of the Convention), while relief is provided irrespective of the cause of a disaster and is provided on the basis of solidarity rather than commitment. The commitments of Annex I Parties under the Convention could therefore best be used to fund vulnerability reduction.

There are several reasons why adaptation should remain a central topic in a multilateral agreement. Firstly, binding obligations for Parties to fund adaptation could prove crucial in order to keep commitment and pressure on Parties to put efforts into mitigation. Secondly, having an obligation to finance adaptation under a multilateral agreement would prevent countries regarding their contribution to other (general) development goals, such as ODA, as an effort to finance adaptation. Thirdly, some serious commitment in the form of substantial adaptation funding is needed to keep faith within the Climate Convention. However, these arguments only hold true once a legally binding and substantial contribution to adaptation is negotiated under the Convention.

7.4.4 Mainstreaming climate change adaptation

Mainstreaming adaptation refers to integrating adaptation policy and measures into already ongoing (national) sectoral planning and decision-making processes. To a large extent this is already happening in developed countries with regard to current climate variability and weather extremes. However, this is often not the case in developing countries, and many cheap and simple opportunities to reduce vulnerability may be available. Efforts to mainstream adaptation to climate change into national planning and activities in the various sectors have been relatively successful for the agricultural sector (which, for example, has a long history of working in drought-prone areas), but less successful in other sectors (e.g. water resources) and at national policy-making and planning levels (Huq et al., 2003).

Mainstreaming seems sensible, since adaptation measures are difficult to separate from other issues in the various sectors (e.g. water, agriculture), particularly in relation to natural hazards and current climate variability. In developing countries, NGOs play a major role in developing adaptation measures at the community level; the level at which most impacts are expected. Research has shown that many NGOs claim to be prepared for potential threats from climate change. However, they are often unaware of the latest scientific developments. Hence, mainstreaming adaptation in the daily practices of NGOs requires capacity building of scientific knowledge and better communication with e.g. regional universities. Another aspect is NGO access to adaptation funds. The current funding mechanism requires an official government application. Although NGOs try to work closely with their government, communication is sub-optimal in many instances. Moreover, fundraising by NGOs via the government would severely threaten their independent status and hence their ability to effectively work with communities (Rojas, 2004).

Current policies with regard to climate risk management, if existent, tend to be fragmented into these different sectors. Adaptation policies should therefore also be implemented into these sectors, instead of arranging new institutions. Knowledge and capacity could be increased in these sectors. Mainstreaming of adaptation policy is also increasingly recognized. Examples include the planning within international financial institutions, such as the World Bank, where the proactive management of natural disasters and climate change is already gaining more attention (Burton and Van Aalst, 1999; Kreimer and Arnold, 2000; Burton and Van Aalst, 2004).

Successful climate change adaptation depends largely on all the facets of the capacity to adapt (Smit et al., 2001), while the actual implementation of adaptation measures (technical, institutional, legal or behavioural) would best be performed by sectoral planning and management 'on the ground', by governmental agencies and as well as private companies (Klein et al., 2003). Mainstreaming would require considerable capacity building and creation of mechanisms and incentives (Klein et al., 2003; Huq et al., 2003).

One way of mainstreaming adaptation is to develop a risk management approach, where climate risk assessments would become a standard part of other activities, for example in development bank work. Such climate risk assessment should focus on climate change, climate variability and extreme weather events (Burton and Van Aalst, 2004). National climate risk management can be integrated into the existing (sectoral) risk management practices. International organisations, such as the International Strategy for Disaster Reduction and the Provention Consortium (see Section 7.3.7) as well as NGOs and risk-related private companies can aid implementation of risk management at the national and local levels. A central question is whether mainstreaming of risk management into other planning and development processes would provide the most efficient use of limited financial means for these development processes, but it appears that low-cost or no-cost opportunities allow for including adaptation objectives into development processes.

7.5 Discussion and conclusions

With regard to shaping policy, we propose following a two-track approach which attempts to secure funding of climate change adaptation under a multilateral agreement, but which also improves mainstreaming of climate risk management into development plans. In the short term, mainstreaming is extremely important and can be regarded as a no-regret strategy, with capacity building being a prerequisite. If MEAs increasingly support adaptation, then mainstreaming these efforts into development plans will prove useful. Moreover, at present it seems unlikely that all capacity building and awareness-raising activities, particularly funding of adaptation measures, will be fully supported under a climate agreement. In both the shorter and longer term the possibilities to incorporate adaptation into the next climate agreement will need to be pursued further.

There are a number of issues that need to be resolved within future climate policies in order to arrive at efficient integration of adaptation into a multilateral climate agreement and mainstreaming. Some of the immediate issues and recommendations are listed below.

7.5.1 Funding

There is currently no commitment by Annex I countries to provide funding for incremental costs, let alone for funding full adaptation costs. This is due to the fact that the current Climate Convention does not explicitly mention the commitment by Annex I countries to fund adaptation. The current funds from the Marrakech Accords are very limited, when compared to the expected costs of assessing vulnerability and adaptation, plus the planning and implementation of adaptation measures. A clear commitment under the Convention in terms of funding could improve this situation; for example as a fixed percentage of GDP for Annex I countries. The benefits of adaptation for both Annex I and Annex II countries could be made more explicit, in order to gain more commitment for funding. The benefits for Annex I could be return flows of adaptation contributions, through research, expertise and construction contracts. The benefits for Annex II countries (reduced vulnerability and impacts and other possible benefits) could be clarified through risk management studies.

Adaptation could become a fundamental part of a new agreement, but the question remains as to whether (or not) only the incremental costs should be funded. A separate protocol on adaptation is unattractive, as it would lead to additional delays in the negotiation process, since negotiations would have to start from scratch. If incremental costs are funded, then basic funding will have to come from other sources, mostly from development banks, other conventions, ODA and domestic savings.

Another option is to define simplified funding rules for funding part or all of the adaptation costs in developing countries (Gupta and Dorland, 2003) and make sure that the funding of measures also has other environmental benefits (Huq, 2003). It could be opportune for developing countries to agree on partial funding under agreed cost-sharing rules, rather than under complicated incremental cost calculations. Setting criteria would limit the interest in the funds. V&A studies would provide a basis for determining priorities. Some practical experience in using simplified rules can be gained from pilots that have recently started under the GEF strategic priority for adaptation. Simplified rules for incremental costs and less attention to the issue of global environmental benefits would speed up the process of implementation. However, substantial commitment to fund adaptation measures (by Annex I countries) would be needed if funding adaptation under the Convention were to cover a substantial part of the costs. Mainstreaming climate change into other development processes and risk management is also needed and ample opportunities are available. Opportunities for additional funding are also available outside the Convention.

7.5.2 Links with other multilateral initiatives and conventions

The linking of the UNFCCC to other conventions and institutions could be improved (see also Chapter 9), although resources for funding in other conventions are likely to be even more limited. In general, the climate research and negotiation community appears to be separated from other areas, such as biodiversity, water resources, risk management communities, etc. This gives the opportunity to create a situation in which (at least) a part of adaptation policy from the climate policy arena is integrated into already ongoing efforts in the various areas of sustainable development, under other conventions - as opposed to keeping adaptation only under the UNFCCC. However, it would require considerable efforts to attach adaptation goals to the other conventions. Emphasis should therefore be given to mainstreaming within national sectoral and development planning processes rather than activities under other MEAs.

7.5.3 Capacity building and awareness raising

Capacity building is already (partly) covered under UNFCCC Stage I and II activities and other bilateral programmes, such as NCCSAP (Netherlands Climate Change Studies Assistance Programme), the US country studies programme, etc. This is appropriate for the national policy-making level, but improving awareness and capacity at the planning and local levels would require considerably more effort. It therefore appears to be logical to integrate the awareness of vulnerability and adaptation into development projects and ODA. Raising awareness of vulnerability and adaptation could be improved, initially by stimulating knowledge exchange between the various scientific and negotiation communities. R&D cooperation is already recognized by the European Community as a key capacity building element for climate change adaptation in the development cooperation sector (EC, 2003). This would increase the exchange of information on vulnerability and adaptation between the climate community and the community of sustainable development, which is particularly useful at the national level. In addition, technology transfer currently includes very few aspects of climate change adaptation, but mostly addresses mitigation. Adaptation could be included in technology transfer where synergies with mitigation can be found.

A major challenge is to increase the level of awareness concerning the necessity to incorporate climate change adaptation into development in the medium and long term. This can be achieved by a broad implementation of the adaptation policy framework (APF) but foremost by involving ministerial policymakers (besides the Ministry for Environment and Water Resources) in the negotiations under the Convention and the communication on adaptation, e.g. by involving the Ministries of Finance, Economic Affairs, Trade, Energy, Industry, etc.

7.5.4 Mainstreaming climate change

Mainstreaming climate change into other development processes is likely to provide many opportunities, although there are also a number of challenges. Firstly, the quality and use of information for developing and implementing adaptation measures is likely to be a major challenge. Secondly, reducing vulnerability to climate variability is often seen as an additional objective, alongside many others such as cost efficiency, environment, gender, etc. Issues such as the lack of proper management also hold true for other development efforts but still need to be resolved. More (and improved) risk management efforts are an improvement for development projects that currently often ignore climate risks, in particular where spatial planning and infrastructure planning are concerned. Linking to risk management practices in national sectors as well as multilateral donor institutions appears to be viable, since reducing (weather-related) natural disasters is gaining attention. Capacity building of integrated climate risk management can be improved through conventional programmes, such as those by the UNDP, Red Cross, World Bank etc., in particular by linking to Integrated River Basin Management (IRBM) and Integrated Coastal Zone Management (ICZM) and associated national and multilateral institutions, such as the UNISDR, development agencies and NGOs. But recognizing climate risks as a threat to development goals and incorporating aspects of adaptation into National Strategies for Sustainable Development (NSSDs) and the Poverty Reduction Strategy Papers (PRSPs) would also be beneficial to poverty alleviation.

A particular aspect of risk management can focus on encouraging the use of financial tools, such as insurance, micro-credits, CAT (catastrophe) bonds, and disaster pooling (public, private). The financial services sector can also contribute to capacity building for risk management and to the implementation of standards for disaster reduction. In particular land-use planning and the agricultural sector would benefit from increased application of such instruments.

Some institutions working on disaster reduction and relief, such as the Red Cross, have recognized climate change as an issue that affects their work. Financing disaster preparedness from UNFCCC funds could be an option for the short term, in order to meet the most urgent needs. This would go beyond merely funding incremental costs. When funds are limited, attention could be concentrated on hot spots. Financing disaster preparedness could also result in reduced spending on disaster relief.

7.5.5 Information and research needs

Information and research needs for shaping future adaptation policies include three elements. The first requirement is an assessment of the demand and supply of adaptation funding, as well as the timing of adaptation. Secondly, there is a need to determine the additional costs of incorporating risk management and adaptation into (large) development projects. Thirdly, mainstreaming pilot projects need to be evaluated: what are priorities for mainstreaming; how can the various stakeholders contribute; what are key aspects for success, such as cooperation, institutions, rules for funding; which projects have an adaptation benefit and which do not?

7.6 Recommendations

Recommendations within the UNFCCC:

- Commitment is needed by Annex I countries to supply reasonable amounts of funding for adaptation.
- Many groups of stakeholders have thus far not been involved in developing adaptation strategies. The involvement of the various Ministries (Finance, Economic Affairs, Trade, Energy, Industry, etc.) in de-

veloping countries in the climate negotiations and communication on adaptation should be improved, possibly via COP meetings, joint studies and NGOs.
- Simplified rules should be developed for funding adaptation in the least developed countries under the Climate Convention in order to launch adaptation projects. If little or no complementary ODA or development bank loans are available, full-cost financing should be possible. Developing countries could also agree to partial funding under agreed cost-sharing rules.
- A set of 'best practice' guidelines could be developed from adaptation pilot projects, but also based on experience gained in developed countries of adaptation in the coastal zone, water management, agriculture, etc.

Recommendations in other areas:
- Climate adaptation should not be seen as an environmental problem but as a general risk management problem that affects all policy areas (agriculture, water resources, coastal protection, finances, trade, energy, industry). The importance for these policy areas should be clearly shown and communicated.
- There should be a focus on risk reduction and disaster preparedness in the short term within development projects, perhaps with support from the UNFCCC. Commitment should be achieved between developing countries and developed countries to implement measures, similar to e.g. the World Water Forum.
- The Netherlands and the EU could take climate adaptation aspects into account in their development and ODA efforts; particularly with regard to large infrastructural projects that are designed for the medium and long term. This could lead to a more limited number of projects, as costs increase, but these projects could prove to be more sustainable in the long term.

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8. Bottom up climate mitigation policies and the linkages with non-climate policy areas

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Abstract
In contrast to the previous chapters, this chapter focuses on climate mitigation policies but also explores the linkages with other policy areas. It focuses particularly on so-called bottom-up approaches to defining future climate mitigation commitments. Such types of commitments are not based on quantitative emission targets as in the Kyoto Protocol, but on policy measures. It can thus be expected that these allow more for linkages with other policy areas than the top-down approaches based on emission reduction targets. Such bottom-up policies are likely to become more important in post-2012 climate regimes than at present, as the group of countries with mitigation commitments is extended to include developing countries and becomes more diverse. In examining the strengths and weaknesses of bottom-up instruments for international climate policy-making, we conclude that owing to their uncertainty about the overall effectiveness of climate policies, they do not seem to offer a full alternative to a climate regime defining quantified emission reduction and limitation targets. However, they do offer particularly interesting opportunities for additional components of a future climate regime and for defining contributions of developing countries to mitigation and enhancing the integration of climate policies in other areas of policy making, ultimately promoting sustainable development.

8.1 Introduction
In 1997, during the Third Conference of Parties (CoP3) in Kyoto, agreement was reached on binding quantitative emission targets for the Annex I countries, leading to a reduction of CO_2-equivalent emissions of 5.2% in the 2008-2012 period compared with base-year levels (UNFCCC, 1998). This current climate regime can be characterized as a top-down, imposing greenhouse gas emission targets on a country level and leaving the details of implementation to the countries themselves, even though certain mechanisms to increase cost-effectiveness have been introduced, such as international emissions trading and the Clean Development Mechanism.

Future commitments could well be considerably different from those made under the Kyoto Protocol for the 2008-2012 period. There are two main reasons for this. First, to enhance the effectiveness of the climate regimes, there is a need to broaden the group of countries taking on (quantified) emission reduction or limitation commitments beyond the group of developed countries. The increase in the diversity of the group of countries in terms of their economic, technical and institutional capabilities will make it more difficult to agree on the same type of commitments. Second, there are also signals from several developed countries that question the appropriateness of post-Kyoto regimes being based on the targets and timetables adopted under the Kyoto Protocol. The USA decided not to ratify the Kyoto Protocol and, instead, adopted an alternative domestic approach based on voluntary, relative emission targets, and the promotion of research and development on new technologies.[108] In Japan, the Ministry of Trade and Industry (METI) has also indicated considering other types of commitments than fixed binding targets and timetables, although this is still under discussion (METI, 2004).

Many of the approaches proposed or explored for defining future climate-change commitments, particularly from European scholars, have been top-down in character; i.e. allocating emission targets on the basis of criteria and rules for allocating emission allowances (see, for example, Den Elzen (2002), Evans (2002); Höhne et al. (2003), and the German Advisory Council on Global Change (WBGU, 2003)). These proposals focus mainly on the distributional aspects of future climate mitigation action. In contrast, other proposals, particu-

[108] However, it remains unclear if any future American administration would actually propose such so-called intensity targets for future climate commitments.

larly from US scholars, focus much more on approaches that are bottom-up in character, i.e., where the emission reduction effort is not pre-defined but results from the policies and measures agreed upon. Here the focus is more on the type of commitments to be adopted than on the distribution and the stringency of efforts (e.g. Aldy et al. (2003a)).

This division seen in the literature reflects the differences in political context. In 1996 the European Council adopted as its long-term climate policy objective that global-mean temperature change would not exceed 2 degrees Celsius compared to pre-industrial levels. This target has since been reconfirmed and has resulted in discussions focusing on deducing its implications for short-term emission reduction efforts. It reflects the top-down way of approaching the climate problem. In contrast, in the USA, climate change policy has always been mainly debated from an economic perspective with a focus on cost-benefit analysis and avoidance of negative economic impacts from climate policies[109].

The aim of this chapter is to review and evaluate the strengths and weaknesses of various proposals for bottom-up approaches defining and differentiating future mitigation commitments. In addition, we will also discuss how the bottom-up type of commitments might be linked to policies in other areas - particularly those identified in the previous chapter - and how this can provide additional incentives. We will address the following research questions.

1. What bottom-up approaches have been proposed in the literature and policy circles, and what are their strengths and weaknesses?
2. What might be the contribution of bottom-up approaches to future climate policy regime?
3. What options are there to link bottom-up approaches to other policy areas?

In answering these questions, we will start by defining more precisely what we mean by bottom-up approaches, since different definitions in the context of future climate change regimes are used. Next, we will provide an overview of some bottom-up approaches for defining and differentiating future climate change commitments proposed in the literature and policy circles. We will discuss, in particular, commitments on a sectoral or technology basis, research and development agreements, sector targets and new proposals on the Clean Development Mechanism e will evaluate the various approaches on the basis of the different policy criteria defined in Chapter 1 (Introduction). Third, we will discuss how a bottom-up approach could be linked to policy measures in other policy areas, as identified in the previous chapters. Finally, we will conclude with some overall observations related to the research questions.

8.2 International bottom-up approaches within the climate change regime

8.2.1 Definitions of bottom-up approaches

In the literature three different definitions or interpretations of bottom-up approaches to international climate policies can be distinguished:

- *Bottom-up approaches to regime development* - coalition versus multilateral approaches. A global multila-teral regime building further on the UNFCCC and the Kyoto Protocol is considered to be a top-down approach; while a bottom-up approach consists of regimes based on smaller coalitions between like-minded parties, the most important players or collaboration being at the regional level (Egenhofer and Fujiwara 2003). This approach is often promoted as being more efficient than the UNFCCC approach and is also associated with countries pledging to achieve certain goals based on their own 'willingness to pay'; it is not pre-determined by any conceived need for action and burden-sharing rules.
- *Bottom-up types of commitments*. Another more common definition of bottom-up approaches to defining mitigation commitments is related to the characteristics of the commitments adopted. Here a distinction is made between output commitments in relation to results achieved, such as limits on the emissions of

[109] Interestingly, in the negotiations on the Kyoto Protocol, this difference has been less clear-cut. In fact, in the early negotiations on the Kyoto Protocol, it was the EU that was much in favour of adopting (binding) common policies and measures, while the USA preferred a more flexible target and time-table approach.

greenhouse gases that may not be exceeded, and input commitments related to conduct, such as agreements about Policies And Measures (PAMs) that must be implemented (Aldy et al., 2003a; Bodansky, 2003; OECD/IEA, 2002). Approaches focusing on the latter type of commitments are then considered to be bottom-up. Such bottom-up commitments can be defined both at the national and sectoral levels. The literature documents various proposals for defining commitments in other ways than national emission targets. Such bottom-up commitments can be defined both at the national and sectoral levels. The literature reveals proposals on technology and performance standards, such as energy-efficiency (e.g. Barrett, 2001; Edmonds and Wise, 1998;1999; Tol, 2003), technology and research and development incentives (e.g. Barrett 2001; Edmonds and Wise 1999; Buchner et al. 2003), technology protocols (e.g. Sindico and Gupta 2004), sectoral targets and sector-based Clean Development Mechanism (S-CDM) (e.g. Samaniego and Figueres, 2002), financial measures, including subsidies and government-funded investments (e.g. Schelling, 2002), taxes (e.g. Cooper, 2001; Nordhaus 2002) and sustainable development PAMs (Winkler et al., 2002).

- *Bottom-up approaches for differentiating national targets*. Bottom-up approaches to defining mitigation commitments also sometimes refer to climate regimes where national GHG targets are determined in an assessment of feasible and acceptable measures for controlling emission control, taking into account different national circumstances related to economic structure and potential for technical change (e.g. the Triptych approach (Groenenberg, 2002) and the Multi-sector convergence approach (Sijm et al., 2001)).

The first definition will be used in the exploration of issue and institutional linkages in Chapter 9, while this chapter focuses on the latter two definitions, in particularly the second one.

8.2.2 Defining commitments on a sectoral or technology basis

Technology and performance standards

International commitments may relate to the use of common technology standards, such as energy efficiency standards for appliances, residential insulation levels, or the prescribed use of low or zero-carbon technologies, such as a minimum share of renewable energy in energy production. It could also set minimum standards for the energy efficiency of industrial-production processes or power plants.

Barrett (2001) argues that such an approach would improve the incentives for compliance and participation, and that the technology standards approach would be largely self-enforcing because if enough countries adopt them, other countries and their industries would tend to follow common standards to ensure market excess, economies of scale in production and network effects. Common technology standards should also help in realising an international level playing field and provide incentives for investments in climate-friendly technologies. A successful example is the control of oil pollution from ships through applying technology standards to oil tankers within the MARPOL[110] convention. To ensure access to harbours, shipping companies will tend to adopt these standards. Another example is the regulation of noise standards for aeroplanes induced by airports in response to local noise problems. A drawback of this approach, however, is the impacts on developing countries, since they will be forced into buying the best technologies, which many of them cannot afford (cf. Gupta, 1997).

Edmonds (1998) and Edmonds and Wise (1999) made a more specific proposal for an international agreement on international technology standards that would specify that any new fossil-fuel electric power plant and synthetic fuels plant installed in industrialized countries after 2020 would be required to capture and sequester its CO_2 emissions. Developing countries would be required to do the same when their per capita in-

[110] The International Convention for the Prevention of Pollution from Ships (MARPOL), adopted on 2 November 1973 at IMO, deals with pollution by oil, chemicals, harmful substances in packaged form, sewage and garbage. It includes regulations aimed at preventing and minimizing pollution from ships - both accidental pollution and that from routine operations - laid down in various protocols, such as the need for double-walled ships (see: www.imo.org). See also Chapter 9.

come equals the average industrialized country income levels in purchasing power parity (PPP[111]) terms, for example.

Tol (2002) proposed a technology protocol which would specify the speed at which Best Available Technologies (BAT) standards would progress and inferior technologies would need to converge to that level; standards would only apply to developed countries. The progress of BAT standards would be the subject of repetitive negotiations. This would make the costs of emission reductions predictable and robust against economic variability, and emphasize the improvement of technology (a positive thing) rather than reduction of emissions (a negative thing).

In general, technology standards being a regulatory instrument as opposed to a market-based instrument have been considered by economists to be very negative. However, there appears to be some recognition that at the national level, technology and performance standards, particularly mandatory energy-performance standards (MEPS) for household appliances and insulation standards for buildings, have helped making consumers use more efficient technologies (OECD, 2003). For these sectors, standards have proven more effective than price instruments. However, the use of technology standards for industrial processes, including heavy industry and energy production, is much more controversial (Grubb et al. 2001; OECD 2003; Bodansky 2003) because:

- governments do not know which technologies are the most cost-effective and may set technology standards that result in more costly outcomes than market-based instruments; neither do they provide an incentive for further improving the performance-regulated technologies beyond the standard (as a carbon tax would).
- technology standards may create conditions for exploiting economies of scale and can also result in a technological lock-in that may prove less promising in the long term and hinder future innovation.
- national circumstances may affect the feasibility of meeting certain standards, such as options for switching to other energy resources; this may have unequal cost implications for industries in different countries.
- the regulation of specific technologies may be very sensitive to political influence by affected interest groups (e.g. the fossil-fuel industry, which opposes the phasing out of coal-based energy production).
- the use of technology standards to sufficiently affect the level of GHG emissions may require too large and complex a set of agreements to be negotiated.
- while the non-discriminatory use of product standards has been generally accepted under World Trade Organisation (WTO) trade rules, the use of process-related (industrial production) standards in regulating trade is much more controversial and likely to result in trade conflicts with third parties (see Chapter 9). In particular, developing countries are likely to resist production standards out of fear that they may be used as a tool of protectionism and result in a loss of their own industries' competitiveness (see Campins and Gupta, 2002).

Müller et al. (2001) conclude that 'an approach based purely on technology standards may be unworkable, and at best that it would be a poor and ineffective - and potentially highly inequitable - substitute for an international regime that focuses on the actual problem, namely greenhouse gas emissions'.

The risks related to the technology standards approach are that developed countries would be unlikely to accept technology standards that would benefit technological companies in other countries, and that individual countries would like to promote their own standards and their own technologies. This has been demonstrated amply in the discussions on technology transfer, where the developing countries have asked the developed countries to help draw up a list of priority technologies (Gupta 1997). The Kyoto Protocol negotiations have also shown that there is much resistance to adopting specific commitments on policies and measures.[112]
In 2002, an EU proposal that all countries should commit themselves to reaching some agreed percentage of renewable energy sources in their primary energy supply during the World Summit on Sustainable Deve-

[111] GDP levels of different countries are normally compared on the basis of conversion to a common currency using Market Exchange Rates (MER). However, this is known to underestimate the purchasing power of people in low-income countries. Therefore, an alternative conversion has been developed on the basis of purchasing power parity (PPP).

[112] During the negotiation of the Kyoto Protocol, the European Union pushed for the inclusion of commitments related to policies and measures. But owing to strong resistance from the United States, the Protocol eventually included only an illustrative list of possible policies and measures, without requiring parties to adopt them (Gupta and van der Grijp, 2000).

lopment met opposition from both developed and most developing countries (who considered the target too constraining).

8.2.3 Technology research and development agreements

One alleged limitation of the Kyoto Protocol and its mechanisms is its short-term focus on cost-effective mitigation (e.g. Berk et al., 2001; Sandén and Azar, 2004). To meet the long-term objective of the Climate Convention for stabilising GHG concentrations, global emissions will eventually have to be sharply reduced, that is, by more than 60% (IPCC, 2001a). This poses an enormous technological challenge because of the projected increase in the world energy demand (Hoffert et al., 1998, 2002). It has been argued that this will require major investments in the development and application of new breakthrough technologies (Edmonds, 1998), while energy R&D investments have declined the last few decades (Margolis and Kammen, 1999; OECD, 2003). This view is also reflected in the technology initiatives of the Bush Administration, which focus R&D on a hydrogen-based energy system combined with carbon-sequestration technologies. This R&D, carried out in collaboration with a group of developed and developing countries, is called the International Hydrogen Initiative (White House, 2002; USDOE, 2002; 2004; Sindico and Gupta, 2004; see also Chapter 9).

Barrett (2001) has proposed the idea of international technology research and development agreements providing the ‘push’ component to his proposal for agreements on international technology standards (the ‘pull’ complement). These agreements should consist of common research efforts for the development of climate-friendly technologies, particularly in the area of electric-power production and transportation. Sindico and Gupta (2004) have elaborated on this idea in relation to a Hydrogen Protocol to the Climate Convention.
Countries could also make a financial contribution to such research programmes based on their ability and willingness to pay and/or the United Nations scale of assessments. To provide incentives for participation, each country’s contribution to the collaborative effort would be contingent on the total level of participation, while the fruits of the R&D efforts would be shared among the participating countries (and its industries) only (e.g. by shared patents or exemption from royalties from licences). Sandén and Azar (2004) make a simpler proposal, suggesting that all countries should agree on an R&D carbon levy of 1 dollar per ton of carbon. This would raise revenues corresponding to 6 billion dollars, i.e., almost the entire OECD public investments in energy research.

Successful international commitments to provide funding for internationally coordinated research and development include space exploration (e.g. the international space station) and research on nuclear fusion and agriculture (Consultative Group on International Agricultural Research). While an international R&D agreement would supplement the already existing international cooperation on R&D in (energy) technologies, particularly as part of the IEA’s Implementation Agreements (see Chapter 9), it could help counter the trend of decreasing rates of government and private investment in energy-related R&D (OECD 2003). Moreover, international R&D programmes can also enhance the transfer of new climate-friendly technologies to developing countries. Besides, they could also help to consolidate the bilateral agreements on research and make sure they are internally consistent (see Chapter 9).
However, there are some major limitations:

- Just as with technology standards, governments may not support the proper technologies; for this reason Sandén and Azar propose a strategy of technology diversity.
- For new, more costly, technologies to enter the market, governmental support for R&D will have to be supplemented by policies creating the market opportunities that enable large private investments in development and applications of these new technologies. This will require technical regulations (e.g. MEPs), mandatory shares of new technologies in production (e.g. renewables or carbon-free vehicles), niche market creation (e.g. by procurement programmes), subsidies, a carbon tax or an emission cap-and-trade system.
- Without overall emission targets, large investments in new technologies may not result in real reductions in GHG emissions. While intensified international technological cooperation may reduce the emission intensity of production, it may also induce more economic growth, and in turn higher absolute emissions (Buchner et al., 2003).

- Such R&D agreements may marginalize developing countries with low R&D capabilities, although these countries may also benefit from technological spill-over effects.

Overall, while technology research and development agreements may be valuable components of any future climate regime, by themselves they do not offer a real alternative to a climate regime based on quantified targets because their effectiveness is uncertain.

8.2.4 Sectoral targets

Sectoral targets can be of three types: national sectoral commitments, transnational sectoral targets for limiting transboundary GHG emissions and sectoral CDM, which is the extension of project-based CDM to the sectoral level. The international targets are of interest to the developed countries, while the other two are particularly interesting for developing countries.

National sectoral targets may be related to the limitation or reduction commitments for levels of either GHG emissions or energy use (efficiency) and be defined as either absolute or relative targets (e.g. emission intensity improvements). Such commitments may be suitable for developing countries, since they offer the option of addressing GHG emissions in a step-by-step manner (Bodansky 2003), starting with commitments for specific sectors or gases, as opposed to the entire economy and all six types of gases. Sectoral targets may focus first on the sectors whose GHG emissions are best known, easiest to address given available technical capabilities and least demanding from a monitoring and implementation perspective. Generally, developing countries have less capacity to adequately monitor all GHGs from all activities. Moreover, activities in some sectors, like energy production and manufacturing, may lend themselves better to limiting GHG emissions than other sectors such as agriculture do. They provide more certainty about their ability to comply with the international commitments and costs involved. Sectoral targets could also allow developing countries to engage early in international emissions trading, at least for the sectors covered. This could provide a potential source of financing for emissions abatement and technology improvements. From an international perspective, sectoral commitments for developing countries for industries that compete on the international markets could also reduce the risks of leakage and ease the competitiveness concerns of developed countries (Aldy et al., 2003b).

However, sectoral targets could prevent countries and firms from making trade-offs across sectors – i.e., expending more effort in a sector where emissions reductions are cheaper than where they are more expensive; and may result in emission leakage to other sectors without targets, if substitutes to the products of the capped activity were to be available (Aldy et al., 2003b). The net effect on emission leakage will depend on the positive impact of the sectoral target in reducing leakage from countries with economy-wide commitments and the negative impact on inter-sectoral emissions leakage within the country (Aldy et al., 2003b).

Transnational sectoral commitments /targets such as for civil aviation, steel production or automobile manufacturing would be comparable to those under international technology standards discussed above and may consist of either overall emission limitation or reduction targets for the total sector, or process or product-related targets, such as regulated minimum energy-performance standards or the use of low-emission technologies. These types of commitments would be particularly interesting for internationally oriented sectors with a fairly limited number of actors – i.e., those that would be able to collectively adopt sector-wide targets. One example is the 1998 voluntary agreement between the EU and the European Automobile Industry Association (ACEA) to reduce CO_2 emissions to 140 g/km by 2008 and 120 g/km by 2012. While this only covers the EU market, it could be upgraded to a worldwide agreement with more binding commitments. In fact, similar voluntary agreements have been concluded with Korean and Japanese automobile manufacturers (Rinkema, 2003). The incentives for adopting such targets could be the creation of new markets for innovative products (like hybrid cars), the desire to avoid being exposed to a diversity of climate policies and measures in various countries, or even to be exempted from other regulations (e.g. taxation).

The advantages of such international sectoral targets include a high level of policy effectiveness due to the global application of policy measures, and avoidance of emission leakage and disturbance of international competitiveness of internationally oriented industries. The limitations of the approach are the following:

- It is an approach that can be used mainly for the industrial and transport sectors. Contrary to the proposal by Edmonds and Wise (1999) to set standards for power plants, it may not even include an important

sector such as energy production. Unlike industrial processes, energy production is far more dependent on local circumstances like resource availability. Moreover, the energy sector is less internationalized (i.e. controlled by multi-national companies) than some major heavy industrial processes, which limits its general access to modern technologies. Other sectors such as agriculture, services and households are much less easily regulated by international sectoral standards because of the much larger number of actors involved and the greater diversity in production and consumption circumstances. For these sectors a harmonization of national PAMs is a much more feasible approach.
- While worldwide voluntary agreements amongst international industries or with a group of mainly industrialized countries are conceivable (e.g. the USA, the EU, Japan and South Korea for the automobile sector), it is more difficult to directly link these to future international climate regimes. In order to link them, they need to become part of the international climate regime. A potential obstacle for this approach could be the lack of willingness on the part of national governments to accept special international arrangements under the UNFCCC with private multi-national companies, which would limit their national jurisdiction to regulate these actors. Besides, voluntary agreements are themselves difficult to enforce. On the other hand, such voluntary agreements may serve to supplement the existing measures being taken within the UNFCCC.

8.2.5 Sector-based CDM (S-CDM)

One specific approach to adopting sectoral commitments would be the sector-based CDM one (Samaniego and Figueres, 2002). Like the project-based CDM under the Kyoto Protocol, this instrument would involve foreign investments in sustainable development measures in developing countries in return for emission reduction credits (Certified Emission Reductions– CERs), but the scale would be extended to economic sectors or to the regional level. It would thus reduce a number of drawbacks related to project-based CDM, such as the relatively large institutional overhead and the risk of leakage. Under the S-CDM, developing countries would be able to develop regional, (sub)sectoral, cross-sectoral or even regional projects (which may be the result of specific sustainable development policies), measure the additional emission reduction attained and offer these for sale on the international emission trading market as S-CDM. They would also have an incentive for doing so. Examples of such projects would be the modernization of a country’s cement or steel-production sector, conversion of coal-fuelled power plants to natural gas or reducing emissions from the transportation sector.

In contrast to legally binding sectoral targets discussed above, S-CDM, like project-based CDM, would operate without legally binding commitments. Similar to project-based CDM, baseline emissions under ‘business-as-usual’ policies would need to be established and internationally agreed upon in order to determine emission reductions generated. However, Samaniego and Figueres propose changing the additionality requirements for the S-CDM. For instance, additionality could be based on the adoption of policies and measures instead of project investments. Some advantages of S-CDM are that (Samaniego and Figueres, 2002):
- by building on Kyoto Protocol, it fits in well with the present climate regime and can profit from the learning experiences in developing countries with project-based CDM;
- it provides better incentives for developing countries to transform entire sectors and thus helps them engage in low-carbon-intensive developing pathways;
- its voluntary nature makes it more acceptable for developing countries than binding sectoral targets and reduces the risk of setting lenient targets resulting in tropical hot air;
- it is more cost-effective than project-based CDM because it reduces institutional transaction costs and has economy-of-scale effects, while also enhancing the international cost-effectiveness of emission mitigation by enlarging the supply of emission reduction credits from developing countries.

The disadvantages include the limited capacity in developing countries to develop, implement and monitor S-CDM projects, the difficulty of establishing credible baseline projections and the (remaining) risks of hot air.

Overall, S-CDM seems to be an interesting intermediate step for developing countries before adopting binding national emission limitation or mitigation commitments; it is, in particular, interesting for more advanced developing countries with sufficient institutional capacity to properly implement such an approach.

8.2.6 Sustainable Development Policies and Measures (SD-PAMs)

Given the low priority of climate mitigation in developing countries, some authors have proposed an approach that does not focus on climate goals but on development objectives and country-specific development needs. This is called the Sustainable Policies and Measures (SD-PAMs) approach, a pledge-based approach to developing-country participation in mitigating climate change (Winkler et al., 2002; compare Gupta, 1997) to examine development priorities and identify how they could be met in a (more) sustainable way. This is done by backcasting possible pathways for development from a desired future state of development and identifying the most sustainable pathways. Next, synergies between sustainable development and climate change policies are identified. Finally, the net impact of a basket of SD PAMs on the development of GHG emissions (and other sustainability aims) is quantified.
This approach can be formalized under the UNFCCC to allow developing countries to demonstrate their commitment to controlling climate change, as well as to obtain funding for ‘full agreed incremental costs’ (Article 4(1), UNFCCC). Formalized SD-PAMs could be supported by climate funds (see Chapter 7), the CDM and S-CDM.

The SD-PAMs approach is comparable to the sector-based CDM approach. Like the S-CDM approach, its advantage is that it would be able to overcome the limitations of a project-based approach. And like the S-CDM, it also promotes more coherent and consistent policies that reduce the risks of leakage resulting from a project based approach. Even more than the S-CDM, SD-PAM is likely to fit in with development priorities of developing countries and enhances the mainstreaming of environmental concerns in development policies; it also makes explicit use of synergies between economic and environmental policies. The voluntary nature and pledge-based approach provides certainty on costs of policies, and finally, enhances the build-up of institutional capacity in developing countries, which is required before binding commitments can be adopted and participation in international emissions trading become feasible.

The approach also has its limitations. Its environmental gains are uncertain as the effectiveness will depend on the level of funding to cover the incremental costs. It may not be effective enough to meet more stringent long-term climate targets, particularly if large developing countries were to stick to it and over time not take on more binding and stringent climate targets. From an economic perspective, the focus on ‘no-regret’ measures and the dependence on CDM and other funding could form a limitation to the utilization of the emission-reduction potential in developing countries by developed countries. Practically speaking, linking SD-PAMs approach to an S-CDM approach may not be as easy as suggested, as in the latter there will be much more stringent monitoring and verification requirements. The S-CDM option probably will only be feasible for more advanced developing countries, while SD-PAMs would be suitable for most developing countries.

Overall, the approach is particularly attractive to engaging developing countries in climate mitigation in a way that avoids some disadvantages of CDM projects and enhances the mainstreaming of climate concerns into economic development policies. Given its limited environmental effectiveness, the approach would seem particularly useful as an intermediate stage before developing countries take on binding climate targets.

8.2.7 Bottom-up approaches to defining targets

There have also been a number of bottom-up approaches to defining targets. These include:

- The *Triptych approach* shares emission allowances among a group of countries based on sectoral considerations, originally the power sector, energy-intensive industries, and ‘domestic’ sectors. The selection of these categories is based on differences in national circumstances such as the standard of living, fuel mix for the generation of electricity, economic structure and the competitiveness of internationally oriented industries (Blok et al., 1997). In the international variant, Groenenberg (2002) developed convergence trajectories in each of the three energy-consuming sectors: convergence of energy efficiency in the energy-intensive industrial sector, convergence of GHG emission intensity in electricity production and convergence of per capita emissions in the domestic sector. Global long-term targets are defined for each of these variables. Improvement and transfer of technology will be necessary for ultimate achievement of these targets. The total calculated emission allowances add up to binding national emission allowances for each country. Only one national target per country is proposed; there are no sectoral targets so as to allow countries the flexibility to pursue any cost-effective emission reduction strategy.

- *The Multi-Sector Convergence approach* (MSC) (Sijm et al., 2001) combines features of the Contraction and Convergence (C&C) [113] and Triptych approaches. It aims at a convergence of per capita emission levels, but tries to account for differences in national circumstances that cause variations of per capita emission requirements among countries. It groups emission sources into seven sectors for defining national emission allowances (electric power generation, households, transportation, heavy industry, services, agriculture, and waste), but this grouping could be adjusted. For each of these sectors, global convergence rates are defined on the basis of global trends in activity level and emission factors. National emission allowances result from combining the sectoral allowances.
- *The Jacoby Rule approach* introduced by Jacoby et al. (1999) is based on the ability to pay. Regional emission allowances are calculated using a mathematical equation reflecting the notion that Parties only enter the international climate regime (and reduce their emissions) once they have exceeded a level of per capita welfare (a welfare 'trigger'). Otherwise, they follow their reference emissions (unconstrained no-policy emissions trajectory). The emissions reduction is calculated on the basis of the difference between the per capita welfare income trigger level and a region's per capita welfare. Therefore, the total regional emissions are calculated from the bottom up.
- *The Emission Intensity Targets approach* assumes that all regions adopt GHG intensity targets directly after the Kyoto Protocol period after reaching a certain income threshold (Den Elzen and Berk, 2003).[114] This includes rules for differentiating the level of improvements in GHG intensity related to levels of per capita income and initial carbon intensity. Thus, the differentiation of commitments is based both on the ability to *pay* as well as on (initial) national circumstances. Western Europe and Japan, both OECD regions that are already relatively efficient and therefore do not lend themselves to much improvement, are assumed to improve at a lower rate. In contrast, higher rates are assumed for the former Soviet Union (FSU), since the emission intensity of this region is much higher than other regions. For the emission intensity level, it is assumed that *all* other regions will ultimately converge to the level of the most efficient regions (Japan, Europe) and then follows similar rates of improvement.

These bottom-up approaches have been evaluated quantitatively in Den Elzen et al. (2003) and Den Elzen and Berk (2003). The advantage of the Triptych approach is that emission allowances are broken down according to sectors, which makes the link to real-world emission reduction potentials and strategies more concrete. It allows for discussions on sectors that compete worldwide and, in a natural way, to discuss the role of developing countries in making contributions to emission limitation and reduction targets. The Global Triptych offers the opportunity for early developing country participation without the risk of creating large (and unacceptable) surplus emissions as in C&C. Its advantage over approaches where there is a gradual broadening (and deeping) of developing country commitments to global greenhouse gas emission abatement, such as the Multi-stage approach (Den Elzen, 2002; Den Elzen and Berk, 2003), is that it does not require a splitting up of the non-Annex I countries and offers a means of early participation in international emission trading for all countries. At the same time, there will be substantial implementation problems due to the lack of institutional and technical capacity to define both proper baseline levels and to meet eligibility requirements of participating in international emissions trading. Thus it would seem better to exclude the least-developed countries in a global application of the Triptych approach, and have them first participate using one of the alternative bottom-up approaches such as the SD-PAMs approach. But in all cases it will remain a complex approach calling for the projections of production growth rates. It is also problematic in that most of the developing countries will not have the capacity to participate in emissions trading.

8.2.8 A comparative assessment of bottom-up approaches

The previous section examined several options for defining future climate change commitments and identified their strengths and weaknesses. The results of our assessment of the strength and weaknesses of the various bottom-up approaches so far have been summarized in Table 8.1.

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[113] The contraction and convergence approach in effect calls on the developed countries to reduce (contract) their emissions and allows developing countries the possibility of increasing emissions until they converge at a specific level.

[114] This builds on ideas developed by Philibert et al. (2003) and the Climate Change initiative of the Bush Administration (White House, 2002).

Table 8.1: Strength and weaknesses of different types of bottom-up commitments

Type of commitment	Strengths	Weaknesses
Technology standards	- More certainty about actions and policies - Certainty about costs - No disturbance of international competitiveness - Compliance based on market forces Enhanced technological spill-over and transfer - Easy to monitor	- Uncertainty about environmental effectiveness - Rigid, leaves no policy choice - Not acceptable for developing countries (DCs) - Technically complex negotiations - Economically inefficient - No incentive for technological innovation /over-performing - Risk of technological lock-in - Risk of trade conflicts on process-related standards
R&D commitments	- Enhances long-term perspective - Compensates for market failures - Enhances technological capacity (DCs)	- Uncertainty about environmental effectiveness; - Risk of selecting less effective or efficient technologies - Lack of market incentives to apply technologies
Sectoral Targets (national/ transnational)	- Easier to negotiate, implement and monitor - Policy effectiveness - Creates a level playing field for international sectors - Option for link with sector based CDM; Enhanced technological spill-over / transfer	- Definition problems - Need to separate sectors from national emissions and national jurisdiction (transnational targets) - No accounting for different national circumstances - Less efficient - More carbon leakage if not globally applied - Compliance complicated
Sectoral CDM	- Fits in with development priorities (of DCs) - Less risk of leakage than in the case of project-based CDM - Certainty about costs - Use of policy synergies - Enhances institutional capacity of DCs	- Uncertainty about environmental effectiveness - Not optimal economically - Difficult to link to international emissions trading - Complicates CDM projects - Difficult to compare efforts
SD Policy and Measures	- Fits in with development priorities (of DCs) - More certainty about actions and policies - Certainty about costs; - Use of policy synergies; - Enhances institutional capacity of DCs	- Uncertainty about environmental effectiveness - Limited environmental effectiveness - Limited use of economic efficient potential - Complicated financing - Difficult to compare efforts

The following conclusions can be derived on the basis of the assessment:

- While bottom-up approaches can be valuable components of a future climate regime, they in themselves do not seem to offer a real alternative to a climate regime defining quantified emission reduction and limitation targets. This is because they provide too little certainty about the overall effectiveness of climate policies. However, bottom-up approaches can make a valuable addition, in particular, to allow for an early involvement of developing countries, enhance the implementation of mitigation measures, stimulate mainstreaming of climate policies in other policy areas and help prepare for deep long-term emission reductions. International technology standards and R&D agreements can be useful - if not essential - additional components of a future climate regime based on emission targets and Kyoto mechanisms. These will enhance its long-term perspective and effectiveness, avoid leakage and make use of market forces driving technological spill-over. They may form part of an international climate strategy with both ‘push’ and ‘pull’ components.

- In addition, some bottom-up approaches, notably SD-PAMs, sectoral CDM, and sectoral targets, seem useful intermediate stages for developing countries to gradually get more engaged in international GHG mitigation efforts.
- Finally, transnational agreements with international industrial sectors could well supplement a future regime to link and strengthen its ‘push’ and ‘pull’ components. The feasibility of various options for such transnational agreements and how these can be formally linked to the climate regime requires further study.

Overall it can be concluded that several bottom-up approaches may be quite useful in developing a future climate regime. They seem especially useful for enhancing the early involvement of developing countries in mitigating climate change. However, in order to maintain the certainty of emission reductions that a Kyoto Protocol type of top-down regime gives, bottom-up approaches should be mainly considered as an additional part of climate policy.

8.3 Options for linking actions in other policy areas to bottom-up approaches to climate change

In the previous chapters on poverty, land use, energy security of supply, international trade and finance, air pollution and health, various options for mainstreaming climate change have been identified and discussed. In this section we will look at options for linking such options for actions in other policy areas to the bottom-up approaches to climate change discussed above and try to answer the question of how bottom-up approaches could enhance the mainstreaming of climate policies in other policy areas. We will do so by first summarizing the (priority) policy measures identified that would serve both mitigating climate change and meeting other sustainable development goals.

8.3.1 Policy measures supporting climate change mitigation

On the basis of the previous chapters we can make a list of policy measures with synergies in mitigating climate change (Table 8.1). Many policy measures relate to different policy areas (chapters) and would have various benefits. As indicated in several chapters, the benefits of some policy measures will depend on the way they are implemented; further, there may also be trade-offs between different policy areas. If not properly regulated, the development of modern biomass use can be beneficial to mitigating climate change but have negative implications for sustainable land use (if based on monocultures and crowding out food production) and air pollution. Removal of fossil fuel subsidies is likely to be generally ecologically and economically beneficial, but may prove socially unacceptable and thus politically very difficult, even in developed countries.

Table 8.2: Mitigation measures and benefits

Mitigation measure	Related area	Benefit
• Small-scale off-grid renewable energy services for both consumptive (cooking and lighting) and productive use (to improve efficiency of production) in rural areas •	• Poverty reduction • Land use • Air pollution (in-door)	• More economic activity • Reduce local /indoor air pollution • Improve health
• Bio-mass energy (rural grid-connected biomass energy production; short rotations plantations) •	• Land use • Poverty • Security of energy supply	• More economic activity • Less deforestation, soil degradation and desertification • Saves cost of fossil fuels
• Community based re/afforestation • Multifunctional forestry /Agroforestry	• Land use • Poverty reduction	• Less deforestation, soil degradation and desertification • Reduces vulnerability to weather extremes • Saves costs of fuelwood (collection) and fossil fuels
• Sustainable agriculture including efficient input use (water, pesticide and fertilizers)	• Land use	• Less soil degradation • Fewer environmental and health impacts of pesticides and fertilizers while saving costs
• Demand side management: energy conservation and technical efficiency improvements in energy and material use (including both processes and products)	• Security of energy supply • Air pollution	• Reduces energy demand, and hence energy investment costs • Less air pollution • Less dependency of fossil fuel imports • Balance of payments improvements
• Development of renewable energy	• Security of energy supply • Air pollution	• Less air pollution • Less dependency of fossil fuel imports • Balance of payments improvements
• Development of new energy technologies (including fuel cells, hydrogen and carbon storage and sequestration techniques (e.g. enhanced oil/gas recovery)	• Security of energy supply • Air pollution	• Less air pollution • Less dependency of fossil fuel imports • Balance of payments improvements
• Development of mass public transport systems	• Air pollution	• Less air pollution; improved health • Less traffic congestion
• Fuel switch to CNG and LPG in the transport sector;	• Air pollution	• Less air pollution; improved health
• Removal of fossil energy subsidies	• Trade and finance • Air pollution	• Saves government expenditures • Less air pollution

8.3.2 Matching non-climate policy measures with bottom-up climate policies

We now will assess how the policy measures identified could be linked to the various options for bottom-up approaches for the development of the climate regime. Such linkages can found both at the national level via coordinated policies and at the international level via international agreements on common policies and measures or through the use of climate regime instruments. Here, we will focus on the link with international climate policy.

Policies in the other areas do not need to be optimal for mitigating climate change and vice-versa. Air pollution is a clear case in which the focus on end-of-pipe solutions is not optimal for mitigating climate change and may even result in more greenhouse gas emissions when efficiency is reduced. To reap the benefits of the synergies of policy, integration at the (sub)national level is often a prerequisite. This may involve overcoming institutional barriers (e.g. lack of communication between different branches of governance or lack of institutional capacity), the application of different accounting systems (e.g. internalizing social costs in decision-making), public information, and regulation and financial incentives. International bottom-up climate policy instruments can be helpful in providing (additional) incentives and support for choosing options that are synergistic for mitigating climate change and meeting other policy objectives.

Table 8.3 Policy measures and international bottom-up climate policy instruments

Mitigation measure	**International bottom-up climate policy instruments**
• Small-scale off-grid renewable energy services for both consumptive (cooking and lighting) and productive use (to improve efficiency of production) in rural areas	• CDM • SD-PAMS
• Bio-mass energy (rural grid-connected biomass energy production; short rotations plantations) •	• CDM •
• Community based re/afforestation • Multifunctional forestry /agroforestry	• CDM • SD-PAMS
• Sustainable agriculture, including efficient input use (water, pesticide and fertilizers)	• SD-PAMS
• Demand side management: energy conservation and technical efficiency improvements in energy and material use (including both processes and products)	• (Sector-based) CDM /JI • Sector targets • Transnational sector agreements • Regional and international technology standards
• Development of renewable energy	• (Sector-based) CDM/JI • SD-PAMS
• Development of new energy technologies (including fuel cells, hydrogen and carbon storage and sequestration techniques (e.g. enhanced oil/gas recovery)	• Regional and international R&D agreements • (JI)
• Development of mass public transport systems	• Sector-based CDM
• Fuel switch to CNG and LPG in the transport sector	• (Sector-based) CDM • SD-PAMS
• Removal of fossil energy subsidies	• SD-PAMS

Table 8.3 gives an overview of the policy instruments that might form part of international bottom-up climate policy approaches that could support the implementation of the synergistic policy measures identified. It shows that many policy measures could be part of bottom-up climate policy approaches; in the case of developing countries particularly (sector-based) CDM and SD-PAMS. S-CDM (and JI) seems particularly useful for supporting demand side management in industry, the application of renewable energy in both rural and urban areas, and policies in the transport sector (like the development of public transport systems and fuel switch to CNG and LPG in urban areas). Applying S-CDM to afforestation/re-forestation is also quite conceivable, but may require a change in monitoring and verification requirements. SD-PAMs may also be particularly useful where sector-CDM cannot be easily applied because of monitoring and verification requirements that are too strict, where emission reductions are too indirect (like the removal of subsidies or where sustainable agriculture/agroforestry reduces deforestation), or where baseline developments /emission reductions are hard to establish. Technical energy-efficiency improvements could be supported by both S-CDM, sector targets (with emissions trading), and transnational sector agreements. International technology standards and transnational sector agreements may be useful to improve the energy-efficiency of products and scraping outdated products. International R&D agreements can be useful instruments for supporting the development of new energy technologies.

It should be noted though that the use of market-based international climate policy instruments like the CDM and emissions trading always involves the risk that they will focus on measures that are not optimal from a sustainability perspective. These mechanisms will tend to focus on least-cost and usually large-scale options. This may be particularly detrimental for the development of (from a climate perspective) less-cost effective options such as renewables or public transport systems, and implies that further regulation or additional incentives may be required to secure that that bottom-up policy instruments really support sustainable development.

8.4 Conclusions

This chapter has assessed bottom-up approaches for defining future climate change commitments and tried to identify their strengths and weaknesses. It was concluded that while bottom-up approaches can represent valuable components of future climate regime, they in themselves do not seem to offer a real alternative to a climate regime defining quantified emission reduction and limitation targets, as they provide too little certainty about the overall effectiveness of climate policies. However, bottom-up approaches can mean a valuable addition, in particular, to allow for an early involvement of developing countries, enhance the implementation of mitigation measures, stimulate mainstreaming of climate policies in other policy areas and help prepare for deep long-term emission reductions.

International technology standards and R&D agreements may be useful - if not essential - additional components of a future climate regime based on emission targets and Kyoto mechanisms to enhance its long-term perspective and effectiveness, avoid leakage and make use of market forces driving technological spill-over. They may form part of an international climate strategy with both ‘push’ and ‘pull’ components.

In addition, some bottom-up approaches, notably SD-PAMs, sector-based CDM, and sectoral targets would seem to be useful intermediate stages for developing countries to gradually get more engaged in international GHG mitigation efforts. Finally, transnational agreements relating to international industrial sectors could well supplement a future regime to link and strengthen its ‘push’ and ‘pull’ components. The feasibility of various options for such transnational agreements and how these could be formally linked to the climate regime require further study.

Next we also looked at how policy measures beneficial to meeting goals in other areas (poverty reduction, land use, trade and finance, security of energy supply and air pollution abatement) and mitigating climate change could be linked to the various options for bottom-up approaches for the development of the climate regime. Since all these policies have beneficial impacts on socio-economic development, poverty reduction, land and forest conservation, energy supply and security and health, there is already sufficient reason to undertake these, using national policy instruments. Yet, bottom-up types of climate policy measures at the international level, including technology standards; joint technology research, transnational sectoral standards, sector-based CDM and Sustainable Development PAMs can provide important additional incentives for taking such policy measures. However, in the case of market-based mechanisms such as CDM further regulation or additional incentives may be needed to ensure that such bottom-up policy instruments really support sustainable development.

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9. Interlinkages of Global Climate Governance

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Abstract

This chapter looks at the options for future global climate change policies from an institutional and legal perspective. Thereby, it focuses on the questions through which possible routes these policies can be strengthened and how a future climate change regime can be designed taking into account the mainstreaming of climate change in other policy areas. We address these questions by examining the potential synergies and trade-offs in linking the climate change regime to other climate-relevant policy regimes, by looking at the potential for mainstreaming climate change in other policy areas, and by studying the design options for the future climate change regime itself. We propose a "menu" of policy measures to be taken at the sectoral, national, regional and global levels, paying due regard to the specific characteristics of the other policy areas. The measures to be taken are (a) between the FCCC and other regimes, including the conclusion of a Memorandum of Understanding with the GEF, ICAO and IMO and WTO, or the establishment of common fora for cooperation, such as a possible International Partnership on Sustainable Energy Policy; (b) within and/or outside the FCCC regime, including a developing an agreement on clean fossil-fuel technologies and best practices, and the promotion of joint technological research and development; (c) in other regimes, including the mainstreaming of climate change in FAO and UN Habitat policies and foreign direct investment strategies; and (d) primarily within the framework of the FCCC, including measures to optimize cooperation with Ramsar, CBD and CCD.

9.1 Introduction

9.1.1. Purpose

This chapter focuses on the two questions: (1) what are the possible routes for strengthening global climate change policy and (2) how can one design a climate change regime and export climate change policies to other policy areas? This chapter addresses these two questions by examining the potential synergies and trade-offs in linking the climate change regime to other climate-relevant policy regimes, by looking at the potential for mainstreaming climate change in other policy areas, and by studying the design options for the future climate change regime itself.

As a first step, this chapter will examine the key issues and institutional linkages with other regimes, classified in line with the issue areas identified for the report (see 9.2). It will also examine some other policy options (see 9.3) before developing a 'menu' of policy choices to be implemented from sectoral through national to international levels (see 9.4).

In designing a follow-up regime, it should be noted that key European Union countries and the Netherlands appear to be committed to a long-term goal of keeping temperature rise limited to a maximum of 2 degrees Centigrade. This is approximately the same as a stabilization of concentration levels at 550 ppmv CO_2 equivalence (see Gupta and Van Asselt, 2004). In keeping with such a long-term commitment, the developed countries can be expected to reduce their emissions by 60% in 2050 and about 30% in 2020-2030. This chapter will look at alternative approaches to developing the regime further, keeping these goals in mind.

It is not out of place to make a few precautionary remarks. First, the research in this chapter is not exhaustive, since it represents, primarily, an assessment of existing research. In some policy areas, substantial research has been done on the issue of linkages between the climate change and these regimes (e.g. climate change and the Montreal Protocol on the ozone-depleting substances, and climate change, environment and trade[115]). However, in other cases there is very limited information (e.g. water and climate change institutions). Second, for optimal global climate change policy, the political conditions have to be conducive to negotiations for cooperation in achieving global sustainable development goals at the lowest cost. Nevertheless, the aim here will be to search for solutions that may work, even in the absence of the active participation of some countries, for example, the United States.

9.1.2. Regional agreements

Before examining the issue and institutional linkages with regard to climate change and other areas, we will deal briefly in the following subsections with other recently emerging design considerations, particularly the conclusion of regional agreements and public–private and private-private partnerships.

Some authors have proposed to negotiate regional climate regimes either outside, or in addition to, the global approach of the Kyoto Protocol (independent of its entry into force). To be more specific, some suggest that the United States should conclude such a regional agreement with like-minded countries with a similar interest in using market-based approaches, for example, certain Latin-American countries (Bodansky 2002a). Likewise, Stewart and Wiener (2003) suggest that the United States should initially stay outside the Kyoto framework, seeking instead to establish a new framework with China and, possibly, with other key developing countries. This would address the world's two largest greenhouse gas emitters and allow for experimentation of alternative international climate regulatory frameworks. This, in turn, would allow regulatory competition that could be beneficial, provided that it does not lead to a regulatory race to the bottom. The advantage of fewer parties has been emphasized in the negotiation theory: i.e. the more negotiating parties, the greater the likelihood is for weaker commitments and slower progress. For some authors, such an approach could provide a first step for involving more 'moderate' developing countries. Such a group of countries would not want to be committed to stringent targets in order to prevent compromising their competitive advantages; this again may weaken the political message (Sugiyama 2003). However, Bodansky notes that it is better to have a modest target than none at all. This would make the approach to a certain extent similar to the Kyoto Protocol, with the difference that the use of a safety valve should be promoted in order to prevent excessive economic costs. In other words, any emission reduction is welcome as long as the economic consequences can be controlled. This promotion of modest short-term targets is reflected in other studies (see Aldy et al., 2003). Another drawback of the 'like-minded countries' approach is the decreased opportunity for creating package deals (Sugiyama, 2003; Tangen and Hasselknippe, 2003).

Although Bodansky's proposal of regional agreements is aimed at the United States, it is not unthinkable that countries that have ratified Kyoto are following a similar approach. Egenhofer and Fujiwara (2003), for example, discuss the prospects of a 'European Climate Change Area' and its extension to a 'Eurasian Climate Change Area'.[116] They conclude that the first will effectively be realized, given the large degree of political or economic integration of the EEA countries and Switzerland with the European Union, and that the prospects of a Eurasian agreement involving Russia are considerable. Whether such regional agreements could provide a model for global cooperation, however, is debatable. Developing countries have not yet sought cooperation outside the Climate Convention; this is partly because they still have no binding emission targets. Europe might be a special case, given its recent history of intense economic and political cooperation. The absence of such a regional framework in, for example, North-East Asia might be one reason why it is not too likely that similar cooperation efforts will occur in this region in the short-term (Egenhofer and Fujiwara, 2003, 28).

9.1.3. Public-private and private-private partnerships

Other proposals envisage an increased role of non-state actors in climate initiatives, primarily business and environmentalist groups. Possibilities for public–private and private-private are not exploited to the extent they could be (see also Rinkema, 2003). Especially the involvement of (key) business actors in climate-

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115 See, for example, Assunção, 2000; Assunção and Zhang, 2002; Biermann, 2001; Brack and Grubb, 2000; Bradnee Chambers, 2001; Brewer, 2002; Buck and Verheyen, 2000; Charnovitz, 2003; Doelle, 2004; Lodefalk et al. 2004; Sampson, 2000; Wysham, 2003; and Zhang, 2001.

116 The European Climate Change Area would be based on the European Economic Area, which consists of the EU, Iceland, Liechtenstein and Norway. Egenhofer and Fujiwara also include Switzerland in their analysis.

related initiatives holds great potential, since this would address the actors responsible for most greenhouse gas emissions. Options to involve these actors include environmental contracts, such as:

- the agreement between the EU and the European Automobile Manufacturers Association (ACEA)[117];
- green or sustainability labelling, such as the EU eco-label or the Energy Star in the United States, and environmental management and auditing systems, such as EMAS and ISO 14000[118];
- collective adoption of business principles, such as the CERES principles, or
- the establishment of public–private trading systems, such as the Chicago Climate Exchange[119].

Although there are sufficient reasons for firms to pursue these alternatives,[120] the effectiveness of these largely voluntary initiatives should be ensured by making it possible for NGOs to check compliance (Rinkema 2003, 757).

9.1.4. Relation to the FCCC process

None of the above proposals actually suggests rejecting the multilateral framework completely. On the contrary, all proposals suggest either a role of the Climate Convention in facilitating other approaches (e.g. Sugiyama, 2003) or envisage a return to this framework in due time (e.g. Stewart and Wiener, 2003; Bodansky, 2002a; 2002b). This indicates that an approach characterized by fragmentation does not exclude a multilateral approach. The most important question is then under what conditions these approaches can best be combined. With regard to emissions trading, this has already been discussed to a certain extent (Bodansky, 2002a; Danish, 2004). There is certainly potential for linking the emissions trading systems in the USA and the EU. Several design conditions need to be fulfilled, however. These include commonly defined permits; compatible systems for tracking trades; comparably stringent emission targets; comparably rigorous greenhouse gas emissions monitoring and reporting systems, and comparably stringent compliance systems (Danish, 2004). The recently agreed 'linking directive' of the EU acknowledges the option of linking trading schemes by providing for the possibility of linking the EU trading scheme with that of regional authorities in non-Kyoto countries in the future.[121] The options discussed above are therefore not mutually exclusive. Together with the possibility of linking up to the existing multilateral climate process, this implies that a diverse post-2012 climate architecture is not unthinkable.

9.1.5. Classification of the measures

In preparing this chapter, it soon became clear that three types of measures were emerging from the literature. Although a number of policy options were emerging for each measure, they were not used consistently. Below we present the types of policy options, along with the tools and the reasons for classifying them:

- Measures to enhance the collaboration between climate change and other regimes:
  - Memorandums of understanding/cooperation: An MOU provides a formal legal mandate for cooperation and specifies the conditions under which such cooperation will take place. We argue that

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117 Through this 1998 agreement, the European car manufacturers committed themselves to a 25% reduction of CO_2 emissions from new passenger cars by 2008 (See also Chapter 8). Similar agreements, albeit with different targets, have subsequently been concluded with the Japanese (JAMA) and Korean (KAMA) car industries.

118 For an analysis of the role of ISO standards in achieving the Kyoto goals, see Schneider and Yamin (1999).

119 See http://www.chicagoclimatex.com. Companies joining the CCX commit themselves to an annual reduction of 1% of certain greenhouse gases. Companies that exceed this target can trade excess emission allowances at the exchange. The CCX is not only aimed at businesses, but also at local authorities and educational institutions in the USA, Canada and Mexico.

120 Besides giving the corporations a 'green' profile, voluntary initiatives could give them a head start if command-and-control regulation is put into place, of course, provided that these voluntary initiatives are acknowledged.

121 'Environment Daily' 7 April 2004. In order to reach consensus on the proposed directive, the European Parliament was forced to tone down the wording of this provision. Providing explicitly for a possibility to link the EU trading scheme with, for example, the New England/Eastern Canadian trading scheme could undermine the US domestic approach and would probably be an affront to the Bush Administration. The final text reads: 'Following entry into force of the Kyoto Protocol, the Commission should examine whether it could be possible to conclude agreements with countries listed in Annex B [including the United States] to the Kyoto Protocol which have yet to ratify it, to provide for the recognition of allowances between the Community scheme and mandatory greenhouse gas emissions trading schemes capping absolute emissions established within those countries'.

MOUs are considered necessary wherever there are too many explicit trade-offs between the key goals of the climate change regime and the other regime being examined.
- Common fora: A common forum is also a formal arrangement to promote discussion between two or more regimes. We argue here that such formal arrangements may be adequate where primarily synergies between the regimes are to be enhanced.
- Measures in other regimes:
  - Mainstreaming climate change: Where the other regime discussed implicitly deals with climate relevant policy areas, we recommend mainstreaming climate change policy.
  - Specific measures: Where the other regime has minor overlaps with climate change policy areas, we develop tailor-made recommendations based on the literature.
- Measures directly concerned with climate change:
  - Those exclusive to the FCCC context: seen as being necessary to improve the design of various mechanisms under the FCCC.
  - Those possible within and outside the FCCC context (including regional agreements and public–private and private–private partnerships): can be adopted as protocols to the FCCC, but also as independent agreements outside the FCCC.

9.2 Issue-linkages with other policy areas

9.2.1. Introduction

This chapter analyses the issue and institutional[122] interlinkages[123] between the climate change regime and other regimes on poverty through to development, energy, finance and economics, air pollution and other regimes. This chapter thus merges the substantive information that emanates from the previous chapters with the institutional research undertaken in the context of this chapter into an integrated discussion. Each section will first elaborate the substantive issue linkages between climate change and the policy area being discussed. Subsequently, it will briefly examine the institutional context of the other policy area in relation to climate change, discuss common policymaking fora if present, provide the potential institutional links, and finally, discuss possible policy options.

9.2.2. Issue and institutional linkages with poverty

The *substantive issue linkage* between climate change and poverty is that climate change affects the poor the most, since they are the most vulnerable to climate change; and as the poor become richer, there is a higher chance of them using GHG-intensive technology and of emissions increasing (see Chapter 2).

The *international institutional context* for poverty policy consists primarily of foreign aid policy of developed countries and development bank policies.

The *key interlinkages*
- Synergies in the rhetorical goals of the development agencies and the fact that reducing poverty goes hand-in-hand with reducing vulnerability to climate change (see Chapter 2).

The *policy options* include

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[122] Institutions have been defined as 'systems of rules, decision-making procedures, and programs that give rise to social practices, assign roles to the participants in these practices, and guide interactions among the occupants of the relevant roles' (Young et al. 1999, p. 5). This definition shows similarities with the definition of regimes, and the terms are indeed often used interchangeably. Keohane (1996, p. 191) provides a broader definition, by explaining that it may refer to a general pattern or categorisation of activity or to a particular human-constructed arrangement, formally or informally organized. It should be noted that 'institutions' or 'regimes' are not the same as 'international organizations' (Young et al., 1999, pp. 8-9; Biermann and Bauer, 2004).

[123] Many terms have been used (though not always consistently) to describe the relationship between different institutions. These include institutional interaction, interplay, linkage and interlinkage, overlap and interconnection (Oberthür and Gehring 2003).

- Mainstreaming climate change policy in national sectoral policy is essential in helping developing countries to integrate adaptation into their planning processes (see also Chapter 7).
- Developing small-scale renewable energy programmes in rural areas is an option in the developing countries; however, such programmes should be both affordable and sustainable, and integrated into rural development programmes (see Chapter 2; Gupta et al., 2000).
- The possibility of developing simple rules for funding adaptation needs to be explored in joint FCCC working groups and the aid agencies (see also Chapter 7).

9.2.3. Issue and institutional linkages with land use

The *substantive link* between climate change and land use is that the way the land is used and covered will have significant impacts on emission and absorption of GHG; and, conversely climate change may have adverse impacts on land use. For example, certain types of agriculture contribute to greenhouse gas emissions, while agricultural production will most certainly be affected by changing precipitation and temperature levels. Afforestation constitutes a sink for GHG emissions, while deforestation leads to emissions and desertification to increased emissions. Wetlands, including peatlands, are important carbon reservoirs, but also sensitive to changes in climate and sea-level rise (refer to Chapter 3; Bergkamp and Orlando, 1999; Parish and Looi, 1999). Ecosystems prone to desertification may lose their function as carbon sinks or reservoirs, which, in turn, contributes to climate change.[124]

The *international institutional context* for land-use policy consists of links with the institutions dealing with:

- Forests and biodiversity: the 2001 United Nations Forum on Forests (UNFF)[125] was established to develop global forest policy and is expected to make recommendations for a legal agreement which will include definitions and measures for sustainable forest management.[126] This policy developed in the UNFF is complemented by the 1992 Convention on Biodiversity[127], which aims to conserve biological diversity, the sustainable use of its components, and the fair and equitable sharing of the benefits arising from the utilisation of genetic resources.
- Desertification: The 1994 UN Convention to Combat Desertification[128], aims at combating desertification and mitigate the effects of droughts. Article 8 of the CCD encourages coordination of activities with those carried out under the climate and biodiversity conventions 'in order to derive maximum benefit from activities under each agreement while avoiding duplication of effort'. The CCD secretariat is testing initiatives for integrating FCCC considerations into their own afforestation and reforestation schemes. The CCD also aims to enhance synergies between the conventions by organizing national workshops in developing countries to strengthen co-ordination at the national level, to facilitate dialogue between key stakeholders (including the donor community) and to catalyse local approaches to synergy among stakeholders.
- Wetlands: The 1971 Ramsar Convention[129] aims to conserve wetlands and their wise use; it currently designates a total of 1364 sites with 120,409,301 hectares as protected sites by member states. In 2002 the Ramsar parties adopted a resolution on climate change and wetlands (VIII.3), which encouraged:
  - wetland management so as to increase resilience to climate change,
  - promote restoration and improved management of wetlands that have the ability to sequester carbon,

124 See 'Review of activities for the promotion and strengthening of relationships with other relevant conventions and relevant international organisations, institutions and agencies'. Note by the UNCCD Secretariat. ICCD/COP(3)/9, 28 September 1999.

125 The UNFF succeeded a period (1995-2000) of forest policy dialogue facilitated by the Intergovernmental Panel on Forests (IPF) and the Intergovernmental Forum on Forests. The UNFF includes all UN Parties; see for more details http://www.un.org/esa/forests/about.html.

126 These recommendations will build on past initiatives, including the International Tropical Timber Agreement, the Forest Principles adopted at Rio in 1992 and the work undertaken by the Intergovernmental Forum on Forests and the Intergovernmental Panel on Forests.

127 Convention on Biological Diversity (Rio de Janeiro), 5 June 1992, in force on 29 December 1993, 31 I.L.M. 1992; convention has 188 parties, but the USA is not one of them.

128 Convention to Combat Desertification,(Paris), 17 June 1994, in force on 26 December 1996, 33 I.L.M 1994; convention has 191 parties.

129 Convention on Wetlands of International Importance, Ramsar, 2 February 1971, in force on 21 December 1975, 11 I.L.M. 1971. Currently, the Ramsar Convention has 138 parties. See http://www.ramsar.org.

- study the role of wetlands in carbon storage and sequestration and in mitigating impacts of sea-level rise and
- pay special attention to building and strengthening institutional capacity and synergies between the related instruments, also through the mechanism of focal points' participation in National Ramsar Committees. The resolution also recognized potential conflicts between the implementation of the climate commitments through re-vegetation and forest management, afforestation and reforestation, and the commitments to the conservation and sustainable use of wetlands.

- Agriculture: International agricultural policy originates primarily[130] in the United Nations Food and Agriculture Organization (FAO).[131] In 1988, it established an Interdepartmental Working Group on Climate in Relation to Agriculture and Food Security[132] and created a task force on forestry and carbon sequestration to co-ordinate forestry and climate activities. The FAO hosts the Global Terrestrial Observing System (GTOS), under which the Terrestrial Carbon Observation Initiative (TCOI) was developed to monitor carbon sources and sinks in agricultural and rural sectors. The FAO aims to play a role in implementing the flexible mechanisms of the Kyoto Protocol, and seeks to be involved in helping rural communities in adapting to climate impacts.[133]

Some *common fora* for discussing cooperation with the climate change regime include:

- A Collaborative Partnership on Forests (CPF)[134], set up in 2001. It includes representatives from the FCCC, CBD, and the CCD to support the UNFF work and to foster increased co-operation and co-ordination on forests.
- All convention secretariats have observer status in each other's regimes; however, the FCCC only occasionally participates in the COPs of the other regimes (Hayashi 2004). In 2001, a Joint Liaison Group (JLG)[135] was established between the secretariats of FCCC, CBD and CCD to promote cooperation, exchange information on future plans and enhance cohesion at international but also national level. The Ramsar Secretariat was also invited to participate, but at the most recent meeting (January 2004), nobody from Ramsar was present. Maybe this is due to the small size of the Ramsar Secretariat. At the previous meeting, there was someone from Ramsar reporting to the JLG.[136] Interviews reveal that the smaller Convention secretariats (CBD and Ramsar) are keener on cooperation than the larger ones, these probably having more complicated goals and being more self-sufficient (Hayashi 2004).
- FAO, an observer to the FCCC negotiations, is in a position to link its activities with the activities of these regimes.

The *key interlinkages* are discussed under: objectives, mechanisms and financial mechanisms.

- Objectives: The objectives of the FCCC, CBD, CCD, forestry and Ramsar are mutually supportive since they pursue-directly or indirectly—the conservation of ecosystems (Oberthür 2001).[137]
- Principles: The principles in the FCCC are synergetic with those in the CBD, CCD, forestry and Ramsar. However, the principle of cost-effectiveness within the FCCC can pose major challenges to the way policy is executed in the climate change regime. The FAO does not have major principles in its structure as such. Thus, mainstreaming key climate change principles in the FAO could be a future area of attention.
- Mechanisms: It is at the level of the mechanisms that potential conflicts arise. This is because mechanisms within the climate change regime aim to reduce GHGs in the most cost-effective manner available[138], even though they also call on parties to take account of other environmental goals[139]. However, the

130 Policies influencing agriculture are also initiated within the WTO, OECD and the EU.
131 The FAO was established in 1948 and has 188 members; see http://www.fao.org/Legal/member-e.htm.
132 http://www.fao.org/sd/epdirect/EPre0035.htm.
133 http://www.fao.org/docrep/meeting/003/X8785e.htm.
134 http://www.fao.org/forestry/cpf.
135 See 'Review of activities for the promotion and strengthening of relationships with other relevant conventions and relevant international organisations, institutions and agencies'. Note by the UNCCD Secretariat. ICCD/CRIC(1)/9, 15 October 2002.
136 These are the links to the reports of the last two meetings: http://unfccc.int/sessions/othermt/jlg/reportjlg5.pdf and http://unfccc.int/sessions/othermt/jlg/jlg4sum.pd.
137 See, for example, the CCD preamble. Article 4(1)(e) of the UNFCCC calls for co-operation 'in preparing for adaptation to the impacts of climate change' and the development and elaboration of 'appropriate and integrated plans (….) for the protection and rehabilitation of areas, particularly in Africa, affected by drought and desertification'.
138 See Article 3(3) of the FCCC.

other regimes aim to protect other resources. This can lead to a trade-off between the costs and the competing goals. The climate regime has established mechanisms to promote the development of sinks (calling for growing biomass and reversing desertification). However, in the process of finding the cheapest way of increasing sinks, such as fast-growing mono-culture forest plantations, concerns for biodiversity conservation may be lost. Similarly, if the use of land for carbon sequestration leads to the conversion of wetlands, this will contradict the goals of Ramsar (see, for example, Oberthür, 2001; Jacquemont and Caparrós, 2002, 169; Bradnee-Chambers et al., 1999, 60; Gillespie, 1998; Pontecorvo, 1999). This does not *a priori* signal a conflict, but there is a potential for conflict, which can be resolved through better and coordinated rules within the different bodies (Oberthür, 2001, 7). However, making such linkages is not easy given the different interests of the parties. Although some rules were developed with regard to forestry activities at the ninth COP to the FCCC in 2003, NGOs still see these rules as not excluding large-scale monoculture plantations (Meinshausen and Hare, 2003).[140] At the national level, forest departments are not yet convinced of the link to climate change (Hayashi 2004).

- Financial mechanisms: The FCCC, CCD and CBD include financial mechanisms to help developing countries deal with sink protection, desertification and biodiversity.[141]

The *policy options* include:

- Mainstreaming climate change principles and objectives within the FAO to develop principles for sustainable agriculture.
- A memorandum of co-operation between Ramsar and the FCCC, similar to that already produced by Ramsar, CCD and CBD (Hayashi, 2004).
- Interactions between the regimes that may be synergetic if: (a) the climate regime prohibits carbon credits from previous, converted wetlands and provides additional resources for wetland management; (b) fragile ecosystems are zoned, in order to protect them from the impacts of climate change policy measures; (c) the concept of multi-functional use of land is better developed; and (d) land subsidies and incentives are synchronized, so as to optimize the multifunctional use of land by land owners and users and to promote the protection of zones (see also Chapter 3).
- Inadequate access for people living in drylands to energy sources other than firewood as a key factor for desertification and also contributory to climate change. Financial support for developing renewable energy sources (especially solar) in drylands is thus a particularly synergetic technical option (see also Chapter 2).
- Organizing national workshops to explore synergies between the regimes as a necessary precondition for securing such interlinkages at international level.

Bottlenecks in pursuing these policy options include the diverging goals of parties, lack of interest and capacity, and a tendency to engage in linkages in an ad hoc manner (Hayashi 2004).

9.2.4. Issue and institutional linkages with energy

The *substantive issue linkage* between climate change and energy is that energy consumption presently contributes to more than half the world's GHG emissions. Different energy sources and technologies are associated with different levels of emissions. Furthermore, exploiting such links is politically significant, since energy is a top priority of all countries (Gupta 1997), even where climate change is not.

The *international institutional context* for energy policy comprises energy policy, nuclear energy policy, and other multilateral and bilateral initiatives.

- Energy policy: The International Energy Agency (IEA) promotes cooperation on numerous energy-related issues and has since 1977 also promoted cooperation on hydrogen research.
- Nuclear energy policy: The International Atomic Energy Agency (IAEA) makes policy on nuclear energy to 'accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the

139 See, for example, Article 4(1)(d) of the Kyoto Protocol.

140 IISD Earth Negotiations Bulletin, vol. 12, no. 231.

141 Articles 6 and 20 of the CCD call upon industrialized countries to assist affected developing countries in combating desertification, while Article 4(8) of the FCCC requests industrialized countries to assist countries with arid and semi-arid areas, forested areas and areas liable to forest decay, and countries with areas liable to drought and desertification.

world'.[142] The IAEA sees positive synergies between their programmes and climate change because of low GHG emissions associated with nuclear energy, although nuclear energy has and is perceived to have many other negative impacts (Hasselknippe et al., 2001).

- Other multilateral and bilateral initiatives: Other multilateral initiatives include the 1994 Energy Charter Treaty, which some industrialized countries negotiated to regulate energy investment, trade and the transit of energy through member states. Both the Climate Convention and the Kyoto Protocol emphasize the need to develop energy-efficient technologies and new sources of energy as well as technological co-operation[143], but otherwise remain quite general on energy issues. Hydrogen is seen by some as a promising area of synergy between energy and climate policy. The US government has recently signed three agreements focusing directly on the promotion of a hydrogen economy with Brazil, the European Union and Italy, as well as several climate agreements (also covering hydrogen) with Canada, India, Republic of Korea, New Zealand, Russia, China, Australia, Mexico, South Africa and Japan.[144] These agreements aim to enhance security of energy supply, to increase diversity of energy sources, and to improve local and global environment quality. However, in promoting hydrogen, these agreements do not always emphasize the need for hydrogen to be developed in the way in which the least GHGs are generated and, therefore, there is a potential for conflict with the climate regime. One might even argue that these new agreements are primarily aimed at locating new markets for hydrogen technology, without first ensuring that the technology is in fact the most appropriate solution to the problem of climate change.[145] In the meantime, an International Partnership on a Hydrogen Economy has been launched by 15 countries and a hydrogen-related organization is expected to be established soon.[146]

Although the IEA participates as observer in the FCCC negotiations[147], there are presently no common fora for discussing cooperation with the climate change regime.

The *key interlinkages* are objectives, mechanisms and the UN-CSD.

- Objectives: there is some overlap between the different institutions working on energy-related issues, since they all promote energy production and energy efficiency. But the ecological and environmental impacts of these different production processes have not been adequately integrated in the energy regimes.
- Mechanisms: the FCCC promotes investment in energy-efficient technologies and new energy sources through the Clean Development Mechanism, Joint Implementation and the national obligations. As one of the key issues in the climate change arena, it is surprising that there are no other formal mechanisms for cooperation.
- United Nations Commission on Sustainable Development (CSD): although the CSD also discusses energy policy, and has a mandate to do so since the Johannesburg Summit of 2002, it has not been very effective thus far.[148]

The *policy options* include:

- Developing an International Partnership on Sustainable Energy Policy to include representatives from countries engaging in bilateral energy initiatives, multilateral energy initiatives and the climate change regime, along with countries primarily dependent on fossil fuel exports. The purpose of such a partnership will be to develop a comprehensive sustainable energy policy and a coalition to discuss the risks of nuclear power, the potential for coal gasification, and the possibilities for new sources such as hydrogen, etc. (see also Chapter 4).

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142 Article II IAEA Statute.
143 See Article 4(1)(c) FCCC and Article 10(c) Kyoto Protocol.
144 See for a detailed analysis - Sindico and Gupta (2004).
145 See the US-EU Joint Statement and the US-Italy Joint Statement. On this point, both instruments have practically the same wording.
146 Information about the meeting is available at http://www.usea.org/iphe.htm.
147 See http://unfccc.int/resource/igo/igo.html.
148 The CSD has been fairly active in the field of energy policy: see http://www.un.org/esa/sustdev/sdissues/energy/intergov/intergov.htm. See also Marauhn (2003).

- Developing a protocol to the FCCC, increasing the share of renewable energy in a country's energy supply (to help meet increasing energy needs), and increasing employment and development opportunities, while reducing balance of payment problems and local air pollution (see also Chapters 4 and 8).
- Making agreements with the Development Banks in relation to investments in energy infrastructure (see also Chapter 4).
- Developing and promoting technologies such as energy-efficiency technology, more efficient fuel conversion, renewable energy, fuel switch in transport to CNG or LPG (and then to hydrogen), increased use of mass transit, energy efficiency in cooking stoves and decentralized renewable energy through technology standards or protocols (see also Chapter 6).

9.2.5. Issue and institutional linkages with international trade and finance

The *substantive issue linkages* between climate change and investment is that for some authors climate change is in fact an investment regime because it calls for a complete overhaul in the way investment is undertaken and what sort of policies are encouraged and what not. Investment regimes and Banks have often invested in projects that have negative environmental impacts and high GHG emissions, leading to potential conflicts with climate change (Sands, 2003, 1026).[149] The substantive linkage between climate change and trade regimes is that international trade stimulates economic activities, which contribute to climate change (see Chapter 5).

The *international institutional context* for trade and finance policy consists of:
- Trade policy and the World Trade Organisation (WTO): the WTO[150] regulating policies in relation to trade. Regional trade agreements, such as the North American Free Trade Agreement (NAFTA) and the EU internal market, are also important.
- Investment policy regimes: international investment, currently regulated by the more than 2000 bilateral investment treaties between countries. Attempts at developing a comprehensive Multilateral Agreement on Investment failed as a result of the objections of civil society and developing countries (see also Chapter 5). In addition, there are regional agreements, including NAFTA, but also the framework agreement on the ASEAN investment area. Further to this, investment rules under the WTO already exist[151] and additional rules might be negotiated in the near future.
- The World Bank[152]: originally aimed at promoting development and recently focused on poverty reduction. Partly in response to the Kyoto Protocol, the Bank initiated various activities related to carbon finance, including the Prototype Carbon Fund. The latter aims to show how project-based greenhouse gas emission reduction transactions can promote and contribute to sustainable development[153] and aims to incorporate GHG reductions into its investment portfolio, as well as helping with the reduction of vulnerability and adaptation to climate change and capacity-building. An assessment of climate risks is likely to become routine in the Bank's operations (Mathur et al. 2004; Oberthür 2001).
- The Global Environment Facility (GEF)[154]: a mechanism financing the incremental costs of activities in the areas of biodiversity, climate change, international waters, desertification and land degradation in as far as it affects climate change, depletion of the ozone layer and persistent organic pollutants (POPs). Recently, the Operational Strategy of the GEF has come to incorporate the policy guidance of the Conferences of the Parties of both the Climate Convention and the Biodiversity Convention.[155] The GEF under-

[149] This alarming situation was apparently confirmed by the Bank itself, which stated that the investments made in oil, gas, and mining projects in poor and developing countries presented a 'clear and present danger' to the global environment. See http://www.seen.org/pages/press_releases/pr_leak.shtml.

[150] Established in 1994 as a follow-up to the system established by the General Agreement on Tariffs and Trade (GATT), which was one of the products of the Bretton Woods Conference in 1944; it has 147 member countries.

[151] The Agreement on Trade-Related Investment Measures (TRIMs) was one of the outcomes of the so-called Uruguay Round in 1994.

[152] Established in 1944 at Bretton Woods; it has 184 member countries.

[153] See http://prototypecarbonfund.org.

[154] Established in 1990 by UNEP, UNDP and the World Bank, and restructured in 1994.

[155] Operational Strategy of the Global Environment Facility, chapters 2 and 3. Available at: http://www.gefweb.org/Operational_Policies/Operational_Strategy/op_stat/op_stat.html.

takes investment and capacity-building projects primarily on long-term[156] emission limitation and research activities on adaptation.

Some *common fora* for discussing cooperation with the climate change regime include:
- The FCCC secretariat - with observer status in the meetings of the WTO Committee on Trade and Environment.
- The World Bank - observer to the FCCC negotiations.
- The GEF - by virtue of being named as the interim financial mechanism of the FCCC[157] and through its designation as the manager of three newly established funds[158], has a close institutional link with the FCCC which was further strengthened in the 1996 Memorandum of Understanding (MOU) between the FCCC parties and the GEF Council (see Chapter 7). The GEF has observer status and reports annually to the FCCC-COP. Despite this regular communication, the GEF makes its own decisions (Oberthür 2001).

Notwithstanding these initiatives, we should note that there are no common fora for discussing trade and investment issues on climate change in general.

The *key elements interlinking institutions* are principles and objectives and measures.
- Principles and objectives. In relation to the WTO and the FCCC these are prima facie compatible (see also Chapter 5), as both focus on sustainable development[159] , while the climate regime aims explicitly at compatibility with the trade regime.[160] There is also prima facie compatibility with the goals of the World Bank and the GEF, since these bodies have incorporated the objectives of climate change into their policies. However, in the area of investment, some bilateral and regional investment agreements prohibit the kind of conditioning of investments that the FCCC's Clean Development Mechanism and Joint Implementation promote. Through the Kyoto mechanisms, governments can intervene in investment decisions in several ways that could be contrary to the rules of certain international investment agreements (Werksman and Santoro, 1998; Werksman et al. 2001; 2003). The largest possible conflict of interest between these two policy areas is that international contracts between parties will be governed by private international law and investment law. Therefore, in a conflict between parties on joint implementation or in a contract under the Clean Development Mechanism, parties may seek recourse to private international law rules of dispute settlement as opposed to seeking solutions within the climate regime (compare with Gupta 2004). One potential normative conflict with regard to the GEF is the question of who has the final say in project funding and general decisions. In the case of conflicts, the GEF could ultimately be held accountable by the FCCC-COP (Sands 2003, p. 1036). However, apart from some minor problems related to GEF procedures, and the fact that the GEF has systematically postponed financing major adaptation projects, serious conflicts between the GEF and the climate convention have not yet occurred (Oberthür

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156 The Operational Strategy states that long-term mitigation and adaptation measures will constitute the largest share of the GEF climate change portfolio, with enabling activities in support of national communications forming a relatively small and declining share. Short-term mitigation projects will constitute only a small part of the portfolio to maintain the operational emphasis on long-term measures.

157 Article 21(3) of the FCCC named the GEF as the interim operating entity of the financial mechanism and in 1978 it was accepted as the permanent financial mechanism.

158 Namely, the Climate Fund, the Adaptation Fund and the Least Developed Countries Fund, adopted in the Marrakesh Accords of 2001.

159 The first paragraph of the WTO Charter states '[r]aising standards of living, ensuring full employment and a large and steadily growing volume of real income and effective demand, and expanding the production of and trade in goods and services, while allowing for the optimal use of the world's resources *in accordance with the objective of sustainable development*, seeking both to protect and preserve the environment and to enhance the means for doing so in a manner consistent with their respective needs and concerns at different levels of economic development' (emphasis added).

160 Article 3(5) of the Climate Convention states that '[t]he Parties should co-operate to promote a supportive and open international economic system that would lead to sustainable economic growth and development in all Parties, particularly developing country Parties, thus enabling them to better address the problems of climate change. Measures taken to combat climate change, including unilateral ones, should not constitute a means of arbitrary or unjustifiable discrimination or a disguised restriction on international trade'. Article 2(3) of the Kyoto Protocol mentions that '[t]he Parties included in Annex I shall strive to implement policies and measures (….) in such a way as to minimize adverse effects, including the (….) effects on international trade'.

2001). However, the GEF will begin soon with adaptation projects based on simple rules in relation to incremental costs.

- Measures. Measures to reduce subsidies on fossil fuels and certain energy-efficiency programmes also leading to reduced GHG emissions will be compatible with international trade rules (e.g. Brack and Grubb, 2000), although there are many potential conflicts. However, where the climate regime leads to explicit trade restrictions[161] through eco-labelling[162]or border tax adjustments[163], for example, these may be challenged under the WTO. To what extent WTO rules allow the trading of emission allowances in a certain region is also an open question. Although these issues are within the scope of the WTO, it may not be the proper forum to address environmental matters.[164] There are also potential 'lose-lose situations' for the climate and trade regimes (Brewer, 2003, p. 336), which could be become a reality if broader conflicts arose between parties to both regimes that could undermine confidence in both regimes (such as the non-participation of the USA in the Kyoto Protocol). The fundamental goal of the World Bank is to promote development, reduce poverty and ensure that the shareholders' interests are met. When it comes to actual investment policies, these may often conflict with changing investment patterns.

The *policy options* include:

- Improved coordination of activities undertaken in the climate and international trade regimes, which could help to identify and address potential conflicts. One proposal would be to establish a joint WTO/FCCC working group (Assunção and Zhang, 2002). However, given the fundamental conflict of interests between the two regimes, a MOU would perhaps be more appropriate as this would discuss the legality of the adoption of GHG taxes and border tax adjustments, and sustainability labelling schemes.
- Avoidance of conflicts between international investment agreements and the Clean Development Mechanism, perhaps with a properly designed CDM and through negotiation of additional, adjusted investment agreements. Measures under the CDM are, in particular, more likely to be consistent with international investment agreements if they are based on a collective endorsement (Werksman et al. 2001; 2003).
- Mainstreaming climate change policy in foreign direct investments strategies and not just in aid policies, since the stream of FDI is larger than the stream of aid policy. (see also Chapter 5). This can be done by promoting demand-side management in countries, reducing perverse subsidies, and by calling on countries to design guidelines for FDI. A 'grand bargain' between phasing out subsidies in OECD countries, in return for phasing out subsidies in the key developing countries, is one of the options that could be considered.

9.2.6. Issue and institutional linkages with other air-pollution regimes and health

The *substantive linkage* between climate change and air-pollution and health regimes can be summed up in three points. First, many substances that deplete the ozone layer and many of their substitutes (notably hydrofluorocarbons - HFCs) are potential GHGs (Van der Valk et al., 2000). Hence, although the elimination of ozone-depleting substances generally creates synergies with the climate regime, it could create conflicts

[161] Specific measures to reduce GHG emissions may affect the production costs of goods and thereby competitiveness, and efforts of countries to address the 'unequal playing field' could be judged as inconsistent with world trade law (Sampson, 2000: 30).

[162] The use of standards referring to non-product-related process and production methods (PPMs), the use of which is still debated within the world trade regime regarding both legality and practicality could be challenged in the WTO (Biermann, 2001; Campins and Gupta, 2002). For example, a measure aimed at restricting international trade in products based on different levels of greenhouse gas emissions due to energy efficiency of production methods could be open to challenge in the WTO (Doelle, 2004, pp. 93-95).

[163] Border tax adjustments regarding energy taxes enacted by the European Union could lead to a conflict between the US and the EU, but could also provide incentives for US industry to join the mechanisms of the Kyoto Protocol (Biermann and Brohm, 2003 and 2004) (see also Chapter 5).

[164] Charnovitz (2003, p. 162) notes that the case against addressing environmental issues in the WTO is that 'trade diplomats and bureaucrats in the WTO have too narrow a mindset to make constructive contributions to non-trade issues'. However, the case for WTO involvement would be an improvement in the coherence of global governance.

with climate protection if the wrong alternative substances or processes are supported.[165] Second, other air pollu-tants and greenhouse gases often have common sources, interact with each other in the atmosphere and, either separately or jointly, cause a variety of environmental effects.[166] Third, climate change can affect human health in different ways. These range from direct effects (e.g. increase in diseases caused by storms or floods) to indirect effects (e.g. increase in vector-borne diseases, food- or water-related diseases and pollen allergies).

The *international institutional context* for air-pollution and health policies is primarily constituted by the regimes on the protection of the ozone layer and on long-range transboundary air pollution, as well as the World Health Organization (WHO).

- The 1985 Vienna Convention for the Protection of the Ozone Layer[167], its 1987 Montreal Protocol[168] and their amendments phase out the emissions of ozone depleting substances.
- The 1979 Convention on Long-Range Transboundary Air Pollution (LRTAP),[169] and its Protocols aim inter alia to reduce sulphur dioxide emissions. Reducing such emissions, especially from coal-fired plants, also leads to a reduction of CO_2 emissions (Jhaveri et al., 1998; Gupta et al., 2002). The 1988 Sofia Protocol on nitrogen oxides and the 1991 Geneva Protocol on volatile organic compounds, for example, aim at reducing emissions of substances that are precursors of tropospheric ozone, a GHG. Overall, reducing emissions of air pollutants would most likely lead to a general reduction of GHG emissions as well.[170] In addition, it is important to mention that this regime has an elaborate Programme for Monitoring and Evaluation of Air Pollutants in Europe (EMEP) established in 1977. This programme is now seeking co-operation with the IPCC scientists[171] and there is considerable potential for cooperation in the area of monitoring.[172] Jhaveri et al. (1998, pp. 63-67) provide a few lessons for the climate regime from the LRTAP regime history; for example, that air pollution can be effectively dealt with at regional level, that a definition of critical loads by scientists is possible and that the regime can move forward by forming coalitions of like-minded countries.
- The World Health Organization (WHO) regulates health policy (see also Chapter 6). It has collaborated with the climate regime in developing guidelines for assessing the health impacts of climate change and related adaptation measures. In 2003, the WHO, in cooperation with the World Meteorological Organization (WMO) and UNEP, published a large report on the relation between climate change and health (WHO, WMO and UNEP, 2003).

Common fora for discussing cooperation with the climate change regime include:

- WHO, which has submitted periodic reports on its activities to the SBSTA. Furthermore, there is some coordination between the two regimes.[173]

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[165] For an extensive assessment on the functional interlinkages between climate change and ozone depletion, see UNEP (2002). Currently, an assessment is being prepared by WG III of the IPCC on Safeguarding the Ozone Layer and the Global Climate System: Issues Related to Hydrofluorocarbons and Perfluorocarbons. See: http://arch.rivm.nl/env/int/ipcc/pages_media/Fgas-report.html.

[166] Draft conclusions of the Workshop on Linkages and Synergies of Regional and Global Emission Control, 27-29 January 2003, Laxenburg, Austria. Available at: http://www.iiasa.ac.at/rains/meetings/AP&GHG-Jan2003/conclusions.pdf. See also Chapter 6.

[167] Convention for the Protection of the Ozone Layer (Vienna) 22 March 1985, in force on 22 September 1988; 26 I.L.M. 1987, 1529.

[168] Protocol on Substances that Deplete the Ozone Layer (Montreal), 16 September 1987, in force on 1 January 1989, 26 I.L.M. (1987), 154; it has 187 parties.

[169] Convention on Long-Range Transboundary Air Pollution (Geneva), 13 November 1979, in force on 16 March 1983; 18 I.L.M. 1979; it has 49 parties. The LRTAP Convention is one of several conventions negotiated within the UN-ECE to deal with, *inter alia*, air pollution.

[170] Technically speaking, sulphur dioxide emissions can have a temporary cooling effect in the atmosphere (Van der Valk et al., 2000, p. 24). This can to some extent mask the warming effect of climate change. While some may argue that this is a negative interlinkage between the two regimes, we take the position that sulphur emissions cause acid rain and hence represent a serious environmental problem. Besides, the cooling effect is temporary. Hence, there is no real conflict between the air pollution regime and climate change on this issue.

[171] Press Release ECE/ENV/03/P02, 31 January 2003.

[172] Ibid.

[173] http://www.who.int/globalchange/climate/unfccc/en/.

- UNFCCC and the Vienna Convention (IPCC and Technical and Economic Advisory Panel-TEAP), whose technical assessment bodies held a joint expert meeting in 1999, thereby initiating scientific cooperation. Another meeting was held in 2003.[174]
- There are no other formal cooperative fora between these regimes, although the different organizations are observers to the negotiation sessions of the other.

The *key interlinkages* are objectives and mechanisms. Objectives: there are no direct and obvious overlaps in the objectives of the four regimes, but there are indirect overlaps. The removal of ozone-depleting substances does not automatically lead to a reduction in GHGs, unless the two goals are explicitly aligned. The reduction of other air pollutants, however, may directly or indirectly affect the emissions of greenhouse gases and here the synergies are easier to derive. The WHO policies aim to help people to become more resilient to diseases, offering more potential synergies with adaptation measures in relation to climate change.

- Mechanisms: there are synergies possible between the financial mechanism of the Montreal Protocol and the FCCC, but only if the two goals of the two treaties are explicitly synchronized. The FCCC explicitly focuses on GHGs not covered by the Montreal Protocol,[175] but the Montreal Protocol must ensure that it does not introduce ODSs that are GHGs. There are considerable steps underway to explore the interlinkages between these two regimes (Malabed et al., 2001) and there is also a positive interlinkage in the sense that the Climate Convention has copied the rather innovative non-compliance procedure of the Montreal Protocol (see Oberthür 2001, p. 4). The monitoring mechanism of EMEP may be put to use to support monitoring exercises within the FCCC; these are presently being explored.

The *policy options* include:

- Although there is a clear potential for synergies, as both the WHO and the climate convention seek to reduce adverse impacts of climate change on human health, it seems that these are exploited only to a limited extent. Possibly more work can be done here, especially in relation to adaptation to climate change.
- There is potential for further exploring the links between EMEP and monitoring under the climate regime.
- There is potential for aligning the financial mechanism of the Montreal Protocol and that of the FCCC to optimize the synergies.

9.2.7. Issue and institutional linkages with other policy areas

In the course of the assessment, we identified other issue areas that were also of significance. These were not initially discussed in the course of this project. Included are linkages with freshwater regimes, oceans and seas, marine and air transport and human settlements.

The *substantive link* between climate change and freshwater regimes is the huge impact that climate change is expected to have on the hydrological system of the earth through changing precipitation patterns, melting of glaciers and changes in evaporation rates as a result of the changes in the temperature. Climate change may influence oceans and their ecosystems through rising sea levels and rising temperatures. Oceans and seas also represent a major sink for GHGs but they can release these gases when there is a change in temperature. Linkages between climate change and oceans include the severe threat of marine ecosystems, especially coral reefs, through climate change and the function of oceans as sinks (Van der Valk et al., 2000). Climate change could indirectly affect the Law of the Sea Convention. For example, the possible gradual disappearance of island states would affect their status under this Convention. Climate change is also affected by emissions associated with ocean and air transport. Finally, since human settlements are a source of GHG emissions, there is likely to be an impact on human settlements when these are located in vulnerable areas, such as riverbanks, arid and semi-arid regions or coastal regions.

The *international institutional context* for these other policy areas consists of:

- The freshwater regime: use and protection of global freshwater resources is regulated in hundreds of regional regimes. In addition, Chapter 18 of Agenda 21 (1992), the 1997 UN Convention on the Law of the Non-Navigational Uses of International Watercourses, the World Water Forums (1997, 2000, 2003) and

[174] See: http://www.unep.ch/ozone/Events/print_ver.asp?fname=7Bii_events_meeting2003.asp&folder=Events.
[175] Article 4.1a of the UNFCCC.

23 UN bodies (including FAO, UNEP, UNDP, the World Bank, etc.) form a part of international freshwater policy. The 1997 Watercourses Convention[176] encourages countries to develop systems for the equitable and optimal use of water resources.[177] Finally, Programme G of Chapter 18 of Agenda 21 specifically recommends that countries should adopt measures to cope with the impacts of climate change (Van der Valk et al., 2000).

- The oceans and seas regime: the 1982 United Nations Convention on the Law of the Sea[178] and regional agreements, such as the 1972 London Dumping Convention[179], govern the oceans (including marine environmental protection). The Law of the Sea Convention aims at *inter alia* 'the conservation of (….) living resources, and the study, protection and preservation of the marine environment' (preamble) - in line with the Climate Convention's ultimate objective. The MARPOL[180] regime has effectively used standards as a way to promote the development of the regime.
- The international transport regime including ICAO and IMO: while the International Civil Aviation Organization (ICAO) regulates civil aviation and the emissions stemming from aircraft, the International Maritime Organization (IMO) regulates *inter alia* emissions from ships.
- The UN Centre for Human Settlements (Habitat): this centre was created in 1978, following the 1996 United Nations Conference on Human Settlements (UNCHS), Habitat aims at promoting sustainable housing for all, improving urban governance, reducing urban poverty, improving the living environment, and managing disaster and post-conflict rehabilitation.

There are no formal *common for*a for discussing cooperation with the climate change regime. The dialogue on water and climate aims to improve the capacity in water resources management to adapt to climate change.[181] A scoping paper of this dialogue concluded that cooperation was needed between institutions dealing with water, weather and climate, whether they be operational agencies or research groups. In addition, investment in capacity building in the South is recommended in order to enhance their adaptive strategies (Kabat et al., 2002, pp. x-xi).

The *key interlinkages*

- Objectives: although the goals of fresh water regimes, seas and oceans regimes, IMO and ICAO and Habitat are not similar (see Oberthür 2003 for ICAO, IMO and FCCC), there are important overlaps between them at this objectives level. However, actual mechanisms have not been developed in any of the regimes to ensure that the synergies are realized. Some efforts at ensuring synergies have been initiated. The Kyoto Protocol requests the ICAO and IMO to take up the issue of GHG emissions by international transport (Article 2(2)), but the latter have not taken any substantive action as of yet. A potential normative conflict could arise through carbon storage in oceans, which is currently debated within the climate regime as a potential mitigation method.[182] Yet, this option may in certain cases contravene several of the aforementioned international agreements on abating pollution of the marine environment, depending on the methods used for storage (Heinrich 2002; Churchill 1996; Jabour-Green 2001). It would seem advis-

176 Convention on the Non-Navigational Uses of International Watercourses, 21 May 1997; 26 I.L.M. 1997; not yet entered into force.

177 Equitable use implies consideration of geographic, hydrographical, hydrological, climatic, ecological and other factors of a natural character; social and economic needs; the effects of the use of watercourses by one state on another state; existing and potential uses; conservation, protection, development and economy of the use of water and the costs of measures taken to that effect, and the availability of alternatives (Article 6).

178 United Nations Convention on the Law of the Sea (Montego Bay) 10 December 1982, in force on 16 November 1994, 21 I.L.M. (1982) 1261.

179 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London, Mexico City, Moscow, Washington D.C.) 29 December 1972, in force on 30 August 1975, 1046 UNTS 120. The Convention was adopted on 2 November 1973 at IMO and covered pollution by oil, chemicals, harmful substances in packaged form, sewage and garbage. It includes regulations aimed at preventing and minimizing pollution from ships - both accidental pollution and that from routine operations as laid down in various protocols (see http://www.imo.org).

180 International Convention for the Prevention of Marine Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78), 12 I.L.M. 1973/17 I.L.M. 1978; in force on 2 October 1983; it has 128 parties.

181 http://www.waterandclimate.org.

182 It also seems that formal recognition of geological carbon storage is absent in the climate convention and Kyoto Protocol (Torvanger et al., 2004).

able to have parties to the Climate Convention explicitly address potential conflicts with existing marine pollution agreements. If carbon storage is considered an environmentally viable option, these agreements should be amended (Heinrich 2002). At present, there are no major efforts to link Habitat with climate change. To the extent that the human settlements programme does not take climate change into account, there is potential for contradiction.

The *policy options* include:

- Given that climate change may have a major impact on the world's hydrological system,[183] it is likely to put existing uses and rights under considerable stress. Existing water allocation regimes based on property rights could be re-examined to permit more flexible responses to changed conditions in order to enhance synergies.
- Existing hydropower planning needs to take into account the possible impacts of climate change on these water systems before the investments are made.
- At the same time, the water regimes have historically, over the last two thousand years, confronted equity issues and have incrementally developed rules to deal with equity. In this area the climate regime could potentially draw lessons from the experience of the water regimes (Gupta, 2004).
- The seas and ocean regimes could explore the consequences of deep-sea carbon storage on their ecosystems.
- A formal common policy between the ICAO, IMO and the FCCC is needed to increase the pressure for cooperation and to ensure that the parties align their goals. Furthermore, unilateral action by individual countries or the European Union to reduce emissions could improve the situation (Oberthür 2003).
- In the area of housing, the climate agenda needs to be an agenda item of Habitat. This could include designing housing and settlements to minimize GHG emissions and ensuring that settlements in high-risk zones are avoided (or strengthened through disaster prevention measures).
- The climate adaptation agenda could be incorporated into the agenda of the Disaster Management Programme of Habitat, so that a common and comprehensive adaptation programme can be developed for vulnerable urban areas.
- In cooperation with Habitat and Agenda 21, the climate change regime could investigate further global-local partnerships, that is, cooperation programmes between the UN and the local municipalities to enhance implementation of the climate agenda. The International Coalition of Local Environmental Initiatives (ICLEI), a network of cities with far-reaching greenhouse gas reduction targets, could be one positive example. Another example is the Local Agenda 21 initiative.

9.2.8. Analysis and inferences

This section integrates the information provided thus far, first showing the links with the various regimes (see Table 9.1).

[183] The IPCC predicts that regions already facing water stresses are likely to face even more serious water problems in the future (Gupta, 2004).

Table 9.1 Comparative analysis of links, synergies, conflicts and lessons learnt

Regime	Links	Synergy potential	Conflict potential	Assessment	Lessons learnt
Poverty					
Development coop policy		√	√	+/-	
Land-use					
Forests and CBD	CPF and JLG	√	√	+/-	
Ramsar		√	√	+	
UNCCD		√		+	National co-ordination of goals
Agriculture and FAO	Observer	√		+	
Energy					
IEA	Observer	√	√	+/-	+
IAEA					
ECT		√	√	+/-	
Economic					
WTO	Observer	√	√	+/-	+
Investment			√	-	No
World Bank	Observer	√	√	+/-	+
GEF	Implementing agency	√		+	+++
Air pollution & health					
Ozone depletion	TEAP has met with IPCC	√	√	+/-	
LRTAP		√		+	Critical loads, BAT
WHO	Observer status and reports to SBSTA	√		+	+
Others					
Freshwater		√		+	Not formally
Oceans and seas		√	√	+	Use of standards
ICAO/IMO	Observer status	√		+	+
Human settlements		√		+	-

The following table sums up the adaptation and mitigation measures that emerge from this chapter, and the relevant tools and anticipated benefits.

Table 9.2 Measures, tools and benefits from an institutional - interlinkages perspective

Adaptation measure	Mitigation measure	Tool	Benefit
Poverty			
Integrating CC adaptation in development cooperation policy of Development Banks and developed countries		International and regional: mainstreaming	Increases synergies between aid policy and environmental assistance policy
Integrating adaptation policy into national developmental policies		National: mainstreaming	Increases synergies between different policy areas
Simple rules for adaptation funding		Within FCCC: Specific	Reduces transaction costs in implementation
Land use & agriculture			
Climate change within FAO: developing a sustainable agriculture policy		International: mainstreaming	Reduces GHG emissions and increases resilience of agriculture
	Climate change and Ramsar	International: MOU	Minimizes trade-offs between the regimes by prohibiting carbon credits from previously converted wetlands; zoning of fragile wetlands, promoting multi-functional land use
	Renewable energy sources in rural areas	National and international: rural development policy; public-private partnerships	Reduces deforestation and desertification; improves local health and development
National workshops on land-use and climate change		National: integration workshops	Explores synergies between deforestation, desertification, zoning, wetlands and CC; supports international efforts
Energy			
International partnership on sustainable energy options (IPSE)		International and regional: common forum	Develops common guidelines for a common sustainable development policy
Integrating CC in the energy investment policy of the Development Banks		International: MOU with the Banks	Enhances implementation of the sustainable energy policy
	Increased investment in renewable energy	International and national: protocol/policy on share of renewables in national energy	Collectively increases the share of renewables and hence decreases the costs.
	Increased investment in clean fossil fuel technology	Protocols on standards and sectoral agreements; public-private partnerships	Collectively promotes the use of clean fossil fuel technologies
Trade and Finance			
	WTO and FCCC	International: MOU	Discuss and addresses potential trade-offs, including the role of border tax adjustments and sustainability labelling
	Improve legal design of CDM	Within FCCC	Pre-empts legal conflicts with the investment regime
	Climate policy in FDI strategies of receiving and investing countries	National: mainstreaming	Prevents potential conflicts in investment
Air pollution and health			
	Better links to WHO	International: Common forum	To enhance synergies from both policy fields
	Develop a better monitoring	International: Common forum	To enhance synergies from both policy fields

	regime with EMEP		
	Align ODS policy to GHG policy	International: MOU with GEF/MP	To ensure mutually consistent policy
Other policy areas			
Re-examining property rights systems in water		Request to International Law Association to study this	Enhances the opportunities for adaptation in the field of water
Hydropower investments need to take impacts on water into account		See IPSE above	Minimizes investment into areas affected by melting glaciers
	UNCLOS needs to explore deep-sea carbon storage and impacts	International: measures within UNCLOS	
	Climate policy needs to be taken into account by IMO and ICAO	International: MOU	Minimizes trade-offs
Climate limitation and adaptation policy needs to be taken into account by Habitat		International: mainstreaming	Enhances synergies

The above table supplements Table 8.2 in Chapter 8. The policy options in both chapters can be integrated as follows in Table 9.3.

Table 9.3 Policy options to develop the climate change regime from a development and institutional interlinkages perspective

	National	International
Within FCCC	Research into national vulnerabilities National adaptation programmes Spatial planning, early warning and insurance schemes against storms, floods, pests, and epidemics	Simple rules for allocating adaptation funds Improvement of legal design of CDM to pre-empt investment disputes Amendment to include tropospheric ozone and soot Pilot phase on sector-based CDM and sustainable development PAMs A SBSTA working group on differentiation of targets A SBSTA/ILA working group on lessons learnt from equity principles in water law A global–local mechanism to promote local implementation
	Integrating NAPAs into PRSPs and NSSDs	
Outside FCCC	Mainstreaming CC adaptation policy in national development policy	Mainstreaming CC in FAO and Habitat International Partnership on Sustainable Energy Re-visiting existing property-rights-based water allocation in freshwater regimes. Exploring consequences of deep-sea carbon storage on ecosystems by the seas and oceans regime. Alerting countries to ensure that investment regimes do not contradict the climate change regime
	Mainstreaming CC adaptation policy in ODA, FDI	
Within and/or outside FCCC	National workshops on land-use: Protocol/Policy and/or PPS on demand-side management, reducing consumption, renewables, clean fossil fuels, fuel-switch in transport, renewable energy services for rural areas, and joint research agreement on new energy technologies Transnational sectoral targets in civil aviation and shipping sector	
Between FCCC and other regimes		MOU with Ramsar, the Development Banks, GEF, WTO, ICAO/IMO Common forum with WHO, EMEP, ISO

9.3 Conclusions: Alternative designs for a future climate change regime

9.3.1. Introduction

Section 9.2 explored the issue and institutional linkages between climate change and poverty, land use, energy, trade, investment and finance, and air pollution and health, as well as a selection of other issue areas. It concluded with a list of policy options for each issue area.

Authors have increasingly emphasized the merits of a fragmented approach towards abating climate change (e.g. Rinkema, 2003; Stewart and Wiener, 2003; Egenhofer and Fujiwara, 2003; Carraro and Galeotti, 2003). In contrast, others emphasize that it is crucially important that solutions be found in a multilateral framework (e.g. Müller et al., 2003). These approaches are, however, not as irreconcilable as they may seem. Even authors advocating a more fragmented approach recognize the importance of the multilateral system established under the climate convention. In fact, the assessment in Chapter 8 also concludes that the bottom-up approaches do not guarantee the emission reductions needed to address climate change, and that they will be most effective if undertaken within the context of a multilateral climate change regime.

9.3.2. Policy options

This chapter has examined the possible routes for strengthening the climate change regime by looking at the *issue* and *institutional interlinkages* between climate change and other regimes, and by examining the literature on how the climate change regime can be developed further.

The policy recommendations emerging from this section can be placed in four clusters: between the FCCC and other regimes, within and/or outside the FCCC, outside the FCCC and within the FCCC.

1. Between the FCCC and other regimes

1a Developing Memoranda of Understanding

One could argue that where the relationship is fairly straightforward but where other regimes are more or less reluctant to take action, it may make sense to develop a Memorandum of Understanding to create greater political will for action. This is discussed below for some regimes.

- GEF. It might make sense for the FCCC to sign a revised MOU with the GEF in relation to two other GEF areas, i.e. the Montreal Protocol and desertification, to optimize the synergies. For example, this would ensure that the GEF does not finance ODS substitutes that are GHGs and *inter alia* would provide financial support for the development of renewable energy sources (especially solar) in drylands, so as to reduce the demand for firewood and address climate change.
- ICAO and IMO. The actions to be taken by ICAO and IMO are quite clear, as there have been IPCC reports on the subject. The political bottlenecks for taking action are greater. One way to prioritize climate goals within ICAO and IMO is to develop a MOU with these bodies.
- Development Banks. Given that the World and Regional Banks play an important role in financing investment, and that there are often conflicts of interest between shareholder goals and environmental goals, it may also make sense to engage in MOUs with these banks. This would *inter alia* mean that hydropower planning would take into account the possible impacts of climate change on the water systems before making investments and that other energy investments would explicitly take climate change considerations into account.
- WTO. Developing a MOU with the WTO might help ease some of the anticipated problems between the two regimes.

1b. Development of common fora for cooperation

The development of formal fora for cooperation ensures institutionalized cooperation between regimes. On the basis of the above research we believe that there are five new areas in which such (improved) institutionalized cooperation may prove fruitful:

- Developing an International Partnership on Sustainable Energy Policy to include representatives from countries engaging in bilateral energy initiatives, multilateral energy initiatives and the climate change regime, as well as countries primarily dependent on fossil fuel exports. The purpose of such a partnership will be to develop comprehensive sustainable energy policy principles, so that the same principles are pursued in all the different fora. The partnership can discuss the risks of nuclear power, the potential for coal gasification, the possibilities for new sources such as hydrogen, etc. This can prevent problems such as encouraging the development of hydrogen in bilateral agreements, without taking into account ways to minimize the GHG implications.
- Establishing a joint working group between those working on adaptation within the FCCC and the WHO to optimize the adaptation strategies in relation to health.
- Establishing a joint working group between EMEP, IPCC and SBSTA to explore the potential of cost-effective cooperation in monitoring GHG emissions.
- Making Ramsar a full member of the JLG.
- Developing a joint working group with ISO to discuss common standards for technologies.

2. Within and/or outside the FCCC

2a Developing Protocols within the FCCC and/or independent regional/international agreements and/or public/private partnerships, which including, where appropriate, technology standards

- Promoting demand-side management through jointly set targets and best practices.
- Reducing consumption through public awareness programmes and social goals.
- Developing agreements increasing the share of renewable energy in a country's energy supply; this could help meet increasing energy needs, increase employment and development opportunities, while reducing balance of payment problems and local air pollution.
- Developing an agreement on clean fossil-fuel technologies and best practices.
- Encouraging fuel-switch in transport to gas in the short term and hydrogen in the long term.
- Developing transnational sectoral targets in highly internationalized sectors where a few multinationals control the world market such as civil aviation and shipping.
- Promoting small-scale renewable energy programmes through the CDM in rural areas in the developing countries; however, such programmes should be both affordable and sustainable, and integrated into rural development programmes.
- Promoting joint technological research and development through multi-lateral agreements. Such agreements could be undertaken as a protocol to the FCCC using, for example, an R&D levy of 1 US$ per ton so that all countries paying into the fund could become joint owners of the research. This could generate financial resources for R&D, address the fear of developing countries about technological dependency and promote research. Technologies could be developed; for example, energy-efficiency technology, more efficient fuel conversion, renewable energy, fuel switch in transport to CNG or LPG (and then to hydrogen), increased use of mass transit, energy efficiency in cooking stoves and decentralized renewable energy.

2b Promoting national workshops on:

- Land-use and climate change in order to integrate concerns relating to desertification, deforestation, and development with climate change. This is a necessary precondition for securing such interlinkages at international level, as can be learnt from the experiences of the CCD.

3. Outside the FCCC

3a. Mainstreaming climate change policy in international regimes

It might further make sense to mainstream climate change in other policy areas that maybe either directly affected by or have a direct effect on climate change. From the research, the following five areas appear to be particularly promising:

- Food and Agriculture Organization. Food production processes may have a major impact on GHG emissions and production systems, but are, in turn, vulnerable to the impacts of climate change. This implies that it is of vital importance to mainstream climate change concerns within the FAO and all its agencies.
- Habitat. The climate agenda also needs to be mainstreamed within the agenda of Habitat. This could include recommending that housing and settlements be designed to minimize GHG emissions and that settlements in high-risk zones be avoided (or strengthened through disaster prevention measures).
- Development policy. Mainstreaming climate change adaptation into the development policy of the developed countries and the major banks may also yield improved results. This also holds for the Poverty Reduction Strategy Papers, which should be implemented in the developing countries.
- Foreign Direct Investment (FDI). Climate change policy needs to be mainstreamed in FDI strategies and not just in aid policies, since the former stream is larger than the latter. This can be done by promoting demand-side management in countries, reducing perverse subsidies and calling on countries to make guidelines for FDI. A 'grand bargain' between phasing out subsidies in OECD countries in return for phasing out subsidies in the key developing countries is one of the options that could be considered.
- Sectoral policy. Mainstreaming climate change policy in national sectoral policy is essential to helping developing countries integrate adaptation thinking into their planning processes. Mainstreaming can be enhanced through development cooperation, but also by knowledge exchange within the FCCC or NGOs.

3b Mainstreaming climate change policy in national and international contexts
- Climate change policy needs to be mainstreamed into the development cooperation policy of the rich countries.
- Climate change policy needs to be mainstreamed into the policies of developing countries that affect foreign direct investment in their countries. It also needs to be included in advice given to multinationals by the developed countries where appropriate.

3c Specific measures in other regimes
There are also some issues on which other regimes may wish to take specific action, such as:
- Fresh water. Given that climate change may have a major impact on the world's hydrological system, it is likely to put existing uses and rights under considerable stress. Existing property-rights-based water allocation regimes could be re-examined to permit more flexible responses to altered conditions in order to enhance synergies.
- Seas and oceans. These regimes could explore the consequences of deep-sea carbon storage on their ecosystems.
- Investment regimes: There are so many investment regimes that it becomes difficult to find a "body" to send a message to, but the point to make is that investment regimes need to take environmental goals into account. Countries and NGOs need to be alert on this issue and try to ensure compatibility whenever such agreements are being (re-)negotiated.

3d Mainstreaming climate change policy in national contexts
- Climate change adaptation policy needs to be mainstreamed into national policy making processes if it is to be prioritized in an efficient manner.

4. Within the FCCC
4a At the international level
- Exploring how to develop simple rules for funding adaptations in joint working groups of the FCCC and the aid agencies.
- Improving the legal design of CDM to pre-empt investment disputes.
- Optimising cooperation with Ramsar, CBD and CCD, the climate regime should: (a) prohibit carbon credits from previous, converted wetlands and provide additional resources for wetland management; (b) promote zoning and monitoring of fragile ecosystems as one way to conserve these from the impacts of climate change policy measures; (c) develop the concept of multi-functional land use; and (d) synchronize land subsidies and incentives so as to optimize the multifunctional use of land by land owners and users and to promote the protection of zones.
- An amendment and/or annex to the climate change treaty to include tropospheric ozone and soot as GHGs.
- More research into the feasibility and attractiveness of sector-based CDM and sustainable development PAMs, including a possible pilot phase.
- A SBSTA working group should work on a comparative analysis of the different approaches for designing targets for all countries, including the long-term implications for international law as a first step towards developing new targets and timetables.
- Establishing a SBSTA and ILA working group to examine lessons on equity from freshwater regimes that have a 2000-year history.
- Establishing a mechanism for global-local partnerships to promote implementation just as Habitat and Agenda 21 already do.

4b At the national level
- Encouraging research into national vulnerabilities.
- Encouraging the development of national adaptation plans.
- Encouraging spatial planning, early warning systems, insurance schemes for damage due to storms, floods, pests and epidemics.

4c At the national and international level
- Integrating the NAPAs into the PRSPs and the NSSDs.

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10. Beyond climate: synthesis and conclusions

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10.1 Introduction

International and national climate policies, i.e. the UNFCCC and the implementation of the Kyoto Protocol, are currently not well linked to other policy areas. Connections between climate policies and broader development issues that are in the center of policy attention are poorly developed. The level of policy integration differs from country to country; some progress in integration is made for energy and air quality policies.

Climate change policy will benefit from being framed in a coherent and consistent policy context. Maximizing the synergies of climate change with other policy fields could improve the effectiveness of climate policy as well as to contributing to other policy fields, and in this way also increase the acceptability and support of climate policies in these policy fields. It will also help to prevent the climate risks of unfavourable developments in other policy areas. Options for broadening climate policy have been analysed in this report. Addressing the long-term climate change challenge will therefore require broadening the spectrum of governments, sectors, scientists and decision-makers beyond those involved at present. To be able to improve coordination and reap the benefits of mainstreaming climate change concerns in other policy areas, the climate policies introduced through the UNFCCC and its international and national implementation (referred to further as the 'climate policy track') could be complemented with a 'non-climate policy track'. This 'non-climate track' could be developed with the aim of systematically broadening climate policy to other policy areas, for instance, to poverty or land-use policy.

This report has identified the possibilities for such an approach arising from the analysis of a selected number of policy areas and exploration of the implications for adaptation and mitigation policy. This analysis in this report is not meant to represent an extensive analysis of all relevant policy areas, nor does it imply a prioritization, i.e. the most important policy areas. Rather, the report illustrates what might be achieved through a supplementary 'non-climate policy track'. The following climate-relevant policy areas were addressed in Chapters 2 to 6: poverty reduction (Chapter 2), land use (Chapter 3), security of energy supply (Chapter 4), trade and finance (Chapter 5), and air quality and health (Chapter 6). The research questions pertaining to these chapters are:

1. In what way do the respective policy areas *interact with climate change,* and what are the technical and/or policy options for exploiting possible synergies and dealing with trade-offs?
2. What are the *most promising options and concrete policy recommendations* for addressing the respective policy problems and, at the same time, encouraging low emission economies (mitigation) and increasing resilience to climate change (adaptation)?

Chapters 7, 8 and 9 are partly built on the analysis in the previous chapters, and give insight into how a 'non-climate' policy track aiming at broadening climate policies could relate to future climate adaptation and mitigation policies. The questions addressed in these chapters are:

3. How can a 'non-climate track' be linked to climate change *adaptation and mitigation policies*?
4. How can *(inter)national policies* contribute to mainstreaming climate change in other policy areas?

10.2 General conclusions

The possibilities to enhance the effectiveness of climate policy through mainstreaming climate change concerns into other policy areas depend on the potential synergies of linking with other policy goals, the potential trade-offs, the means to establish such links, the timing of action, the feasibility of implementation and the interlinkages with other issues.

Is there a potential for climate co-benefits in policy areas covered in this report?

Chapters 2 to 6 show considerable potential for addressing climate change through actions targeted at other policy objectives on a no-regret basis. More detailed conclusions touching on poverty, land use, security of energy supply, international trade and finance, and air pollution and health are provided in 10.3. Although not included in this report, other policy areas may contain a similar potential and could be worth investigating, development of technology and water for example.

If there is so much potential, why have these synergies not yet been captured?
The need for policy integration within the environmental domain and external integration of environment in other societal domains has long been recognized, but progress has been limited. Reasons for this are lack of knowledge or awareness on actual possibilities, bureaucratic inertia (compartmentalization, lack of capacity and lack of incentives) and vested interests, but also the complexities in terms of numbers of actors and issues to be included when combining policy agendas. Very few delegations in the UNFCCC negotiations manage to involve participants from ministries with responsibilities other than environment and foreign affairs, whereas climate policy is directly related to activities of a large number of ministries: energy, agriculture, infrastructure, water, transport and economic affairs, to name but a few.

What are the characteristics of the non-climate policy track?
The 'climate track' refers to climate policies that reside under the UNFCCC and its international and national implementation. The 'non-climate track' refers to policies that contribute to realizing climate goals by treading through other policy areas. These policies can be implemented at local, national and various international levels. The appropriate level of action depends on the specific questions for a policy area. It requires recognition of the fact that a specific policy area does have an interest in mainstreaming climate changes and climate policy makers can support this awareness. One could also note here that combining policy agendas needs to be accepted at national level before it will really move forward at international level, as countries decide on the international level. Integration at the local level is important for poverty reduction, land-use and some air quality issues. The national and international levels are important for security of energy supply and subsidy questions. The international level may be more important for other air quality problems, trade and finance, and other environmental issues (e.g. biodiversity and desertification).

The reason why a 'non-climate policy track' may succeed is that outside climate policy many policies and measures can be taken to realize other specific policy goals that happen to be beneficial from a climate adaptation or mitigation perspective. A non-climate track could integrate climate into these other policy areas, i.e., 'mainstreaming climate change' to increase the chances of climate friendly or climate proof action.

How might a non-climate policy track be part of adaptation and mitigation policies?
For adaptation policies it is suggested in this report that a non-climate policy track needs to be a crucial component of any policy effort to decrease the vulnerability of humans and ecosystems to climate change, in particular, in the short term. Climate change needs to be integrated in all relevant national and sector planning processes, and the sooner the better, given the inevitability of climate change impacts. This is of great importance for development planning and development assistance, especially within developing countries.

For mitigation policies, this report concludes that target setting, timetables and instruments and mechanisms for mitigation will need to be established through the climate track if environmental integrity is to be guaranteed (to realize the EU climate target, for instance). The non-climate track issues will be essential for the implementation of an international and national mitigation strategy. It draws attention to targeting (alternative) policies and measures that are attractive because they can be taken on the basis of non-climate concerns and are, at the same time, also climate friendly.

How can a 'non-climate track' be implemented?
Implementing the non-climate track as part of an international strategy could start immediately independent of the UNFCCC. Climate policy makers could take the iniative for this. Progress through a non-climate policy track may also help generate momentum for the UNFCCC negotiations, as it could help to build confidence between Parties if action beneficial to climate is taken in other areas without formal linkage to UNFCCC.

In other policy areas broader awareness is needed of the importance of climate change and the opportunities climate measures may also offer. If there is political will and a sense of urgency to include climate concerns in these policy areas, many opportunities for action do exist. It is thus important that the way climate policy could be beneficial to other policy objectives is further substantiated and more broadly understood. Climate policy needs to be regarded as an issue that can be dealt with, along with realizing primary policy objectives and maybe even offering opportunities for doing so. If sufficient political will is present, mechanisms for implementation could be installed.

A key requirement for an effective non-climate policy track would be co-ordination between different policy areas to achieve policy coherence for a consistent policy framework. The report identifies a number of policy options to improve the institutional and organizational interlinkages between the climate regime and other regimes. These vary from the development of common fora, Memoranda of Understanding, mainstreaming measures, specific measures in other regimes and specific climate-change measures. These are further elaborated in section 10.6.

10.3 The most promising options for dealing with climate change in other policy areas

Although the detailed analysis featured in Chapters 2 to 6 differs in scope, detail and level of concreteness, it does provide material for concrete conclusions and policy recommendations in each field. A summary of the main outcomes of the analysis on poverty reduction, land use, security of energy supply, trade and air pollution and health is followed by identification of the most promising options for linking the respective policy areas with climate change.

Chapter 2 addresses the relationships between climate change and poverty reduction - relationships that should be understood in the wider context of the dynamic interactions between human and natural systems, socio-economic development paths and climate change. The Sustainable Livelihood framework is a useful tool for indicating the dimensions of these interactions. As such, this framework could be considered as the basis for the formulation of poverty reduction strategies, and for integrating of vulnerability assessments and adaptation measures in these strategies.

Synergies may be obtained through proper selection of strategic entry points for adaptation to climate change programmes. Such entry points are provided in the following three closely related areas: (1) reducing the vulnerability of livelihoods; (2) strengthening local capacity (institutions, skills and knowledge) and reducing sensitivity (in particular, the sensitivity of production systems to climate change); (3) risk management and early warning. Development planning mechanisms such as those underlying Poverty Reduction Strategies processes appear, at least in principle, to be suitable for mainstreaming adaptation. There is experience available on which ‘best practices’ could help to achieve mainstreaming.

Chapter 3 on land-use and climate change shows that the fundamental differences in infrastructure, economic and human capacity, socio-political systems and environmental awareness between industrialized and developing countries need to be taken into account when considering implementation of adaptation and mitigation policies into land-use practices and rural development. Land-use systems such as carriers of essential functions and providers of basic needs to both industrialized and developing countries are partly shaped by climate. Improving the resilience of current land-use systems constitutes a start for incorporating climate change and climate variability into current land-use policies. But also when designing new forms of land use or when executing rural development programmes aiming at long-term sustainability, incorporating climate change and climate variability can reduce vulnerability and loss on investment. Such strategies would also help reduce poverty through more productive agriculture and sustainable forestry. Extra efforts to adapt to changes in climatic conditions will be necessary for vulnerable areas and groups.

Chapter 4 on security of energy supply notes a growing tension between the growing energy and fossil fuel needs on the one hand and the need to reduce CO_2 emissions and the limited number of countries that control the available resources on the other. Reducing energy dependence (for example, through improving energy efficiency and diversification of energy sources) and ensuring energy supply security (by establishing links with the supplying countries) are national objectives in many countries. This is hard to realize on a supranational level, although some groups of countries co-operate via organizations such as the International Energy Agency. Climate change mitigation is usually not considered when increasing security of energy supply. Regional circumstances impact the available and possible options for integrated security of energy supply and climate change mitigation policies. Many regions cannot do without fossil fuels to meet energy demand and it would be a necessity to at least reduce the negative impacts of their use. Using technologies that are not compromising the interests of the fossil-fuel exporting countries, such as CO_2 capture and storage or hydrogen production could prove beneficial to international relations while helping to mitigate climate change. Economic incentives (such as an international emissions trading market) may help to internalise climate change mitigation in decision-making on energy supply by including the price for CO_2 emissions in the overall cost-benefit analysis. It could even be agreed between fossil-fuel exporting countries and industrialized, fossil-fuel importing countries that transfer of climate friendly technologies could be exchanged with fossil fuels delivery. Large oil and gas companies could be vehicles for such international technology initiatives, ideally via principles of corporate social responsibility and voluntary agreements, otherwise enforced by legislative measures on energy efficiency and environment.

Chapter 5 on trade and finance indicates that trade policies offer limited opportunities to enhance climate policy. Environmental policies aimed at incorporating the negative environmental external effects of production processes could affect trade flows towards more sustainable production. The chapter has identified the areas of subsidy reform in agriculture and energy as being crucial to using trade and finance regimes to address climate change. It also contains proposals to design a ‘double-switch’ approach that moves towards rewarding farmers/land-owners for services furthering nature conservation and land stewardship. Resources released from subsidy removal could be used to compensate OECD farmers and thereby finance a system of payments that encourage nature conservation and land stewardship. A Grand Bargain is proposed for the energy sector. The vision behind this arrangement is that if OECD countries were to remove and ban fossil fuel subsidies and assist non-OECD countries in their energy subsidy reform through financial and technology transfers, they would require that non-Annex-I countries join the regime and accept national ceilings on GHG emissions in return as part of the bargain.

Chapter 6 on air pollution and health indicates that air pollution as a severe problem in both developing and industrialized countries, and that in both there is much room for improvement of air quality. There is also potential for synergies in air pollution and climate change policy, especially in the technological measures taken, because the main causes of both air pollution and climate change lie in the burning of fossil fuels. Furthermore, policy harmonization has been found necessary to capture synergies, but fully integrating the two policy areas is not viable because the time scale and location of impacts and measure effects will make the formulation of common goals and targets virtually impossible. However, structural integration of air and climate policy could be achieved by including ozone and soot in either international climate or non-climate agreements. These substances directly link air and climate problems. The importance that countries attach to health and air quality may result in addressing climate change by essential countries in climate negotiations (e.g. United States and China) in an indirect way, namely, via measures reducing air pollution, such as energy efficiency or clean coal technologies. There is usually more support for measures against air pollution than for climate change mitigation. This could be used for the improvement of climate change mitigation.

The most promising options are summarized in Table 10.1. These were identified on the basis of a multi-criteria analysis, the benefits the option offers for climate and the suitability for the policy area itself. The criteria included environmental, technological, ease of implementation and socio-economic criteria. The table aims at providing an overview of options for mainstreaming climate change in the appropriate policy areas. Many opportunities do exist for synergies between climate and the different policy areas, but implementation cannot automatically be assumed. Implementation requires careful attention as the most promising options in different fields have significantly different characteristics and also differ in time-scale of implementation, costs and geographical distribution.

Table 10.1 Promising options, and relevant countries and regions, for the non-climate policy areas.

Issue	Mitigation/ Adaptation	Area of interaction	Relevant countries or regions	Most promising options for integrating climate change policy
Poverty/vulnerability	A	Synergy: sustainable livelihoods as an approach to reducing poverty and dealing with climate change	Developing countries	Three strategic entry areas for adaptation: (1) reduction of vulnerability of livelihoods; (2) strengthening of local capacity and reduction of sensitivity; (3) risk management and early warning.
	A	Synergy: Poverty Reduction Strategy Papers and National Strategies for Sustainable Development	Developing countries	Combination of PRSPs and NSSDs in an integrated framework. Mainstreaming of adaptation measures and programmes and measures to achieve low emission economy in PRSP-type of mechanisms, using documented 'best practices'
Energy for development	M	Synergy: providing energy for development	Developing countries	Connecting rural households by means of renewable energy or improved traditional sources
Land-use	A	Synergy: effects of flooding in degraded and deforested areas	Semi-arid regions, Southern Europe, parts of the USA and China.	Arrange landscape mosaic so as to minimise the effects of flash floods.
	A	Synergy: drought prevention		Early warning systems aimed at land managers
	A	Synergy: extreme events prevention (fire, storms)		Landscape arrangement and insurance
Security of energy supply	M	Synergy: more efficient use of energy	Global	Energy saving policies to reduce demand
	M	Trade-off: use of coal to meet increasing energy demand	India, China	Policy package for more efficient and cleaner fossil fuel use and incentives for development of new low-CO_2 coal technologies (including CO_2 capture and storage)
	M	Synergy: reduced use of fossil fuels through use of renewable energy	Energy dependent countries with much potential for renewable energy	A large portfolio of RES does exist (see for instance IRC Bonn (2004). There are many interests that can be served by RES application. Countries and parties may overlook some of these and could be encouraged by helping them to see the interests
	M	Synergy: reduction of energy use subsidising	All countries Subsidizing Energy use, e.g. USA, Russia, EU	Energy prices should reflect economic *and* external costs
	M	Trade-off: conviction enhancing renewables means an economic threat to energy-exporting regions in the world	OPEC, GECF, United States	Technological co-operation in climate-friendly fossil fuel applications: in fossil-based hydrogen, CO_2 capture and storage and clean fossil fuel technologies

Issue	Mitigation/ Adaptation	Area of interaction	Relevant countries or regions	Most promising options for integrating climate change policy
Trade and finance	M	Trade-off: huge investments still targeted to fossil fuel investments	Global	– Reducing energy consumption so less investment is needed – Providing GHG taxes or border tax adjustment to favour climate-friendly Foreign Direct Investment
Air pollution/Health	M	Synergy: urban air pollution Finds its causes in the same activities as greenhouse gas emissions	Global	Policy harmonization: – Energy conservation in supply and demand – For transport, fuel switch to gas and in the longer term to hydrogen; mass transit systems and vehicle maintenance programmes – Decentralised renewable energy for electricity, cooking and lighting;
	M	Trade-off: transboundary air pollution (SO_2 and NO_x) is currently mostly mitigated by end-of-pipe technology	OECD; long term: also in industrialized developing countries	Policy harmonization: Demand reduction and efficiency measures, or only climate-friendly end-of-pipe measures
	M	Synergy: access to modern energy services in rural areas reduces indoor air pollution and GHG	Developing countries	Modern energy services by renewables, more efficient heating and cooking techniques and clean fossil fuels use
	M	Synergy: both ozone and soot are significant air pollutants; both are contributing to climate change	Global	Policy integration: include ozone and soot in climate negotiations, possibly in trading system
Subsidies	M	Trade-off: energy subsidies favour greenhouse gas emitting activities	Global	Reduction or elimination of subsidies for fossil fuels, more subsidies for climate-friendly energy supply as part of electricity reform
	A	Trade-off: current agricultural subsidy regime is not enhancing resilience or sustainable land-use	Global	Broad 'double-switch' reform of subsidies moving towards rewarding farmers for sustainable land-use and reducing vulnerability
Agriculture	A	Synergy: drought resistance	Especially important in subsistence agriculture	Increased water use efficiency, improved soil crop management, insurance
	A	Synergy: more efficient use of inputs (nutrients and water)		Precision agriculture, improved soil and crop management
	A	Synergy: more resistance against pests and diseases		Research needed into more resilient crops; Insurance
	A	Synergy: dealing with climate variability		Early warning systems, also helpful to deal with climate change
Soils and sinks	M	Synergy: combat land degradation, overexploitation	Global	Intensification of agriculture freeing land for carbon management. Extensification: enhancing carbon management, zero tillage

10.4 The non-climate policy track as part of the adaptation and mitigation policies

Based on the results of Chapters 2 to 6, Chapters 7 and 8 explored the possibilities for a non-climate policy track as part of climate adaptation and mitigation policies.

Chapter 7 discussed the topic of adaptation as part of the non-climate track in future climate change policy. Some climate change impacts are expected to be unavoidable and therefore adaptation will be needed. Major questions in adaptation policy concern the level at which the policy should be shaped and coordinated within the UNFCCC or outside the Convention, and whether it should be financed under the UNFCCC or by other sources.

For adaptation to climate change, a non-climate policy track it is concluded that it would be a necessary component of any policy effort to decrease the vulnerability of humans and ecosystems to climate change, in particular, in the short term. Climate change needs to be integrated in all relevant national and sectoral planning processes, the sooner the better, given the fact that climate change impacts are inevitable. This is of great importance for development planning and development assistance. Table 10.1 provides insight into how adaptation measures are often highly synergetic with poverty reduction, sustainable land-use and a general reduction of vulnerability to climate extremes. Therefore in terms of conflicting policy interests, mainstreaming of adaptation is unlikely to cause problems; however, it has to be recognized that especially developing countries will generally find it difficult to take up new issues in their priorities.

In the operationalization of the climate and non-climate track, attempts can be made to secure funding for climate change adaptation under the climate regime, and at the same time also to improve mainstreaming of climate risk management into development plans. It could be opportune for developing countries to agree on partial funding under agreed cost-sharing rules, rather than under complicated incremental cost calculations. Some practical experience in using simplified rules can be gained from pilots that have recently started under the GEF strategic priority on adaptation. Using simplified rules for incremental costs and paying less attention to the issue of global environmental benefits would speed up the implementation process. However, substantial commitment to fund adaptation measures from Annex I countries would be needed if funding adaptation under the Convention were to cover a substantial part of the costs. Mainstreaming climate change into other development processes and risk management is thus also needed; some opportunities are elaborated in chapter 7. Opportunities for additional funding can also be found outside the Convention. The linking of the UNFCCC with other conventions and institutions could be improved, although resources for funding under other conventions are likely to be even more limited. Linking to risk management practices in national sectors as well as multilateral donor institutions appears to be viable, since the reduction of weather-related natural disasters is gaining attention. Enhanced financing for disaster preparedness from UNFCCC funds and disaster relief funds could be an option for the short term, in order to meet the most urgent needs. Adaptation measures have strong interaction with the policy areas of poverty and land use, for which the priorities need to be incorporated into whatever adaptation policy is agreed.

For mitigation policies this report concludes that target setting, timetables and instruments and mechanisms for mitigation need to be established through the climate track, if environmental goals and targets need to be guaranteed (to realize for instance the EU climate target). The non-climate track issues could be essential for the implementation of an international mitigation strategy. It draws the attention to targeting (alternative) policies and measures that are attractive because they can be taken on the basis of non-climate concerns and are the same time also climate friendly.

The analysis in chapter 8 focuses particularly on so-called bottom up approaches to defining future climate mitigation commitments and the linkages with other policy areas. Such types of commitments are not based on quantitative emission targets like in the Kyoto Protocol, but on policy measures. It can thus be expected that these allow more for linkages with other policy areas than the top-down approaches based on emission reduction targets. Such bottom-up policies are likely to become more important in post-2012 climate regimes than presently, as the group of countries with mitigation commitments may be extended to developing countries and become more diverse. In examining the strengths and weaknesses of bottom-up instruments for international climate policy making it is concluded that they do not seem to offer a full alternative to a climate regime defining quantified emission reduction and limitation targets as the provide little certainty about the overall effectiveness of climate policies. However, they offer particularly interesting opportunities for additional components of a future climate regime and for defining contributions of developing countries to mitigation and for enhancing the integration of climate policies in other areas of policy making, promoting sustainable development.

Building on Barrett (2002) - see also chapter 8 - a distinction could be made between a push and pull component of a climate change strategy. An agreement on emission reductions and adaptation (the climate track) could be considered as the pull factor and the non-climate track as the push factor. If in other policy areas things will move while climate concerns are included (as a result of a non-climate policy track) this will also drive the climate agenda forward. The recommendation to policy makers is to develop climate strategies that include both pull and push factors.

The conclusions on developing a non-climate track of climate policy making that reduce the vulnerability to climate change (adaptation perspective) and economic development with low emissions (mitigation perspective) can be summarized as follows:

Decrease vulnerability to climate change	Economic development with low emissions
• Mainstreaming climate in development and sector planning should be core of adaptation track. • Mainstreaming adaptation has to start now and should not be an add-on in decision making. • Mainstreaming helps to deal with part of the costs of adaptation. • Sustainable development as a lead could induce short-term policies to adapt to present climate variability and change that fit within long term strategies to deal with long term impacts of climate change. • Enhance collaboration with other conventions and sectors.	• Alternative policies and measure that are directly related to interests of countries come to the forefront. • Action can be taken now. • A non-climate policy track alone can not guarantee environmental integrity. • Non-climate policy track essential component of the implementation of an international climate strategy. • A regime based on targets and flexible mechanisms will be the pull factor of such strategy. • The non-climate track will as a push factor especially help to strengthen the long term component of the climate regime.

10.5 The institutional perspective

A major issue is not only *which* promising options are available, but also especially *how* climate change could become part of the core of policymaking at the different policy levels. Key requirement for an effective non-climate policy track would be improved co-ordination between different policy areas to achieve policy coherence. Countries could realize improved co-ordination with a variety of options:

- Within the UNFCCC context (e.g. in the design of the convention). This includes measures within the UNFCCC aimed at minimizing contradictions and maximizing synergies with other regimes (such as pre-empting investment disputes through a proper design of the CDM, and improved co-operation with the multilateral environmental agreements). Furthermore, reporting obligations, analogous to the ‘national communications’ under the UNFCCC could be part of the instrumentation.
- Between the climate change policy area and other policy areas (with a legal mandate through Memoranda of Understanding). The conclusion of a Memorandum of Understanding with the GEF, ICAO and IMO and WTO provides a formal legal mandate for co-operation, and may address the political bottlenecks with regard to climate change in these policy areas. Other options would be the streamlining of existing obligations under various treaties and the establishment of common ground for a co-operation, such as a possible International Partnership on Sustainable Energy Policy. The synergies between the climate change and other policy areas may be enhanced through institutionalized co-operation.
- Through other policy regimes (on a voluntary basis through mainstreaming). This includes the mainstreaming of climate change concerns in policy areas that are directly affected by or have a direct effect on climate change, such as FAO and UN Habitat policies and foreign direct investment strategies. Spe-

cifically, climate change adaptation concerns could be mainstreamed into the development policy of the developed countries and the major banks.

- Mainstreaming is also important at the national level. Inter-ministerial task forces could make a significant contribution in this sense (through exchange of information, creating consistency in national policy with regard to climate change, understanding of the various aspects of climate policy, etc.), although these forces tend to carry less authority or political weight than governments.

On the international level, several organizations and conventions are already looking into climate change. The IEA, for instance, is clearly linking security of energy supply to climate change mitigation goals. The Convention on Long-Range Transboundary Air Pollution is looking into up-scaling models on air pollution to cover global problems and considering CO_2 in its protocols, and thus following the research results on synergies with climate mitigation measures with interest. The United Nations Convention on Combating Desertification and Convention on Biological Diversity take part in a Joint Liaison Group with the UNFCCC, to which also the secretariat of the Ramsar Convention is an observer. On the national/supranational level, the EU is looking into synergies between air and energy policy. In national environmental departments, policy areas are often combined into one work unit. The opportunities for mainstreaming climate policy (see Chapter 9) attributed to the different climate-related policy areas are indicated in Table 10.2.

Table 10.2 Windows of opportunity in institutional inter-linkages between climate change and other environmental and economic agreements, and intergovernmental organizations

Issue linked with climate change	**Institutional linkages and opportunities**	**Window of opportunity**
Poverty	– UNFCCC, GEF, and the Adaptation Fund, Disaster Reduction Community	– Funding of adaptation-related activities
	– World Trade Organization	– Doha-round, including subsidy reforms on agriculture
	– Millennium Development Goals	– Review of progress taking place in 2006, show importance of climate change for realizing MDGs
	– Fresh Waters Convention	– MEA co-ordination UNEP
Land-use	– Ramsar Convention on Wetlands	– Joint Liaison Group, MEA co-ordination UNEP
	– United Nations Convention on Combating Desertification	– Joint Liaison Group, MEA co-ordination UNEP
	– Convention on Biological Diversity	– Joint Liaison Group, MEA co-ordination UNEP
Trade and finance	– World Trade Organisation, IMF, World Bank, Regional Development banks, OECD	– Greening of the decisions – Greening of regional trade and investment agreements
Air quality and health	– UNFCCC	– Ozone and soot in international climate agreements
	– Convention on Long-Range Transboundary Air Pollution	– Include CO_2
	– Montreal Protocol	– Exclusion of greenhouse gases as CFC substitutes; aligning financial mechanisms MP and UNFCCC
	– World Health Organization	– Intensification of existing co-operation
Energy for development	– CSD-2006/2007	– Energy and climate on the agenda in the next CSD cycle – Use PPPs set up after WSSD
	– Millennium Development Goals	– Energy for development more prominent within MDGs, review of progress taking place in 2006

Security of energy supply	– OPEC, Gas Exporting Countries Forum, IEF, IEA, IAEA	– Use high oil prices to attract attention of potential of combining both agendas
Subsidies	– World Trade Organization	– Special focus on subsidies counterproductive to climate change mitigation
Agriculture	– Food and Agricultural Organization of the United Nations	– Intensification of existing co-operation
Soils and sinks	– United Nations Convention on Combating Desertification and Convention on Biological Diversity	– Use carbon sinks as bases for improved co-ordination
	– United Nations Forum on Forests	– This forum is exploring the possibilities to become a convention

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