adaptation

PROGRESS ON ADAPTATION TO CLIMATE CHANGE IN DEVELOPED COUNTRIES

AN ANALYSIS OF BROAD TRENDS

Frédéric Gagnon-Lebrun and Shardul Agrawala

OECD

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Foreword

Since 2002, the OECD has been working on adaptation to climate change in the context of development co-operation. During 2005-06 new work was also initiated on adaptation in developed country contexts. This report on "Progress on Adaptation to Climate Change in Developed Countries: An Analysis of Broad Trends" (ENV/EPOC/GSP(2006)1/Final) is an output from this work.

Frédéric Gagnon-Lebrun (Écoressources Consultants) and Shardul Agrawala (OECD) have authored this report. The authors are grateful for comments and other valuable input from Simone Gigli throughout the production of this report. Comments from delegates to the OECD Working Party on Global and Structural Policies, and from Georges Beauchemin, Tom Jones, Simon Jetté-Nantel, and Joel Smith are also gratefully acknowledged.

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List of Abbreviations

CHF	Swiss Francs
COP	Conference of the Parties (to the UNFCCC)
DEFRA	Department for Environment, Food and Rural Affairs (United Kingdom)
EC	European Commission
EITs	Economies in Transition
GHG	Greenhouse gas
IPCC	Intergovernmental Panel on Climate Change
NC	National Communication
NC1	First National Communication
NC2	Second National Communication
NC3	Third National Communication
NC4	Fourth National Communication
NGS	National Greenhouse Strategy (Australia)
OECD	Organisation for Economic Co-operation and Development
UKCIP	United Kingdom Climate Impacts Programme
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
US$	United States Dollars

Executive Summary

This paper provides an assessment of broad trends in progress on assessment and implementation of adaptation to climate change in "developed countries", defined here as being Member states of the OECD and/or Parties listed under Annex I of the United Nations Framework Convention on Climate Change (UNFCCC). Primary inputs to this analysis are the National Communications (NCs) by these countries to the UNFCCC. NCs follow a standardised reporting format which facilitates cross-national comparison. They also reflect "whole government" perspectives. At the same time, however, the coverage of particular issues within these documents need not be comprehensive, nor might it necessarily reflect policy priorities on the ground. Therefore, this paper also examines other policies and projects which highlight progress on implementing adaptation, but which have not been reflected in the NCs.

The analysis shows that climate change impacts and adaptation receive limited attention within the NCs relative to the discussion of greenhouse gas emissions and mitigation policies. Within the discussion on impacts and adaptation in the NCs, it is the assessment of future climatic changes and impacts that tend to dominate. The discussion on adaptation, meanwhile, is often limited to the identification of generic options. Some developed countries do identify existing policies, particularly in the area of natural hazards management, that might be synergistic with adaptation to climate change. However, only very few countries currently report on actual implementation of anticipatory measures that take into account future climate change.

A preliminary review was also conducted of adaptation-related initiatives that have not (yet) been covered in the NCs. This review indicates that there is, in fact, a small but growing number of cases where climate change is being considered in anticipatory planning. Some of these measures were undertaken as "one-off" projects more or less autonomously by engineers and project managers, particularly in the design of long-lived infrastructure. More recently, there is also a more concerted effort in a few developed countries to develop more comprehensive national and regional adaptation strategies and frameworks. This is clearly an encouraging sign, although it is too early at this stage to assess the eventual impact of such measures.

1 Introduction

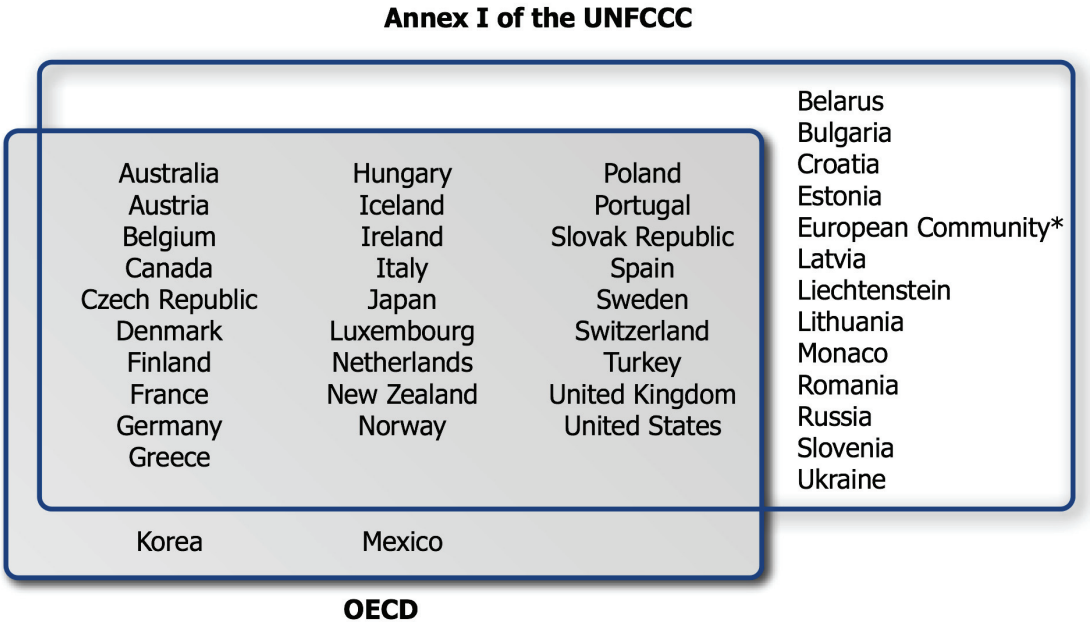
In recent years adaptation to climate change impacts has slowly established itself as an important and complementary response to greenhouse gas (GHG) mitigation. However, adaptation is still regarded as a priority primarily for developing countries. This is on account of two reasons. First, developing countries have a relatively larger proportion of their population dependent on climate sensitive natural resources. Second, they typically have significantly lower adaptive capacity, thereby making them much more vulnerable to the potential impacts of climate change (IPCC 2001b).

Considerably less attention has been paid thus far to the experiences of developed countries in planning and implementing adaptation measures. This is a significant research gap that deserves greater attention for two main reasons. First, many of the observed and projected climatic changes are considerably greater in temperate latitudes where many developed countries are located (IPCC 2001a). Therefore, the need to adapt to these changes might be quite significant. Second, developed countries have access to considerably greater technical and financial resources and often have a stronger institutional base, both of which provide a better enabling environment for adaptation planning. Examining developed country experiences can therefore highlight examples of good practices and know-how, as well as identify constraints and limits to adaptation. Such insights would be valuable not only for other developed countries but for developing countries as well.

This paper provides an assessment of broad patterns in progress on analysing, prioritising, and implementing adaptation measures in developed countries. In this paper, the term "developed countries" is used rather broadly and includes the 30 Member states of the Organisation for Economic Co-operation and Development (OECD) and/or the 41 Parties identified under Annex I to the United Nations Framework Convention on Climate Change (UNFCCC).[1] The two have overlapping membership, as shown in Figure 1. Annex I countries also include several Economies in Transition (EITs), which are not OECD members. On the other hand, (South) Korea and Mexico are members of the OECD, but are not included in Annex I of the UNFCCC.

[1] This includes the six countries added to Annex I by an amendment that entered into force on 13 August 1998.

Figure 1. "Developed countries" covered in this analysis



2 Scope and framework

While progress on mitigation can be interpreted from trends in national GHG emissions, no such measurable outcomes exist for adaptation. Further, adaptation measures are often embedded within a complex web of decisions undertaken by a range of public and private actors. While there have been attempts to develop frameworks for judging the success of adaptation measures (*e.g.*, Smith and Lenhart 1996; Adger *et al.* 2005), it is difficult, if not impossible, to draw a one-to-one correspondence between specific measures and outcomes such as reduced climate damages, let alone aggregate the outcomes to gauge the overall efficacy of such measures in a particular national context. Comparing countries on the basis of these outcomes is even more intractable.

While the effects and effectiveness of adaptation measures remain hard to gauge, it is nevertheless possible to assess progress made by countries in conducting various activities related to adaptation. These activities include a) undertaking analytical work on vulnerability and impact assessment that would underpin the analysis of adaptation options; b) establishing enabling environments and institutional frameworks for implementation; and c) actually implementing adaptation measures as part of programmes and/or as stand-alone projects. Countries are required to report on these and related issues as part of their National Communications (NCs) under the UNFCCC.[2]

This paper examines the attention given to, and progress on, adaptation in the latest two NCs from developed countries. These are generally the Second and Third National Communications (hereafter referred to as NC2 and NC3 respectively). If NC3 has not yet been submitted, then the First National Communication (NC1) and NC2 are examined. In cases where neither NC2 nor NC3 were submitted, only NC1 constitutes the basis of the analysis. Table 1 documents the status of submission of the various NCs by the countries covered in this analysis.[3]

The first part of this assessment is an empirical comparison through content analysis, which refers to techniques that enable "objective, systematic, and quantitative description of manifest content of communications" (Berelson 1974). Content analysis is a tool that has been used to systematically assess written and other material in a large number of research areas such as marketing and media studies, ethnography, psychology and cognitive science. It is also

[2] Articles 4.1, 4.2, and 12.

[3] While the European Commission is a Party to the UNFCCC it has been excluded from the rest of this analysis, as domestic actions on adaptation are covered in the individual National Communications of the EC member states.

routinely used within the context of programme evaluation. Here the focus is on an empirical comparison of the space devoted to sections of the NCs that address adaptation. Relative coverage of particular issues within the NCs, however, need not reflect priorities in terms of action. Nevertheless, the space devoted to particular issues in a wide range of print media (including newspapers, annual reports, and government documents) is not entirely arbitrary, but rather the outcome of considerable editorial deliberation. Issues that are deemed more central or important usually do tend to get more coverage.

The empirical part of the analysis is complemented by a more in-depth examination of the NCs and relevant supporting documents that relate to adaptation to climate change. The focus here is on the scope and depth of the discussion on climate change impacts and adaptation, particularly the degree to which progress is being made on identifying and implementing adaptation measures. Recognising that the coverage of particular issues within NCs need not be comprehensive or up to date, this analysis also examines other relevant national strategies, sectoral plans, and projects that have not (yet) fallen within the purview of the NCs.

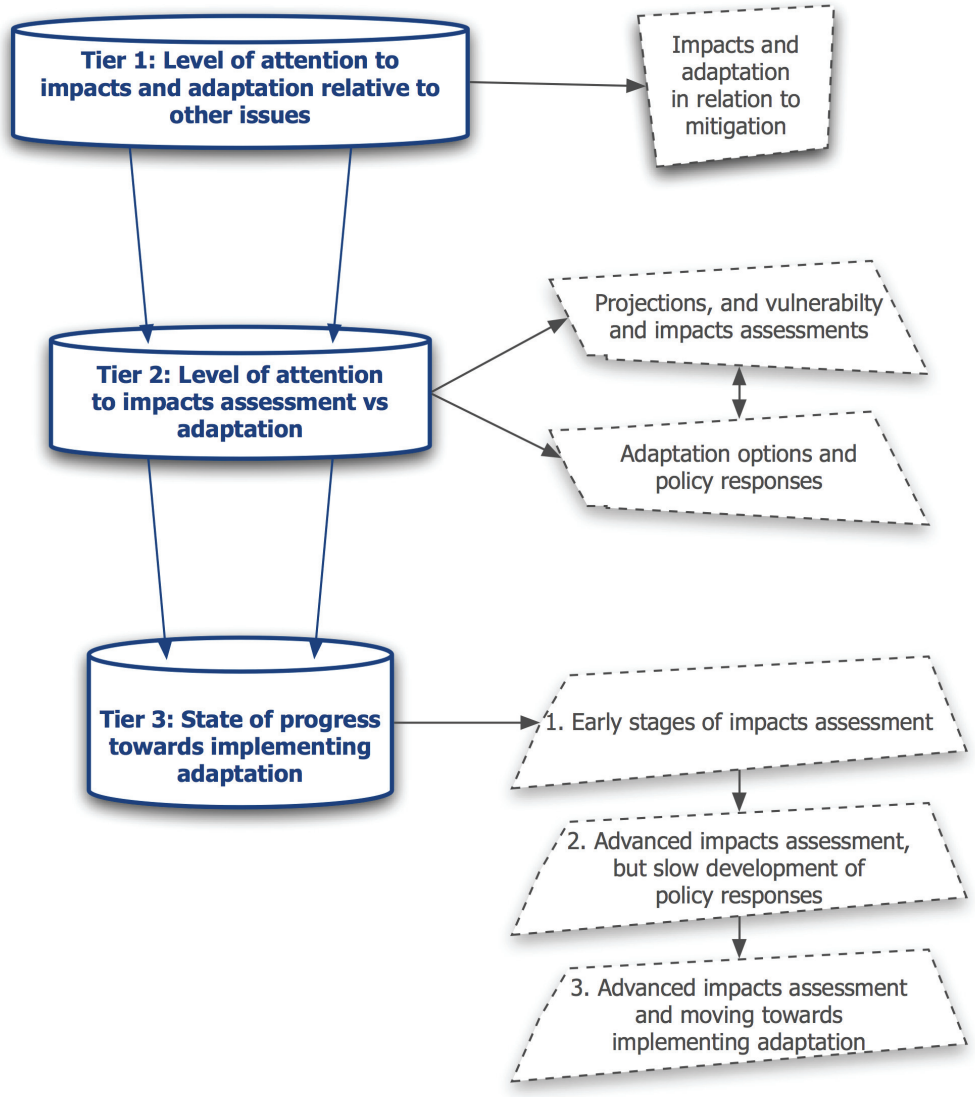
The discussion follows a three-tier framework that starts with an analysis of broad patterns and becomes progressively deeper (see Figure 2):

- *Tier-1: Level of attention to impacts and adaptation relative to other issues*: How much attention is devoted to impacts and adaptation relative to GHG emissions, mitigation, and other issues?

- *Tier-2: Level of attention to impacts assessment versus adaptation*: Within the discussion on impacts and adaptation in NCs, how much attention is currently given to a) climate change vulnerability and impact assessments versus b) the identification of actual adaptation options and the establishment of the enabling environment for their eventual implementation?

- *Tier-3: State of progress towards implementing adaptation*: Beyond the analysis of vulnerability and impacts and the identification of adaptation options, how much progress are countries making in actually implementing adaptation measures? Here the countries are classified into three categories: a) early stages of impacts assessment and; b) advanced impacts assessment, but slow development of policy responses; or c) advanced impacts assessment and moving towards implementing adaptation.

Figure 2. Three-tier framework for assessing attention to adaptation in National Communications



An analysis of this kind, drawing considerably upon NCs, offers several advantages. First, it allows for a comprehensive coverage, since all developed countries – except Turkey[4] – have submitted at least one NC.[5] Furthermore, NCs follow a standardised reporting format and guidelines[6] (see Box 1) and lend themselves to comparative assessment via empirical analysis which facilitates the identification of trends and patterns, both over time and across the countries being examined. Finally, NCs represent official, "whole government" perspectives, and are therefore less subject to the selection bias of the analyst.

On the other hand, one obvious limitation is that countries may judge differently the level of detail needed in their NCs on particular subjects. This analysis therefore covers not only the NCs but also all relevant background reports and other documents that have been referred to within the NCs. However, there may well be additional relevant assessments or policy initiatives underway which are not included in the NCs or supporting documents. This may, for example, be the case if national authorities are not fully aware of all initiatives going on in their country. Nevertheless, given that the NCs are the "public face" of national actions on climate change, it can be expected that countries will provide as much relevant detail as possible in the NCs and/or refer to relevant supporting material on adaptation within these documents.

Another limitation is that given the time it takes to prepare and publish the NCs, the information contained within them might already be somewhat dated. Furthermore, in the time it has taken to conduct this analysis (which primarily reviews NC2 and NC3), several developed countries have published their NC4 with more recent information. Recognising these issues, an attempt has been made in Section 6 of this paper to go beyond the NCs and highlight more recent progress, as well as examples of previous adaptation measures that have not been covered within the NCs.

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4 Turkey has therefore been excluded from this analysis.

5 Most other countries covered in this analysis submitted their NC1 during 1994-1995, their NC2 during 1997–1998, and NC3 during 2001-2003. As of October 2004, 37 out of 43 developed countries have submitted their NC3 (see Table 1). In fact, most countries are currently in the process of preparing their Fourth NC (NC4), which is due on January 1st, 2006 in accordance with decision 4/CP.8.

6 Most other countries covered in this analysis submitted their NC1 during 1994-1995, their NC2 during 1997–1998, and NC3 during 2001-2003. As of October 2004, 37 out of 43 developed countries have submitted their NC3 (see Table 1). In fact, most countries are currently in the process of preparing their Fourth NC (NC4), which is due on January 1st, 2006 in accordance with decision 4/CP.8.

Table 1. Submission dates for National Communications by developed countries

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Australia					2nd					3rd				
Austria						2nd			3rd					
Belarus											1st			
Belgium					2nd					3rd				
Bulgaria						2nd				3rd				
Canada					2nd				3rd					
Croatia										1st				
Czech Republic					2nd				3rd					
Denmark						2nd					3rd			
Estonia						2nd			3rd					
Finland					2nd				3rd					
France					2nd				3rd					
Germany					2nd					3rd				
Greece					2nd						3rd			
Hungary					2nd					3rd				
Iceland					2nd						3rd			
Ireland					2nd						3rd			
Italy						2nd					3rd			
Japan					2nd					3rd				
Korea						1st								
Latvia									3rd					
Liechtenstein										2nd / 3rd				
Lithuania	1st										2nd			
Luxembourg			1st											
Mexico					1st				2nd					
Monaco					2nd				3rd					
Netherlands					2nd				3rd					
New Zealand					2nd				3rd					
Norway					2nd					3rd				
Poland						2nd			3rd					
Portugal					2nd						3rd			
Romania						2nd							3rd	
Russia							2nd			3rd				
Slovak Republic					2nd				3rd					
Slovenia												2nd / 3rd		
Spain					2nd					3rd				
Sweden					2nd				3rd					
Switzerland					2nd				3rd					
Ukraine									1st					
United Kingdom					2nd				3rd					
United States					2nd					3rd				

Annex I NC1 Guidelines

Annex I NC2 Guidelines & Non-Annex I NC1 Guidelines

Adoption of the Kyoto Protocol

Annex I NC3 Guidelines

Non-Annex I NC2 Guidelines

Entry into force of the Kyoto Protocol

Box 1. Impacts and adaptation-relevant sections in guidelines for National Communications

All Parties to the UNFCCC committed to report on their implementation of the Convention.[7] This is done through National Communications (NCs) that countries have to submit to the UNFCCC Secretariat at regular intervals. The guidelines for submitting these reports differ for Annex I and non-Annex I countries.

The first guidelines for Annex I countries were published in 1994. They have since been revised twice: at the Second Conference of the Parties (COP 2) to the UNFCCC in 1996 for the preparation of NC2,[8] and again at COP 5 in 1999 for NC3[9]. The first guidelines contained one sentence encouraging Parties to report "on the expected impacts of climate change for the Party concerned and outline the actions taken to implement Article 4.1(b) and (e) with regard to adaptation". The 1996 revised guidelines retained this sentence, but in addition, encouraged Parties to follow an "indicative outline", which includes two chapters respectively titled "Expected impacts of climate change and vulnerability assessment" and "Adaptation measures". The 1999 revised version of the Annex I guidelines meanwhile stipulates mandatory elements to be addressed in the NC. These include a chapter on "Vulnerability assessment, climate change impacts and adaptation measures" to be divided into three sections, namely "Expected impacts of climate change", "Vulnerability assessment", and "Adaptation measures". The tone and wording also became stronger in the guidelines for NC3. For instance, the wording evolved from "A communication should review briefly […]" for NC2 to "A national communication shall include information on […]" for NC3.

For non-Annex I countries, the first guidelines were adopted at COP 2 in 1996[10] and then revised at COP 8 in 2002[11]. These guidelines are more extensive and detailed than those for Annex I countries. The first of these guidelines recommended that countries include information on "policy frameworks for implementing adaptation measures and response strategies" in various contexts and sectors "with a view to integrating climate change impact information […] into national planning processes". The guidelines called for provision of information on the "building of national, regional and/or sub-regional capacity […] to integrate climate change concerns in medium and long-term planning". Finally, countries were encouraged to include information on national technological needs to facilitate adequate adaptation to climate change. In the 2002 revised non-Annex I guidelines, countries are requested to "communicate a general description of steps taken or envisaged towards formulating, implementing, publishing and regularly updating national and […] regional programmes containing measures to facilitate adequate adaptation to climate change". These guidelines also focus on the need to identify "vulnerable areas that are most critical" and to report on measures and strategies to address impacts in those priority areas. Countries are also urged to describe approaches, methodologies and tools used, including any uncertainties inherent in these and to provide information on barriers to the implementation of adaptation measures.

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7 Article 4.1 of the UNFCCC

8 Decision 9/CP.2

9 Decision 4/CP.5

10 Decision 10/CP.2

11 Decision 17/CP.8

3 Level of attention to impacts and adaptation in National Communications (Tier-1)

The discussion on climate change impacts and adaptation is clustered within the NCs. Tier-1 of this analysis examines the level of attention given to the impacts and adaptation cluster, compared to GHG emissions and mitigation-related issues. "Level of attention" here is quantified in terms of the percentage of space (in pages) within NCs devoted to the discussion of impacts and adaptation. As noted earlier, relative coverage of particular issues within the NCs need not necessarily reflect priorities in terms of action. Nevertheless, the space devoted to particular issues documents of this nature is the outcome of considerable deliberation: issues that are deemed more central or important usually do tend to get more coverage.

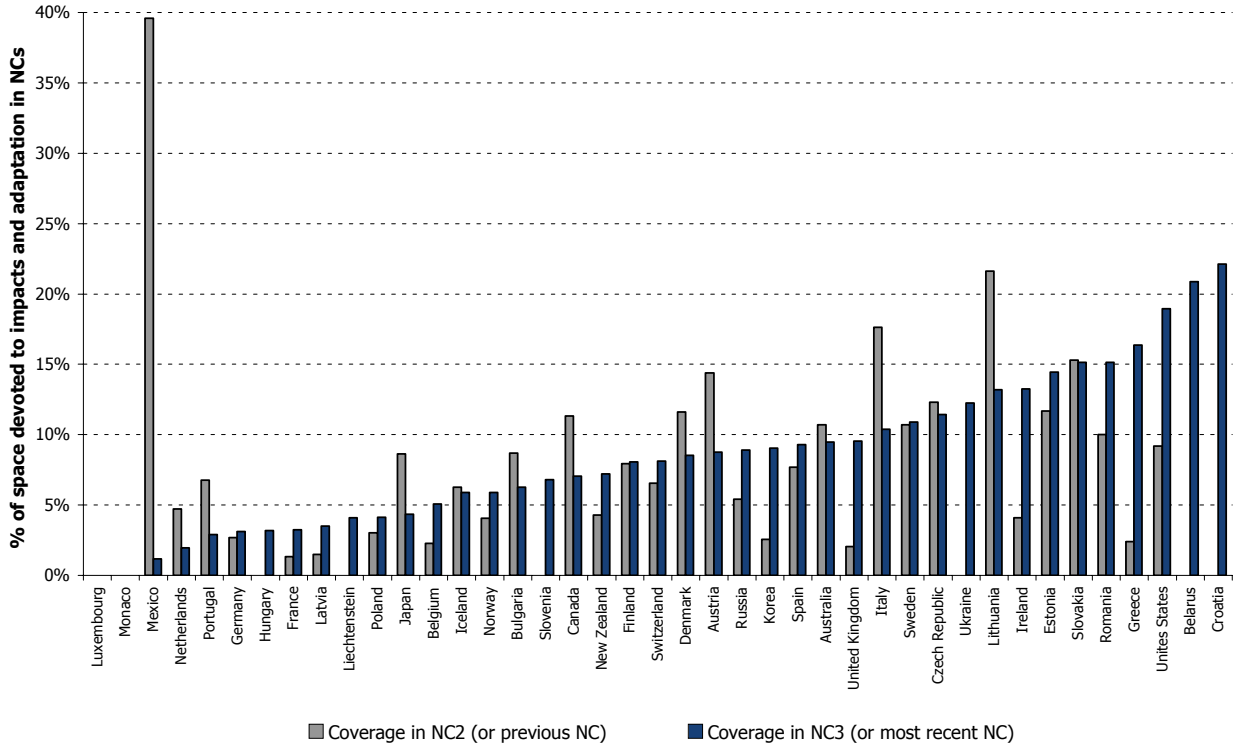
3.1 Overall level of attention to impacts and adaptation

An examination of the space devoted to the chapters pertaining to impacts and adaptation in the latest two NCs shows that countries have focused their activities under the UNFCCC on mitigation and related issues. Figure 3 demonstrates this cleavage. The vast majority of countries devoted less than one-fifth of their latest two NCs to the chapter(s) on impacts and adaptation, with eight countries – including France, Germany, and the Netherlands – devoting less than 5% to these issues in NC2 and NC3. Luxembourg and Monaco did not report on impacts and adaptation.[12]

A notable exception is Mexico, which devoted almost half of its NC1 to impacts and adaptation. A member of the OECD, Mexico nevertheless has a considerably high vulnerability to climate that is more typical of developing country. Greater attention to impacts and adaptation may therefore reflect this context. Further, a key input to the NC1 was the Mexico Country Study (under the US Country Studies Program), which provided considerable detail on climate change projections and impacts. In contrast, Mexico's NC2 has very little coverage on impacts and adaptation, in part because of greater coverage of mitigation issues in this document. NC2, for instance, presents data on projections of GHG emissions and on the use of flexibility mechanisms, two topics that had not been discussed in NC1.

12 Luxembourg and Monaco are therefore left out of the rest of the analysis.

Figure 3. Coverage of impacts and adaptation within National Communications



The limited attention to impacts and adaptation in the NCs shown here is indicative in part of the primary focus on mitigation until the late 1990s, both within international climate negotiations (c.f. Najam *et al.* 2003) and within scientific assessments as well (Kates 1997; Agrawala 1998; 2004). Adaptation also frequently occurs within a suite of responses that may be linked to a broad range of societal concerns, many of which have fallen outside the "climate change only" focus of climate assessments and policy.

Even the UNFCCC Guidelines for Annex I NCs, which have considerable specificity in terms of reporting on mitigation, treat adaptation in a very limited and amorphous fashion. The adaptation-relevant sections of these documents have, in fact, evolved very little since the guidelines for NC1 were developed. The guidelines for both NC2 and NC3 for Annex I countries do however suggest the use of more detailed frameworks on assessing impacts and adaptation developed by the IPCC and UNEP respectively.[13] Nevertheless, more detailed and precise guidelines for the impacts and adaptation sections of the NCs themselves might encourage greater and more consistent coverage of adaptation.

3.2 Evolution of the level of attention given to impacts and adaptation over time

Some interesting observations can also be made when examining the evolution in coverage of impacts and adaptation over the latest two NCs of developed countries (see Figure 3). On the one hand, comparing the more recent NC with its predecessor, it appears that some countries have significantly

[13] IPCC *Technical Guidelines for Assessing Climate Change Impacts* (1995) and the UNEP *Handbook on Methods for Climate Change Impacts Assessment and Adaptation Strategies* (UNEP/IES 1998).

increased the importance given to impacts and adaptation. For example, the relative coverage of these issues doubled from NC2 to NC3 for Belgium and the United States. It increased by three times in the cases of France and Ireland, five times in the case of the United Kingdom and almost eight-fold in the case of Greece. Such increases may, *inter alia*, result from the availability of new and more complete vulnerability and impacts assessments (*e.g.*, Belgium, Greece, and the United States), and/or progress in the assessment of adaptation measures since NC2 (*e.g.*, France, Ireland, and United Kingdom).

On the other hand, some other countries (*e.g.,* Canada, Austria, and Italy) reduced their relative coverage of impacts and adaptation in the more recent NC. This may be in part because some countries considered NC3 as complementary to NC2, which led some of them to not repeat information already included in NC2. Further, some countries may have missed, or provided an incomplete coverage of, some issues related to mitigation in NC2, and hence emphasised mitigation more in their NC3.

Finally, the negotiation of the Kyoto Protocol may have also resulted in greater emphasis on mitigation related discussion in NC3 which followed soon after. Austria provides an example of the influence the adoption of the Kyoto Protocol had; it significantly increased its coverage of emission projections, financing resources and technology transfer, research and systematic observations, as well as education, training and public awareness in its NC3, while the coverage of impacts and adaptation was reduced.

4 Level of attention to adaptation relative to impacts assessment in National Communications (Tier-2)

The analysis thus far has only examined the significance of impacts and adaptation, taken together, relative to mitigation and related issues within NCs. In this second tier of the analysis, the focus is on the *relative* coverage of impacts vis-à-vis adaptation.

Specifically, the "impacts and adaptation" discussion within the two most recent NCs (in most cases NC2 and NC3) is examined to assess the level of attention countries have given to:

- Examination of historical climate trends and/or national level projections of future climate change and assessing the vulnerability and impacts related to such changes;
- Identification of adaptation options, as well as the design and implementation of adaptation measures to both current climate variability and projected climate change;
- Establishment of enabling institutional mechanisms for assessment and implementation of adaptation measures.

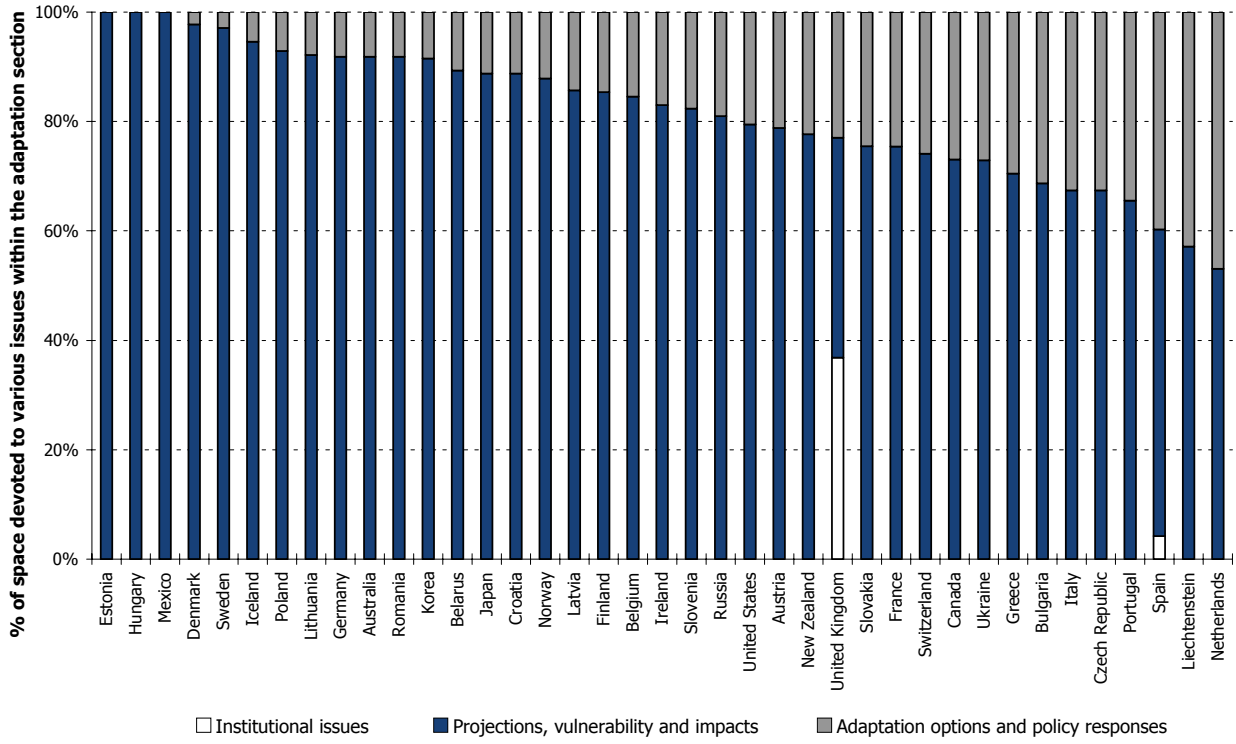
As in the previous section, the level of attention here is quantified in terms of the percentage space devoted to each of these aspects (climate change and impacts; identification of adaptation options; and roughly equal coverage of impacts analysis, institutional issues) within the section on impacts and adaptation of the NCs.

All developed countries that have submitted NCs have reported on assessments of climate change impacts and vulnerability[14]. However, the degree of reporting on the identification and/or implementation of adaptation options varies greatly between countries, as shown in Figure 4. For instance, Mexico, Hungary,15 and Estonia focus exclusively on climate change impacts assessment and do not discuss adaptation measures. Several countries, including Australia, Denmark, Germany, Iceland, Korea, Poland, and Sweden, have very limited discussion of adaptation. Some other countries, including Spain, Liechtenstein, and the Netherlands, have significantly greater coverage of adaptation, relative to impacts assessment. Most countries, however, do not extensively discuss institutional issues and enabling frameworks for adaptation. One exception is the United Kingdom, which has adaptation, and institutional issues.

[14] With the exception of Monaco and Luxembourg, as previously noted.

[15] Hungary has a large section in its NC3 titled "Adaptation measures", but the section does not discuss adaptation measures *per se*. Instead, the section discusses the development and application of indices (*e.g.*, the Pálfai Aridity Index) in national impact assessments.

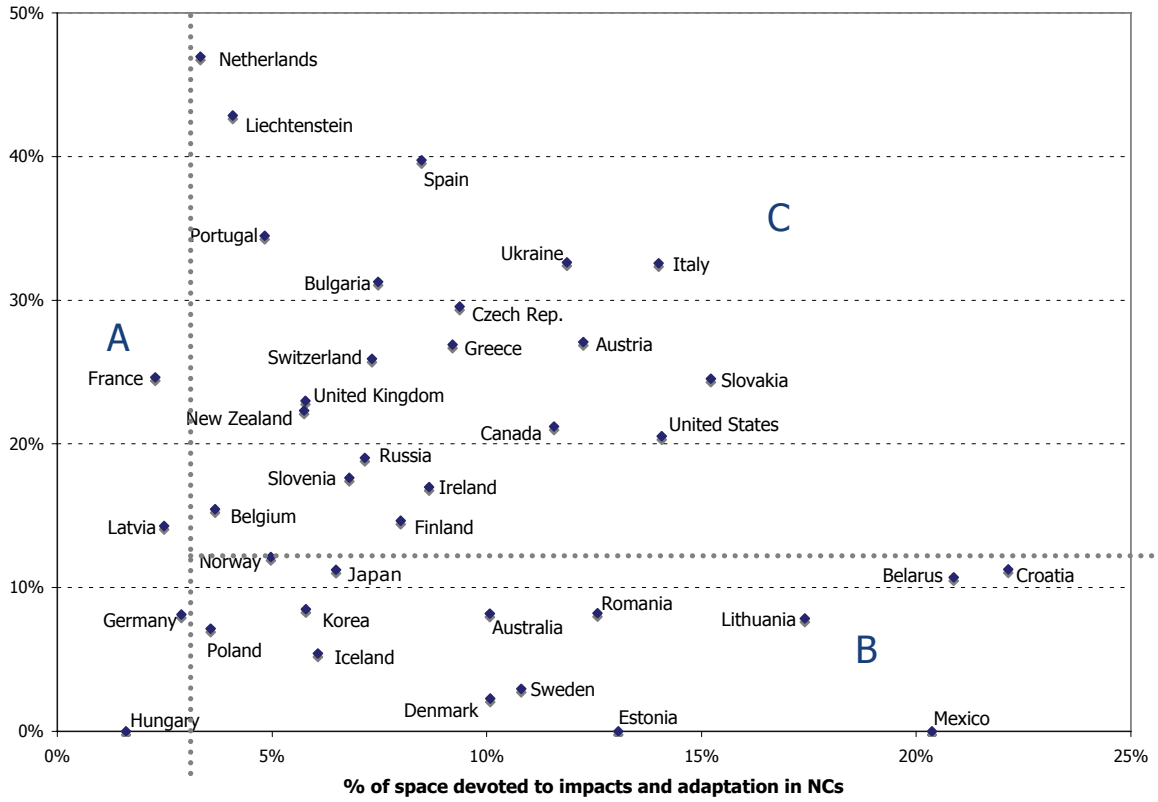
Figure 4. Relative coverage of impacts assessment versus adaptation issues in the latest two NCs



It is, however, important not to view the coverage of adaptation relative to impacts in isolation, but rather in conjunction with how well the two issues taken together are covered in the NC itself. Figure 5 is an attempt to present this composite information. Countries are loosely grouped into three categories:[16] Group A: countries which have limited discussion of impacts and adaptation (relative to mitigation) in their NCs; Group B: countries which have greater coverage of these issues, but focus almost entirely on assessment of impacts; and Group C: countries which have greater coverage of impacts and adaptation, as well as greater balance between the two. Among other things, the Figure shows that although the Netherlands, Liechtenstein, and Portugal give a lot of attention to adaptation relative to impacts assessment, impacts and adaptation taken together are covered only in a very limited fashion in the overall NC.

[16] The boundaries between the three groups are only illustrative and should not be interpreted literally.

Figure 5. Coverage of adaptation within the section on impacts and adaptation [Y-axis] versus coverage of impacts and adaptation [X-axis] within National Communications



Legend:

A. Limited coverage of impacts and adaptation
B. Focus primarily on impacts assessments
C. Attention to adaptation, in addition to impacts assessment

5 In-depth analysis of progress on adaptation (Tier-3)

The empirical analysis in the preceding sections has revealed broad patterns in terms of coverage of adaptation-related issues within NCs. It does not, however, provide any information on the *quality* of the discussion. For instance, the preceding discussion cannot be used to answer questions such as: How specific is the analysis of adaptation in the NCs? Do countries give concrete adaptation examples in their NCs or is adaptation only discussed at a generic level? How much progress has been made on actually implementing adaptation and on integrating or "mainstreaming" such measures in sectoral policies? Answers to these and other related issues require a more in-depth analysis of NCs.

This section provides an assessment of the scope and depth of coverage of adaptation-related issues within the developed country NCs, as well as relevant documents referred to in these communications.[17]

5.1 Stages for evaluating progress on adaptation

Adaptation planning and implementation inevitably needs to be based on some level of understanding of historical and present climate, projections of climate change, and the current and future implications on vulnerability and impacts.

Developed countries are therefore first assessed in terms of the scope and depth of their coverage of historical climate trends, scenarios for future climate change, and vulnerability and impact assessments within their NCs.

The core of the assessment, however, is on progress in the translation of impacts and vulnerability assessments into adaptation policy responses. Here, a distinction is made between the articulation of *intentions* to act, and adaptation *actions* themselves.[18] *Intentions* include the identification of adaptation options and the discussion of existing policies, which might be synergistic with adaptation. Such policies may be developed to deal with current climate variability, but may also be related, for example, to biodiversity protection, natural hazards management, or urban planning.

With regard to *action*s, three stages of progress are identified: a) the establishment of institutional mechanisms for guiding and implementing adaptation; b) the formulation of policies for adapting to climate change or

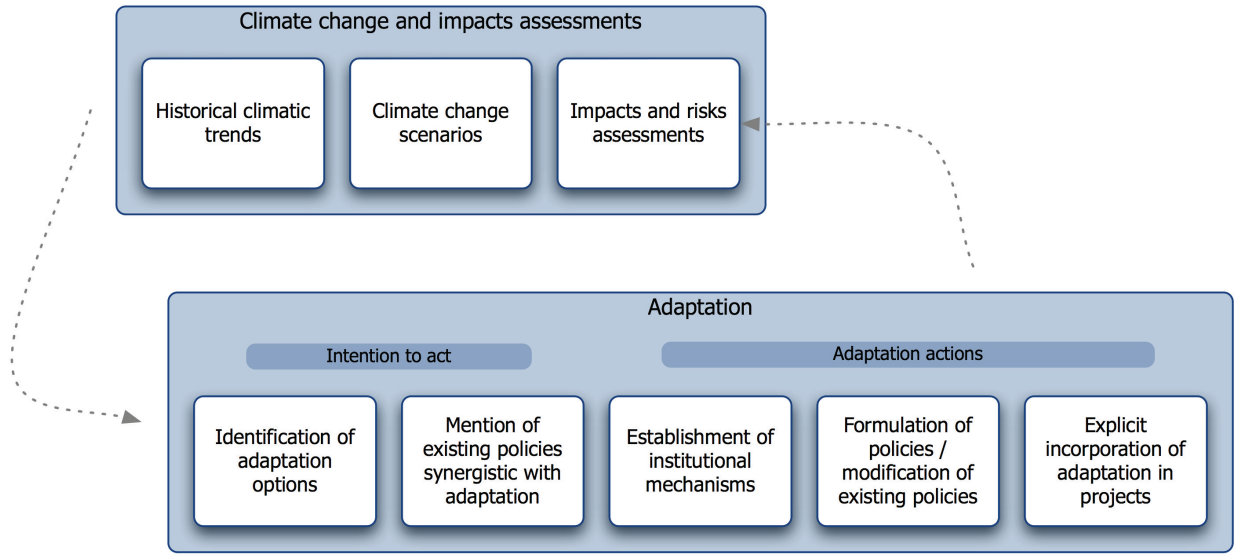
[17] The guidelines for NC3s (FCCC/CP/1999/7) in fact request Parties to "provide references to additional relevant background information in an annex to the national communication."

[18] This draws upon the OECD Environmental Performance Review framework. The framework contains an additional step – results – which hardly applies to adaptation responses, and has therefore been left out here.

the modification of existing policies to take adaptation into account; and, c) the explicit incorporation of adaptation measures at the project level. This last category recognises the role of private sector and other decision-makers in creating an impetus for considering climate change risks at the project level. Adaptation actions undertaken now will, in turn, condition the assessment of net future impacts from climate change.

Figure 6 shows these various elements of the adaptation process which are then used to assess progress made by various developed countries.

Figure 6. The adaptation process



5.2 Discussion and results

The two most recent NCs for developed countries were assessed in terms of the scope and depth of their coverage of the eight elements of the adaptation process shown in Figure 6.[19] Two overlapping criteria were used to subjectively assess each of these eight elements, one for the *scope* of the issues covered, and the other focussing on the *depth* of coverage. The scope of the coverage was categorised as a) *extensive,* b) *limited,* or c) *lacking*. The depth of coverage, meanwhile, was categorised as: a) *detailed*, i.e. for more than one sector or ecosystem, and/or providing examples of policies implemented, and/or based on sectoral/national scenarios; b) *generic*, i.e. based on IPCC or regional assessments, and/or providing limited details/no examples/only examples of planned measures as opposed to measures implemented; c) *limited* information in NCs, but references to comprehensive national studies; or d) *lacking*.

Based on this analysis, countries are classified in one of three categories, as shown

[19] Analysis of historical climate trends; climate change scenarios; impacts assessments; identification of adaptation options; mention of synergistic policies; establishment of institutional mechanisms; formulation of adaptation policies; explicit incorporation of adaptation in projects.

in Table 2: (i) early stages of impacts assessment; (ii) advanced impacts assessment, but slow development of adaptation responses; (iii) advanced impacts assessment and moving towards implementing adaptation.

It is immediately evident from Table 2 that most NCs are "top heavy" in terms of climate change projections and impact assessments, with very little on adaptation intentions and actions. Within the discussion on adaptation, the focus is primarily on the identification of options. A few countries identify existing policies that might be synergistic with adaptation, even fewer countries discuss the establishment of institutional mechanisms, and only a couple of countries discuss the actual implementation of adaptation at the policy and/or project level.

5.2.1 Early stages of impacts assessment

The NCs of countries in this category have limited discussion of historical and current climate, climate change projections, and vulnerability and impact assessment, which are the precursors for the formulation of adaptation responses. Adaptation itself is either not discussed at all, or at a very generic level. Three countries (Iceland, Portugal, and Hungary) have a very limited discussion of impact assessments and do not report on adaptation at all. For instance, Iceland and Portugal only provide a generic discussion of climate change impacts; the discussion is based on historical climatic trends in the case of Portugal and on regional climate scenarios for Iceland. Hungary, on the other hand, provides somewhat more detail on impact assessments, but also does not report on adaptation.

Another four countries (Germany, Latvia, Liechtenstein and Russia), while discussing climate change impacts in only a limited fashion, do nevertheless identify some generic adaptation options in their NCs. For example, Russia provides numerous adaptation options for the agriculture, forestry and water sectors – *e.g.*, "the expansion of agricultural lands under winter cereal crops" or "the reduction of the population of pests and weakening of impact on forests". In fact, these only provide general orientations for action, rather than suggesting concrete policy options under study. Latvia has reported extensively on historical climatic trends and has assessed in great detail the vulnerability of its coastal zones and vegetated areas based on those trends. It has also identified a few adaptation options for coastal zones, agriculture and forestry. Liechtenstein highlights policies being implemented in the agricultural and tourism sectors which may be synergistic with adapting to climate change. Germany does not discuss adaptation, although it does provide one specific example of policy/project level adaptation: the inclusion of a safety margin for sea-level rise (15-30 cm in 100 years) in the construction of coastal protection structures.

5.2.2 Advanced impacts assessment, but slow development of adaptation responses

Most developed countries fall in this category, as shown in Table 2. Here, the understanding of current and future climate and associated impacts is quite advanced, but adaptation is either not discussed altogether in NCs, or such discussion is limited to assessment of options, and does not yet include implementation.

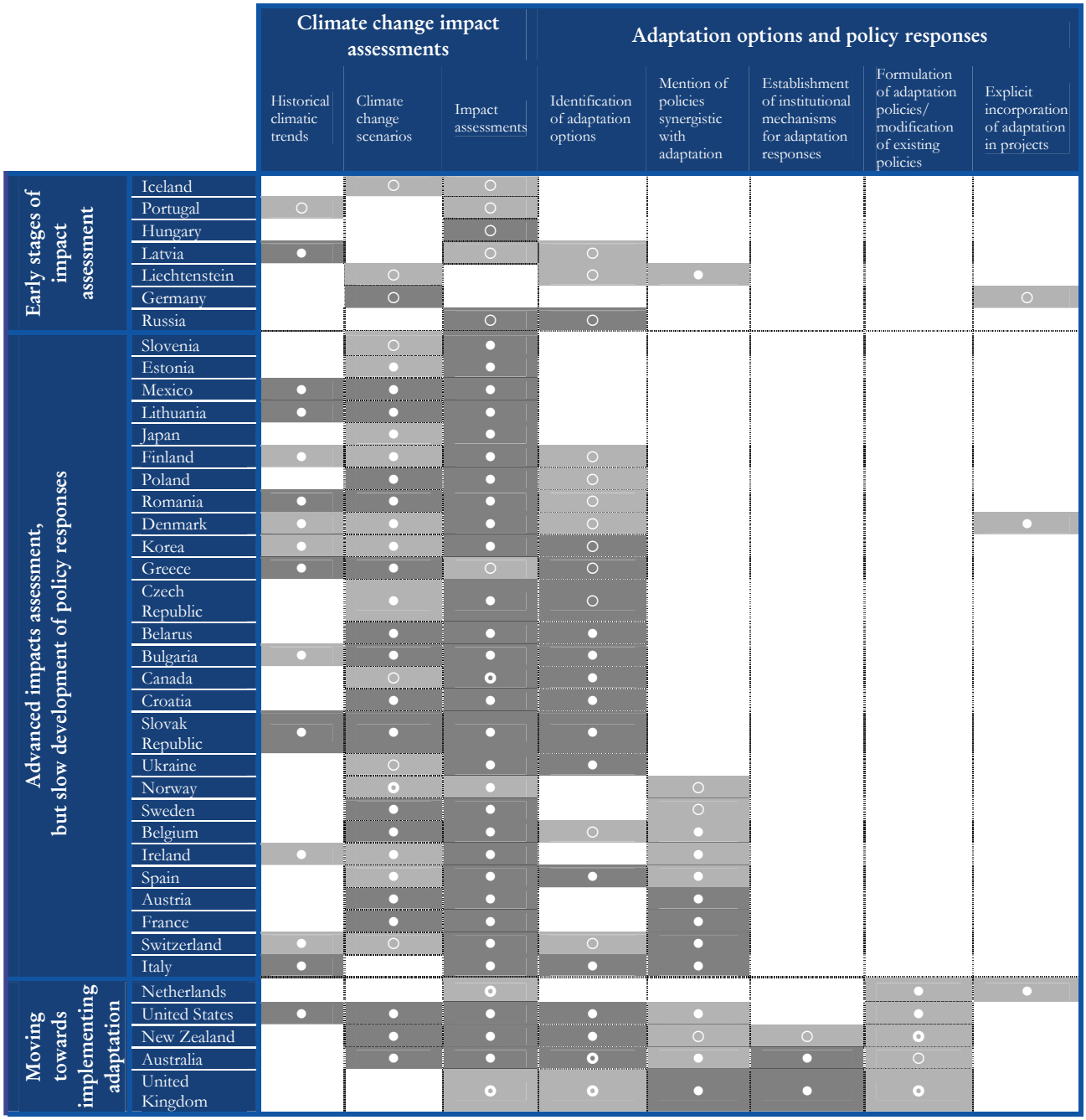
On the impacts side, most of the countries in this group have developed comprehensive scenarios of future climate change and assessed impacts at the national level. Several have also used downscaling techniques to better assess climate impacts at finer spatial scales. Some countries have also conducted in-depth sectoral impact and vulnerability assessments. Poland, for example, has assessed changes in agricultural production as a result of climate change. It has also developed scenarios for variability of wind, wave field and sea-level along the Baltic coast as a result of climate change. Estonia is one of

the few countries to have examined *economic* vulnerability to climate change, whereas Canada, Finland, and New Zealand are developing indicators to monitor the impacts of climate change on their economies. However, as also highlighted by the UNFCCC (Pilifosova 2004), there is a general weakness in providing information on methodologies that have been used as a basis for impact and vulnerability assessments.

With regard to adaptation, five countries within this group (Slovenia, Estonia, Lithuania, Mexico and Japan) do not report at all on adaptation options or policy responses. Another seven (Finland, Poland, Romania, Denmark, Korea, Greece and the Czech Republic) identify adaptation options, but discuss them at a fairly generic level, *e.g.*, measures like crop switching, coastal protection, and so on, without reference to their specific contexts. Denmark is among the countries which only have a generic discussion of adaptation measures, although it stands out from the others in this group because it *also* provides one specific example of an infrastructure project in which climate change risks have been taken into account. During the construction of the district of Ørestad near Copenhagen, the level of metro stations was raised to take into account a 50-cm sea-level rise.

Considerably more specificity on the screening and prioritisation of adaptation measures is provided in the NCs of six other countries (Belarus, Bulgaria, Canada, Croatia, Slovak Republic, and Ukraine). These countries have presented adaptation measures that "will be necessary", "should be implemented", or "are under consideration". Sectors of particular importance for many countries presenting adaptation options include agriculture, forestry, infrastructure, and water management. Box 2 provides examples of adaptation options being considered in Belarus.

Table 2. Coverage of impacts and adaptation in National Communications



Legend:

Coverage:

	Extensive discussion
	Some mention/ limited discussion
	No mention or discussion

Quality of discussion:

●	Discussed in detail, i.e. for more than one sector or ecosystem, and/or providing examples of policies implemented, and/or is based on sectoral/national scenarios
○	Discussed in generic terms, i.e. based on IPCC or regional assessments, and/or providing limited details/no examples/only examples of planned measures as opposed to measures implemented
◘	Limited information in NCs, but references to comprehensive national studies

Box 2. Sectoral adaptation options in the National Communication of Belarus

The NC1of Belarus (submitted in 2003) provides a good example of systematic progression from national level climate change projections, impact assessments, and identification of specific adaptation responses. The impact assessments cover all crucial climate sensitive sectors for the national economy, namely agriculture, forestry and water management. For each of these sectors, the NC1 provides adaptation options bearing in mind other trends in these sectors. Furthermore, adaptation options have also been prioritised (bearing in mind the national circumstances) for agriculture and water resource management.

Based on an in-depth analysis of climate change projections and impacts on agriculture, NC1 notes that the main losses are expected due to extreme events rather than a progressive change in climatic conditions, the low technological advancement in agriculture, and the vulnerability of the country to severe aridity. Extreme events are thought to be a serious threat to Belarus agricultural sector, as it is estimated that agricultural losses due to extreme weather events may reduce yields between 50-60%. In addition, severe aridity could increase farming expenses – for example by 15% for cereal crops – which may be due to unscheduled tillage, overuse of machinery, or increase in fuel consumption, amongst other causes. Adaptation options envisaged include a) continuing farming intensification, by increasing the use of fertilisers, b) introducing more late ripening varieties to prevent losses from early ripening due to higher temperatures, c) determining optimum terms of land treatment and selecting optimum crop varieties for the new conditions and d), introducing post-harvest crops.

In the case of forestry, the NC1 notes that temperature increases in Belarus are expected to cause less plant hibernation in winter and increase aridity during some periods of the year. Other reported impacts include an increase in the probability of late spring frost, an increase in the risk of forest fires, and a higher probability of mass insect propagation. On a more positive side, there could be an expansion of species of the forest-steppe and steppe flora into forest ecosystems. Shorter and warmer winters could, for example, reduce the accessibility of harvesting machinery to marshy areas, which result from shorter periods of snow cover. This would have significant economic impacts for the sector. The NC1 identifies adaptation measures both to cope with the adverse impacts, as well as to benefit from the more favourable impacts of climate change. Furthermore, the document identifies the need for sectoral strategies, as well as for current regulations and policies to take climate change into account. The NC1 also emphasises education as a long-term adaptation strategy – specifically it proposes to amend the curricula of secondary schools, professional forestry training programmes, as well as advanced training courses for current workers in the sector.

The NC1 also notes that water resources in Belarus are very sensitive to climate change and the sector is therefore a priority for adaptation. Water available for economic activities and hydroelectricity production is expected to be affected by higher temperatures and longer duration of dry spells. A drop in minimum water levels in rivers is anticipated, which would affect the operation of water intakes not provided with a dam, domestic water transport and recreational activities. The quality of the water is expected to be deteriorated due to a reduction in water quantity and thereby a lower degree of dilution of effluents and other pollution sources in rivers and lakes. A number of adaptation measures are also identified to address the projected decline in quantity and quality of water resources. Among the "most critical adaptation measures", the NC1 identifies flood control actions in the Polessie region (taking into account the runoff formation in Ukraine), and the construction of underground water storage facilities in the most vulnerable regions of the country. This report also goes a step further and provides a priority list of possible assessments to guide adaptation decisions. These range from comprehensive assessment of vulnerability of five rivers to climate change and economic development, to the establishment of a common information-exchange system with neighbouring states to assess water resources.

Finally, there are nine other countries within this category (Norway, Sweden, Belgium, Ireland, Spain, Austria, France, Switzerland, and Italy) which identify policies and measures currently in place that are also synergistic with adaptation to climate change. While Norway and Sweden mention synergistic policies only briefly, Belgium, Ireland, Spain, Austria, France, Switzerland, and Italy describe existing measures in greater detail. The NC3 of France perhaps stands out as it provides an example of long-term cross-sectoral strategic planning that applies to several sectors and is synergistic with adaptation. France's Guidance on Urban and Rural Development and Sustainable Development of June 1999 obliges regional authorities "to elaborate planning tools covering a 20-year period." These tools are to cover nine policy sectors – among them natural and rural land, energy, freight and passenger transport – and are to be re-evaluated every five years. For many of the other countries, the discussion of synergistic policies is primarily focussed on coastal zone and natural hazard management.

Ireland and Italy in particular highlight the synergies between existing coastal zone management policies and adaptation to sea level rise. Ireland's NC3 describes the 2000 Integrated Coastal Zone Management Policy and the Planning and Development Act, both of which require that development plans include objectives for: a) regulating, restricting or controlling development in areas at risk of flooding, erosion and other hazards; b) regulating, restricting or controlling the development of coastal areas and development in the vicinity of inland waterways; and c) regulating, restricting and controlling development on the foreshore. Meanwhile, Italy, in its NC2, mentions the Mose Plan which aims to protect Venice from peak sea levels and high water episodes. While the measures outlined in this Plan are aimed at dealing with current vulnerabilities, they may also be synergistic with adaptation to climate change.

Austria and Switzerland, meanwhile, highlight the synergies between natural hazards management policies and adaptation to climate change in their NCs. This is probably because in alpine environments, the current climate and projected climate change have clear implications on natural hazards such as landslides, floods, avalanches and mudflows. Measures in place to manage natural hazards are therefore closely aligned with climate change adaptation. Both Austria and Switzerland report that they have been implementing torrent and avalanche control measures for over a hundred years. Switzerland for instance notes that it has spent more than 1.5 billion CHF (about 970 million Euros) in avalanche control measures and land-use planning to reduce the risks of such hazards since 1950. Austria meanwhile points to a suite of responses aimed at prevention against natural hazards, risk management, and water protection. Risk management is done, *inter alia*, through the preparation and re-evaluation of hazard zone maps, which are subsequently incorporated into the environmental planning of the Länder. In Switzerland, the strategy for dealing with natural hazards has shifted towards ex ante risk management in the late 1980s. Two regulations were put in place in 1991, namely the Federal Law on Flood Protection and the Federal Forest Law. Under these laws cantons are required to establish registers of events and hazards maps to help them take hazards into account for the purposes of land-use planning.

In the discussion of policies that might be synergistic with adaptation, what is generally not addressed, however, is whether such existing measures are adequate, or what – if any – "tweaking" might be needed to cope with any additional risks posed by climate change.

5.2.3 Advanced impacts assessment and moving towards implementing adaptation

No developed country has yet formulated a comprehensive approach to implementing adaptation and the "mainstreaming" of such measures within sectoral policies and projects. However, a handful of countries can be said to be *moving towards* implementing adaptation. Such initiatives are still in the early stages, and are typically being undertaken within specific contexts (*e.g.*, coastal zone management and in certain infrastructure projects). Table 2 identifies five countries in this category: the Netherlands, the United States, New Zealand, Australia, and the United Kingdom.

The NCs of these countries report on climate change scenarios and assessments of the impacts of climate change on natural and human systems. New Zealand, for instance, provides downscaled results from global climate model scenarios, although it does not report extensively on impacts. Australia and the United States, on the other hand, report in-depth on climate change projections and potential impacts on several sectors. In addition, the NC of Australia stands out as it reports on studies of the impacts of climate change on *global* food production as well as on the resulting market dynamics and their implications for Australia's economy. Such trans-boundary considerations are not discussed in the NCs of most countries. The United Kingdom only provided some key examples of anticipated impacts of climate change within its NC3, but this document identifies web addresses where more comprehensive studies can be found. Likewise, the Netherlands reports briefly on impacts within its NC but refers to a report (Können 1999) that provides additional detail. The analysis here therefore not only covers the NCs themselves, but also any studies referenced in such documents that provide further detail on impacts and adaptation.

The implementation of adaptation measures is occurring at two levels: specific actions at the policy and project level that take climate change risks into account and broader institutional measures that lay the foundations for implementing adaptation across a range of sectors and decision-making contexts.

Examples of the former type of initiatives (*i.e.*, specific actions at the project/policy level) can be found in the NCs of the Netherlands, the United States and New Zealand. In the case of the Netherlands, a primary focus is on adaptation measures to protect coastal zones. For instance, NC2 of the Netherlands reports that new engineering works are required to take a 50-cm sea-level rise into account; this has already been done for a storm surge barrier built in Rotterdam in 1997. Even prior to that, in 1995, a government technical committee recommended some precautionary measures based on a scenario of 85-cm sea-level rise and a 10% increase in storms (TAW 1995, as referred to in NC2). These recommendations are reflected in the 1996 Flooding Defence Act and the 2000 Coastal Defence Policy. The Flooding Defence Act sets safety standards for all water defences and is to be reviewed every five years, which should make it possible to incorporate any emerging trends in climate as well as updated scenarios of climate change in the design of flood defences. This type of precautionary approach is also apparent in the Coastal Defence Policy, which prevents fixed structures to be built in vulnerable coastal zones. The Dutch NC3 also states that the government prefers spatial – rather than technical – measures, such as those planned to limit the risk of flooding of the Rhine and Meuse rivers.

The NC3 of the United States presents a generic discussion of adaptation options in key impacted sectors. Examples include revaluating basic engineering assumptions used in construction work and changing planting dates and crop varieties in agriculture. The

NC3 also notes that in some sectors (*e.g.*, health), adaptation is likely to occur through synergistic measures that will be implemented mainly for other reasons than climate change. In terms of concrete actions, the NC3 primarily reports on initiatives undertaken by certain individual states to include sea-level rise in their planning. New Jersey, for instance, has set aside US$15 million per annum for shore protection programmes. Four other states have implemented different types of policies to ensure that wetlands and beaches have room to migrate inland as the sea level rises.

New Zealand's NC3 cites more detailed background studies (Bell *et al.* 2001 and Kenny 2001) that identify a number of adaptation options for coastal margins and agriculture. The NC3 emphasises the importance of providing clear national guidance to local authorities on adaptation. The only guidance of this nature that is mentioned in the NC3 is the New Zealand Coastal Policy Statement, which dates back to 1994. New Zealand also has a few programmes that are synergistic with adaptation, such as the development of guidance material for farmers to deal with current climate variability. In terms of concrete adaptation responses, the NC3 cites a study by Bell *et al.* (2001) which surveyed regional, coastal and district plans. This study concluded that while the surveyed plans mention sea-level rise, only two involve commitment towards the actual incorporation of sea-level rise into hazard zone and area assessments. The NC3 points to continued uncertainties of possible impacts of climate change as one reason that makes it difficult to plan and implement anticipatory adaptation (see Box 3 for the implications of uncertainty on planning adaptation).

In addition to mentioning specific adaptation policies or projects, some NCs discuss institutional measures that establish the enabling environment for assessment and implementation of adaptation actions. Australia stands out for its explicit recognition of adaptation and mitigation as equal and complementary responses to climate change as well as for its development of institutional mechanisms for mainstreaming adaptation. Its NC3 mentions that one of the three goals of the National Greenhouse Strategy (NGS) (Commonwealth of Australia 1998) is laying the foundations for adaptation. The NGS outlines a mechanism to deliver adaptation strategies, which should allow for a) the identification of means to increase the flexibility of existing planning processes, b) the identification of barriers to the implementation of adaptive responses and corresponding solutions, and c) the analysis of risks associated with various adaptation options. This mechanism is intended to build on current experiences in dealing with current climate variability. Another innovative feature of the NGS is the clear identification of organisations that hold the responsibility of implementing specific measures and programmes. The NCs of Australia, however, do not generally report on concrete adaptation policies, with two exceptions. NC2 reports on a policy in South Australia requiring that coastal developments be safe for a 30-cm sea-level rise. It also reports on a biodiversity strategy in New South Wales that recognises the potential role of natural corridors in enabling species migration in response to climate change. The NGS details priority sectors along with numerous sectoral measures that could be implemented, but does not outline measures that are already in place. Priority is given to five key sectors: coastal zones, agriculture, biodiversity, forests, and health.

Box 3. Dealing with uncertainty

Recent work by the OECD (2005) and elsewhere highlights that the level of certainty associated with climate change and impact projections is often key to determining the extent to which such information can be used to formulate appropriate adaptation responses. Large-scale climate change projections typically have lower uncertainty than those specific to a particular location. In contrast, most decisions relevant for adaptation are made at local to regional scale (Agrawala and van Aalst 2005; Dessai et al. 2005). Further, uncertainty also varies from one region to another, as well as from one climate variable to another. For example, temperature is typically more easily projected than precipitation or other climate variables (Smith et al. 2005).

Such nuances are seldom conveyed within the NCs, and often not even in the underlying studies that form the basis for these documents. Among the developed countries examined here, several touch upon scientific uncertainty very briefly, for example to justify slow progress in implementing adaptation. Others (e.g., Australia, Belgium, Germany, Iceland, and New Zealand) were more specific in recognising the uncertainty of projections of rainfall, and the difficulty in using such information in planning adaptation in sectors such as agriculture, forestry and water resource management. A few other countries provide greater specificity on the nature of the underlying uncertainties in their NCs. For example, the NCs of Finland and the United States present results from different scenarios, including an uncertainty range rather than simply showing single values. Finland, for instance, describes results from a central "best guess" scenario together with lower and higher estimates.

The NCs of some other countries, meanwhile, make the case for "no regrets" adaptation measures that can be implemented in the near term, regardless of prevailing uncertainties about future climate. The NC3 of New Zealand, for example, identifies measures to alleviate the potential increase in drought frequency and severity in eastern regions of the country. The United Kingdom NC3, meanwhile, identifies no or low regrets measures in five priority areas.

The local and regional level uncertainties associated with particular climate projections and the influence of local overriding factors, such as land subsidence, have also led some NCs, for example Australia and New Zealand, to emphasise decentralisation of the design and implementation of specific adaptation measures to regional and local authorities. Along the same lines, the United Kingdom NC3 indicates that guidelines are being developed for use by a wide range of decision-makers in dealing with climate change risk and uncertainty in decision-making.

The United Kingdom provides another example of a forward-looking institutional approach to facilitate the mainstreaming of adaptation. Its NC3 highlights the achievements of the United Kingdom Climate Impacts Programme (UKCIP), established in 1997 with the aim of providing a coordinated framework for assessing impacts and identifying potential adaptation strategies. UKCIP facilitates and supports organisations to initiate studies of their own vulnerability and act upon it. A key element of the programme is the development of guiding tools for decision-makers. These tools include guidance on undertaking impact assessments, a methodology for costing impacts of climate change, and guidance on dealing with risk and uncertainty in decision-making. The institutional mechanisms established in the United Kingdom played a role in the integration of adaptation into many policies from governments and devolved administrations. Initial work to identify priorities for the United Kingdom over the next 30 to 50 years is already underway. The NC3 provides a number of examples of the way climate change risks are taken into account in water resource management, flood and coastal defence planning, building regulations, countryside and biodiversity

protection, and land-use planning. Examples of measures are the consideration of climate change projections in a) the rolling programme of review of technical requirements included in the Building Regulations in England, Wales, Scotland, and Northern Ireland and b) the strategies and plans for water resource management, catchment abstraction management, and maintenance of supplies in drought conditions.

6 Beyond the National Communications – Other examples of implementing adaptation

The discussion thus far has focussed entirely on NCs, particularly NC2 and NC3. In addition, there are examples of other adaptation-related activities which have not made their way into NCs. This section therefore discusses some more recent adaptation measures that are being implemented in developed countries since the publication of their respective NC3s. It also highlights illustrative examples of earlier adaptation measures that have fallen outside the purview of the NCs. Some of these measures were undertaken autonomously at the initiative of forward-looking project engineers or planning agencies and not as part of any top-down government initiative. In other cases, adaptations take the form of comprehensive government strategies and plans that attempt to inject adaptation into all sectoral or national decision-making processes rather than only with regards to a specific project.

6.1 Project-specific responses

There are a wide variety of projects in many sectors that routinely take adaptation to current climate (including seasonal to inter-annual fluctuations in climate) into account. In addition, future climate change risks are also beginning to be taken into account at the project level. Many examples of this kind come from infrastructure projects, as they are long-lived assets that necessitate consideration of medium to long-term risks. Projects, for which results from climate change scenarios have been incorporated, include, for example, the Confederation Bridge in Canada, the Deer Island sewage treatment plant in the Boston Harbour in the United States, and the improvement of the Thames Barrier in the United Kingdom. There are, of course, other such examples (albeit still rather limited) of actions both by public and private actors where consideration of future climate change is taken into account at the project level.

The Confederation Bridge, which links New Brunswick and Prince Edward Island, was completed in 1997 and is expected to have a hundred-year lifespan. To accommodate for the potential sea-level rise over that period, the vertical clearance planned to allow for the navigation of ocean-going vessels has been increased by one meter, compared to the level currently required (McKenzie and Parlee 2003). Another key concern was the amount, thickness and movement of ice through the Northumberland Strait, which the bridge crosses. In this case, forecasts of future winter conditions and ice formation and movement were used to estimate the necessary spacing of the piers (Boyd 2003).

Another example is that of a new sewage treatment plant that was built in 1998 by the Massachusetts Water Resource Authority (Klein *et al.* 2005). The plant is located on

Deer Island within Boston Harbor. The raw sewage collected from coastal communities needed to be pumped under the Harbor and then up to the plant on the island for treatment, before being discharged into the Harbor through a downhill pipe. While the short term costs of pumping untreated sewage up to the plant would have been lower had the plant been built at lower level, engineers were concerned, that in such a case, future sea level rise would subsequently necessitate construction of a protective wall around the plant and an expensive pumping equipment to carry the effluent over the wall. To avoid these long-term costs, the plant was sited at a higher location than originally planned. Such measures also enhanced the resilience of the treatment system to current storm surges (Klein *et al.* 2005).

The improvement of the Thames Barrier in the United Kingdom (Hall et al. 2005) is another example of adaptation to climate change at the project level.[20] The Barrier was originally built over a 30-year period, following the 1953 floods, to protect London. While even the original design complied with high standards (generally one-in-a-1000-year flooding event), it did not explicitly take climate change into account at that time, nor did the design make any specific allowance for changes due to climate change in fluvial flows coming down the Thames or the size of the storm surges arising in the North Sea. The combination of rising sea level, due to climate change, and rapid housing development within the tidal flood plain is expected to increase the flood risk; it is estimated that by the year 2030 modifications to the barrier will be required if flood protection standards are to be kept at present levels. A Flood Risk Management Plan is therefore currently being developed to protect London and the Thames Estuary for the next 100 years. A multi-faceted study of adaptation options is currently underway and is assessing, among others, a) 337 kilometres of coastal defences (including nine major flood control barriers); b) the evolution of the socio-economic context and its significance for flood risk throughout the Thames estuary; and c) the influence of political and other drivers on the choice of specific options.

6.2 Strategic responses at city, provincial and national levels

In addition to specific adaptations to current and future climate at the project level, there are now also some examples of more comprehensive risk management strategies that are considering climate change scenarios. These initiatives, while still relatively limited, are nevertheless being undertaken at a variety of levels, including by city, regional and national governments.

At the city level, the implications of climate change scenarios are being considered by New York City as part of the review of its water supply system. A 2001 assessment concluded that the water supply of New York City is vulnerable to changes in climate parameters – such as temperature and precipitation, as well as sea-level rise and extreme events (Rosenzweig and Solecki 2001). On the basis of this assessment, the New York City Department of Environmental Protection initiated work to identify adaptation options and their implications for management, infrastructure design, and policy planning. Examples of adaptation options currently under consideration include: a) tightening of drought regulations, which can be enacted promptly in the event of an unusually severe drought, b) long-term infrastructure measures consisting of the construction of floodwalls around low-lying wastewater treatment plants to protect against higher storm surges; and c) [at the policy level] the integration of the New York City system with other regional systems to alleviate the impacts of temporary disruption in some

[20] Tompkins *et al.* (2005) document some other adaptation practices that have been implemented in the UK.

facilities as a result of inland flooding or of variations in water supply due to changes in temperature or precipitation.

At the provincial level, the province of British Columbia in Canada has published a climate change action plan, titled *Weather, Climate and the Future: B.C.'s Plan*, which incorporates adaptation concerns throughout the Plan (Government of British Columbia 2004). The Plan is structured by sector activity (forest, transport, etc.) and outlines actions to be undertaken to tackle both mitigation and adaptation. However, the Plan does not examine interactions between mitigation and adaptation measures. Examples of measures include improving fire protection, limiting the economic and social costs of the mountain pine beetle outbreak, supporting integrated watershed management to address water resource issues including drought and flooding. Also in Canada, but at a more regional level, an innovative partnership between government, industry and the research community was launched in 2002 through the Ouranos Consortium. Ouranos is a joint initiative of the Government of Québec, Hydro-Québec, and the Meteorological Service of Canada, with an integrated mission that not only includes generation of regional climate scenarios but also works with stakeholders on the development and implementation of adaptation response measures.

At the national level meanwhile, France and the United Kingdom provide good examples of strategies to adapt to climate change. France's Strategy for Adapting to Climate Change (ONERC 2005) is a good example of a comprehensive initiative to address adaptation across the national economy. The Strategy is meant as an intermediary step between scientific assessments of climate change risks and the implementation of adaptation action plans. The Strategy recognises that adapting to climate change requires value judgements and trade-offs, and therefore emphasises the engagement of relevant stakeholders as part of the process for formulation of appropriate responses. An initial draft of the Strategy was published in the summer 2005 for public consultation. It is intended for completion in 2006, when the preparation of an Adaptation Action Plan would begin.

The French Strategy has four overarching goals:

- Protecting people and goods by prioritising public security and health;
- Considering social aspects in order to alleviate inequalities before risks;
- Minimising costs and maximise benefits;
- Conserving the natural environment.

To provide guidance on planning for adaptation, the Strategy first identifies eight strategic axes for integrating adaptation in relevant decision-making processes. These include: a) fostering growth, by understanding climate science and prioritising adaptation actions; b) strengthening [climate] monitoring systems, c) raising awareness [of climate risks] among all actors; d), promoting flexible regional approaches that take into account the scale of relevant climate impacts; e) financing adaptation actions, and f) making use of [existing] policy instruments. More concretely, the Strategy proposes three complementary and overlapping approaches to develop adaptation measures: a cross-sectoral approach (water, risks, health, and biodiversity), an approach based on sectoral views (agriculture, energy and industry, transport, buildings and housing, and tourism), and an approach based on ecosystems (urban environments, coasts, mountains, and forests). Understandingly, the experience of the 2003 heat wave in France permeates the discussion on adaptation. For example, this experience highlights the need to reduce social inequities and to act to improve

construction codes to make houses more comfortable and salubrious.

In the United Kingdom, meanwhile, a consultation is currently under way on developing an Adaptation Policy Framework (DEFRA 2005). The Framework aims to provide stronger strategic direction by setting agreed cross-cutting objectives and measuring progress. It is envisaged that this will ensure that adaptation to climate change can be weighed alongside other policy objectives and priorities. Three stages are planned for the implementation of the Framework:

- Depict the national picture of climate change adaptation;
- Analyse activities taking place and the reasons why some sectors are adapting more successfully than others;
- Assess why adaptation is not occurring in certain areas and what incentives and assistance are required in order to ensure that it is considered in future planning and development.

Another initiative, also in the United Kingdom, is more inward looking in that it examines the implications of climate change across the range of responsibilities of the Department for Environment, Food and Rural Affairs (DEFRA) (Thomson 2003). Among others, this study highlights the need to develop ways to enhance DEFRA's capacity to address cross-cutting issues, to set policy in a longer term context, and to develop a risk management framework. For instance, this means developing a capacity to explore not only the interactions between climate impacts but also between climate impacts and other economic, environmental and social drivers of change. The study also proposes that tools be developed to guide policy-makers, for example, to help them identify issues where pro-active planning is needed by government, and it is hoped that this initiative may become a model for other government departments in preparing their own assessments.

7 Concluding remarks

This analysis, covering members of the OECD and the Annex I to the UNFCCC, highlights several broad patterns and trends in the progress on adaptation to climate change. Impacts and adaptation receive much more limited attention within the NCs of these countries than discussions of GHG emissions and mitigation policies and measures. This is in part because mitigation has traditionally been viewed as being more central to climate policy, but also because the impacts and adaptation sections of the National Communications Guidelines themselves have much less detail and specificity.

Within the discussion on impacts and adaptation, it is the assessment of future climatic changes and impacts that tend to dominate, while the coverage of adaptation measures is often quite limited and generic. Most developed countries now have reasonably sophisticated information on scenarios for climate change and associated impacts, although there is considerable variation in the scope and specificity of reporting on adaptation measures. Many countries do, in fact, identify adaptation options, but only at a very generic level; some even highlight synergies between existing sectoral policies (particularly to current climate variability and natural hazards) and measures that might be needed to adapt to climate change.

Currently, only a few NCs of developed countries report on actual implementation of anticipatory measures that take into account future climate change. Some of the early examples, in fact, have been in place for almost a decade now (since the mid/late 1990s), and relate to zoning policies and coastal construction projects that take scenarios of future sea-level rise into account. More recently, a few countries have reported on a somewhat broader range of responses, including the establishment of institutional mechanisms for assessing and implementing adaptation.

One key issue in terms of anticipatory planning based on scenarios of future climate change is the uncertainty associated with projections of climate variables at the geographic locations and at the spatial scales at which particular decisions are made. Most NCs do not address the issue of uncertainty, although some cite it as a reason for the difficulty in using climate change scenarios for adaptation planning beyond "no regrets" measures. One country also reports on the development of formal guidelines for use by a wide range of decision-makers in dealing with climate change risk and uncertainty in decision-making.

Finally, in the time it has taken to conduct this analysis for over forty countries, some amongst them have published their Fourth National Communication reporting on more recent measures, including on adaptation. This is inevitable as there is an ongoing stream of such submissions, although it might be some

time (even years) before all developed countries in this analysis submit their NC4. A preliminary review of activities that have not made their way into NCs indicates that there is, in fact, a growing number of examples where climate change is being considered in anticipatory planning. Some of these measures were undertaken as one-off projects, more or less autonomously by engineers and project managers particularly in the design of long-lived infrastructure. More recently, there is also a more concerted effort in a few developed countries to develop more comprehensive national and regional level adaptation strategies and frameworks. This is clearly an encouraging sign, although it is too early at this stage to assess the eventual impact of such measures.

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Appendix

EXERPTS FROM SELECTED NATIONAL COMMUNICATIONS AND RELATED DOCUMENTS ON ADAPTATION POLICIES AND MEASURES

AUSTRALIA

Excerpts from the Second National Communication:

Chapter 6: Impacts, vulnerability and adaptation

National Greenhouse Strategy
The 1992 National Greenhouse Strategy aims to 'protect Australia's natural, human and built environment from the potential impacts of the enhanced greenhouse effect'. As mentioned in the Preface to this communication, the Strategy is currently under review, and outcomes will be published in a supplement.

State and Local Government initiatives
Various initiatives that specifically address impacts of global warming have been undertaken by State and Local Governments. For example, South Australian Government planning principles now require that coastal developments be safe for a 30 centimetre rise in sea level, or one metre in special circumstances. Developments must also be safe for, or capable of being protected against, 100 years of coastal erosion, with allowance made for the erosion resulting from a sea level rise of 30 centimetres. In New South Wales, the National Parks and Wildlife Service has developed a biodiversity strategy that recognises the potential role of environmentally managed 'corridors' in enabling species migration in response to climate change.

An example of action by Local Government is the development of a greenhouse strategy by the Southern Sydney Regional Organisation of Councils. This recommends that the organisation's eleven member councils adopt a minimum design level for coastal and tidal structures taking into account potential rises in sea level and increased storm surge risk. Other recommendations include restricting on low lying areas likely to be affected by sea level rise, monitoring research on sea levels and adjusting policy accordingly, and reviewing design standards for storm water drains to ensure that they can cope with predicted future conditions. Many current measures to protect human health – such as programs to reduce smog levels in cities and monitor the spread of arthropod-borne diseases – would become increasingly important if climate change were to raise hazard levels.

Excerpts from The National Greenhouse Strategy: Strategic Framework for Advancing Australia's Greenhouse Response (1998)

8.3 Mechanisms to deliver adaptation strategies

The extent to which current planning processes and strategies (both public and private), which deal with existing climatic variability, can provide a basis for developing climate change adaptation strategies will be investigated. Gaps will be identified and strategies and actions developed where necessary to improve planning processes to support adaptation to climate change.

As part of the investigations, consideration will be given to:

- identifying the means of increasing the flexibility and breadth of issues coverage in existing planning processes to provide for incorporation of potential climate change impacts into planning horizons and arrangements;
- identifying barriers to the implementation of adaptive responses (including lack of adequate information/knowledge and constraints imposed by financial and institutional arrangements) and appropriate solutions to these barriers (including their benefits and costs);
- analysing the risks associated with various options including status quo.

Responsibilities – to be pursued by the Commonwealth, ACT, NSW, Queensland, SA, Tasmania, Victoria and WA in collaboration with local governments. Where appropriate, investigations to be coordinated to achieve added value and efficiency. Consultation to occur with private sector/sectoral interest groups and stakeholders.

Indicative timeframe – to be advanced from 1998/99.
Adaptation strategies for key sectors
In a changing climate, various sectors may experience significant impacts. In sectors such as forests or agricultural production, plant species will be reacting to direct and indirect effects caused by climate change, and by rising atmospheric CO2 concentrations. These effects will in turn have various impacts on economic viability and environmental values. For example, forests may be affected by changing temperature and rainfall regimes, direct CO2 effects, and possible changes in competitive relationships between forest and other species including pests. Forest managers will need to develop adaptive strategies which take account of these changes to ensure that management goals (e.g. timber production or maintenance of natural values) are met. Therefore, adaptation planning for several key sectors or areas which have been identified as sensitive to the direct effects of climate change needs to be undertaken. These sectors include:

- coastal and marine environments and resources;
- agriculture (including agricultural pests and diseases);
- biodiversity;
- forests; and
- human health (e.g. through vector-borne diseases).

There are also secondary impacts which may arise from climate change which will need to be taken into account in developing adaptation strategies (e.g. reduced water availability, as a result of climate change, may have direct impacts on cotton production with possible flow on effects to the textile industry). Further development of adaptation strategies will occur over time as our understanding of climate change impacts in these and other sectors (such as alpine areas) advances.

Existing measures

Sectoral climate change adaptation assessment
Australian experts are currently undertaking preliminary investigations into the development of adaptation strategies for key sectors of the economy, including agriculture and coasts, to respond to climate change. These assessments have generally been made as part of a limited number of climate change impact/vulnerability studies, and as a consequence only preliminary adaptation options for these sectors have been identified to date. Some sectors are further advanced in terms of assessing adaptation needs, and specific adaptation measures for those sectors have been outlined. In the longer term, these measures will be updated, and where possible supplemented by other sectoral measures as the state of the knowledge (under development through measure 8.4) allows.

AUSTRIA

Excerpts from the Third National Communication:

6.3 Adaptation Measures

6.3.2 Forest Ecosystems

Broadening the genetic diversity can be achieved by enhancing natural regeneration in more or less natural forest plant communities and by mixing appropriate seed lots where artificial reforestation is necessary. Also, artificial establishment of satellite tree populations is a conceivable measure. Such populations have genetic compositions which make them well adapted to environmental conditions in future decades.

The measures classified under the term of *nature-conforming forestry* are equally oriented to the natural dynamics of forest ecosystems. Typical examples are the integration of natural succession in the regeneration of forests or the use of self-differentiation in forest tending.

As considerable uncertainties with respect to the best strategies for the different forest areas in Austria exist, research is an important part of the activities directed towards adaptation measures. A project about climate change effects on forests in the east of Austria has resulted in recommendations on how to mitigate the effects of climate change, which are very much based on the expertise and knowledge of forest managers. Austrian researchers also participate in European efforts to develop adaptive forest management strategies.

6.3.3 Avalanche, Erosion and Torrent Control Measures

Preventive measures for protection against natural disasters have a high status in Austria and are perceived as state tasks. They extend from development-planning and settlement-planning to silvicultural and technical precaution measures. The measures are based on the documentation of damage-events and the investigation of their causes. Regarding a possible increase of damage events due to climate-change, protection against natural disasters is also of importance as an adaptation measure.

6.3.3.1 Torrent and Avalanche Control

Since 1884, the lawful basis for precautions has existed for drainage of rivers in mountainous areas and for prevention measures against formation or damaging release of certain avalanches (RGBl.117/1884). These tasks for protection against torrents, avalanches, erosion and rock falls are performed by the Federal Service for Torrent and Avalanche Control. This service represents the only task force in Austria, which performs qualified support-actions and protection-measures in a disaster situation and which is permanently ready for action (Schmidt, 2001). The general tasks are:

- Prevention against natural dangers in the sense of a lasting nature-area- and culture-area- planning, -forming and -maintenance under the purpose of the damage-defense as well as damage-minimization;
- Risk-management by process-based link of natural-dangers - and potential of resource use with the ultimate goal of a preventive country utilization-control;
- Water-protection-strategies in the catchments (management strategies, technical and biological measures) under consideration of hydrological, geological and nature-spatial aspects, (Mayer, 2001).

6.3.3.2 Natural Danger Research and Event Documentation

The Institute for Avalanche and Torrent Research at the Federal Forest Research Station enforces research on natural dangers and disasters in cooperation with its partners in research and practise. For example, examinations on the effects of the decline of many alpine glaciers, which occurred in recent decades, on runoff behaviour and sediment transport will be started.

The documentation of avalanches, floods, mudflow events or landslides is a basic requirement for hazard zone mapping, planning and performance of preventive measures. […] Therefore, this documentation will especially serve as a basis to allow for conclusions on the frequency of damage events due to climatic change.

The Federal Service for Torrent and Avalanche Control is supported in documentation and evaluation of events by the Institute for Natural-dangers and Engineering Forestry at the University of Agricultural Sciences Vienna. The regional administrative bodies, especially local communities, perform qualitative and quantitative recording of events as well.

6.3.3.3 Improvement of the protective forest function

Enormous efforts to protect critical areas against lying fallow are made by the mainly agricultural landowners during their land and forestry management. In addition, nearly 550 redevelopment projects on an area of approximately 110.000 ha are currently supported by public funds. The priority ranking takes place on the basis of concepts of forest protection of the countries. Besides the functional improvement of the mountain forest belt, the redevelopment projects also include afforestations above the current timberline as well as the improvement of agriculturally used areas of Alpine pastures with respect to its protective function. The implementation of measures is mostly done by the forestowners, due to the property structure, especially by mountain farmers.

Financial means for the described technical and biological precaution measures are provided a. o. by the federal government (61%) and the Länder (20%). At the federal government level, measures are proportionally financed by the Austrian Fonds for the Protection of Natural Disasters and the 'Green Plan' (support in accordance with section X of the forest-law 1975) (Knieling, 2001).

6.3.3.4 Systems for Crisis Management

The development of crisis-management systems under inclusion of numerical models represents another main focus of current work.

The system is based on the analysis of documented events as well as the generalisation of different disaster scenarios. The preparation of a sound security-plan, taking into account all different areas of responsibility, serves as an essential prerequisite for fast and efficient rescue-measures in the case of a disaster situation. Tasks and activities of all concerned organisation units are established and documented as well as evaluated in regular intervals.

6.3.3.5 Hazard Zone Mapping

The consequences of a possible climate-change show the need for the Federal Service for Torrent and Avalanche Control to enforce a new evaluation of the risk potentials on the one hand and to influence settlement-development by instruments for environmental planning, like hazard zone maps, on the other hand.

The preparation and re-evaluation of hazard zone maps is done by the Federal Service for Torrent and Avalanche Control. Concerned communes may give their views on the draft, which is examined by a commission afterwards and approved by the Federal Minister of Agriculture and Forestry, Environment and Water management. Hazard zone maps are then incorporated into the environmental planning laws of the Länder.

CANADA

Excerpts from the Third National Communication:

Sectoral Implications of Climate Change in Canada

Potential Adaptation Measures

Water Resources

Frequently identified adaptation options (no regrets or worth doing anyway measures) include:

- water conservation measures by all users;
- greater emphasis on planning and preparedness for droughts and severe floods;
- expanded efforts at water quality protection from agricultural, industrial, and human wastes;
- renewal of national monitoring efforts for water quantity and quality and climate; and
- improved procedures for fair allocation of water within basins and provinces and between jurisdictions, taking in-stream ecosystems into account.

Coastal Zone Management

Among the main types of adaptation measures are:

- construction of physical protection structures, such as breakwaters, groins, dikes, floodwalls, and seawalls;
- natural shore stabilization measures, such as dune building, marsh building, artificial beach nourishing, and floodproofing; and
- land use regulations that restrict development along coastal areas.

Human Health and Safety

For each anticipated adverse health impact, there is a range of social, institutional (e.g., enhanced and informed public health infrastructure), technological (e.g., health-oriented management of the environment, including air and water quality, food safety, urban and housing design, and surface water management), and behavioural adaptation options that could lessen that impact. Based on the results of research to determine the extent of the potential impacts of summer heat on public health and identify unique weather-related thresholds for Toronto, the Toronto Atmospheric Fund and Toronto Public Health developed a Heat/Health Alert system. Implemented in the summer of 2001, this project involved the customization and operationalization of software that provides public health officials with a 48- to 60-hour warning before a potentially lethal air mass is predicted to arrive in the city. With this information, the Medical Officer of Health can issue a Heat Alert or the Mayor can issue a Heat Emergency and activate the Hot Weather Response protocol, which includes notifying the public on methods of keeping cool, identifying air-conditioned areas open to the public, delivering bottled water to these areas, and identifying agencies that will monitor vulnerable clients (such as seniors). This project, supported by the CCAF, is also investigating several methods of reducing the urban heat island effect.

Agriculture, Fisheries, and Forestry

There is a large range of potential adaptation options for Canadian agriculture. These will vary depending on the climate changes involved and on non-climatic forces such as the economy, politics, environment, and technology. Adaptation options include:

- diversifying crop and livestock types and varieties to reduce economic vulnerability to climate change;
- changing the location of crop and livestock production areas;
- changing farm practices to encourage soil moisture retention;
- diversifying agricultural household incomes;
- developing new temperature- and moisture tolerant crop varieties;
- developing early-warning systems to inform farmers about the variability and probability of extreme climatic events;
- developing or enhancing irrigation and other water management systems; and
- modifying subsidy, support, and incentive programs to influence farm-level production and management practices.

Preliminary results of recent research funded through the CCAF suggests that there may be a need to consider how climate change risk management options fit into the general framework of agricultural decision making.

Forestry

Predictability and uncertainty are major problems in adapting to climate change in the forestry sector. It will be necessary to first determine the sensitivity of forests to climate change and then identify the degree of change that would have a serious impacts (IPCC, 1998). Adaptation strategies may include:

- concentrating management efforts on sites that are less vulnerable;
- changing harvest schedules;
- adjusting replanting behaviour, including planting species more tolerant to variable climates;
- protecting existing forests by enhancing fire and pest prevention programs; and
- considering short rotation options to reduce risks during tree life span.

Fisheries

Adaptation measures could include:

- modifying and strengthening fishery operations and fish monitoring programs to prevent overfishing and ensure sustainable harvesting;
- enhancing fish breeding to preserve the genetic diversity of fish populations;
- restocking areas with robust species;
- considering fish habitat needs in planning coastal development; and
- encouraging novelty fishery operations.

Communities and Infrastructure

Adaptation measures could include:

- incorporating climate change into land use, community, and transportation planning;
- revising building codes and regulations to reflect new climate conditions:
  - revising design parameters for flood protection infrastructure,
  - revising ventilation requirements for buildings,
  - implementing metered water pricing policies to reduce waste; and
- redesigning water cooling towers to reduce evaporation losses.

Recreation and Tourism

Tourists and sports enthusiasts may be expected to adapt to changing climate conditions by using alternative recreational locations, reducing or stopping participation, and substituting activities. The recreation and tourism industry may be able to adapt by creating a capacity for flexibility in relocating facilities, taking advantage of advances in equipment technologies, and diversifying their offerings — for example, providing a number of recreational alternatives having a range of climatic requirements and sensitivities

GERMANY

Excerpts from the Third National Communication:

VI Expected impacts of climate change and risk assessment

VI.1 Agriculture

With a range of options in annual crop selection and farming methods, Germany's farmers are likely to be able to deal with climate changes in the foreseeable future, and thus no climate-related problems are expected to occur in the area of food production – especially since higher CO2 concentrations and higher temperatures could have a positive effect on crop yields.

VI.2 Forests

• As part of forest management, attempts can be made to prepare for expected climate changes – for example, via selection of suitable tree species. This option has limited usefulness, however, due to the considerable uncertainties prevailing in regional climate forecasts and the longevity of forest trees.

• But even gradual adaptation, actively supported by forest management, is likely to lead to losses of biodiversity: animal and plant species that are unable to move to n
ew biotopes, due to the isolated locations of their current habitats or to their slow rate of propagation, could die out. Climate change will also spark directional genetic selection (loss of genetic diversity).

In 1997, to improve understanding of possible trend scenarios, the Federal Government commissioned a research project entitled "Germany's forests and forest management sector under global change". [...] The authors concluded that overall, Germany's forest-management sector would be able to deal with the impacts of climate change.

VI.7 Coastal regions

Coastal habitats cannot be conserved and developed unless coastal-protection measures are taken. German coastal-protection facilities are designed to provide a level of protection in keeping with analysis of long-term observations of storm-flood events and careful consideration of any expected impacts of climate changes. For this reason, Germany's coastal-protection structures have long been designed to include a safety margin, with respect to sea-level increases, of 25 - 30 cm in 100 years and of 15 - 25 cm in 100 years in Mecklenburg-West Pomerania. Developments along coastlines are continually monitored and carefully evaluated, to permit prompt response to any changes that cannot be foreseen at the present time. Especially careful attention must be given to changes in the frequency and intensity of extreme events such as storms and storm floods, since the high-water levels and changes resulting from extreme weather situations provide indications of how coastal-protection systems and facilities need to be enlarged in order to protect coastal dwellers and property.

Ever since the catastrophic storm flood of 1962, construction of coastal-protection structures has been given special priority. The inhabited areas that must be protected along the German North-Sea and Baltic-Sea coasts comprise some 11,000 km2 of lowland areas (land lower than 5 m in elevation). While no precise statistics are available concerning the numbers of people and amounts of assets that must be protected in these areas, it is clear that very considerable numbers of inhabitants and amounts of assets are involved. For example, it is estimated that the following numbers of people and amounts of assets must be protected: in the Weser-Marsch region, 76,000 inhabitants, 30,900 jobs and 8 billion € in assets; in Hamburg, 180,000 inhabitants and 10 billion € in assets; and in Mecklenburg-West Pomerania, a flood plain totaling 105 km2 in area and harbouring 163,000 inhabitants and assets worth some 2 billion €. Today, 90 % of Germany's North-Sea and Baltic-Sea coastlines are already protected by means of coastal-protection structures. The protection afforded by these structures is such that, given current coastal-protection practice, impacts on protection levels for people and assets in coastal regions could occur only if sea levels were to rise, quickly, to levels higher than today's safety margins. Such rises in sea levels are not currently expected. Today, 249 km, or 70%, of Mecklenburg-West Pomerania's Baltic-Sea coast is retreating. The mean rate of coastal retreat is 34 m / 100 years. Such land losses could accelerate, however.

The working group "Coastal protection and increases in sea levels" of the Trilateral Wadden Sea Conference studied the possible impacts of higher sea levels on the natural systems of the Wadden Sea, along the North Sea. In this working group, experts responsible for coastal protection and nature conservation along the North Sea coast worked jointly. In its report, the group concluded that the Wadden Sea ecosystem is highly adaptable and would thus be able to compensate for changes resulting from a sea-level rise of 25 cm over 50 years. As explained above, current understanding indicates that such a sea-level rise will not occur, or be exceeded, along German coasts. As a result, no negative impacts on the Wadden Sea's natural systems, such as changes in species composition or bioproductivity, are expected. On the other hand, for such a scenario, the group estimated that 5 - 15 % in additional costs would be incurred in maintaining current levels of protection afforded by coastal-protection systems.

NETHERLANDS

Excerpts from the Second National Communication:

7.2 Adaptation Measures

Coastal Zone Management

The 1995 evaluation of the implemented policy for 'dynamic preservation' of the 1990 coastline led to the conclusion that the 1990 coastline has been maintained at almost all locations and that the chosen strategy of beach nourishment has been successful. An analysis showed that the threats to the coast will greatly increase in the coming decades. Accelerated sea-level rise, land reclamation plans, extraction of gas and sand, and further urbanization in the coastal area will have major consequences for the defence-against-flooding function of the coastal system. These developments call for an integrated approach, in which the different functions of the coastal area are in balance. This is an important task for the Provincial Advisory Boards, where national government, coastal provinces, water boards. coastal municipalities and shareholders cooperate.

Restoring and maintaining this function is a prerequisite for a sustainable development of the coastal areas, in other words, the natural processes in the coastal zone should not be disturbed and there must be enough space for the coastal system to adapt to new circumstances like sea-level rise. Only then will a coastal system develop which can be maintained at an acceptable cost, also in the future. The *Technical Advisory Committee on Water Defence* has recommended reserving space in the dune area to guarantee safety for the next 200 years, with a worst-case scenario of 85 cm sea-level rise and a 10% per century increase in storms (TAW, 1995).

It was decided in 1996 that structural erosion loss is to be supplemented also for the long-term, as much as possible by sand nourishment (RWS, 1996). Research will be carried out to determine the best way to supplement the loss of sediment from the foreshore (7-12 m deep) from the year 2000 onwards. The policy will be evaluated every five years and the expectations for the future, including climate change aspects, will be used to design the appropriate measures.

The design of (unavoidable) new engineering works with a long lifetime, like storm surge barriers and dams, will incorporate an expected sea-level rise of 50 cm. The first structure of this kind will be the storm surge barrier near Rotterdam, which is expected to open in 1997.

Water Management

The *Flooding Defence Act* came into force in 1996. This act mentions, the safety standards for all water defences varying from one in 10,000 to one in 1250 years. Every five years the Minister has to determine the decisive water levels matching to these frequencies. Since these decisive levels will determine the height of the embankments, the most recent knowledge on climate change can be incorporated every 5 years into the design of the flood defence.

Protection against high floods is not only a matter for the Netherlands but demands measures for the entire international catchment area. International agreements have been made for both the Rhine and the Meuse to reduce and prevent damage due to high floods. The type of measures are: land-use changes to slow down the discharge; increase in upstream storage, improvement of the protection system (like dikes) and increase in the discharge and storage capacity of the river bed. Especially the last two measures are applicable to the Netherlands. Parallel to the policy on our coastal defence, in which the capacity of the natural coast to maintain its resilience is going to be restored and maintained, is the one for the river system. This can be achieved through widening and deepening the riverbed, enlarging the flood-prone areas, developing natural areas in the winter bed of the river, regulating the settlement pattern in the flood plain and reserving space for future flooding in consideration of the influence climate change will have on the flood levels. An integrated approach, whereby the different functions of the river system here are in balance, is also essential.

Excerpts from the Third National Communication:

6.3 Adaptation measures

As a result of the *Coastal Defence Policy* the loss of material in the zone between minus 7 m and plus 3 m will be compensated for by nourishment on the beach and, if possible, in the shallow-water zone. Besides this the total coastal system (the area between minus 20 m and plus 3 m) is also losing material, with total losses estimated to be double the loss in the shallow zone. This loss will also be compensated for. As a result of an increased relative sea-level rise scenario of 60 cm per century, the amount of sand needed will increase by 30%. A commission was appointed after the extreme discharges and related risks of inundation by the rivers Rhine and Meuse. This group advised the government to further anticipate future developments in climate, ground subsidence, population and economic values, rather than responding to individual incidents, and also to develop spatial measures for the water systems (RWS water, 2000). The government took this advice and concluded that safety must be guaranteed and the chance of flooding may not increase. A good mix of spatial and technical measures should be applied, with a preference for spatial measures. These spatial measures include widening riverbanks and deploying water storage and retention areas. Being strongly dependent on upstream activities, trans-boundary cooperation is also taking place with the other countries in the catchment area, to implement necessary measures.

The main features of governmental policy are:

- to stimulate public awareness of the problems and risks relating to water;
- a new approach to safety and flooding based on the following three principles:

a) to anticipate instead of reacting;
b) not to transfer water management problems to others by following a three-stage strategy: holding, storage and removal;
c) implement more spatial techniques;

- new investments in water management of national and regional water systems.

Furthermore, the safety characteristics of all dykes and other protecting infrastructure are reviewed every five years. The relevant criteria and boundary conditions develop over time, partly due to the consequences of e.g. climate change and changes in land use.

NEW ZEALAND

Excerpts from the Third National Communication:

6.3 Expected impacts of climate change and sea-level rise

The Ministry for the Environment commissioned a summary report on potential climate change impacts on New Zealand agriculture, which forms the national basis for identification of key problem areas and adaptation options (Kenny et al., 2001).

The Ministry for the Environment commissioned in 2001 a comprehensive summary of the impacts of climate change on coastal margins, which identifies these factors and forms the basis for individual, site-specific hazard assessments to be carried out by local government, in particular district councils (Bell et al., 2001).

6.4 Avoidance and mitigation of natural hazards arising from climate change

Local authorities have the responsibility of planning for and mitigating coastal hazards. After extensive public consultation, the New Zealand Coastal Policy Statement (NZCPS) was prepared under the RMA in 1994. This policy statement is to guide local authorities in their day-to-day management of the coastal environment.

The NZCPS has provided a structure for adaptive response to sea-level rise as part of the national strategic planning framework. The NZCPS requires recognition of the potential impacts of likely changes in sea level, including the need to avoid development in areas prone to inundation or accelerated erosion; protecting human life, essential facilities and economic activities; and ensuring that the integrity of natural systems and their buffers is not unduly affected. The NZCPS is currently under review, and its update will reflect new scientific evidence on the magnitude and impacts of climate change on New Zealand's coasts. An overview on the assessment methods and mitigation strategies of coastal hazards connected with climate change are provided in the recent report published by the Ministry for the Environment referred to above (Bell et al., 2001).

Under the New Zealand approach to risk management, concrete actions to address and minimise impacts of climate change fall under the authority of territorial authorities (city and district councils). The formulation of clear national guidelines for managing climate-related risks for these territorial authorities, apart from the Coastal Policy Statement, has to date been limited by the absence of conclusive nation-wide projections for changes in the frequency of extreme events such as floods and droughts, and by uncertainty of sea-level rise projections and the influence of local overriding factors such as land subsidence. For this reason, specific implementation of risk management schemes and consideration of regional relevance of climate change impacts has largely been left to individual territorial authorities.

6.5 Avoidance and mitigation of other climate change impacts

A number of research programmes provide specific information to define potential adaptation measures in the area of agriculture. These include investigating the response of various pasture and arable species to changes in temperature, CO2 concentration and rainfall, and adaptive breeding of new cultivars (for example, kiwifruit with reduced winter chill requirements, drought resistant pastures, or high-quality subtropical pastures). Further adaptation measures are management of irrigation schemes and water supply systems, changing land-use in response to changing erosion and drought risk. Current impacts of climate variability, particularly droughts, have prompted the development of guidance material for farmers by the Ministry for Agriculture and Forestry (Ministry for Agriculture and Forestry, 1998). Adaptation to a potential increase in drought frequency and severity in eastern regions of New Zealand represents an important 'no-regrets' option in adjusting to uncertain climate change projections. The Ministry for the Environment has issued a guidance document on climate change impacts on agriculture which includes a list of short, medium and long term adaptation options as outlined above (Kenny et al., 2001).

To date there has been limited engagement by the private sector in addressing climate change impacts and adaptation measures. The New Zealand Government recognises that collaboration between local and central government and the private sector is needed to adequately respond to the challenge of climate change impacts and to make best use of sector-specific knowledge. The National Science Strategy Committee for Climate Change10 (NSSCCC), among other things, coordinates a range of workshops that focus on impacts and adaptation opportunities, and are aimed at achieving a greater interest and level of knowledge in the private sector on these matters.

NEW ZEALAND (CONT'D)

Excerpts from references cited in Third National Communication of New Zealand:

Bell, R.G., Hume, T.M., Hicks D.M. (2001). Planning for Climate Change Effects on Coastal Margins. Ministry for the Environment, Wellington. Case study 9: Regional, coastal and district plans (sea-level rise)

A recent survey of territorial authorities and regional councils was undertaken by DTec Consultants (Derek Todd) and NIWA to assess the degree to which current statutory plans and policies have specifically taken sea-level rise into account.

Some regional coastal plans (Southland, Otago, Bay of Plenty) and regional policy statements (Southland) have specifically included a magnitude of sea-level rise to be used for new developments and consenting, although a range of magnitudes were sourced from either the 1990 or 1995 IPCC assessment reports, the former being markedly higher than current projections. Other regional councils have included a more general statement about using the most recent IPCC projections for sea-level rise impact assessments. Five other councils (Canterbury, West Coast, Waikato, Auckland, and Northland), who have restrictions on structure and reclamation design due to sea-level rise, are less definite in what level of restriction they will apply, using words such as "have regard to", "adequate", "appropriate" in terms of sea-level rise. In theory this allows them to use discretion on a case-by-case basis for what level to allow, but in reality they could be bound by the precedent of their first decision and face Environment Court hearings if they do not use widely accepted rates of sea-level rise. Only two coastal plans (Gisborne and Bay of Plenty) stated that the effects of sea-level rise will be incorporated into hazard zone or area assessments, while Canterbury will include these within five years of its plan becoming operative. We assume this is to allow further information on the effects of sea-level rise to be gathered.

From the small sample of 11 district plans reviewed, it appears that district council plans have less emphasis on sea-level rise than city council plans. The size of the population and value of infrastructure potentially at risk seem to influence how much emphasis there is on sea-level rise in the statutory planning documents. An exception to this is that there appears to be more emphasis on investigations of coastal hazards, which may or may not include sea-level rise, in the district council plans than in the city council plans.

There are two side issues associated with incorporating sea-level rise into planning instruments. One is the inflexibility of plans to be changed regularly (because of the lengthy public process) and how best to regularly incorporate changes in climate and sea-level projections from each five-yearly IPCC climate assessment or regional predictions. There is also the issue of translating IPCC global projections down to the regional level. Further work is needed to establish regional values for relative sea-level rise around New Zealand by monitoring both sea-level and vertical land movements. It may well be that IPCC projections are appropriate, but this needs to be established by monitoring.

In summary:

- all surveyed councils are aware of sea-level rise, but not all have implemented policies and rules to deal with its potential effects
- the wording of some policies and rules does not allow the councils to use the more recent estimates of sea-level rise
- there is no consistency in the planning horizon used to plan for sea-level rise, with some councils choosing 50 years and others 100 years.

NEW ZEALAND (CONT'D)

Excerpts from references cited in Third National Communication of New Zealand:

Kenny, G., (2001). Climate Change: Likely Impacts on New Zealand Agriculture. Ministry for the Environment, Wellington.

3. Climate Change and Pastoral Agriculture

3.4 What measures can be taken to adapt?

Short-term planning
In the short term, the best option is to keep developing and implementing strategies for dealing with present climate variability. Such strategies will arise from individual farmer experience, farmer discussion groups, service industries and improved linkages with climate monitoring and short-term prediction services. Regional councils have an important role in this context, and some are very proactive in working with farmers, particularly on soil and water conservation.

A good source of information on drought is the drought-recovery strategies report prepared by Agriculture New Zealand (1998). This report provides a comprehensive range of options that can be implemented in the short term. MAF has identified key factors that contribute to recovery from drought (Ministry of Agriculture and Forestry, 1998). In northern New Zealand drought is less of a problem, but some areas are experiencing increasing problems with invasive subtropical species. A range of management practices are used, including spraying and re-sowing of pasture, and mulching mower management, which has been used effectively to manage kikuyu on dairy farms in Northland.

Medium-term planning
Medium-term planning may need to take more explicit account of some of the changes that are expected with climate change. Pasture breeding programmes should focus increasingly on higher temperature- and drought-tolerant species which also provide high feed quality. Availability of water for irrigation will be an increasingly important management issue, particularly in eastern regions. Developing efficient and effective water conservation strategies should become a priority, which will be driven by continued increases in demand. The uncertainty of a changing climate and the need to deal with an increasingly competitive global market will probably require an increasingly delicate balance between conservatism and risk-taking in farm planning. Climate change will also affect our global export market, which could have both positive and negative effects on our export potential, in addition to the strong exposure that New Zealand agriculture already experiences.

Long-term planning
A long-term farm plan has a timescale of no more than 20 to 30 years and is normally focused on issues such as catchment management for soil conservation, as encouraged by the Hawke's Bay Regional Council, for example. Ideally, strategies to adapt to climate change need to be considered over even longer time horizons, out to the next 50 to 100 years, and designed around whole catchment planning that encompasses climate change along with a range of other issues, including biodiversity, biosecurity, land degradation and water resource use.

In the short to medium term, the pastoral sector could gain under climate change conditions if it effectively manages the potential changes in soil moisture availability and species composition. This would probably require a range of adaptation measures, targeted regionally, including the wider use of current drought-tolerant species, and development of new drought-tolerant forage species and high-quality subtropical grasses. Long-term impacts and adaptation measures are very uncertain at this stage, particularly due to the limited knowledge of changes in rainfall patterns and the rate at which extreme events like droughts and heavy rainfall will occur. Current models indicate that the benefits from climate change will gradually decrease, while the negative effects from extreme events are likely to become stronger as climate change progresses.

4. Climate Change and Arable Crops

4.3 What measures can be taken to adapt?

Despite the overall positive outlook for the near term, a number of adaptive measures have been identified for arable cropping, which will probably need to be considered over time [9]. Proactive adaptation could not only avoid negative impacts from identified risks, but also increase the benefits of climate change to arable cropping.

Breeding new cultivars that are suited to changing conditions in the different arable cropping regions in New Zealand may be required.

Arable crops such as soybeans, rice and sorghum may become increasingly viable in some areas. Success of such crops will be strongly dependent on market conditions in the future.

Changed pest and disease regimes could require altered plant protection strategies.

Any geographical changes in crops grown could require changes in infrastructure that need to be considered long-term (for example, irrigation systems and water resource allocation).

5. Climate Change and Fruit Production

What measures can be taken to adapt?

Short-term planning
In the short term (over the next decade) the industry can cope with measures already in place, particularly with a continued focus on developing acceptable alternatives to HiCane.

Medium-term planning
In the medium term (over the next 10 to 30 years) there could be an increased need for varieties with a lower chill requirement. These may not replace Hayward, which the industry presently expects to maintain as its main variety, but will help spread the risk with the likely trend towards more frequent warm winters. A possible downside is that a greater diversity of varieties will add greater complexity – and cost – to both orchard management and marketing.

Long-term planning
Over the next 50 to 100 years relocation could be a possibility, but is not considered an option by Zespri because of the very high cost of relocating the industry infrastructure. There would be potential for greater plantings of kiwifruit in Hawke's Bay and Nelson, although the present view is that the percentage of the national crop grown in Hawke's Bay is likely to diminish, principally as a result of an expansion of plantings in the Bay of Plenty. The ability of the industry to develop commercially viable varieties with low chilling requirements and maintain production of high-quality fruit in the Bay of Plenty will probably be crucial.

SWITZERLAND

Excerpts from the Third National Communication:

6.3. Adaptation measures

6.3.1. Natural hazards

Located in the Alps, Switzerland is a small 'hazard prone' country exposed to natural disasters, such as debris flows, earthquakes, floods, forest fires, hail storms, landslides, rockfalls, wind storms and snow and ice avalanches. Reliable data on the frequency and intensity of landslides, flooding and others hazards are now available.

Legal regulations have not been designed to cope with potentially disastrous changes in the climate system. These regulations are sector-based and present notable omissions, particularly with regard to natural hazards that occur rarely but cause massive damage. The distribution of tasks and roles (responsibility, subsidiary support) is also unclear. Nevertheless, strong efforts have been made to apply the same strategy and similar approaches for dealing with all kind of natural hazards. The legal and technical framework for the management of natural risks has undergone considerable changes during recent years. Since 1987, when major flooding affected many valleys, the strategy has shifted from fighting against the natural disaster towards the management of risk. Two new regulations, the Federal Law on Flood Protection and the Federal Forest Law came into force in 1991 to protect human lives, objects of value and the environment from damaging effects caused by water, landslides, forest fires and snow and ice avalanches. But the responsibilities still remain at cantonal level. The main emphasis is now to an increasing extent placed on preventive measures. Therefore, hazard and risk assessment, the definition of protection targets, the integral planning of measures (mapping, technical measures and warning systems) and the limitation of the residual risk are of central importance. The cantons are required to establish registers of events and hazards maps at a scale of 1:5,000 (local large-scale map) depicting endangered areas. They also have to take hazards into account for the purposes of land-use planning. For the elaboration of registers of events and hazards maps, the federal government provides subsides to the cantonal authorities of up to 70 per cent of the costs, as well as helping with new guidelines to elaborate these hazard maps (Kienholz & Krummenacher 1995, Petrascheck & Loat 1997, Lateltin 1997). A digital database (StorMe) to register all the events is now operational at the Swiss Agency for the Environment, Forests and Landscape.

For engineering-based action, the total financial support from the Confederation between 1988 and 1999 was 65 million CHF per year for flood protection and 80 million CHF per year for protection against snow avalanches, erosion and landslides. The federal government assists the cantons in the protection of built-up areas and transport infrastructure, providing early warning systems and the associated monitoring points and information systems. Avalanche forecasting and subsequent measures such as the evacuation of people, the closure of traffic routes, and the artificial release of avalanches under controlled conditions allow risk to be minimised in areas not kept safe by long-term protective measures. In order to alert the authorities responsible, and any endangered industrial sites, an alarm system has been installed at various sites in Switzerland, and this automatically reports a breach of specified water levels to a permanently staffed control centre. This centre, located at the Federal Office for Water and Geology, alerts parties concerned and publishes daily hydrological data via the Internet.

The large variety of natural hazards, the intense use of endangered areas, the impacts of climate changes and the high dependence on technical systems require a re-evaluation of the natural hazard policy. A global approach to coping with natural hazards must be taken, and climate change aspects have to be included. A concerted effort by all players enables efficient reductions in future disasters. The reduction of destruction caused by natural disasters requires an integral prevention strategy. Natural hazards, socio-economic conditions and cultural values have to be given equal consideration. The implementation of the measures requires co-operation with the population directly affected. It is not possible to achieve 100 per cent safety. The existing land use defines the safety objectives necessary. In the long term, the acceptance of certain risk has to be discussed openly. The step from the battle against nature to a distinct management of risks ('risk culture') proclaimed since 1997 by the national platform for natural hazards (PLANAT) is being prepared in Switzerland. It also enables changing hazard conditions due to global warming and changing demands and possibilities of society to be considered adequately and quickly.

6.3.2. Forests and sylviculture

The history and models of changes in vegetation with time suggest that forests will be affected, though the mode of transition is uncertain. Impacts will vary between different regions. Damage must be expected from storms, drought, atmospheric pollution, and (according to the level of warming) new or intensified pests and diseases. During the 20th century, increasing forest damage through extreme climatic events has been reported. No adaptation strategy exists to prevent such effects, but well-suited legal provisions are in place that allow for public assistance, where necessary, to counteract damage to forests and their protective functions. In addition, a number of measures are in place to preserve forests that serve the objective of damage prevention.

1. Addressing ecological imperatives through sylviculture:
• Ban on clear-felling.
• Regeneration practices imitating the natural behaviour of a 'virgin' forest (near natural forest management).
• Sustainable sylviculture with financial support for forest management, logging and hauling the timber, since total costs of near natural forest management are high. Average annual subsidies of 65.2 million CHF were spent in the period 1996 to 1999 (60.35 million CHF from 1992 to 1995). Special emphasis has been placed on re-establishing well adapted stands on the forested areas destroyed by the storm Lothar. For this purpose, a special guide for decisionmaking on areas damaged by storm has been established. After the storm Lothar, 10 million CHF were provided to gain more information for preventing disasters due to heavy storms.

2. To maintain the vitality of forests, average annual subsidies were 12.875 million CHF between 1996 and 1999 (a total of 40.9 million CHF from 1992 to 1995) for the following measures:
• Measures to prevent and combat pests and parasites.
• Repairing damage where forest conservation might be threatened.

3. Conservation of the genetic resources of forests (0.37 million CHF average annual subsidy for 1996 to 1999) using the following measures:
• National register of seed tree stands on the basis of internationally defined parameters.
• Launching a gene conservation network.
• Creation of seed orchards to improve the supply of indigenous reproductive material.

All these measures are intended to improve the stability and autonomous adjustment of forest stands to changing natural conditions.

UNITED KINGDOM

Excerpts from the Third National Communication:

5.11 UKCIP has developed additional supporting products for undertaking impacts assessments: socio-economic scenarios for the UK; a methodology for costing the impacts of climate change in the UK; and guidance to decision-makers on dealing with risk and uncertainty in decision making in the context of climate change.

5.15 Initial work has been undertaken to identify strategic adaptation priorities for the UK over the next 30 to 50 years. Water resource management; coastal and river flood defence; enhanced resilience of buildings and infrastructure; management of wildlife, forestry and agriculture; and co-ordinated approaches to planning were identified as key priorities for adaptation. The work also made a preliminary assessment of financial costs for options to address these issues, and suggested how no or low regrets action could be taken in the five priority areas.

Priority areas for adaptation

Water resources

Climate change projections are taken into account in strategies and plans for water resource management, catchment abstraction management, and maintenance of supplies in drought conditions. Efficient use of water by households has been promoted through new Water Regulations, by water companies in England and Wales, through water bylaws by water authorities in Scotland, and through Government public information campaigns. Guidance has been provided to industrial water users and government departments on best practice and water conservation. The use of Sustainable Urban Drainage Systems has the potential to bring benefits in terms of water quality control, reduction in flood impacts and likely increase in groundwater recharge, and is therefore being encourage.

Flood and coastal defence

Government issues guidance to flood defence operating authorities in England and Wales which includes allowances for sea level rise and higher river flows as a result of climate change. Climate change and sea level rise projections will also be considered in Shoreline Management Plans, Coastal Habitat Management Plans and River Catchment Flood Management Plans, which will be used to inform long-term policies on land use planning and coastal and river management. Investment has been made in improving flood warning services, increasing public awareness of flood risk, improving flood and coastal defence infrastructure, and promoting new high level targets for flood and coastal defence, aimed at reducing long term risk.

In Scotland, the Scottish Executive has published research on climate change impacts on flood risk on Scottish rivers and the coast so that local authorities, and others, may take account of climate change in developing appropriate measures. The Executive has also conducted research to consider *Potential Adaptation Strategies for Climate Change in Scotland*. This research, and subsequent consultation, will inform consideration of a climate change adaptation strategy for Scotland. Flood prevention and coastal protection will be part of that consideration. Additional resources have been made available for improvements to flood warning dissemination, flood prevention and coast protection infrastructure.

Building regulations

Climate change projections are being considered as part of the rolling programme of review of the Building Regulations in England and Wales, Scotland, and in Northern Ireland. This includes considering any revisions to the technical requirements that may be required to address climate change impacts.

Countryside and Biodiversity

Research has been undertaken into the effects of climate change on biodiversity and UK species and habitat conservation policy. Action has been taken to strengthen the protection and management of Sites of Special Scientific Interest (SSSIs), which will help the management of sites adjust to changing climatic conditions; and increased support has been given to agri-environment schemes which will help to maintain and enhance biodiversity in the wider countryside.

To raise awareness of climate change issues within the agricultural community, the Government produced a booklet on climate change and agriculture in April 2000. This urges farmers to start to anticipate a changing climate in their day-to-day and longer term planning decisions and provides advice on how to reduce emissions of greenhouse gases from agriculture. A project is also underway to establish a forum for liaison with key stakeholders on climate change impacts, assessing the industry's priorities for information, the value of existing information, and facilitating information provision.

The National Assembly for Wales' strategy, *Woodlands for Wales*, notes the uncertainties involved in predicting climate change and the consequent importance of building flexibility into forestry planning.

Land use planning

Following the widespread flooding in England and Wales in 2000, planning guidance on development in areas at risk of flooding has been strengthened to advise a precautionary and risk-based approach. This guidance will be reviewed three years after publication, in the light of increasing knowledge of the likely impacts of climate change and emerging experience of its implementation and effectiveness. Planning guidance in Scotland continues to be based on avoiding development where there is a significant risk of flooding, and managing the threat in other areas where the risk is less acute.

The National Assembly for Wales is undertaking a full review of its land use planning policies, in partnership with local government, government agencies, business and the voluntary sector. The draft document, *Planning Policy Wales*, contains a new section on climate change and planning and new policy on flood risk and climate change. A final policy document is expected in early 2002. A UK-wide guide is being developed to help those involved in land use planning focus on the role of planning in responding to climate change, including identifying measures that could be taken through the land use planning system to adapt to its effects.

UNITED STATES OF AMERICA

Excerpts from the Third National Communication:

Potential Consequences of and Adaptation to Climate Change

This adaptation to environmental variations and extremes has been accomplished because the public and private sectors have applied technological change and knowledge about fluctuating climate to implement a broad series of steps that have enhanced resilience and reduced vulnerability. For example, these steps have ranged from better design and construction of buildings and communities to greater availability of heating in winter and cooling in summer, and from better warnings about extreme events to advances in public health care. Because of this increasing resilience to climate variations and relative success in adapting to the modest changes in climate that were observed during the 20th century, information about likely future climate changes and continuing efforts to plan for and adapt to these changes are likely to prove useful in minimizing future impacts and preparing to take advantage of the changing conditions.

Potential Adaptation Strategies for Agriculture

To ameliorate the deleterious effects of climate change generally, such adaptation strategies as changing planting dates and varieties are likely to help to significantly offset economic losses and increase relative yields. Adaptive measures are likely to be particularly critical for the Southeast because of the large reductions in yields projected for some crops if summer precipitation declines. With the wide range of growing conditions across the United States, specific breeding for response to CO2 is likely to be required to more fully benefit from the CO2 fertilization effect detected in experimental crop studies. Breeding for tolerance to climatic stress has already been exploited, and varieties that do best under ideal conditions usually also out-perform other varieties under stress conditions.

Potential Adaptation Options for Coastal Regions

Several states have already included sea level rise in their planning, and some have already implemented adaptation activities. For example, in New Jersey, where relative sea level is rising approximately one inch (2.5 cm) every six years, $15 million is now set aside each year for shore protection, and the state discourages construction that would later require sea walls. In addition, Maine, Rhode Island, South Carolina, and Massachusetts have implemented various forms of "rolling easement" policies to ensure that wetlands and beaches can migrate inland as sea level rises, and that coastal landowners and conservation agencies can purchase the required easements. Other states have modified regulations on, for example, beach preservation, land reclamation, and inward migration of wetlands and beaches. Wider consideration of potential consequences is especially important, however, because some regulatory programs continue to permit structures that may block the inland shift of wetlands and beaches, and in some locations shoreline movement is precluded due to the high degree of coastal development.

Potential Adaptation Options to Ensure Public Health

Many of these adaptive responses are desirable from a public health perspective, irrespective of climate change. For example, reducing air pollution obviously has both short- and long-term health benefits. Improving warning systems for extreme weather events and eliminating existing combined sewer and storm-water drainage systems are other measures that can ameliorate some of the potential adverse impacts of current climate extremes and of the possible impacts of climate change. Improved disease surveillance, prevention systems, and other public health infrastructure at the state and local levels are already needed. Because of this, we expect awareness of the potential health consequences of climate change to allow adaptation to proceed in the normal course of social and economic development.

Further Reading

- OECD (2005), **Bridge Over Troubled Waters: Linking Climate Change and Development**, OECD, Paris, ISBN 92-64-01275-3, 154 p.,€ 26.
- OECD (2004), **The Benefits of Climate Change Policies: Analytical and Framework Issues**, OECD, Paris, ISBN 92-6410831-9, 323 p., € 90.
- OECD (2004), **Development and Climate Change in Egypt: Focus on Coastal Resources and the Nile**, COM/ENV/EPOC/DCD/DAC(2004)1/FINAL, OECD, Paris.
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- Munasinghe, M. (2002), **Analysing the Nexus of Sustainable Development and Climate Change: An Overview**, COM/ENV/EPOC/DCD/DAC(2002)2/FINAL, OECD, Paris.