

Prioritizing Climate Change Risks and Actions on Adaptation

A Review of Selected Institutions, Tools, and Approaches

Final Report

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By: Mark Brooks
Frédéric Gagnon-Lebrun
Hélène Harvey
and Claude Sauvé
ÉcoRessources Consultants

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Print copies of this publication are available upon request. Please contact:

Policy Research Initiative
56 Sparks Street, First Floor
Ottawa, ON K1P 5A9

Tel: (613) 947-1956

Fax: (613) 995-6006

E-mail: <questions@prs-srp.gc.ca>

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LIST OF ABBREVIATIONS AND ACRONYMS

AAFC	Agriculture and Agri-Food Canada
ACIA	Arctic Climate Impact Assessment
AIR	Adaptation and Impacts Research Group
APF	Adaptation Policy Framework (United Kingdom)
CBA	Cost-benefit analysis
C-CIARN	Canadian Climate Impacts and Adaptation Research Network
CCSP	Climate Change Science Program (United States)
CEA	Cost-effectiveness analysis
CER	Cost-effectiveness ratio
CESD	Commissioner of the Environment for Sustainable Development
CIP	Climate Impacts Programme (United Kingdom)
DEFRA	Department for Environment, Food and Rural Affairs (United Kingdom)
EC	European Commission
EPA	Environmental Protection Agency (United States)
EU	European Union
GHG	Greenhouse gas
IASC	International Arctic Science Committee
IISD	International Institute for Sustainable Development
INAC	Indian and Northern Affairs Canada
IPCC	Intergovernmental Panel on Climate Change
LDC	Least developed country
MCA	Multi-criteria analysis
MIES	Mission interministérielle de l'effet de serre (France)
NAPAs	National Adaptation Programmes of Action (United Nations)
NRCan	Natural Resources Canada
NRTEE	National Round Table on the Environment and the Economy
ONERC	Observatoire national sur les effets du réchauffement climatique (France)
PSEPC	Public Safety and Emergency Preparedness Canada
RIA	Regulatory Impact Assessment (United Kingdom)
SDS	Sustainable development strategy
TERI	The Energy Resources Institute
UKCIP	United Kingdom Climate Impacts Programme
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WMO	World Meteorological Organization

Executive Summary

This study reviews select tools and institutional approaches used in other jurisdictions to help prioritize climate change risks and adaptation options. The United Kingdom, Finland, and France were selected as case studies for this report as they have all developed national adaptation strategies and each provides an instructive example of institutional mechanisms for responding to climate change risks. The United Nations National Adaptation Programmes of Action (NAPAs) are also considered as this process provides a tool to assess and rank adaptation options.

Although some adaptation measures are being implemented in Canada, there is room for improvement in the institutional and management frameworks to facilitate effective and co-ordinated adaptation planning and risk prioritization. The case studies and research reviewed indicate that other countries also face challenges in integrating adaptation planning into government policy. None has yet established either a rigorous process for prioritizing climate change risks at the national level or an appropriate adaptation response to these risks. Nevertheless, we identified the following key elements in the approaches adopted in other jurisdictions, which may be useful for Canadian policy and decision makers in evaluating climate risks and prioritize adaptation responses.

- **Build capacity:** To varying degrees, all the case study countries are adopting co-ordinated, national approaches to adaptation planning through the establishment of designated institutions, programs, or co-ordinating bodies that can help to build policy-making and management capacity.
- **Involve local stakeholders:** Much of the action on adaptation is being taken at the local level due to the highly location-specific nature of climate change risks. The case studies demonstrated that involving relevant stakeholders, including all levels of government, early on in the adaptation process likely yields better results than a centrally planned process.
- **Develop and use tools and indicators to prioritize climate risks:** Tools, techniques, and indicators that can assist in minimizing and clarifying the extent of climate risk and uncertainty help guide the formation of adaptation policy.

1. Introduction

The impact of increasing greenhouse gas (GHG) emissions on the global climate is no longer disputed by the international scientific community. Although the severity of the impacts due to climate change is a matter of some debate and is difficult to quantify in economic and social terms, there is considerable consensus about the need both to reduce levels of GHG emissions and to alleviate the risks associated with a changing climate.

Some level of climate change is inevitable irrespective of current and future emission reduction strategies. This is reflected by the Intergovernmental Panel on Climate Change (IPCC) in its Fourth Assessment Report (2007a) that adaptation is now a necessary strategy to complement emission mitigation efforts, and vulnerability to the hazards associated with current and future climate variability can be reduced through specific policies and programs, participatory planning, and community approaches. Moreover, in a recent study on Canada's vulnerability to climate change, Natural Resources Canada (NRCan, 2008: 4) stated: "Adaptation is a necessary complement to mitigation in addressing climate change." Much of the climate change likely to be observed over the next few decades will be driven by the action of GHGs already accumulated in the atmosphere.

Canada is already experiencing the impacts of a changing climate. Warmer winters, melting Arctic sea ice and permafrost, more frequent and intense storm activity, coastal erosion due to rising sea levels, mountain pine beetle infestations, changing precipitation patterns, changes in river flows, increasing water evaporation, melting glaciers, and other biophysical changes have a direct influence on social, economic, and environmental systems in Canada. According to the 2008 Natural Resources Canada report, many of the most severe and costly impacts in Canada will be associated with projected increases in the frequency and magnitude of extreme climate events and associated natural disasters, including flooding due to high-intensity rainfall and storm surges, ice and wind storms, heat waves and drought.¹ Although governments and industry are paying increasing attention to the risks associated with climate change, integration of adaptation strategies into policies and programs is in the early stages. Some departments have begun work on their own adaptation strategies, but less progress has been made on developing a formal strategy for federal adaptation efforts and in using available information about the changing climate to assess potential risks of climate change on federal policies and programs (CESD, 2006).

Canada is not alone in its need for a co-ordinated process to prioritize climate change risks and plan for adaptation. A recent review of progress on implementing adaptation in developed countries concluded that only a few countries were establishing institutional mechanisms to address climate change risks (Gagnon-Lebrun and Agrawala, 2007).

This study reviews institutional approaches to adaptation and tools to assist in the prioritization of risks due to climate change and the adaptation options. The United

¹ Potential impacts of climate change in Canada have been well-documented. Other sources include NRCan (2004), Churchill et al. (2006), and Andrey and Mills (2003).

Kingdom, Finland, and France were chosen for the case studies as they have developed national adaptation strategies and provide instructive examples of institutional mechanisms for responding to climate change risks.

- France passed a national adaptation strategy in November 2006. The strategy takes a crosscutting approach involving initiatives based on sectors, regions, and resources. France is now implementing the recommended actions in this strategy.
- Finland completed an adaptation strategy in 2005 that identifies impacts and adaptation measures for all key sectors as well as six priorities for implementation in the period from 2006 to 2015.
- The United Kingdom is developing its Adaptation Policy Framework (APF) that incorporates feedback from public consultations held between November 2005 and January 2006. The APF sets out a structure for the roles and activities of different organizations (from central government to individuals) to ensure a comprehensive and coherent approach to adaptation. This policy initiative complements work in the United Kingdom on tools to support adaptation decision making.²

The National Adaptation Programmes of Action (NAPAs) under the United Nations Framework Convention on Climate Change (UNFCCC) aims to assist least developed country (LDC) governments to identify and prioritize adaptation activities. The NAPA process is relevant because it proposes a tool to assess and rank adaptation options.

In the course of our research, we arrived at two significant conclusions.

- None of the countries we examined has yet developed a formal process for prioritizing risks at the national level and for subsequent adaptation action.
- Climate change is a challenge that will likely require a broad suite of policy responses and has implications for different jurisdictions, government departments, and mandates. The countries examined are working to enhance their institutional and management capacities for adaptation to climate change. To make effective use of the available tools to help prioritize risks, governments must first improve the institutional means to facilitate government-wide adaptation planning.

Section 2 of this study explores the role of government in adaptation planning as a basis for providing insights into the broad range of activities and federal government programs that could be impacted by climate change. Section 3 examines the current state of adaptation policy and programming within the Government of Canada and section 4 reviews adaptation strategies in the three case studies and the UN NAPA program. The final section identifies common elements to the approaches being adopted in the case study countries, which may be insightful for Canadian policy and decision makers.

² For a review of climate change research activity and policy initiatives in the United Kingdom before 2004, see Hulme and Turnpenny (2004).

2. Adaptation and the Role of Government

Adaptation in the context of climate change consists of actions people take in response to, or in anticipation of, projected or actual changes in climate with the objective of moderating harm or exploiting beneficial opportunities (Tompkins and Adger, 2003). Climate projections now enable us to adapt in anticipation of future change as opposed to only reacting to current conditions and planning based on historical climatic trends and risks. In fact, using statistical probabilities based on past climatic events can no longer necessarily be considered a reliable approach to gauging future risks.

The understanding of adaptation to climate change has evolved significantly in recent years from being conceived as a top-down process to one that also builds from the bottom up. Top-down approaches rely heavily on the analysis of future climate scenarios and projected impacts on various ecosystems and sectors, and have tended to recommend technological fixes to climate change risks (Tompkins and Adger, 2003; Klein et al., 2007). This approach has been increasingly challenged, mainly on the basis that, while it is useful in providing information regarding general trends, it is limited in its ability to provide useful information about projected regional or local impacts (e.g., Adger et al., 2003; Dessai et al., 2003; Smith et al., 2003). The idea that a bottom-up, vulnerability-driven approach should complement top-down analyses has emerged in recent years in an attempt to anchor adaptation planning at the local level, where the impacts of climate change are actually felt.

In this context, vulnerability is understood to be a function of *exposure* to climate change impacts and the *adaptive capacity* of a system (Smit et al., 2000; IPCC, 2001), that is, the ability to adjust to climate change, to moderate potential damage, to take advantage of opportunities, or to cope with the consequences. This, in turn, is a function of access to and application of economic resources, technology, information, skills, and infrastructure, as well as the strength of institutions and the equitable distribution and availability of resources (Smit et al., 2000). Hence, whereas the top-down approach emphasizes climate scenario modelling, impact prediction, and technological solutions, the bottom-up, vulnerability approach stresses the need to address the underlying, non-climatic factors, be they economic, demographic, political, or environmental, which limit adaptive capacity and thereby increase vulnerability to change (Orindi and Eriksen, 2005). As seen in the case studies, these approaches can be complementary and are not mutually exclusive as both can be useful in contributing to the adaptation planning and policy-making process.

Embracing this dual approach recognizes that, to be successful, adaptation strategies must be integrated into other dimensions of strategic planning, policy making, and risk management, yet there are still no accepted methods for achieving this integration (Urwin and Jordan, 2008). The process of assessing and prioritizing climate change risks for adaptation planning is inhibited to a large degree by the inherent complexity, long-time scales, and uncertainty of climate change impacts. Moreover, despite increased attention to climate change risks and potential adaptation options, there is little understanding of an option's feasibility, costs,

effectiveness, and likely extent of actual implementation (IPCC, 2007a). Key barriers to integration include (IPCC, 2007a; NRCan, 2008)³:

- access to knowledge, data, and decision support tools;
- specific regulations or legislation that may limit adaptation options;
- policy makers and politicians (who are generally not scientists) struggling to understand sometimes complex scientific climate models;
- uncertainty about the prospects and feasibility of possible technological adaptations;
- financial barriers to implementing adaptation measures;
- difficulties in applying traditional risk management tools to climate change;
- social and cultural barriers (e.g., different risk tolerances and response preferences);
- the need for new decision-making tools to become common place (scenarios, adaptive management, community engagement, collaborative approaches, etc.);
- the range of time frames under consideration from the immediate to the long term; and
- the inconsistency of time frames with decision-making processes.

The emphasis on the context specificity of adaptation is not to say that national governments have no role. On the contrary, given the unique challenges of climate change, government policy and planning is critical to the formulation of an effective national adaptation response. The National Round Table on the Environment and the Economy (NRTEE, 2007) identified three key roles for the federal government with respect to adaptation policy: adaptor, catalyst and facilitator, and as an intervenor or rule setter.

Government as Adaptor

As a service provider and property owner, governments have a responsibility to minimize the risks of climate change impacts on their own programs and activities. This role can encompass, for example, a process through which all government departments are required to carry out studies to identify possible climate change risks to their respective program and policy areas and to prioritize the most significant among them.

For example, climate change may increase the incidence of water scarcity in some dry regions of Canada, such as the Prairies. Such transformations in the water regime could have significant implications for some programs of Agriculture and Agri-Food Canada (AAFC) as well as those of Health Canada. Reductions in surface water can lead to reduced crop yields, greater concentrations of pathogens and toxins in domestic water supplies, and increases in dust production from open sources which, in turn, can enhance the incidence of asthma, allergic rhinitis, bronchitis, hypersensitivity pneumonitis, and organic dust toxic syndrome.

³ For a discussion of the challenges of integrating locally focused adaptation considerations into public policy in the United Kingdom, see Urwin and Jordan (2008).

Government as Catalyst and Facilitator

This role mainly entails supporting research and information dissemination on climate change risks and possible adaptation options. The approach also focuses on building adaptive capacity among various communities and stakeholders so they can develop their own adaptation response. Building adaptive capacity can be done, for example, through the development of decision-making tools and guidance for stakeholders to make their own assessment of the risk and plan adaptation on their own terms. This role also implies that the government acts as a co-ordinator, that is, it ensures that adaptation measures form a coherent whole and that no measures or initiatives taken by one community are counterproductive for another.

Government as Intervener or Rule Setter

In this role, the government legislates to reduce the vulnerability to climate change of its population. For example, this may involve new zoning legislation that restricts or prohibits development in areas that are projected to experience enhanced coastal erosion due to climate change or where melting permafrost could compromise the structural integrity of newly built facilities.

Less attention has been paid to assessing the potential risks of climate change on federal government programs. Climate change impacts and adaptation needs cut across a wide range of activities and portfolios and will present significant implications for the policies and programs of numerous government departments, particularly those related to communities, health, industry, infrastructure, and ecosystem protection.

Against this background, the next section examines the current state of adaptation policy and programming within the Government of Canada.

3. Adaptation Programs and Policy Programs and Policy within the Government of Canada

A number of federal government departments have taken steps, to varying degrees, to integrate adaptation planning and/or analysis into policy and program development. These include Agriculture and Agri-Food Canada, Environment Canada, Fisheries and Oceans Canada, Health Canada, Indian and Northern Affairs Canada (INAC), Justice Canada, Natural Resources Canada, Public Safety and Emergency Preparedness Canada (PSEPC), and Transport Canada. Through these efforts, some measures have been adopted, although the various strategies to date have generally been fragmented, and there has been little collaboration among departments. Recent government program initiatives to facilitate adaptation are summarized in *Canada's Fourth National Report on Climate Change* (Environment Canada, 2006).

Budget 2008 provided \$86 million over four years to help increase the capacity of Canadians to adapt to climate change. Environment Canada will lead the implementation of several new adaptation programs in collaboration with Natural Resources Canada, Indian and Northern Affairs Canada, Health Canada, and the Public Health Agency of Canada. Notably, part of this funding (\$35 million) will be allocated to help Natural Resources Canada develop regional adaptation work programs and risk management tools (guidelines, analytical models, etc.) that will guide stakeholders through a series of steps to examine the implications of climate change impacts on their policies, plans, and operations to determine the most appropriate response options. Regional work programs are meant to facilitate regional adaptation and collaboration among stakeholders in government, economic sectors, and local communities and organizations. Another \$15 million has been targeted to improve climate change scenario modelling to better predict environmental changes, weather patterns, and future climate extremes. In addition, Health Canada (2008) recently issued a report that examines how the health of Canadians is affected by the climate and how governments, communities, and individuals are working to mitigate the effects of climate on health.

At the provincial level, the Ouranos Consortium, a Quebec-based climate change adaptation research organization, released a report in 2004 entitled "Adapting to Climate Change" that sketches a picture of the state of knowledge in terms of climate change affecting the province of Quebec. Adaptation is one of seven elements in the Government of Alberta's plan (2002), *Albertans and Climate Change: Taking Action*. As well, the British Columbia government's climate change division is increasingly active in the area of climate change adaptation. Various other Canadian adaptation studies and initiatives have focused on the potential for collaboration among governments or on the potential distribution of responsibilities across single levels of government. The following is an overview of select departmental adaptation initiatives implemented thus far within the government of Canada.

Intergovernmental Climate Change Impacts and Adaptation Working Group

A national adaptation framework was prepared by the Intergovernmental Climate Change Impacts and Adaptation Working Group and released in 2005 after almost three years of intergovernmental collaboration. This document provides a basis for co-operation among federal, provincial, and territorial governments. It also promotes research and the development of tools to further the development of detailed

adaptation plans and initiatives. However, the framework has not yet been approved by the federal government and no official follow-up of the framework has been made. Table 1 summarizes the framework’s objectives.

Table 1. Objectives of the National Climate Change Adaptation Framework

Elements in which Action Should Be Taken	Objectives
Raise awareness of adaptation	<ul style="list-style-type: none"> • Ensure that key decision makers understand that changes in climate are happening now and that there is a need to adapt to these and future changes to minimize risks and maximize opportunities. • Ensure that decision makers consider climate change impacts in their decisions. • Increase awareness among the Canadian public of the need to adapt to a changing climate.
Facilitate and strengthen capacity for co-ordinated action on adaptation	<ul style="list-style-type: none"> • Develop and maintain a capacity for co-ordinated action between provinces/territories, and the federal government. • Develop and maintain a capacity for sharing information among jurisdictions.
Incorporate adaptation into policy and operations	<ul style="list-style-type: none"> • Ensure governments have the capacity to identify and evaluate climate-related risks to new and existing initiatives and emerging opportunities related to climate change. • Encourage governments to incorporate adaptation into policy and operational planning and to report on their progress in this activity.
Promote and co-ordinate research on impacts and adaptation	<ul style="list-style-type: none"> • Facilitate research that meets the needs of government and stakeholders. • Facilitate interaction between researchers, policy makers, and users of knowledge to define research objectives and stimulate uptake of knowledge. • Achieve a more efficient use of research resources through the co-ordination of efforts and the pursuit of joint initiatives.
Support knowledge sharing networks	<ul style="list-style-type: none"> • Ensure that existing networks effectively facilitate the sharing of information and knowledge about impacts and adaptation.
Provide methods and tools for adaptation planning	<ul style="list-style-type: none"> • Develop a basic adaptation toolkit and make it available to Canadian decision makers.

Natural Resources Canada

The Earth Sciences Sector of Natural Resources Canada is running two major programs addressing adaptation to climate change: Enhancing Resilience in a Changing Climate Program and the Climate Change Impacts and Adaptation Program.

Enhancing Resilience in a Changing Climate Program (Priorities 2006-2009)

The objective is to apply geosciences and geomatics expertise to support Canadians in understanding, preparing for, and adapting to the impacts of climate change on their communities. The program is designed to enhance the resilience of Canadian communities, infrastructure, and ecosystems to climate change through effective adaptation strategies. Numerous collaborative projects are underway including research efforts to transfer knowledge and build capacity in local communities, and to understand the risks of climate change to key economic sectors in Canada. Stakeholders are being engaged from key economic and natural resource sectors, communities, scientific and professional institutions, governments and industry. The following program results are anticipated:

- assessment of the impact of climate change on water-reliant sectors;
- development of adaptation options for agriculture, tar sands production, and habitat management;
- development of criteria and methodology for assessment of community vulnerability;
- documentation of vulnerabilities for community stakeholders;
- learning, decision-making tools adapted for planning use;
- regional assessments of landscape and ecosystem response;
- national datasets and databases on landscape change;
- paleo-environmental reconstructions for impact studies and to constrain models; and
- reports and contributions to national and international assessments.

Climate Change Impacts and Adaptation Program

The Climate Change Impacts and Adaptation Program funds research and activities to improve knowledge about the risks and opportunities associated with climate change. The Program also conducts research projects that address gaps in knowledge of Canada's vulnerability to climate change and provides information for adaptation decision making.

The program has produced a number of important publications, the most recent being an exhaustive assessment of current and future risks and opportunities that climate change presents to Canada. Although the report, *From Impacts to Adaptation: Canada in a Changing Climate 2007* (NRCan, 2008) does not identify specific priority areas for action nor make specific recommendations, it does discuss adaptation actions being taken across the country and presents detailed regional analyses of climate vulnerabilities, adaptive capacity, and potential ecological, economic, sectoral, and infrastructural impacts.

The Canadian Climate Impacts and Adaptation Research Network

The Canadian Climate Impacts and Adaptation Research Network (C-CIARN) was established by Natural Resources Canada in 2001 to promote and encourage research on climate change impacts and adaptation, and promote interaction between researchers and stakeholders. The Network has produced workshop and conference reports, posters, and other communication products, all of which remain accessible to the public through the C-CIARN web site, as well as through the web sites of

organizations that hosted a C-CIARN office and that continue to carry out impacts and adaptation work.

As C-CIARN successfully met the mandate it was given when it was created in 2001, the network closed in 2007.

Environment Canada

Environment Canada created the Adaptation and Impacts Research Group (AIR), which works within the Atmospheric and Science Climate Directorate. The research results and information provided are intended for use by decision and policy makers within communities, organizations, the private sector, and government to promote and facilitate adaptation and to assist in identifying the need for response options.

The AIR Group has produced a number of research projects that consider the following issues:

- vulnerabilities of Canadians to climate change;
- the potential socio-economic impacts;
- viable adaptive responses for Canadians and how these can be identified;
- the limits to adaptability of Canadian socio-economic and ecological systems;
- the relationships (e.g., synergistic, additive, competitive, etc.) between atmospheric issues in terms of their impacts on Canadian socio-economic and ecological systems;
- maladaptations in Canadian systems and how they could be resolved;
- the factors preventing/deterring Canadians from reducing their vulnerability to atmospheric change variability and extremes; and
- the measures needed to motivate Canadians to take the actions necessary to reduce their vulnerability to atmospheric change, variability, and extremes.

Indian and Northern Affairs Canada

The last two sustainable development strategies (SDSs) from INAC included climate change adaptation components. The 2007-2009 SDS had a commitment to support the development of First Nation, Inuit, and northern communities' capacity to adapt to the impacts of climate change. Planned activities include the development by March 2009 of a departmental policy framework that identifies climate change risks and opportunities for the Department.

The 2004-2006 SDS included the objective of developing a long-term strategy to assist Aboriginal and northern communities to adapt to the impacts of climate change. A series of risk assessment workshops on the impacts of climate change on Aboriginal and northern communities and on INAC activities took place, and over 50 impact and adaptation projects were funded. These projects contributed to the assessment and management of risks related to climate change, the development of capacity to advance adaptation to climate change, the building of adaptive capacity of communities, and the development of a strong information base integrating science and traditional knowledge. The Department is developing a framework to assess risks both for INAC and for First Nation, Inuit, and northern communities in managing climate change impacts.

The Department has also developed a climate change planning tool for First Nations that resulted in the creation of six guidebooks to assist First Nations communities in assessing vulnerability and risk, identifying potential impacts and possible solutions, and taking adaptive action.

Key Gaps in the Federal Government's Adaptation Programming

The federal government has provided support for research into climate change impacts and adaptation, and for initiatives that involve working with decision makers on adaptation solutions. In addition to the selected departmental initiatives reviewed above, a great deal of scientific knowledge about climate change in Canada is held and advanced by government departments and agencies, other government-supported centres and programs, universities, think-tanks, and professional and non-governmental organizations. However, as noted by both the 2006 Report of the Commissioner of the Environment and Sustainable Development (CESD) and the recent report, *From Impacts to Adaptation* (NRCan, 2008), critical gaps remain. According to the CESD report:

- The government has not clarified how it intends to manage its own adaptation efforts and has not developed a strategy for federal adaptation efforts to indicate the expected results and time lines, and which departments would assume what responsibilities.
- Work with the provinces and territories has been limited.
- The federal government has not yet organized its adaptation activities in a co-ordinated manner that will ensure Canadians obtain the information needed to take appropriate action in adapting to a changing climate.

The recent NRCan report (2008) noted that much of the adaptation action to date has been achieved through informal actions or strategies in response to specific events or circumstances at the local, regional, or provincial levels. Moreover, the number of adaptation initiatives in Canada is small compared to the scope of adaptation needs. The report recognized the critical importance of integrating climate change considerations into ongoing planning and policy decision making (i.e., “mainstreaming” climate change), but noted that no effort has yet been undertaken to accomplish such an integration process in Canada. The most significant barriers to adaptation identified in the report are access to knowledge, data, and decision support tools, specific regulations or legislation that may limit adaptation options, and societal expectations. According to NRCan, many decision makers do not yet have a clear understanding of the risks of climate change. Decision support tools, climate scenarios, and data sets are needed to support analytical methods and facilitate effective co-ordination and collaboration between industry, academia, government, and local communities. The report noted that a more anticipatory strategic approach to adaptation would help reduce social and economic costs, increase efficiency, and further reduce climate change vulnerability in Canada.

A March 2006 report of the Conference Board of Canada (Churchill et al., 2006) on climate change adaptation in Canada noted that policy makers need better estimates of the financial impacts of climate change on assets as well as the costs of implementing adaptation strategies. According to the report, there is a need for

further research into the impacts of climate change and for a long-term perspective that considers all potential costs and benefits. The Conference Board believes the federal government should establish national guidelines, goals, and initiatives, while implementation and administration of adaptation measures devolve to local authorities.

Despite the challenges, it is clear Canada has the wealth, technology, and expertise to overcome barriers to action on adaptation. The Budget 2008 funding contribution of \$86 million over five years to increase adaptation capacity in Canada should help to address some concerns. Government organizations would also benefit from reviewing policies and programs to assess their vulnerability to climate change and their ability to facilitate adaptation. Specific information is needed to support combined top-down and bottom-up approaches on potential impacts for localities and sectors, including the timing of expected changes. Such analyses have been undertaken in the United Kingdom, and risk management tools have been developed elsewhere that could prove useful to the Government of Canada in its ongoing adaptation efforts.

The following section examines what other governments have done both in fulfilling their key responsibilities and in developing strategies that facilitate adaptation planning by organizations and local authorities.

4. Review of Adaptation Strategies in Other Jurisdictions

European countries have generally been the most active with respect to adaptation policy initiatives; a number now have adaptation plans in place or under development. For instance, the *European Climate Change Programme II: Impacts and Adaptation* (EC, 2007a) has a mandate to explore the scope of a strategy to guide policy in the adaptation to and impacts of unavoidable climate change and to identify how best to assist local, regional, and national efforts. The program has published a report entitled *Building National Adaptation Strategies* (Ecofys, 2006).

In June 2007, a green paper examining adaptation options in the EU emphasized the need to develop a coherent policy response to reduce costs and enable complementary actions based on joint partnerships (EC, 2007b). This paper builds on the results of the European Climate Change Programme study and focuses on the most urgent set of options for priority actions at the community level. With the objective of initiating debate and public consultation across Europe on how to move forward on adaptation, the paper sets out four pillars for which a number of priority options are outlined for further consideration.⁴

- Develop adaptation strategies in areas where current knowledge is sufficient.
- Integrate global adaptation needs into the EU's external relations and build a new alliance with partners around the world.
- Identify and fill knowledge gaps on adaptation through EU-level research and exchange of information.
- Establish a European advisory group on adaptation to climate change to analyze co-ordinated strategies and actions.

The results of a public consultation process serve as a basis for the development of a white paper on adaptation to climate change, which will describe more detailed and concrete measures.⁵ It is anticipated that the European Commission will adopt the white paper in the autumn of 2008.⁶

Within the EU, several member countries are taking adaptation measures. This section examines approaches and tools being implemented and developed in the United Kingdom, Finland, and France as well as the various risk prioritization methodologies being adopted. Finally, another process, the National Adaptation Programmes of Action for least developed countries under the UN Framework

⁴ A web-based public consultation was open from mid-July to the end of November 2007 and four regional workshops took place during the autumn of 2007.

⁵ For more information, see the full Consultation Analysis Report (Entec, 2008).

⁶ A stakeholder workshop was also held in May 2008 to support the process of developing the white paper, but the results of this workshop were not available at the time of writing this study.

Convention on Climate Change is examined, as are NAPAs developed by LDC governments.

United Kingdom Climate Impacts Programme

The Government of the United Kingdom introduced a number of policies and programs in recent years to help prepare for and adapt to the impacts of climate change. The United Kingdom Climate Change Program includes policies on assessing and adapting to the projected impacts of climate change. In 2005, the government launched the development of an adaptation policy framework. The framework provides the basis for further adaptation activities and helps identify areas where the management of climate change risks could be integrated into other policy issues, although it is not yet clear how this identification and integration process will take place as the framework is still in the drafting stage.

The Department for Environment, Food and Rural Affairs (DEFRA) funds strategic research on climate change impacts and adaptation, which includes studies on adaptation options and the relative costs of various responses. A climate change bill, published in March 2007, included the creation of the Committee on Climate Change to assess how the United Kingdom can achieve its emissions reductions goals and enhance its ability to adapt (UK, 2008). The government also established a tool, called the Regulatory Impact Assessment (RIA), which officials use to assess the vulnerability of specific policy proposals to a variety of risks, one of which is the predicted effects of climate change. For instance, the 2006 UK Climate Change Program, which sets out policies and priorities for action, is supported by an RIA that looks at the overall costs and benefits of the program (DEFRA, 2006).

In 1997, the government established an independent organization, the UK Climate Impacts Programme (UKCIP), specifically to help public and private sector organizations assess their vulnerabilities to climate change and to start developing their own adaptation responses. Adaptation and mitigation are viewed by UKCIP as closely related issues that should be considered together when formulating climate change policy. The organization works to co-ordinate and influence research into future climatic conditions in the United Kingdom, identify the risks posed by climate change, and share the results of this research in ways that are useful to stakeholders. The organization is funded primarily by DEFRA and is based at Oxford University.

Since its inception, the UKCIP has come to play a key role in assisting in the development and implementation of adaptation in public and private sectors (Lorenzoni et al., 2007). While the organization has been criticized by some observers for having a poor communications and information dissemination strategy with local authorities (Demeritt and Langdon, 2004), other researchers concluded that the UKCIP has been very influential in raising awareness of climate change among organizations and economic sectors that would not normally be reached by conventional scientific research programs (Hulme and Turnpenny, 2004).

Process Involved in the Formulation of an Adaptation Strategy

The UKCIP provides a range of tools to assist policy and decision makers in the prioritization of risks and the development of a climate change adaptation strategy. The first step is to understand the predicted effects of climate change by geographical region or economic sector. This is accomplished using a scenarios gateway tool that

provides climate change data for a range of possible future scenarios. Following this, the UKCIP provides tools that lead policy and decision makers through a process to determine:

- if they could be vulnerable to these effects;
- how to quantify the risks to help judge the significance of climate change compared to other risks;
- the range of available adaptation responses and the costs of each;
- how best to prioritize action plans to integrate risks into policy decision making; and
- how to develop an adaptation response strategy.

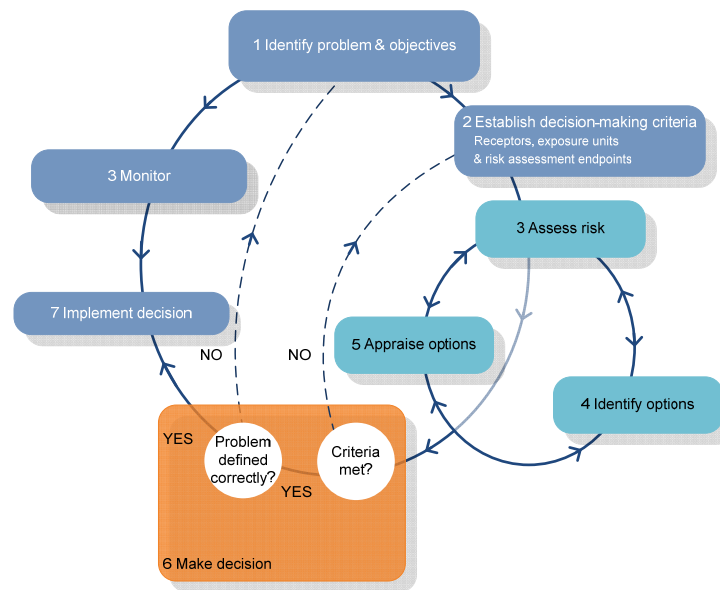
Based on the identification and quantification of risks, an organization may determine that action needs to be taken to reduce the chance of a hazardous event or reduce the magnitude of its consequences. The most suitable response will depend on the nature and extent of the risks identified. Adaptation strategies should be integrated into everyday decision-making processes and should be evaluated to consider whether the strategy is achieving its original objectives.

The UKCIP Risk Framework

Although climate change modelling generates an increasingly robust depiction of the Earth's climate systems, projections of future climate changes still occupy a relatively broad range of possible climate outcomes. The full extent of climate change impacts will be influenced by a number of factors, including atmospheric feedback mechanisms, biophysical responses, technological developments, and the success of policies in mitigating further GHG emissions. As the uncertainty of projections constitutes a key obstacle to decision making and planning, UKCIP developed its Risk, Uncertainty and Decision-Making Framework to help decision makers identify and manage their climate risks in the face of uncertainty.

The Framework is based on standard decision-making and risk principles, such as minimizing damage and costs, maximizing benefits, and encouraging users to consider climate risks alongside non-climate risks. The Framework aims at supporting decision and policy makers who must identify and appraise the effectiveness of adaptation measures that address identified climate risks. Figure 1 shows the key stages of that process.

Figure 1. Key Steps in the Risk, Uncertainty, and Decision-Making Framework



Source: UKCIP (2003).

Prioritization Process for Action on Adaptation in the United Kingdom

Despite being relatively advanced in the development of its institutional capacity, legislation, and tools for adaptation planning, the United Kingdom does not yet have a formal risk prioritization process at the national level. Through the national Adaptation Policy Framework (APF), the government is focusing on a national risk assessment that identifies the most significant climate change risks, though the actual assessment and prioritization process will ultimately be devolved down to the local level for development by affected stakeholders. The APF requires government departments to set their own prioritization process for action on adaptation. In fact, a climate change bill currently before the UK parliament includes a provision that will require the national government, on a regular basis, to assess the risks climate change poses to the United Kingdom, and to develop and update a program to address those risks (UK, 2008). Additionally, new powers in the bill will allow the government to require, where necessary, public bodies to assess the risks of climate change, and set out the action needed in response. These assessments will eventually form the basis for the development of a national risk prioritization process that will, in turn, feed into broader national adaptation planning. In this way, national priorities will be guided by local plans, and organizations will continue to be required to develop their own prioritization processes as the bill does not include directives or policy tools to help with the risk prioritization.

Although the UKCIP is not involved in the process of setting adaptation priorities at the national level, by establishing the organization, the government has recognized the crucial importance of a central co-ordinating body that can engage local stakeholders and develop the risk assessment tools necessary to assist in the prioritization process at the local level and the development of local adaptation strategies that will feed into the national APF. The UKCIP risk framework tool assists stakeholders in the prioritization process by identifying and prioritizing climate risks

in the face of uncertainty. Risks are identified and categorized (e.g., financial, technological, economic, structural), and then designated (but not ranked) as high or low priorities according to the following criteria to determine where an adaptation response may be required:

- high probability risks and risks that pose a significant threat (high impact);
- risks that are already perceived;
- risks that will increase most rapidly;
- risks to areas that are very sensitive to climate changes;
- “early mover” business opportunities; and
- organizations/sectors/regions for which it will take time to implement an adaptation response.

Once the highest priority risks are identified and the vulnerability to these risks established, the UKCIP leads stakeholders through a process of risk assessment in relation to other types of risks to determine how much risk a government or an organization would be prepared to tolerate. In doing so, the UKCIP provides a guidance tool to assess current vulnerability and identify critical thresholds which, if exceeded, will result in unacceptable consequences. These thresholds are defined as those points in a system at which sudden or rapid change occurs. The UKCIP helps stakeholders identify thresholds by reviewing historical data to determine those points that have brought unacceptable losses or opened up new opportunities in the past. While this process does not allow for a comparison of risks, the thresholds are useful reference points for adaptation planners who must consider what adaptation action will be required to prevent the thresholds from being breached at all, or from being breached at an unacceptable frequency.

Box 1. Examples of Critical Thresholds

For stakeholders to manage their climate risk to a level that is acceptable to them, they are encouraged to identify critical thresholds or assessment end points for their activity. A changing climate could mean that a critical threshold will be exceeded more frequently than at present, and they will need to adapt to manage their risks to a level that is acceptable to them. Of course, attitudes toward risk and system resilience will influence what is deemed an acceptable level of risk.

Thresholds may be a natural property of the system (e.g., the water level at which a river bursts its banks), but in policy decisions they are often socially constructed based on risk attitude (e.g., the 1 in 200 year return period standard for coastal floods). There might also be more than one threshold for the same climatic impact. For example, temperatures of 30°C could mean that school children will be uncomfortable in classrooms. If these temperatures were experienced for more than two days, the school may have to close, and if this were to happen more than once a year, this could be deemed unacceptable and appropriate adaptation action (e.g., air conditioning) may be required.

Critical thresholds also relate to positive opportunities, not only threats. For example, the persistence of hotter and drier summer conditions could trigger certain business opportunities as well as increased tourism in some regions.

Source: Adapted from the UKCIP Adaptation Wizard.

Finland: National Strategy for Adaptation to Climate Change

Finland's climate change program was adopted by Parliament in June 2001 following a government report on a national climate change strategy. Parliament's response required that the drafting of a program for adaptation to climate change be initiated.

Process Involved in Formulating Finland's Adaptation Strategy

Work on an adaptation strategy began in the latter half of 2003. It involved an inter-ministerial task force (six departments), the Finnish Meteorological Institute and the Finnish Environment Institute under the co-ordination of the Ministry of Agriculture and Forests. A draft strategy was produced with the co-operation of experts, the research community, and representatives of major stakeholders. The draft was submitted to a public hearing. After feedback from the ministerial committee, the strategy was adopted and published in January 2005. The main elements of the strategy were later included in the National Climate and Energy Strategy of 2006. Annex B provides more information on the events leading to the development of Finland's Adaptation Strategy and activities related to climate change.

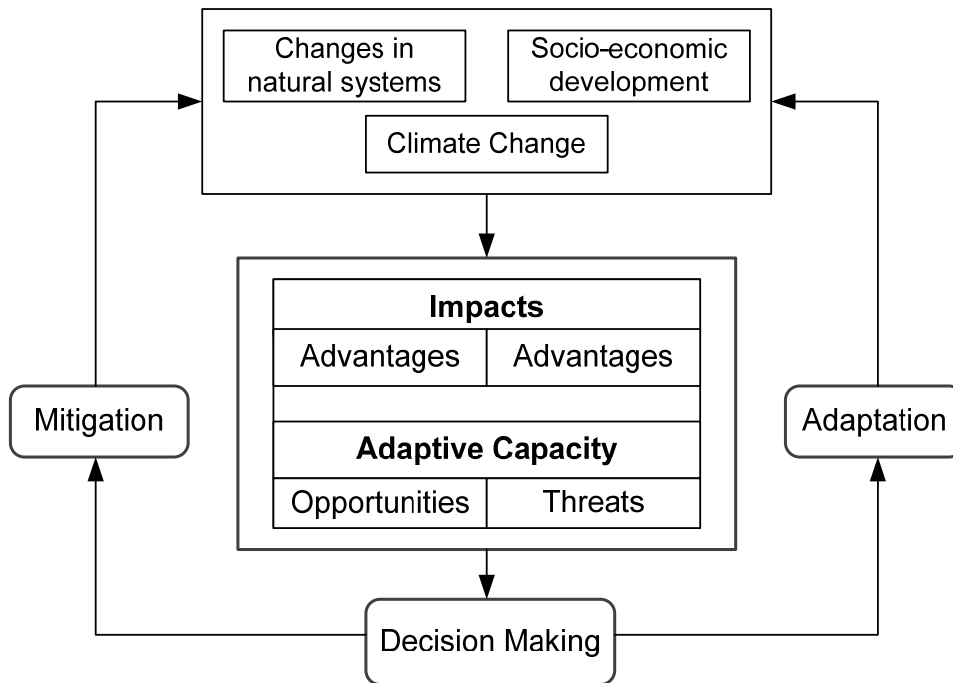
The objective of the National Strategy for Adaptation to Climate Change is to strengthen and increase Finland's adaptive capacity. This is to be achieved by:

- describing climate change and its impacts, as well as assessing the vulnerability of sectors;
- assessing the current adaptive capacity, vulnerability, and opportunities associated with climate change; and
- presenting actions that should be taken immediately (such as research and development) and policies for future actions.

Finland established a comprehensive list (reproduced in Annex B) of the projected impacts and adaptation responses for each sector considered in the National Strategy. The proposed adaptation measures for each sector have been further subdivided according to their type, their time frame (immediate, short, and long term) and their nature (reactive, anticipatory). In addition to the sectoral analysis, the National Strategy examines a number of cross-sectoral issues for which specific measures have been proposed.

Figure 2 presents the conceptual framework used to produce Finland's National Strategy for Adaptation to Climate Change. Climate change impact scenarios help identify changes in natural systems which, combined with socio-economic scenarios, are then translated into potential impacts on activities in different sectors. The impacts identified (positive or negative) feed into the decision-making process in formulating Finland's mitigation and adaptation strategies. It should be stressed, however, that, as in the United Kingdom, relative priorities among the critical sectors and climatic indicators have not been established.

Figure 2. The Conceptual Framework Used to Produce Finland's National Strategy for Adaptation to Climate Change



In parallel to the process of producing the adaptation strategy, a consortium of 11 institutions worked on a major research project on adaptation to climate change. The consortium, called FinAdapt, produced 15 working papers in 2004-2005 on different sectors considered in the strategy and on cross-sectoral issues such as public perception, management, and co-ordination and socio-economics.

As a follow-up to the strategy, a five-year research program focuses on extreme events (floods, droughts, risk assessment, and planning) and on two sectors in particular: agriculture (crop production) and forestry (forest genetics, pest modelling).

Finland's National Prioritization Process for Action on Adaptation

Finland's prioritization process involves the development of indicators to monitor both the impacts of ongoing climate change as well as the impacts of the adaptation measures adopted in response to climatic changes. These indicators help decision makers track changes at the local and regional levels. For example, key indicators selected in Finland's forestry and fishing sectors include soil conditions, tree growth, forest pests, and water temperatures. Monitoring changes in these indicators provides a basis for understanding biophysical changes in relation to historical trends. It should be noted, however, that while indicators can track climatic changes, they alone will not signify whether adaptation action should be taken or the kind of action required.

The following indicators of climatic change have been identified as most relevant to Finland:

- atmospheric temperature;
- water temperature;
- ice conditions;
- precipitation;
- snow cover and ground frost; and
- windiness and solar radiation.

Climatic changes reflected by these indicators are expected to have important impacts on components of Finland's natural systems (soils, water, flora, and fauna) and, consequently, on associated human activities. Building on this information, the Strategy identifies the advantages and disadvantages of projected climate change impacts and the uncertainties for a number of priority sectors including agriculture, forestry, nature conservation and tourism. (See Annex B for sector-specific impacts and adaptation categories in Finland.) Risk assessments have been commissioned for the agriculture and forestry sectors. Although the Strategy does not indicate precisely how or why the priority sectors were selected, all are central to Finland's economy. The Strategy also examines the adaptive capacity of the actors in each of the priority sectors and proposes a number of possible adaptation measures, although Finland has not developed a formal process for prioritizing adaptation action.

France: Observatoire national sur les effets du réchauffement climatique

In mid-1992, the French government created the Mission interministérielle de l'effet de serre (MIES) to co-ordinate French action on climate change in the domestic, European, and international contexts. In 2000, the MIES produced, a *Programme national de lutte aux changements climatiques* (MIES, 2000a), which is solely devoted to France's mitigation strategy to comply with its obligations under the Kyoto Protocol.

The Observatoire national sur les effets du réchauffement climatique (ONERC) was created in 2001 to respond to adaptation issues raised in the process of producing the climate change program of 2000. The Observatory reports each year to the prime minister and to Parliament, and has the mandate to:

- collect and disseminate information, studies, and research results on climate change risks and extreme climate events; and
- make recommendations on preventive and adaptation measures to limit climate change risks.

These objectives reflect some similarities to those of UKCIP in that both help to co-ordinate scientific research into the impacts of climate change and help organizations adapt to unavoidable impacts.

Process Involved in Formulating France's Adaptation Strategy

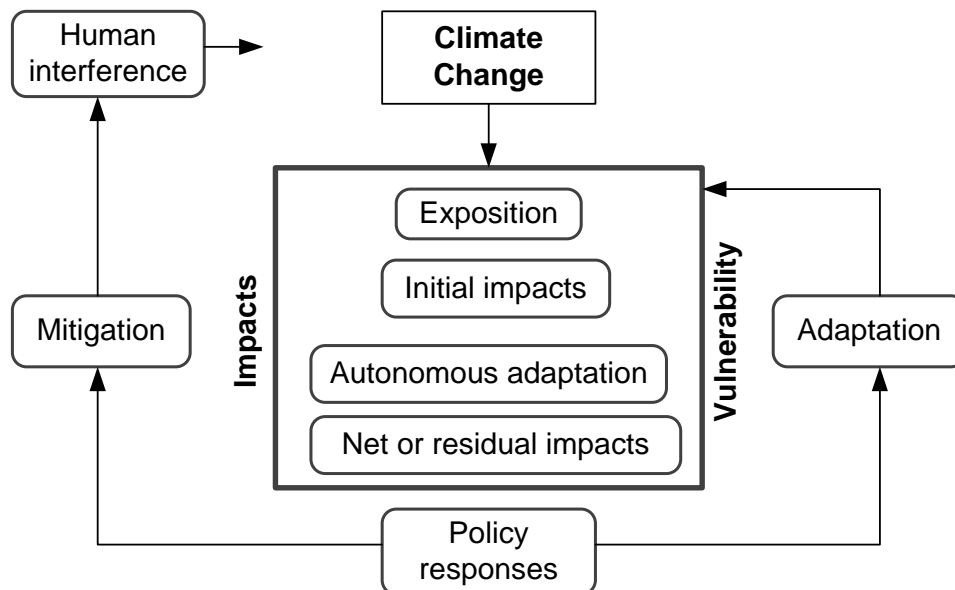
The Observatory provides a range of tools for adaptation planning designed to help local communities. These include indicators of observed climate change and local future climate change scenarios. In its first report to the prime minister in 2005, *Un climat à la dérive : comment s'adapter?*, ONERC described the extent of problems associated with climate change in France and provided possible next steps for the

government. The report included the results of ONERC's recent study on the impacts of climate change on the winery industry and discussed the 2003 heat wave.

In November 2006, the 2004 climate plan was updated and the *Stratégie nationale d'adaptation aux changements climatiques* was approved by government. The Strategy presents a vision of the path forward to address climate change adaptation and sets the stage for action. The Strategy was developed using a conceptual framework very similar to that of Finland, as illustrated in Figure 3, and was developed along nine strategic axes:

- develop scientific knowledge;
- strengthen the observation system, and ensure its operation on the long term;
- inform and motivate all stakeholders;
- promote an approach adapted to local communities;
- finance adaptation;
- use legal instruments;
- encourage voluntary approaches and dialogue with private stakeholders;
- take into account the specific aspects of overseas territories; and
- contribute to international exchanges.

Figure 3. The Conceptual Framework Used to Produce France's National Strategy for Adaptation to Climate Change



In September 2007, ONERC submitted a new report to Parliament on climate change and health risks in France. The report follows up on the heat wave experienced by the country in 2003 and recommends a number of specific actions including a national heat-wave plan. The report is perennial and covers the whole country, and many ministries, and is supported by local plans, particularly in large cities. Other research on climate change impacts and adaptation is ongoing in a number of research organizations.

France's National Prioritization Process for Action on Adaptation

As in the United Kingdom, the risk prioritization process in France is premised on the notion that stakeholders must be involved in the process of identifying and prioritizing risks; hence, the responsibility for conducting the assessments has devolved to various stakeholders in both countries. In this sense, the government of France acts as a facilitator of the prioritization process undertaken by various decision makers within society. Many local communities are engaging in the preparation of adaptation strategies, as part of their own climate change planning and prioritization. However, these local adaptation responses have not been co-ordinated with the national strategy.

Like Finland, the development of climate change indicators is a crucial part of France's national adaptation and prioritization process. The ONERC program develops indicators of observed changes to date and future climate change scenarios to help clarify the extent of problems associated with climate change in France. From a set of 90 proposed indicators, 20 have been selected and developed. These indicators relate to the critical issues that have emerged during the course of the different activities leading up to the development of the strategy. The full list of indicators is presented in Annex C.

Box 2. Start Date of Grape Harvesting as an Indicator

An example of the indicators being adopted is the start date of grape harvesting for wine production in various regions of France. Start dates that are consistently earlier than normal may indicate that an important seasonal shift is taking place and an adaptation response may be required. These indicators are often highly localized in an attempt to reflect regional variability, reach out to local communities, and help decision makers track change.

It is important to keep in mind that the ONERC indicators alone will not signify whether adaptation action should be taken or the kind of action required. Although detailed adaptation planning and a prioritization process for taking action were not included in France's Adaptation Strategy, it does make a number of general recommendations to government setting the course for more specific future action on adaptation. Impact studies have been carried out in virtually all sectors, including health, water, forestry, agriculture, and power generation, and plans containing specific actions are now under development for three major adaptation tracks: sectoral (e.g., agriculture, industry, energy); regional (e.g., city, coast, forest, mountain); and integrated (e.g., water, biodiversity, health). France has also selected six priority sectors for implementing measures, namely agriculture, energy and industry, transport, buildings and habitat, tourism, and banking and insurance, although it is not clear how these priority sectors were identified.

National Adaptation Programmes of Action

Through NAPAs, a participatory process established by the UNFCCC, LDCs develop a list of adaptation activities including, inter alia, projects, capacity building, and

policies that address the present and urgent adaptation needs of their most vulnerable areas. With a focus on enhancing adaptive capacity, NAPAs provide a process for LDCs to identify priority activities that respond to their current vulnerability to climate variability, rather than focusing on assessments of future vulnerability. The NAPA process is country-driven and country-specific and, therefore, can be the basis for the development of national adaptation strategies.

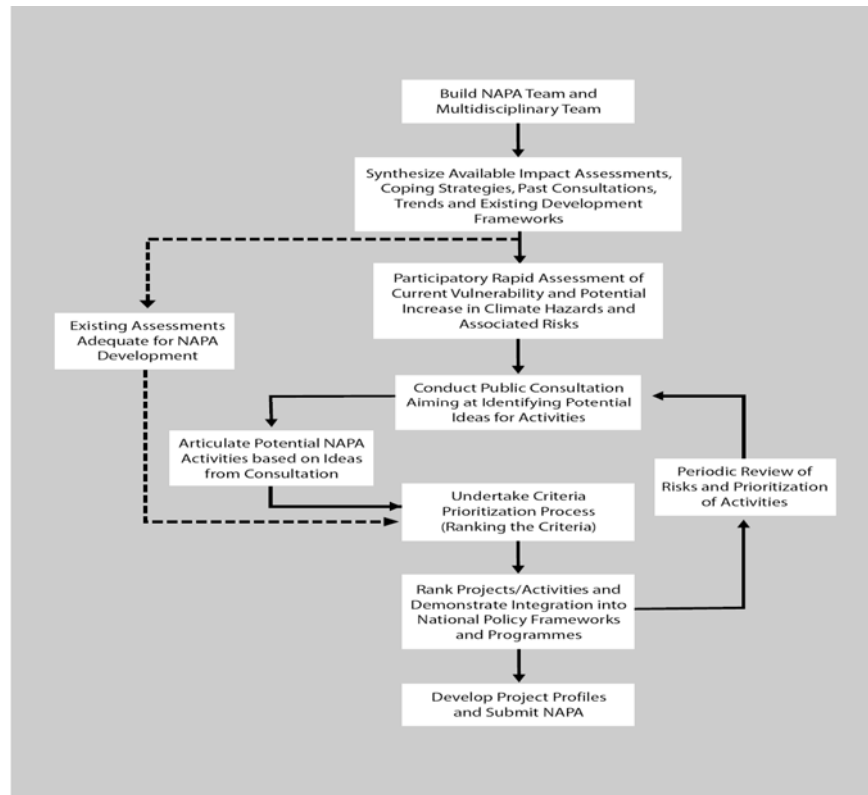
Formulating a NAPA

The NAPA guidelines list the following elements in the preparation of a NAPA:

- a participatory process involving stakeholders, particularly local communities;
- a multidisciplinary approach;
- a complementary approach, building on existing plans and programs, including national action plans under the United Nations Convention to Combat Desertification, national biodiversity strategies, and action plans under the Convention on Biological Diversity, and national sectoral policies;
- sustainable development;
- gender equality;
- a country-driven approach;
- sound environmental management;
- cost effectiveness;
- simplicity; and
- flexibility of procedures based on individual country circumstances.

The guidelines are not prescriptive and some countries have addressed more elements than those recommended by the NAPA process. Figure 4 shows the steps in developing a NAPA.

Figure 4. The NAPA Process



Source: Least Developed Countries Expert Group (UNFCCC, 2002). *Annotated guidelines for the preparation of national adaptation programs of action.*

Prioritization Process for Action on Adaptation

The identification of priority adaptation activities is the main goal of the NAPAs. The NAPA document itself is not intended to be an end, but rather a means for the dissemination of an LDC's proposed program of action to address its urgent needs for adaptation (UNFCCC, 2002). The NAPAs serve as a simplified and direct means of communication with a country's stakeholders, policy makers, and population, and with potential funding organizations.

Although the NAPA guidelines do not include a formal process for ranking the relative importance of risks, most NAPAs contain a sensitivity analysis carried out by the NAPA team, which flags those activities that are particularly sensitive to climate change depending on location, current and projected climate, and the type of adaptation response proposed. The methods used for vulnerability assessments range from stakeholder consultation (through surveys, interviews, questionnaires) and participatory appraisals to modelling of resource allocations under different scenarios. These activities are subsequently deemed to be the most urgent priorities for adaptation action.

The participatory process underlying the preparation of NAPAs involves the collaboration of local, regional, and national stakeholders of vulnerable sectors. As

recommended by the NAPA guidelines, particular attention should be given to local communities that are the most affected by climate variability. In prioritizing adaptation measures to be adopted by a specific country, NAPAs make the following assumptions (UNFCCC, 2002).

- Numerous criteria and indicators must be considered in any adaptation response.
- Climate change costs and their valuation in monetary terms are not always possible.
- There is often insufficient data to conduct a cost-benefit analysis (CBA) or cost-effectiveness analysis (CEA).
- The view of local people must be considered.
- The most appropriate adaptation response is likely that which is understandable and accessible to the greatest number of participants in decision making.

Using this rationale, the UN advocates the multi-criteria analysis (MCA) as the preferred method for LDCs to prioritize and select adaptation policies and measures. This type of analysis is becoming increasingly popular in formulating adaptation strategies as it is considered to be more useful than traditional risk management tools, such as cost-benefit analysis, for structuring problems and decisions (Willows and Connell, 2003). The difficulty in using traditional risk management tools in dealing with the challenges of climate change lies in the fact that the level and types of risk uncertainty tend to be very different compared to more typical and better understood risks.⁷ Tools and techniques that can help to analyze both the risk and the uncertainty that climate change poses may prove more useful. Once a vulnerability and hazards assessment has been carried out, most NAPA countries use the MCA to help rank preferences for adaptation activities and projects, as it is a particularly useful tool when many criteria are relevant to the decision-making process, and the valuation of costs and benefits is difficult due to inherent uncertainty and, therefore, some degree of subjective judgment is required. Annex D provides an example of standardized MCA scoring for a variety of adaptation actions in Burundi.

⁷ See the glossary for definitions and further explanations of the differences between cost-benefit analysis, cost-effectiveness analysis, and multi-criteria analysis.

Box 3. The Multi-Criteria Analysis

Through the MCA process, the various adaptation options are scored against selected criteria. The scores can either be quantitative (corresponding to an estimate and expressed in monetary unit, rate, coefficient, etc.) or qualitative (based on the judgment of the NAPA team, the multidisciplinary team, or various stakeholders and expressed in a variety of scoring scales). In the submitted NAPAs, scoring has been established by discussion and consensus, by expert consultation or by a combination of both. The scores are then standardized and weighted to allow the options to be compared by expressing the value of each score in the same measuring unit on a common scale, and to allow the scores to be ranked by taking into account the relative weight of each criterion. Participatory methods have been used in many cases for weighting criteria to ensure the preferences of people affected and the views of different stakeholders are taken into account.

The guidelines for the preparation of NAPAs suggest a set of criteria for selecting priority adaptation activities and projects, and a list of sectors and ecosystems to be examined (Conference of the Parties, 2002). A set of locally driven criteria are used to select priority adaptation activities. These criteria should include:

- The level or degree of adverse effects of climate change;
- poverty reduction to enhance adaptive capacity;
- synergy with other multilateral environmental agreements; and
- cost effectiveness.

These criteria for prioritization are then applied to:

- the loss of life and livelihood;
- human health;
- food security and agriculture;
- water availability, quality, and accessibility;
- essential infrastructure;
- cultural heritage;
- biological diversity;
- land-use management and forestry;
- other environmental amenities; and
- coastal zones, and associated loss of land.

Overview of Adaptation Policy Instruments

The adaptation strategies and frameworks reviewed above illustrate the breadth of approaches and policy instruments being adopted to prioritize risks, formulate national plans of action, and integrate adaptation considerations into public policy, programs, and financial decisions at various levels of governance. Table 2 provides an overview of these various policy approaches and tools by country/program.

Table 2. Adaptation Policy Instruments

Type of Tools	Countries/ Programs	Tools	Links for More Information
NATIONAL STRATEGIES	United Kingdom	National Adaptation Policy Framework	DEFRA's web page on the Adaptation Policy Framework: < www.defra.gov.uk/environment/climatechange/adapt/policyframe.htm >
	Finland	National Strategy for Adaptation to Climate Change	Finnish Ministry of the Environment's web page on the National Strategy for Adaptation to Climate Change: < www.ymparisto.fi/default.asp?contentid=172203&lan=en >
	France	Stratégie nationale d'adaptation au changement climatique	ONERC's web page on the Stratégie nationale d'adaptation au changement climatique: < www.ecologie.gouv.fr/Adaptation-au-changement.html >
	NAPA	NAPAs developed by the least developed countries	Access to the submitted NAPAs: < http://unfccc.int/adaptation/napas/items/2679.php >
VULNERABILITY, RISK, AND IMPACT ASSESSMENTS	United Kingdom	Regulatory Impact Assessment: Assesses the vulnerability of a proposed policy to a variety of risks, one of which is the predicted effects of climate change.	Department for Business, Enterprise and Regulatory Reform web site: < www.berr.gov.uk/ > Direct access to the Impact Assessment Toolkit: < www.berr.gov.uk/bre/policy/scrutinising-new-regulations/preparing-impact-assessments/toolkit/page44199.html >
		Business Assessment Tool: Helps users explore the implications of climate change for a particular business or sector.	UKCIP web site: < www.ukcip.org.uk/ > Direct access to the UKCIP Tools portfolio: < www.ukcip.org.uk/index.php?option=com_content&task=view&id=74&Itemid=187 >
	Local Climate Impacts Profile: Resource that local authorities can compile so that they better understand their exposure to <i>weather</i> and <i>climate</i> .		

	Finland	Integrated assessment modeling of global change impacts and adaptation: Web tool intended for planners and researchers that allows users to investigate the possible impacts of climate change in Finland on chosen impact areas and at different time periods up to the end of the 21st century.	Direct access to web tool: < www.finessi.info/finessi/ >
SCENARIOS	United Kingdom/ UKCIP	Scenario Gateway: Provides climate change data for a range of possible future scenarios.	UKCIP web site: < www.ukcip.org.uk/ > Direct access to the UKCIP Tools portfolio: < www.ukcip.org.uk/index.php?option=com_content&task=view&id=74&Itemid=187 >
		Socio-Economic Scenarios: Scenarios to help explore what the future might look like, and to consider how socio-economic changes could modify people's vulnerability to climate change and affect adaptation responses.	
	Finland	FINADAPT Scenarios: Scenarios that describe future developments of the Finnish environment and society during the 21st century. The scenarios cover four time frames. The requirements for adaptation are then considered as if they apply in 2005, 2020, 2050, and 2100.	FINADAPT web pages: < www.ymparisto.fi/default.asp?contentid=165496&lan=en > Direct access to the FINADAPT scenarios: < www.ymparisto.fi/default.asp?node=16118&lan=en >
		FINSKEN Scenario Gateway: Offers access to the change projections in environmental and related factors in Finland during the 21st century and beyond.	FINSKEN web site: < www.finessi.info/finsken/ > Direct access to the Scenario Gateway: < www.finessi.info/finsken/sce/ >
France/ON	Local Future Climate Change	ONERC web site: < www.ecologie.gouv.fr/-ONERC-.html >	

	ERC	Scenarios	Direct access to the scenarios: < http://onerc.org/viewChooseScenarioForFirstTime.jsf >
GUIDANCE TO HELP DEVELOP A CLIMATE CHANGE ADAPTATION STRATEGY	United Kingdom/ UKCIP	<p>Adaptation Wizard: Tool leads the user through a five-step process to help determine vulnerability to climate change, identify options to address relevant climate risks, and develop a climate change adaptation strategy.</p> <p>Risk, Uncertainty and Decision-Making Framework: A step-by-step iterative process to help decision makers judge the significance of climate change risk compared to the other risks they face. It enables the users to work out what adaptation measures are most appropriate.</p> <p>Nottingham Declaration Action Pack: Web-based tool that provides guidance for producing action plans covering both mitigation and adaptation to climate change.</p> <p>Adaptation Resources: A range of tools providing guidance to help organizations identify adaptation options and adapting to climate change.</p>	<p>UKCIP web site: <www.ukcip.org.uk/></p> <p>Direct access to the UKCIP Tools portfolio: <www.ukcip.org.uk/index.php?option=com_content&task=view&id=74&Itemid=187></p>
	NAPA	NAPA Guidelines: Provides guiding elements for the preparation of a NAPA, which helps least developed countries identify priority activities that respond to their current vulnerability to climate change.	<p>UNFCCC web site (provides the NAPA guidelines and relevant decisions adopted by the Conference of the Parties): <http://unfccc.int/adaptation/napas/items/2679.php></p> <p>NAPA Data Base web site (provides a knowledge base for the preparation of a NAPA, including specific tools for NAPA)</p>

			support): < www.napa-pana.org >
COSTING IMPACTS	United Kingdom/ UKCIP	Costing the Impacts of Climate Change: A methodology for calculating the costs of climate impacts. This guide also explains how to compare these costs to the costs of adaptation measures.	UKCIP web site: < www.ukcip.org.uk/ > Direct access to the UKCIP Tools portfolio: < www.ukcip.org.uk/index.php?option=com_content&task=view&id=74&Itemid=187 >
INDICATORS	France/ONERC	Indicators of Observed Climate Change	ONERC web site: < www.ecologie.gouv.fr/-ONERC-.html > Direct access to ONERC's indicators: < http://onerc.org/listAllIndicators.jsf >
	Finland	Indicators of Observed Climate Change	Finnish Ministry of the Environment's web page on the National Strategy for Adaptation to Climate Change: < www.ymparisto.fi/default.asp?contentid=172203&lan=en >

5. Informing Canadian Action on Adaptation

The case studies and research reviewed for this study indicate that, as in Canada, other countries face challenges in integrating adaptation planning into government policy. None has yet established either a rigorous process for prioritizing climate change risks at the national level or the appropriate adaptation response to these risks.

Risk prioritization involves both knowledge building and decision-making components. Yet as the level and types of risk uncertainty tend to be different for climate change compared to more typical and better-understood risks, climate change risk analysis will likely require a different set of risk management tools. For example, using statistical probabilities based on past climatic events can no longer be considered a reliable approach to gauging future risks (Tompkins and Adger, 2003). Risk prioritization will therefore need to be guided by tools and techniques that can help to analyze both the potential risks associated with various climate impact scenarios, as well as the uncertainties inherent in assessing these risks.

While a number of approaches and tools are available to help evaluate and integrate climate risks into policy, the case studies explored above indicate there is no uniform approach to the development of adaptation strategies. Adaptation planning must be tailored to specific policy and decision-making contexts and cultures. Nevertheless, it is possible to identify some common elements to the approaches being adopted elsewhere, which may be insightful for Canadian policy and decision makers.

a. Build Institutional Capacity for Co-ordinated Action and Decision Making

The challenge presented by climate calls for a broad suite of policy responses and measures; taking action on adaptation will require a high level of co-ordination and sufficient institutional capacity. Some important work has already been done in Canada on understanding the potential impacts of climate change and identifying vulnerable sectors and regions. Natural Resources Canada (2008) recognized that mechanisms are now needed to facilitate effective co-ordination and collaboration between industry, academia, governments, and local communities.

While much of the actual climate risk management effort will have to be undertaken at the local level, the case study countries examined in this report recognize the need for a co-ordinated approach at the national level. Adaptation planning needs to be informed by a long-term process that links bottom-up consultation and participation with top-down co-ordination and management. As adaptation issues cut across major economic sectors and touch virtually all portfolios and governments, adequate institutional and financial mechanisms for adaptation research and planning must be established and high-level co-ordination will be required to integrate climate risk management into policy making and strategic planning.

The case studies demonstrate the importance of establishing designated institutions, programs, or co-ordinating bodies on adaptation to help build policy-making and management capacity at the national level. The three countries examined are working, to varying degrees, to strengthen their institutional and management capacities for

adaptation. In addition to creating the UKCIP, the United Kingdom has established the Climate Change Programme and has launched the development of the Adaptation Policy Framework. The APF explicitly aims to “ensure that adaptation to climate change is integrated into the wider policy making process” (DEFRA, 2005: 5). A climate change bill includes the creation of a committee on climate change to assess how the United Kingdom can enhance its ability to adapt (UK, 2008). Finland has also initiated a co-ordinated program for adaptation, and France established ONERC specifically to respond to adaptation issues raised by the climate change program of 2000.⁸

These institutions play various co-ordinating roles in the impacts research and adaptation planning processes of their respective countries. Strengthening collaboration between government departments, industry, academia, and local communities in Canada could help improve national co-ordination efforts while providing further studies, guidance, and expert advice on the design and implementation of adaptation policies and programs.

Canadian institutions active on adaptation issues at the provincial level include the Ouranos Consortium in Quebec, the Prairie Adaptation Research Collaborative and the Pacific Climate Impacts Consortium. A new co-ordinating body at the federal level in Canada could build on the efforts of these regional initiatives while working with other stakeholders. Such a new agency could be housed within an existing department, and could rely on outside expertise on adaptation to provide insights into the development of its strategy. Alternately, it could be established outside of government, as is the case with the UKCIP and ONERC, and could work at arm’s length from government.

A co-ordinating institution may also provide a common forum for stakeholders to discuss policy and management issues, develop alternative hypotheses, identify gaps in knowledge, and assess the tools and indicators that could be most useful in setting and updating research and action priorities (Burton et al., 2002; Tompkins and Adger, 2004; Walters, 1986; Walters and Holling, 1990). Such an approach can help produce policies that embrace risk as a way of building understanding and are robust to key uncertainties that test alternative policies, provide opportunities for learning, and monitor policy outcomes (Peterson et al., 1997).⁹

⁸ Another example is Australia, which created the Department of Climate Change in December 2007 and initiated the \$14 million National Climate Change Adaptation Programme. The Programme aims to build government capacity to support adaptation strategies and engage stakeholders at the local level. Objectives include advising government on climate change policy (including key risks and opportunities), building capacity to support adaptation strategies, integrating adaptation considerations into government policies and programs, and engaging stakeholders at the local level by providing targeted tools and information to sectors and regions.

⁹ This is consistent with an “adaptive management” approach to policy making, in which new policies reflect the less predictable impacts and complex challenges associated with climate change (IISD and TERI, 2006).

b. Involve Local Stakeholders

Much action on adaptation has to take at the local level due to the highly location-specific nature of climate change risks. The case studies demonstrate that involving relevant stakeholders, including all levels of government, early on in the adaptation process likely yields better results than a centrally planned process. For instance, the UKCIP has developed several guidebooks to help local authorities make informed decisions about adaptation planning. The NAPA process is also an example of a participatory process that involves stakeholders in adaptation planning through the prioritization of adaptation action using the multi-criteria analysis method.

c. Develop and Use Tools and Indicators to Prioritize Climate Risks

It is clear that an in-depth understanding of the possible effects of climate change is critically important to the development of a comprehensive adaptation strategy. Yet projections of future climate changes still occupy a relatively broad range of possible climate outcomes, and the associated socio-economic impacts remain unclear. Moreover, adaptation response measures that may be desirable for one region or sector may not be so for another. Tools, techniques, and indicators that can assist in minimizing and clarifying the extent of climate risk and uncertainty are needed to help guide the formation of adaptation policy.

The first step in prioritizing risks is to assess which sectors, regions, or programs are most vulnerable. An evaluation must also be made of the ability of a system (social, economic, political, institutional, ecological) to adjust to change, to moderate potential damage, to take advantage of opportunities, or to cope with the consequences (IPCC, 2007a). The identification of risks 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 of vulnerability and impacts. For example, stakeholders at the local level in France helped to design locally relevant indicators of change to flag those biophysical changes that appear to be undergoing a rapid transformation.

Once a risk analysis has been carried out, a process of prioritizing the various risks can be established. While none of the countries examined for this study has yet developed a formal prioritization process, some sectoral prioritization has taken place in Finland and France, and the United Kingdom has developed mechanisms, such as the Risk Framework Tool and the critical threshold procedure, to assist with this ranking process. Thresholds do not allow for a direct comparison of risks, but they do provide a means to determine whether or when adaptation action will be required. Similarly, the NAPA sensitivity analysis can also be a helpful tool to flag those activities that are particularly sensitive to climate and are subsequently deemed to be the most urgent priorities for adaptation action.

The ultimate goal of the risk prioritization process is to inform decision making. In determining the course of action to take, the NAPA MCA tool can be useful in that it guides stakeholders through a process of ranking their preferences for adaptation activities and projects. The optimal response may be a blend of several possible actions and will depend on the nature and extent of the risks identified. The best options tend to be those that help to build the required adaptive capacity to deliver adaptation actions that will maximize welfare over time. Strategies in which benefits will exceed costs or ones that contribute to desired outcomes while improving the

ability to adapt in the future are the most desirable. Some elements that might be considered when defining actions to address priority risks include understanding the resources or time needed to develop an adequate response, the state and accessibility of any required technologies, and the potential for conflict due to public resistance to the proposed measures.

Ultimately, action on adaptation and subsequent funding allocation decisions will be a discretionary matter for governments. Climate change presents both risks and opportunities for Canada, and there are a number of important trade-offs to consider. The allocation of limited time, effort, and resources in a way that is most likely to minimize the adverse impacts of climate change (and reap benefits from new opportunities) will require a combination of the risks and vulnerabilities as described above with a thorough examination of potential costs and benefits to determine how much risk is acceptable and which risks will require an adaptation response. While some impromptu adaptation actions are taking place in Canada, there is a need for improved institutional and management frameworks to facilitate effective and coordinated adaptation planning and risk prioritization.

Annex A: Examples of Federal Government Programs that could be Impacted by Climate Change

Department	Programs/Areas Affected
Agriculture and Agri-Food Canada	<ul style="list-style-type: none"> • Agricultural production • Research and development • Water and salinity
Canadian Heritage	<ul style="list-style-type: none"> • Sport Canada
Environment Canada	<ul style="list-style-type: none"> • Environmental Stewardship • Meteorological Services • Ecosystem Policy • Science and Technology
Fisheries and Oceans	<ul style="list-style-type: none"> • Sustainable Fisheries • Fisheries and Aquaculture Management • Oceans and Habitat Sector • Science Sector • Species at Risk Sector
Foreign Affairs and International Trade Canada	<ul style="list-style-type: none"> • Resources Management
Health Canada	<ul style="list-style-type: none"> • First Nations and Inuit Health • Healthy Environments and Consumer Safety • Health Policy Branch
Human Resources and Social Development Canada	<ul style="list-style-type: none"> • Labour Program • Skills and Employment • Strategic Policy
Indian and Northern Affairs Canada	<ul style="list-style-type: none"> • Aboriginal Business Canada • Economic Development • Education • Infrastructure and Housing • Northern Affairs Program • Water Quality • Sustainable Development
Industry Canada	<ul style="list-style-type: none"> • Industry Sector • Regional Operations
National Defence	<ul style="list-style-type: none"> • Defence Research and Development Canada
Natural Resources Canada	<ul style="list-style-type: none"> • Canadian Forest Service • Earth Sciences Sector • Energy Sector • Science and Policy Integration
Public Safety and Emergency Management Canada	<ul style="list-style-type: none"> • Emergency Management and National Safety
Public Works and Government Services Canada	<ul style="list-style-type: none"> • Property and Buildings

Annex B: Development of the Adaptation Strategy in Finland

Sequence of Events Leading to Finland's National Climate Adaptation Strategy and Strategic Public Choices

DATE	EVENTS
1990-1995	SILMU Research program: First scenarios of climate change impacts <ul style="list-style-type: none"> • Impacts on Agriculture, forest and energy sector identified.
1999-2002	FINSKEN research program: Global change scenarios for Finland.
March 2001	The government submits to Parliament a report on a national climate strategy.
June 2001	Parliament responded that the strategy could be implemented, but there was a need to develop a program for adapting to climate change.
Early 2003	Ministry of trade and commerce with the collaboration of other ministries, submits a progress report to Parliament: <ul style="list-style-type: none"> • The national strategy has to be revised because of the adoption of the EU directive on emission trading. • A separate program for adaptation to climate change will be included in the revised national climate strategy. • The initial phase of the adaptation program requires the implementation of a research program. Research should focus on acquiring the necessary knowledge on the impacts of climate change (both direct and indirect) affecting Finland. Uncertainty factors should also be considered. • The adaptation requirements in different sectors will be assessed. Critical sectors and impacts should be tentatively identified. Sectors that may require special attention include agriculture, forestry, nature conservation, and tourism. • The extent to which there is a need to prepare for, and adapt to, adverse impacts in other parts of the world should also be considered.
June 2003	Revision of the climate strategy begins under the supervision of the Ministerial Working Group on Climate and Energy Policy, chaired by the Minister of Trade and Industry.* <ul style="list-style-type: none"> • The other members are the ministers of the Environment, Finance, Agriculture and Forestry, and Transport and Communications. • The Ministerial Working Group is assisted by a network of central ministries experts. <p>Creation of the Adaptation Strategy Task force to prepare the adaptation strategy.</p> <ul style="list-style-type: none"> • The task force is co-ordinated by the Ministry of Agriculture and Forest and is composed of representatives from the Ministry of Trade and Industry, Ministry of the Environment, Ministry of Transport and Communications, Ministry of Social Affairs and Health, Ministry for Foreign Affairs, as well as the Finnish Meteorological Institute and the Finnish Environment Institute. • Each ministry was responsible for its own sector-specific review. • The Finnish Meteorological Institute compiled the climate change scenarios, which were partly based on the material produced by the FINSKEN project (research program 1999-2001 in preparation of the first climate change strategy). • The Government Institute for Economic Research produced a background study on long-term economic scenarios. • The progress of the preparation for the Adaptation Strategy was reported to the Ministerial Working Group on Climate and Energy Policy.
2003-2004	Preparatory work involved seminars with experts, leading researchers, and representatives of different sectors.
2003-2005	FinAdapt: Consortium of 11 research institution to do 14 research projects on adaptation.
October 2004	The proposal for Finland's National Strategy for Adaptation to Climate Change was presented at an open seminar. The draft was sent to a number of stakeholders for

	comment. The general public was able to comment on the draft through the Internet.
January 2005	National Climate Change Adaptation Strategy published.
November 24, 2005	National Climate and Energy Strategy submitted to Parliament. Adaptation strategy part of the overall strategy.
2006-2010	Climate Change Adaptation Research Program (five years) to support the implementation of the adaptation strategy. Themes: <ul style="list-style-type: none"> • climate • forestry • agriculture • biodiversity • extreme weather events, drought, floods • urban planning and built environment • international dimension.
2007	Government commits to produce a foresight report on climate and energy policy. The report is to be submitted to Parliament during spring 2009.

Note:

* The Ministry of Trade and Industry ceased operations as of December 1, 2007. Its responsibilities were transferred to the Ministry of Employment and the Economy.

Activities Related to Climate Change and Adaptation in Finland

DATE	RESEARCH PROGRAMS	GOVERNMENT INITIATIVES
1990-1995	SILMU <ul style="list-style-type: none"> • First scenarios of climate change impacts. • Impacts on agriculture, forest, and energy sectors identified. 	
1999-2002	FINSKEN <ul style="list-style-type: none"> • Global change scenarios. 	
June 2001		National Climate Change Strategy adopted.
2003-2005	FinAdapt <ul style="list-style-type: none"> • Consortium of 11 research institution to do 14 research projects on adaptation. 	
January 2005		National Climate Adaptation Strategy published.
November 2005		National Climate and Energy Strategy adopted. <ul style="list-style-type: none"> • Incorporates major elements of the National adaptation strategy.
DATE	OSTO <ul style="list-style-type: none"> • To support the implementation of the adaptation strategy. • Themes: climate, forestry, agriculture, biodiversity, extreme weather events and droughts and floods, urban planning and the environment, and the international dimension. 	

Sector-Specific Impacts and Adaptation Categories in Finland

The following table describes, for each sector considered, the impact category examined as well as the focus of the proposed adaptation measures. Note that the measure “Further research on adaptation” was recommended for all sectors. “Possible measures” is used when a diverse number of actions are proposed.

SECTOR	IMPACT	ADAPTATION
Agriculture and food production	<ul style="list-style-type: none"> • Changing climatic and soil conditions • Pests, plant diseases, and weeds • Cultivation of arable crops • Horticultural production • Animal husbandry • Global impacts on food production 	<ul style="list-style-type: none"> • Adaptive capacity of actors • Pests, plant diseases, and weeds • Changes in agricultural production
Forestry	<ul style="list-style-type: none"> • Changing climatic and soil conditions • Growth of trees and composition of stand • Pests and pathogens in forests • Biodiversity in forest • Forest harvesting and utilization • Other products from forests 	<ul style="list-style-type: none"> • Adaptive capacity of actors • Gene pools of forest trees, forest tree improvement, and seed management • Forest management • Forest use
Fisheries	<ul style="list-style-type: none"> • Impacts of climate change on fish stocks and fisheries • Impacts of increased temperature on fish • Changes in areas of distribution • Impacts on professional fishing • Impacts on recreational fishing • Uncertainties 	<ul style="list-style-type: none"> • Adaptation of fish stocks to climate change • Adaptive capacity of actors • Possible measures
Reindeer husbandry	<ul style="list-style-type: none"> • Impacts of climate change on reindeer husbandry 	<ul style="list-style-type: none"> • Adaptive capacity of actors • Possible measures
Game management	<ul style="list-style-type: none"> • Impacts of climate change on the populations of small game and small mammals • Impacts of climate change on deer populations • Impacts of climate change on large predators • Impacts of climate change on the ability of game species to seek shelter • Impacts of climate change on parasites • Uncertainties 	<ul style="list-style-type: none"> • Adaptive capacity of actors • Ability of game to adapt to climate change • Possible measures
Water resources	<ul style="list-style-type: none"> • Impacts of climate change on water resources (floods, drought) 	<ul style="list-style-type: none"> • Adaptive capacity of actors • Possible measures
Biodiversity	<ul style="list-style-type: none"> • Impacts of climate change on biodiversity 	<ul style="list-style-type: none"> • The capacity of species and habitat types to adapt to climate change • Possible measures
Industry	<ul style="list-style-type: none"> • Forest industry • Food industry 	<ul style="list-style-type: none"> • Adaptive capacity of actors • Forest industry

SECTOR	IMPACT	ADAPTATION
	<ul style="list-style-type: none"> • Construction materials and the construction industry • Other sectors 	<ul style="list-style-type: none"> • Food industry • Construction industry
Energy	<ul style="list-style-type: none"> • General impacts on heating requirements and related issues • Power transmission and distribution • Hydro power • Peat • Bioenergy • Wind power • Solar power • Coal, nuclear power, and natural gas 	<ul style="list-style-type: none"> • Adaptive capacity of actors • Hydro power • Peat • Bioenergy • Wind power
Transport and communications	<ul style="list-style-type: none"> • Changes in traffic behaviour • Infrastructure • Maintenance and level of service 	<ul style="list-style-type: none"> • Adaptive capacity of actors • Infrastructure • Maintenance and quality of service
Land use and communities	<ul style="list-style-type: none"> • Land use and communities • Waste management 	<ul style="list-style-type: none"> • Adaptive capacity of actors • Possible measures
Buildings and construction	<ul style="list-style-type: none"> • Impacts of climate change 	<ul style="list-style-type: none"> • Adaptive capacity of actors • Possible measures
Health	<ul style="list-style-type: none"> • Direct health impacts of climate change • Indirect health impacts of climate change 	<ul style="list-style-type: none"> • Adaptive capacity of actors • Possible measures
Tourism and the recreational use of nature	<ul style="list-style-type: none"> • Summer tourism • Winter tourism 	<ul style="list-style-type: none"> • Adaptive capacity of actors • Summer tourism • Winter tourism
Insurance operations	<ul style="list-style-type: none"> • Impacts of climate change on insurance operations 	<ul style="list-style-type: none"> • Adaptive capacity of actors • Possible measures

The proposed adaptation measures for each sector in the above table have been further subdivided according to their type, time frame (immediate, short term, long term) and their nature (reactive, anticipatory). In addition to the sectoral analysis, the Strategy examines a number of cross-sectoral issues for which specific measures have been proposed.

Annex C: Climate Change Impact and Adaptation Indicators and for France

Indicator	Parameters	Related economic activities	Geography	Theme
Mass balance of the Ossoue glacier	Precipitation Temperature	Tourism	Mountain	Water
Mass balance of glaciers in the French Alps	Precipitation		Mountain	Water
Concentration of Chlorophyll-A in oceans	Biomass	Fishing	Coast Oceans	Water
Flowering date of fruit trees		Agriculture		
Flowering date and grape harvesting date in Champagne		Agriculture		
Grape harvesting date in Côte du Rhone		Agriculture		
Grape harvesting date in Saint-Émilion		Agriculture		
Evolution of agricultural practices		Agriculture		
Population risk exposure				
Pine processionary moth progression		Agriculture	Forest	Biodiversity
Winters in Col de Porte	Temperature Precipitation		Mountain	Water
Sea level in Pepeeete			Coast Oceans	
Number of summer days	Temperature			Air
Number of days with temperature below freezing	Temperature			Air
Salinity of ocean surface water	Salinity	Fishing	Coast Oceans	Water
Development stage of grapevines in Alsace		Agriculture		
Sea surface temperature	Temperature		Coast Oceans	Water

Indicator	Parameters	Related economic activities	Geography	Theme
			Overseas	
Air temperature in French colonies in America	Temperature			Air
Sea surface temperature in New Caledonia	Temperature	Tourism	Coast Oceans	Water
Mean air temperatures	Temperature			Air

Source: <<http://onerc.org/listAllIndicators.jsf>>.

Annex D: Example of MCA in Burundi

This Annex provides an example of standardized MCA scoring for a variety of adaptation actions in Burundi.

ALLOCATION OF WEIGHTED SCORES COMPARED TO CRITERIA IN BURUNDI

Criteria	Sustainable environmental management	Cost	Aptitude to adaptation	Struggle against poverty	Food security	Prevention of climate risks	Woman empowerment	Economic growth	Total
Absolute weighting	25	20	15	14	10	10	4	2	100
Relative weighting	0.25	0.20	0.15	0.14	0.10	0.10	0.04	0.02	1.00
1 Enhance the management of existing protected areas and transform into protected areas the natural ecosystems identified as threatened or vulnerable	0.25	0.19	0.08	0.04	0.03	0.08	0.02	0.01	0.68
2 Safeguard existing woodlots and reforest stripped areas	0.2	0.17	0.11	0.07	0.03	0.08	0	0.04	0.70
3 Set up mechanisms to control erosion in sensitive areas	0.2	0.15	0.11	0.04	0.07	0.08	0	0.02	0.67
4 Control river dynamics of watercourses and torrents in Mumirwa, including the city of Bujumbura	0.2	0	0.11	0.04	0.03	0.1	0	0.02	0.50
5 Popularise short cycle and dryness resistant food crops	0	0.19	0.04	0.14	0.1	0.02	0.04	0.06	0.59
6 Popularise rainwater harvesting techniques for agricultural or domestic use	0.15	0.11	0.15	0.07	0.07	0.06	0.03	0.04	0.68
7 Identify and popularise improved techniques of use of wood and renewable new energies	0.15	0.14	0.08	0.04	0.01	0.06	0.04	0.02	0.53
8 Multiply hydropower micro stations	0.05	0.16	0.04	0.07	0	0.02	0	0.04	0.38
9 Establish and protect strategic buffer zones in Lake Tanganyika floodplains and around the lakes of Bugesera	0.2	0.19	0.08	0.04	0.03	0.06	0.02	0.02	0.63
10 Identify and popularise the breeding of species adapted to local climate conditions	0	0.19	0.04	0.11	0.07	0	0.01	0.02	0.43
11 Popularise zero grazing techniques	0.05	0.2	0.04	0.14	0.09	0	0.03	0.04	0.58
12 Identify and popularise dryness resistant forest species	0.15	0.2	0.08	0.07	0.01	0.06	0	0.02	0.59
13 Train and inform the decision makers and other actors, including local communities, on methods of adaptation to climate variability	0.1	0.16	0.04	0	0.03	0.04	0.03	0.06	0.45
14 Improve seasonal early warning climate forecasts	0.2	0.16	0.11	0.11	0.07	0.1	0	0.07	0.75

Source: Burundi (2007).

Glossary

Adaptation

Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.^b

Adaptive Capacity

The ability of a system to adjust to *climate change* (including *climate variability* and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.^b

Adaptation Policy Framework

A structured process for developing adaptation strategies, policies, and measures to enhance and ensure human development in the face of climate change, including climate variability. An adaptation policy framework is designed to link climate change adaptation to sustainable development and other global environmental issues. It consists of five basic components: a scoping and designing and adaptation project, assessing current vulnerability, characterizing future climate risks, developing an adaptation strategy, and continuing the adaptation process.^c

(Climate change) Adaptation Strategy

A climate change adaptation strategy for a country refers to a general plan of action for addressing the impacts of climate change, including climate variability and extremes. It may include a mix of policies and measures, selected to meet the overarching objective of reducing the country's vulnerability.^c

Bottom-Up Approach

A planning approach mainly based on the ability of local stakeholders and communities to identify problems for intervention, to formulate strategies, and fully participate in implementation.

Capacity Building

In the context of adaptation to climate change, capacity building is developing the technical skills and institutional capabilities of stakeholders to enable their participation in all aspects of adaptation to, and research on, climate change.^a

Climate Change

Climate change refers to any change in climate over time, whether due to natural variability or as a result of human activity. This usage differs from that in the United Nations Framework Convention on Climate Change (UNFCCC), which defines climate change as: "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global *atmosphere* and which is in addition to natural climate variability observed over comparable time periods."^b

Climate Projection

The calculated response of the climate system to emissions or concentration scenarios of greenhouse gases and aerosols, or radiative forcing scenarios, often based on simulations by climate models. Because climate projections are based on assumptions concerning, for example, future socio-economic and technological

developments that may or may not be realized, they are subject to substantial uncertainty.^a

Climate Scenario

A plausible and often simplified representation of the future climate, based on an internally consistent set of climate relationships and assumptions of radiative forcing, typically constructed for explicit use as input to climate change impact models. A climate change scenario is the difference between a climate scenario and the current climate.^a

Climate System

The climate system is defined by the dynamics and interactions of five major components: atmosphere, hydrosphere, cryosphere, surface, and biosphere. Climate system dynamics are driven by both internal and external forcing factors, such as volcanic eruptions, solar variations, or human-induced modifications to the planetary radiative balance (e.g., via anthropogenic emissions of greenhouse gases and/or land-use changes).^a

Climate Variability

Variations in the mean and other statistics (e.g., standard deviations, the occurrence of extremes) of the climate on all temporal and spatial scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system or to variations in natural or anthropogenic external forcing.^a

Cost-Benefit Analysis

Cost benefit analysis (CBA) is a decision aid tool that considers the implementation costs as well as all the effects of an adaptation policy or project, meaning all of its costs and benefits, on both market and non-market goods and services. It can be used for two purposes: it allows for comparing different adaptation options by ranking them, and it establishes the social profitability of a proposed adaptation option in comparison with a defined baseline.

Cost-Effectiveness Analysis

As a decision aid tool, a cost-effectiveness analysis (CEA) helps identify the least costly adaptation strategy for attaining a given objective, that is, for avoiding a specific impact or achieving a precise set of benefits. A CEA is used to compare the costs of adaptation options that can meet this objective. Such an objective could be, for example, ensuring the preservation of a threatened species or reducing by a certain percentage the risk of a health hazard. A CEA is based on the hypothesis that the different adaptation options considered bring about the same outcome. However, if the benefits of the avoided impacts cannot be assumed to be the same, a variation of CEA can be used in which the adaptation options are attributed “efficiency units” to calculate a cost-effectiveness ratio (CER). The adaptation option with the highest CER is the preferred one.

Ecosystem

The interactive system formed from all living organisms and their abiotic (physical and chemical) environment within a given area. Ecosystems cover a hierarchy of spatial scales.^a

Ecosystem Approach (ecosystem-based management)

The ecosystem approach is a strategy for the integrated management of land, water, and living resources that promotes conservation and sustainable use in an equitable way. It applies appropriate scientific methodologies focused on the essential structure, processes, functions, and interactions among organisms and their environment, and recognizes that humans, with their cultural diversity, are an integral component of many ecosystems.^a

Ecosystem Services

Ecological processes or functions having monetary or non-monetary value to individuals or society at large. There are supporting services, such as productivity or biodiversity maintenance; provisioning services, such as food, fibre, or fish; regulating services, such as climate regulation or carbon sequestration; and cultural services, such as tourism or spiritual and aesthetic appreciation.^a

Emission Scenario

A plausible representation of the future development of emissions of substances that are potentially radiatively active (e.g., greenhouse gases, aerosols) based on a coherent and internally consistent set of assumptions about driving forces (e.g., demographic and socio-economic development, technological change) and their key relationships. Concentration scenarios, derived from emission scenarios, are used as input to a climate model to compute climate projections.^a

Extreme Weather Event

An event that is rare within its statistical reference distribution at a particular place. Definitions of “rare” vary, but an extreme weather event would normally be as rare as, or rarer than, the 10th or 90th percentile. By definition, the characteristics of what is called “extreme weather” may vary from place to place.^a

Feedback

An interaction mechanism between processes in a system, which results when an initial process triggers changes in a second process and that, in turn, influences the initial one. A positive feedback intensifies the original process, and a negative feedback reduces it.^a

Greenhouse Effect

The process in which the absorption of infrared radiation by the atmosphere warms the Earth. In common parlance, the term “greenhouse effect” may be used to refer either to the natural greenhouse effect, due to naturally occurring greenhouse gases, or to the enhanced (anthropogenic) greenhouse effect, which results from gases emitted as a result of human activities.^a

Greenhouse Gas

Gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth’s surface, by the atmosphere itself and by clouds. Water vapour (H₂O), carbon dioxide (CO₂), nitrous oxide (N₂O), methane (CH₄) and ozone (O₃) are the primary greenhouse gases in the Earth’s atmosphere. In addition, a number of entirely human-made greenhouse gases exist in the atmosphere, such as the halocarbons and other chlorine- and bromine-containing substances.^a

Impacts of Climate Change

The adverse and beneficial effects of climate change on natural and human systems. Depending on the consideration of adaptation, one can distinguish between potential impacts and residual impacts.^a

Intergovernmental Panel on Climate Change

A panel established by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) in 1988 to assess scientific, technical, and socio-economic information relevant for the understanding of climate change, its potential impacts, and options for adaptation and mitigation.^a

Kyoto Protocol

The Kyoto Protocol was adopted at the Third Session of the Conference of the Parties to the UN Framework Convention on Climate Change in 1997 in Kyoto, Japan. It contains legally binding commitments, in addition to those included in the UNFCCC. The Kyoto Protocol entered into force on February 16, 2005.^a

Mainstreaming

In the context of adaptation, mainstreaming refers to the integration of adaptation considerations (or climate risks) such that they become part of policies, programs, and operations at all levels of decision making. The goal is to make the adaptation process a component of existing decision-making and planning frameworks.^a

Maladaptation

Any deliberate adjustments in natural or human systems that inadvertently increase vulnerability to climatic stimuli; an adaptation that does not succeed in reducing vulnerability but increases it instead.^a

Mitigation

In the context of climate change, mitigation is an anthropogenic intervention to reduce the anthropogenic forcing of the climate system; it includes strategies to reduce greenhouse gas sources and emissions and enhance greenhouse gas sinks.^a

Multi-Criteria Analysis

A multi-criteria analysis describes any structured approach used to determine overall preferences among alternative options, where the options accomplish several objectives. In MCA, desirable objectives are specified and corresponding attributes or indicators are identified. The actual measurement of indicators need not be in monetary terms, but are often based on the quantitative analysis (through scoring, ranking, and weighting) of a wide range of qualitative impact categories and criteria. Different environmental and social indicators may be developed side by side with economic costs and benefits. Explicit recognition is given to the fact that a variety of both monetary and non-monetary objectives may influence policy decisions. An MCA is particularly suitable for participatory decision making, as the participation of stakeholders in the process (especially in determining the relevance and the weights of criteria) is a central part of the approach.

No Regrets Policy/Measure

A policy or measure that would generate net social and/or economic benefits irrespective of whether climate change occurs.^a

Permafrost

Ground (soil or rock and included ice and organic material) that remains at or below 0°C for at least two consecutive years.^a

Phenology

The study of natural phenomena that recur periodically (e.g., development stages, migration) and their relation to climate and seasonal changes.^a

Planned Adaptation

Adaptation that is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state.^b

Resilience

The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the same capacity for self-organization, and the same capacity to adapt to stress and change.^a

Risk

A combination of the likelihood (probability of occurrence) and the consequences of an adverse event (e.g., climate-related hazard).^a

Risk Management

A systematic approach to setting the best course of action under uncertainty, by applying management policies, procedures, and practices to the tasks of analyzing, evaluating, controlling, and communicating about risk issues.^a

Sensitivity

Sensitivity is the degree to which a system is affected, either adversely or beneficially, by climate variability or climate change. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g., damage caused by an increase in the frequency of coastal flooding due to sea-level rise).^a

Technologies (for adaptation)

Technologies that, when implemented or applied, work toward adaptation goals. They include “hard” forms (e.g., new irrigation systems or drought-resistant seeds) and “soft” technologies (e.g., insurance schemes or planning processes), or they can be a combination of hard and soft (e.g., early warning systems that combine hard measuring devices with soft knowledge and skills that can raise awareness and stimulate appropriate action).¹

Threshold

The level of magnitude of a system process at which sudden or rapid change occurs. It is also a point or level at which new properties emerge in an ecological, economic, or other system, invalidating predictions based on mathematical relationships that apply at lower levels.^a

Top-Down Approach

Planning approach in which the process of identifying problems for intervention and formulating strategies is primarily carried out under the direction of high-level

governmental instances. Decisions flow from national/regional level to local communities.

Tools (for adaptation)

Methodologies, guidelines and processes that enable stakeholders to assess the implications of climate change impacts and relevant adaptation options in the context of their operating environment. Tools may occur in a variety of formats and have diverse applications: crosscutting or multidisciplinary (e.g., climate models, scenario-building methods, stakeholder analysis, decision-support tools, decision-analytical tools) to specific sectoral applications (e.g., crop or vegetation models, methods for coastal-zone vulnerability assessment).^a

Traditional Knowledge

A cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment.^a

Uncertainty

An expression of the degree to which a value is unknown. Uncertainty can result from lack of information or from disagreement about what is known or even knowable. It may have many types of sources, from quantifiable errors in the data to ambiguously defined concepts or terminology, or uncertain projections of human behaviour. Uncertainty can therefore be represented by quantitative measures (e.g., a range of values calculated by various models) or by qualitative statements (e.g., reflecting the judgment of a team of experts).^a

United Nations Framework Convention on Climate Change

The Convention was adopted on May 9, 1992 in New York and signed at the 1992 Earth Summit in Rio de Janeiro by more than 150 countries and the European Community. Its ultimate objective is the “stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.” It contains commitments for all parties. The Convention entered into force in March 1994. See also Kyoto Protocol.^a

Vulnerability

Vulnerability is the susceptibility to be harmed. Vulnerability to climate change is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability to climate change is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.^a

Sources:

^a *NRCan (2008: “Glossary”).*

^b *IPCC (2007b).*

^c *Burton et al. (2005); ÉcoRessources Consultants (2006); UNFCCC, Secretariat (2004).*

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Note: All URLs were confirmed in November 2008.

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