

2006



Report of the  
**Commissioner of the  
Environment and  
Sustainable Development**  
to the House of Commons

**Chapter 2**  
Adapting to the Impacts of Climate Change



Office of the Auditor General of Canada

*The 2006 Report of the Commissioner of the Environment and Sustainable Development comprises five chapters, The Commissioner's Perspective—2006, Climate Change—An Overview, and Main Points. The main table of contents is found at the end of this publication.*

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Chapter

# 2

Adapting to the Impacts  
of Climate Change

*The audit work reported in this chapter was conducted in accordance with the legislative mandate, policies, and practices of the Office of the Auditor General of Canada. These policies and practices embrace the standards recommended by the Canadian Institute of Chartered Accountants.*

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# Adapting to the Impacts of Climate Change

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## Main Points

### What we examined

We examined whether the federal government has strategies and action plans in place for adapting to and managing the impacts of climate change. We focussed on the work of Environment Canada and Natural Resources Canada in this area. In addition, we examined the work of Public Safety and Emergency Preparedness Canada, Health Canada, and Agriculture and Agri-Food Canada, three departments responsible for areas likely to be affected by climate change. We also looked at whether Indian and Northern Affairs Canada is addressing the implications of climate change in the North.

We also assessed whether the federal government has taken steps to obtain, analyze, and share the information needed to identify the potential impacts to which Canadians are exposed because of climate change. We focussed on the work of Environment Canada and Natural Resources Canada in climate modelling (which provides information on possible future climate conditions), collecting and analyzing climate observations, and conducting research on the impacts of climate change and means of adapting to them.

### Why it's important

Canada is vulnerable to the impacts of climate change. More extreme and intense weather events, such as extended heat waves and winter storms, increase the risk to Canadians' health and safety. Climate change is expected to create additional stresses on Canada's water resources. It is also likely to trigger adverse socio-economic impacts in regions that depend on natural resource industries such as forestry and agriculture. The effects of warming are expected to be greater in Canada's northern latitudes than in other regions; many aspects of life in the North are already affected by melting permafrost and reduced sea ice.

Canada has committed to facilitating adaptation to the expected impacts of climate change. Taking steps now to adapt to a changing climate can help protect Canadians and their assets and reduce the potential economic, social, and environmental costs.

**What we found**

- The government has not yet put in place key measures to support Canadians in adapting to a changing climate. Nor has it clarified how it intends to manage its own adaptation efforts.
- The government has not developed a strategy for federal adaptation efforts to indicate the expected results and timelines, and which departments would assume what responsibilities. Federal progress in working with provinces and territories has been limited.
- Some departments we examined have begun work on their own strategies, but only one has been completed. Departments have made limited progress in using available information about the changing climate to assess potential implications on federal policies and programs.
- The federal government has supported the development of knowledge through impacts and adaptation research and initiatives that involve working with decision makers on adaptation solutions. There is sufficient information for adaptation to proceed. However, the federal government has not yet organized its activities in climate science to make sure that the federal departments and others obtain needed information. For example, there is a lack of up-to-date climate information for use in adapting the design of infrastructures such as storm sewers, and limited information is available to the public on possible future climate conditions in their area.

**The departments and central agencies have responded.** The departments and central agencies have accepted all of our recommendations; responses are included with the related recommendations throughout the chapter. However, the responses make no firm commitment to specific actions with time frames for implementation.



## Introduction

### Canada is vulnerable to the impacts of climate change

For a detailed description of the climate change issue, please consult **The Commissioner's Perspective**, which includes a section called **Climate Change—An Overview**.

**Vulnerability**—The degree to which a natural or man-made system is susceptible to, or is unable to cope with, adverse effects of climate change, including climate variability and extremes.

**Climate adaptation**—Adjustments in ecological, social, or economic systems in response to climatic stimuli and their effects or impacts.



The changing climate creates sustainability challenges for future generations in Aboriginal and northern communities.

**2.1** Over the last 50 years, the climate has been changing due to increasing greenhouse gas emissions, and experts around the world predict more and faster changes. These changes will likely lead to different impacts and **vulnerabilities** across Canada, resulting in benefits for some and **climate adaptation** challenges for many.

**2.2** The majority of Canadians live in urban centres, where a changing climate will likely mean more risks to health from events such as longer and more intense heat waves and smog events (see Toronto's heat-health alert system, page 4). Increased risks to safety and property are also likely in some regions, due for example to coastal erosion from rising sea levels, or to more severe winter storms and more frequent events such as flash floods in areas where rains intensify.

**2.3** The Arctic is expected to respond faster and more severely to projected climate change than other regions of the world. Canada's northern territories, particularly in the western Arctic, are already affected by a changing climate (see Melting permafrost destabilizes northern infrastructure, page 4). The consequences, such as melting of permafrost and the reduction of sea ice, are affecting many aspects of life in the North.

**2.4** Dealing with a changing climate is also a sustainable development issue. The economic and social well-being of most Canadians is greatly influenced by the health and sustainability of our natural resource industries, including agriculture and forestry—sectors likely to suffer negative effects of a changing climate (see Prairie droughts threaten agricultural production, and Beetles ravage British Columbia's pine forests, pages 4 and 5).

### Adaptation involves a wide range of stakeholders

**2.5** Vulnerability to the effects of a changing climate can be reduced by improving the ability to cope with them. In communities, sectors, and regions expected to feel the impacts, developing the capacity of Canadians to adapt is key and involves many players, including all levels of government. Stakeholders include not only residents of regions likely to feel the impacts, but also natural resource managers, transportation and municipal infrastructure managers, industries, nature conservation organizations, public health managers, emergency preparedness managers, engineers and planners, financial investors, the insurance industry, and Aboriginal people.

## Adapting to climate change impacts on Canadian communities, sectors, and regions

### Toronto's heat-health alert system

The number of excessively hot summer days is expected to rise in Toronto. The urban environment—extensive pavement and high-density buildings and structures made of concrete and glass—exacerbates the problem by re-radiating heat. Excessive heat can cause illness and premature death, and it promotes the spread of certain diseases and other adverse outcomes associated with climate change. Based on data from 1954 to 2000, the Toronto Medical Officer of Health estimates that on average, 120 premature deaths in Toronto each year can be attributed to heat. In 1999, Toronto Public Health began to develop a hot-weather response system to protect public health and prevent premature deaths. The Toronto Heat-Health Alert system is based on the historical relationship between heat-related deaths and specific weather types. Environment Canada daily weather forecasts are analyzed to determine when the Toronto Medical Officer of Health should issue a “heat alert” or “extreme heat alert.” An extreme heat alert issued by the Medical Officer of Health triggers a co-ordinated response among key city agencies and community partners. The response includes media announcements about ways to beat the heat, activation of a Heat Information Line, outreach to socially isolated individuals and other vulnerable groups, opening of public cooling centres, and home visits by Emergency Medical Services. Longer-term adaptation strategies include urban reforestation and a move to reflective surfaces on roofs and roads.

### Melting permafrost destabilizes northern infrastructure

Abundant mineral, oil, and gas resources position Canada's North for economic expansion. Natural Resources Canada estimates the value of diamond production in 2005 at \$1.7 billion. But development of northern natural resources is challenged by inadequate transportation infrastructure, a challenge that grows more difficult as northern temperatures rise and permafrost melts. Temperature increases of 4° to 5°C predicted for the Western Arctic by 2080 are likely to affect a large portion of the total permafrost area. Melting of permafrost reduces the load-bearing strength of the land, causes the ground surface to sink, and threatens the stability of roads, airport runways, pipelines, water supplies, waste-water disposal structures, and older buildings. A temperature rise could cause structural damage to infrastructure foundations. An “ice road” is a temporary highway using the surface of frozen rivers and lakes. The “ice road” season could be shortened substantially. Stabilizing existing infrastructure and developing new construction methods to adapt to changing conditions are critical to maintaining ground access in Canada's North.



Changes in ground surface due to melting permafrost can affect the stability of structures.

Photo: Natural Resources Canada

### Prairie droughts threaten agricultural production

The Canadian Prairies have always been susceptible to drought, and many climate models predict that droughts will become more frequent and widespread as temperatures continue to rise. Drought uses up soil moisture and surface waters in the summer, increases the risk of crop failure, and contributes to soil erosion and desertification. Its effects may be too great to be offset by the occasional wet year that climatic extremes are likely to include. The economic fallout of a severe drought can be devastating. In 2001, for example, Alberta livestock inventories plummeted because feed and water were scarce, some crops were almost completely lost, and net farm income was zero in Alberta and at a deficit in Saskatchewan. Crop insurance payments in these two provinces skyrocketed from about \$600 million in 2001 to nearly \$1.9 billion the following year. The Prairie Farm Rehabilitation Administration has been helping farmers adapt to drought in a variety of ways since its creation over 70 years ago. Supporting farmers in the future could require far-sighted adaptation strategies to deal with potential long-term effects of climate change, such as prolonged drought.



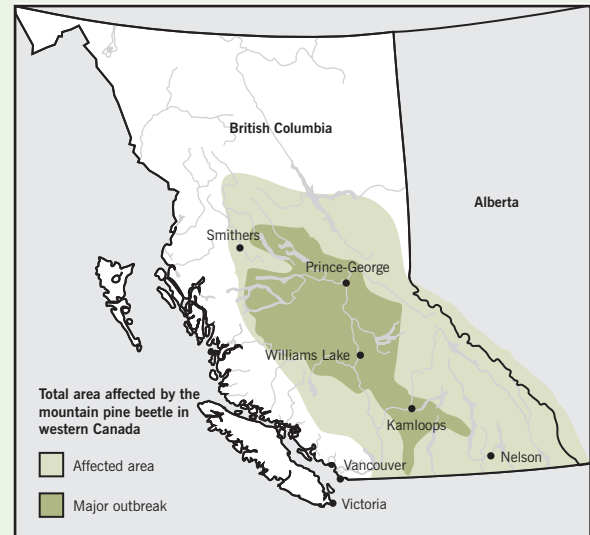
Decisions at the farm level will be key for adaptation to more intense and more frequent droughts.

Photo: Craig Douglas, Canadian Wheat Board

### Adapting to climate change impacts on Canadian communities, sectors, and regions

#### Beetles ravage British Columbia's pine forests

The mountain pine beetle lays its eggs under the bark of lodgepole pine trees, found throughout western North America. Emerging larvae feed on the inner bark of the tree, and bluestain fungi introduced by the beetle discolours the tree's sapwood. Larvae and fungi together kill most infested trees. Unseasonable cold temperatures in the fall, winter, and spring are needed to control populations; hot and dry summers leave trees more susceptible to attack. In the last few decades, B.C. has seen a change in climatic conditions, such as warmer winters that have allowed the mountain pine beetle populations to spread. As the climate continues to change, it is likely that the mountain pine beetle will continue to expand into new habitats. The current outbreak in B.C.'s west-central interior is the largest in the province's history, affecting 8.7 million hectares of forest in 2005, altering wildlife habitat and reducing biodiversity, and threatening the livelihoods of some 30 communities and 25,000 families. Accelerated harvesting allows dead trees to be cut before they lose value, but it will take many decades to rebuild the supply. In 2002 the federal government announced the six-year, \$40-million Mountain Pine Beetle Initiative aimed at studying the impacts of infestations and how to mitigate them. It provided techniques and funding to rehabilitate forestlands and reduce the risk of new outbreaks and included research on the potential effects of a changing climate on outbreaks.



Source: Natural Resources Canada (February 2005)

**2.6** Access to information, technology, resources, and partners, as well as federal involvement can advance adaptation. “Adapting to climate change impacts on Canadian communities, sectors, and regions” (pages 4 and 5) provides examples.

#### Canadians recognize the need to facilitate climate adaptation

**2.7** Canada has recognized the need to facilitate adequate adaptation to a changing climate since 1992, when it ratified the United Nations Framework Convention on Climate Change. In 2005, the House of Commons Standing Committee on Environment and Sustainable Development noted the urgency of this need and recommended that the federal government co-operate with the provinces and territories to develop a strategy for adapting to climate change.

**2.8** The federal government has made commitments and statements recognizing the need to work on adaptation to climate change—for example, through the Climate Change Action Fund, Action Plan 2000, the 2002 Climate Change Plan for Canada, and departmental sustainable development strategies. In particular, Indian and Northern Affairs Canada made a commitment to develop an Impacts and Adaptation Strategy through the Aboriginal and

Northern Community Action Program and in its third sustainable development strategy. Between 1998 and 2006, the government announced a total of about \$82 million in new funding to carry out work related to science, impacts, and adaptation (Exhibit 2.1).

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#### **Exhibit 2.1 Key federal initiatives supporting work on impacts and adaptation**

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**Climate Change Action Fund.** The fund is a \$300-million initiative of the Government of Canada to help develop a national implementation strategy and to support early actions in response to climate change. Between 1998 and 2004, total funding of \$30 million was announced for work on science and on impacts and adaptation. The fund has supported 101 projects under the science component and 106 projects under the impacts and adaptation component. The projects, selected through open calls for proposals, included Arctic research and monitoring, improvement of climate modelling, research on extreme climate and weather events, and assessment of vulnerabilities and risks to areas such as human health, coastal zones, agriculture, and permafrost.

**Action Plan 2000.** The plan is a \$500-million initiative of the Government of Canada intended mainly to reduce Canada's greenhouse gas emissions. It also includes some funding to set the stage for future measures in areas such as technology, science, and adaptation. The plan included additional funding of \$30 million to Natural Resources Canada from 2001 to 2006 to link Canadian researchers and develop knowledge for helping Canadians adapt. The Department used this funding to set up the Climate Change Impacts and Adaptation Program. The plan also included \$20 million for additional science work.

**Aboriginal and Northern Community Action Program.** Funding of \$30.7 million was announced for the program, intended mainly to reduce greenhouse gas emissions by working with Aboriginal and northern communities between 2003 and 2008. The program includes about \$2 million to develop an adaptation strategy and to implement adaptation projects.

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### **The federal role in impacts and adaptation**

**2.9** The federal government has the right to enter into agreements on behalf of Canada, such as the United Nations Framework Convention on Climate Change. Implementing such agreements requires that federal, provincial, and territorial governments work closely together. The federal government and individual departments are responsible for managing risks to their policies and programs, including risks such as those resulting from a changing climate.

**2.10** Natural disasters, including those that are weather-related, are very costly to the economy and society. When the costs of dealing with the consequences of extreme climate conditions exceed what an individual province or territory could reasonably be expected to bear on its own, the Government of Canada often provides financial support. For example, through the Disaster Financial Assistance Arrangements it provides aid to the provinces and territories affected by a disaster. Since the creation of these arrangements in 1970, the

federal government has provided over \$1.7 billion in assistance for over 140 events. Another example is Agriculture and Agri-Food Canada, whose federal/provincial Crop Insurance and Canadian Agriculture Income Stabilization programs compensate for production and income losses caused by drought. Climate change is expected to increase the potential liability to the federal government.

**2.11** The federal role in climate science and research on impacts and adaptation includes

- establishing and operating climate monitoring networks to provide long-term records of the climate system and natural and human systems likely to be affected by climate change;
- carrying out climate modelling to provide information about the possible climate conditions in the future;
- conducting research on impacts and adaptation in response to policy needs; and
- providing a national leadership role in the direction, co-ordination, and funding of climate science in Canada.

#### **Focus of the audit**

**2.12** Our audit focussed on assessing whether the federal government had put in place key elements of a strategy to help Canadians adapt to a changing climate. We examined Environment Canada and Natural Resources Canada (the federal departments most directly involved in climate change activities) and the work of Public Safety and Emergency Preparedness Canada, Health Canada, and Agriculture and Agri-Food Canada (three departments responsible for areas likely to be affected by climate change). We also looked at whether Indian and Northern Affairs Canada is addressing the implications of climate change in the North.

**2.13** We assessed whether the government had identified and prioritized vulnerabilities to potential impacts of a changing climate in Canadian communities, sectors, and regions and whether it had developed and implemented action plans to address them. We examined federal activities government-wide and in departments, at the policy and program level, and in collaboration with provinces and territories.

**2.14** We looked at the government's development and provision of information in three key areas: research on impacts and adaptation, climate monitoring to assess impacts and support adaptation, and modelling of possible future climate conditions on a regional scale.

**2.15** More details on the audit objectives, scope, approach, and criteria are in **About the Audit** at the end of this chapter.

## Observations and Recommendations

### Priorities and adaptation strategies

**2.16** A strategy for adapting to a changing climate is a critical need, given the number of regions and sectors of the country that are potentially vulnerable and the number of players that will need to participate in adaptation efforts. Strategies support action by clarifying priorities for action, expected results and how they will be measured, timelines, and roles and responsibilities of the different players. Yet in none of the spheres of federal activity—government-wide, departmental, policy/program, and national (federal government working with provinces and territories)—did we find an adaptation strategy.

#### **Federal progress in working with provinces and territories has been limited**

**2.17** In 2005, federal, provincial, and territorial officials under the leadership of Natural Resources Canada completed a document that describes potential ways for governments to collaborate on adaptation. This document is the only systematic effort by the federal government to work with provinces and territories on a shared approach to adaptation across the country. It does not identify expected results, timelines, or roles and responsibilities. The document, entitled National Climate Change Adaptation Framework, was developed following a request by federal, provincial, and territorial ministers of the environment and energy in 2002. It has not been approved by the federal government. Natural Resources Canada officials also confirmed that federal officials have not been given authority to negotiate with the provinces to develop action plans for adaptation.

#### **Federal priorities for action were not identified**

**2.18** A federal adaptation strategy was started in 2003 but not completed. In 2003, the federal government identified the need to co-ordinate and develop a federal adaptation strategy. It identified Natural Resources Canada as the lead department to develop a strategy with other federal departments and agencies, including all the departments we examined in this audit. The most recent version of a draft strategy was produced in May 2004.



**2.19** In 2005, officials of Environment Canada and Natural Resources Canada launched another effort to develop a strategy. Unlike the previous effort, this exercise identifies policy issues, such as the extent of the federal role in adaptation. At the time of our audit, the strategy was at an early stage of development. Environment Canada and Natural Resources Canada each had a different interpretation of its own responsibility for completing the strategy. Neither department had been assigned the lead role; nor had roles of other departments in a federal strategy been identified.

### **Some departments have begun work on their own strategies**

**2.20** The federal government has not directed departments to prepare their own adaptation strategies. Nonetheless, every department is responsible for managing risks that may affect their programs and activities. This includes risks created by a changing climate.

**2.21** Some of the departments included in our audit are developing adaptation strategies on a regional or sectoral basis for activities under their responsibility, but none has been approved. For example, Indian and Northern Affairs Canada, along with partners, is making good progress on developing a strategy to identify priorities for action in the North. However, the federal government is left to react to impacts already being felt before a strategy has been completed for that region.

**2.22** Natural Resources Canada is supporting the development of a strategy for the forestry sector. Environment Canada does not have an adaptation strategy apart from plans for programs already involved in adaptation research.

**2.23** Agriculture and Agri-Food Canada and Health Canada have not developed their own adaptation strategies, although both noted that they participated in advancing the draft federal adaptation strategy. In the meantime, Agriculture and Agri-Food Canada is primarily focussing its efforts on various activities to support agricultural producers in dealing with variations in the weather up to a few years. Health Canada officials consider it premature to develop such a strategy.

**2.24** Public Safety and Emergency Preparedness Canada (PSEPC), as a key department with a mandate to ensure the safety of Canadians and their assets, has developed a strategy to deal with natural hazards. The strategy is referred to as the National Disaster Mitigation Strategy. One reason for developing such a strategy is the expected increase in the frequency of certain types of extreme weather and climate events associated with a changing climate. The federal government has not yet approved the National Disaster Mitigation Strategy or funding for it.

**Progress has been limited in assessing the implications of a changing climate for federal policies and programs**

**2.25** Departments we looked at had made only limited progress in identifying how the policies and programs under their responsibility might need to be revised to address the impacts of a changing climate. For example, Natural Resources Canada has not systematically reviewed its legislation, policies, programs, and operations to determine how a changing climate might affect them. Officials told us that the Department plans to address the information gaps and methodological issues that it considers are hindering such an assessment.

**2.26** Indian and Northern Affairs Canada, in collaboration with Aboriginal and northern partners, aims to complete a risk assessment in December 2006 to identify major policy gaps or issues related to climate change. In 2007 Health Canada plans to release the results of an assessment of health risks from climate change, to support the assessment of policies and programs in the health sector. It can then begin to assess the implications for its policies and programs.

**2.27** Without a means to identify which policies and programs could be affected by a changing climate, it is difficult to identify departmental and federal priorities. (See Exhibit 2.2 for an example of a means of assessing the implications of climate change for policy development.)

**2.28** In summary, progress on adaptation strategies has been limited. In the federal government's work with provinces and territories, expected results and an action plan have not been agreed on. At the federal level, there has been limited progress in identifying priorities for action, and the government has not clarified the roles of key

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**Exhibit 2.2 The United Kingdom's tool for assessing the implications of climate change on policies**

Regulatory Impact Assessment (RIA) is an important tool intended to help government departments deliver better regulation. In the United Kingdom (UK), RIAs must be carried out for a wide range of policy initiatives. Climate change is one of the specified environmental impacts to be considered. In particular, officials conducting a RIA are asked to assess whether a proposed policy is vulnerable to the predicted effects of climate change. The UK Cabinet Office and individual departments provide guidance on conducting RIAs. In the case of climate change impacts, this guidance includes department-level definition of possible concerns and identification of departmental resource personnel. Officials also have access to an on-line tool designed to help integrate climate risks into decision making.



departments. At the departmental level, some of the departments included in this audit have started to identify priorities and to develop strategies for adaptation, but these have not been approved. Finally, there is limited progress in using available information about the changing climate to assess the potential implications for federal policies and programs.

**2.29** Since ratifying the United Nations Framework Convention on Climate Change, the federal government has not clarified whether and to what extent it intends to deal proactively with the potential impacts of a changing climate. Furthermore, it has not clarified whether it intends to focus mainly on the implications for its own policies and programs or on the potential impacts on Canadians that it identifies in collaboration with other levels of government. Work with other levels of government and other stakeholders could include, for example,

- identifying regional or sectoral priorities;
- identifying intended federal actions in areas of federal responsibility, and federal actions to be taken with other levels of government and those who will need to adapt; and
- working with other levels of government and those who will need to adapt to develop and implement an adaptation strategy.

**2.30** Climate change will potentially affect the activities of the departments included in this audit as well as those of many other federal departments and agencies. It can be expected that co-ordinated action will be needed among federal departments and agencies to address departmental, federal, and national priorities. The federal government has not clarified how it intends to manage adaptation to a changing climate; nor has it specified the responsibilities of individual departments in a federal adaptation effort. One of the responsibilities of the Privy Council Office is to provide advice on and support to the machinery of government. At the conclusion of our audit, the Privy Council Office advised that the Minister of the Environment has been given the lead responsibility for developing a plan on the environment that covers climate change, including the development of adaptation policy.

**2.31 Recommendation.** Environment Canada and the Privy Council Office should identify the responsibilities and accountabilities of the federal departments and agencies that are to be involved in a federal adaptation effort. Those departments and agencies should then clarify

how the Government of Canada will manage adaptation to a changing climate, including

- identifying the extent to which the federal government intends to work with other levels of government and stakeholders, and what it will contribute; and
- developing and implementing a federal adaptation strategy to address federal priorities. The strategy should include an assessment of the implications of a changing climate for federal policies and programs.

**Government's response.** Recommendation accepted. The Government of Canada is developing a Made-in-Canada environmental agenda for reducing air pollution and greenhouse gas emissions. This approach will establish integrated and effective measures that will achieve tangible and realistic results. The recommendations of the Commissioner of the Environment and Sustainable Development on adapting to the impacts of climate change will be considered in developing the agenda.

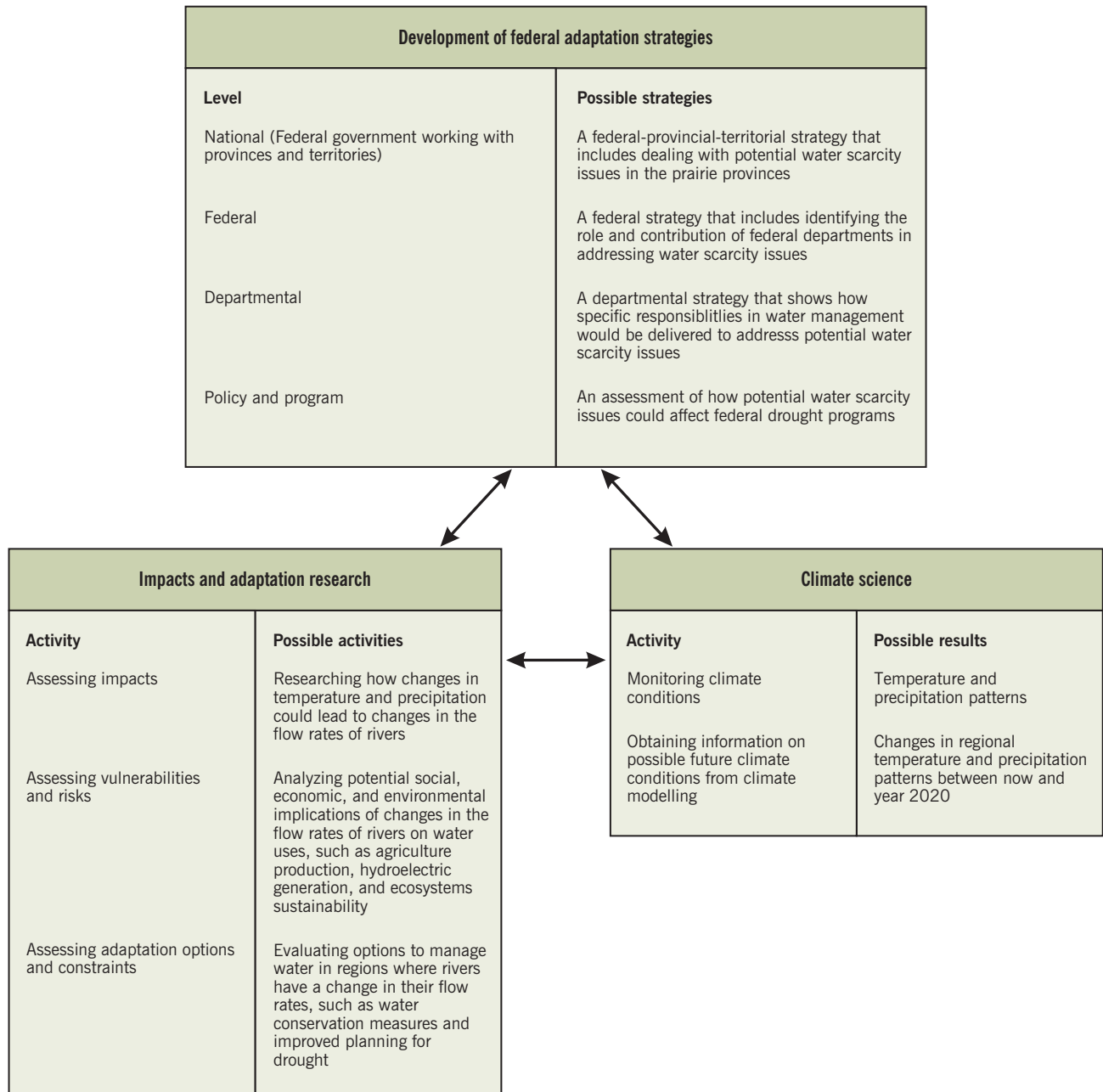
## Information to support adaptation

### Federal research on impacts and adaptation is yielding results

**2.32** Knowledge and information required to identify potential impacts, assess vulnerabilities, and design adaptation measures can come from two sources. One source is research on the potential impacts of climate change and factors to consider in adaptation. The type of information from this research is typically produced by those assessing the vulnerabilities of sectors, communities, and regions, or those designing adaptation options. The second source is climate science activities, such as climate monitoring and modelling. The type of information produced by these activities typically serves a wide range of users, including those who need it for adaptation. Both types of information are important to form a solid basis for adequate adaptation (Exhibit 2.3). We looked at the government's efforts to address the need for both types of information.

**2.33** The first category of information includes understanding impacts and how they can be addressed. Research on impacts and adaptation ranges from the study of biophysical and socio-economic impacts to the study of options for, and constraints to, adaptation. (See Exhibit 2.4 for an example of the results of such research.)

**Exhibit 2.3 Interactions between key federal areas considered in this audit**



**Exhibit 2.4 Rising sea level threatens coastal communities**

**Maritime provinces.** As global temperatures creep upward, polar ice caps are slowly melting and oceans are expanding, causing sea levels to rise. Prince Edward Island (P.E.I.) has already felt the effects, with unusually high tides and storm-surge events becoming more frequent, resulting in coastal erosion, ecosystem alterations, and infrastructure losses. With relative sea levels expected to rise 30 to 110 centimetres by 2100, these effects will only worsen. In 2000–01, a collaborative study in P.E.I. led by Environment Canada and Natural Resources Canada addressed this growing concern. The study generated a new storm-surge model that is now used regularly to predict coastal flooding. Three possible flooding scenarios were modelled in the study, forecasting property losses in Charlottetown of \$172 million to \$202 million as well as huge losses in coastal infrastructure and tourism revenues. The P.E.I. study set the template for similar studies in New Brunswick and on Canada's west coast, which created important tools to assess adaptation measures for Canada's coastal communities as they face the effects of rising sea levels.

**The Roberts Bank tidal flats at the Fraser River Delta.** This is an area where the rise in sea level and increased storminess could have various impacts on different groups. The Roberts Bank tidal flats border the municipality of Delta and the Tsawwassen First Nation Reserve and represent an important habitat for a variety of migratory birds and juvenile salmon. Two major port facilities (the Westshore coal terminal and the Deltaport container terminal) and the Tsawwassen ferry terminal are also located at the edge of the flats. Natural Resources Canada is conducting research on potential impacts in this area, based on continuing discussion with stakeholders. For example, support for the project was sought and officially confirmed by a number of stakeholders before its start. Once the project was underway, the Department organized a workshop with stakeholders to obtain information on their concerns about the potential social, economic, and physical effects of climate change on Roberts Bank and to discuss potential adaptation measures. The workshop was attended by 32 participants from 18 organizations, including municipalities, federal government representatives, academia, and businesses.

**2.34** Three key federal programs focus on researching impacts and adaptation. The **Climate Change Impacts and Adaptation Program**, the largest of the three, is managed by Natural Resources Canada. With a budget of \$30 million over five years (2001–06), the program has provided funding to and shared the results of projects intended to develop new knowledge about the vulnerability of key Canadian sectors to climate changes in the areas of health, landscape hazards, coastal zones, fisheries, forests, water resources, and agriculture. The program has provided support to most of the Canadian impacts and adaptation initiatives discussed in this chapter. It was designed to assist with knowledge needs, capacity building, and information sharing across the country. The program also maintains a database of impacts and adaptation research projects funded by the Climate Change Action Fund and Action Plan 2000. The database contains almost 200 research projects.

**2.35** The Climate Change Impacts and Adaptation Program also manages the Canadian Climate Impacts and Adaptation Research

Network. This is a national network set up to assist in producing new climate change knowledge on key issues by bringing together decision makers from industry, governments, and non-governmental organizations. The network is organized into six regional and seven sectoral offices. Membership includes researchers and stakeholders. The offices are usually hosted by universities or federal departments, and their activities include maintaining a Web site and organizing workshops.

**2.36** The second program, **Reducing Canada's Vulnerability to Climate Change**, is also managed by Natural Resources Canada and supports research to lessen the vulnerability of Canadians and their infrastructure and communities to climate change.

**2.37** The third program is run by the **Adaptation and Impacts Research Division in Environment Canada**, with staff located at four universities. Through partnerships, the program provides climate data, analysis, research on impacts and adaptation, tool development, and scientific advice.

**2.38 Knowledge base is being developed.** The federal government has done many studies to address regional and sectoral issues, and it has supported several projects to connect researchers with decision makers who need to take a changing climate into account. By investing in research on impacts and adaptation, the federal government has recognized that it needs to consider adaptation. This includes addressing such steps as expanding the information base, building the capacity to analyze the issues facing Canada, and engaging stakeholders to draw on their body of knowledge and increase their willingness to deal with this issue.

**2.39 Significant gaps remain.** Canada's first national assessment, The Canada Country Study (Environment Canada, 1998), identified significant gaps in the knowledge of Canada's vulnerability to climate change. While subsequent research has filled some gaps, many are likely to remain. To assess the current state of this knowledge, Natural Resources Canada is undertaking a new national assessment of climate change vulnerability, impacts, and adaptation, to be completed in 2007. However, not having agreed on expected results in adaptation with provinces and territories, government-wide, in departments, or even in programs, it is difficult for the federal government to determine where to focus adaptation research efforts and how it should plan to contribute to them.

### **Planning of climate science activities for adaptation is on hold**

**2.40** Information on actual changes in the climate is obtained from climate monitoring. This includes the observation, recording, and analysis of the past and present state of the climate, based on systematic measurements from facilities with instruments and equipment at various locations, also referred to as climate monitoring networks. Other sources of data, such as tree rings and geological records, are also used. Climate monitoring is one of the building blocks to help us understand how our climate is changing.

**2.41** Information on the possible future conditions of the climate is obtained from climate modelling. Climate models are mathematical representations of the Earth's climate system. One use of the models is to project the future state of the climate under various conditions. Environment Canada is the focal point for climate modelling in Canada. Fisheries and Oceans Canada and the university community are also involved in this work. (See Exhibit 2.5 for an example of the need for this type of information.)

**2.42** In 2003, the federal government began to develop a plan to organize federal activities in climate science, including those in climate monitoring and climate modelling. The most recent draft of this plan, dated January 2005, is entitled the Climate Change Science Plan for Canada. The draft plan identifies desired results that would be developed specifically to support adaptation measures. For example, seasonal forecasts and information about possible future climate conditions would be made available to support decisions in key social and economic sectors. Environment Canada officials told us that the development of the plan is on hold.

### **Climate monitoring activities need to consider adaptation**

**2.43 Adequacy of monitoring networks for adaptation was not assessed.** Environment Canada has consulted stakeholders about the information they need from monitoring, including information to assess the impacts of a changing climate and information to design adaptation solutions. However, the federal budget for climate monitoring networks was reduced substantially during the 1990s, and we found that the Department has not yet assessed whether the monitoring networks are adequate to address the current needs of the stakeholders.

**2.44** The analysis of climate data collected by the monitoring networks is also an important area for work on impacts—to determine trends used to detect changes in climate and produce information that

**Exhibit 2.5 Hydro-Québec seeks answers from climate monitoring and modelling**

Hydroelectric power generation supplies more than 40 percent of Quebec's energy needs, and provincially owned Hydro-Québec is the chief supplier. As climate changes, the water balance on which hydropower depends is also changing, raising questions about the long-term management of this energy source. State-of-the-art global climate models predict rising temperatures and increased precipitation throughout Quebec during this century, particularly in the North. This combination is expected to raise water levels in northern reservoirs, which bodes well for the hydro industry but may also cause flooding of critical waterways. In the south, rising rates of evapotranspiration (the transformation into vapour of water from the soil, plants, and waterbodies) may reduce water availability in the Great Lakes watershed, restricting the flow of the water needed to drive the turbines of St. Lawrence hydro plants. Hydro-Québec is looking to science, including climate monitoring and modelling to answer these questions.



A changing climate may affect the level of hydroelectric reservoirs, leading to financial implications.

Photo: Hydro-Québec

**Did you know?**

The estimated value of commercial, governmental, residential, and industrial infrastructure in Canada in 2000, according to the National Research Council: \$5.5 trillion

is useful for understanding the changing climate conditions.

Environment Canada officials acknowledge that large quantities of climate data still need to be processed, digitized, archived, and made available for analysis.

**2.45 Key analysis of climate data to support infrastructure design was not conducted.** Analysis of extreme weather events is necessary to support the design of infrastructures such as storm sewers. Environment Canada has not done a comprehensive analysis of extreme rainfall events since 1991. Since then, the frequency of extreme rainfall events has increased in some areas, making it more likely that infrastructure is not adequate for current and future climate conditions (Exhibit 2.6). We found that Environment Canada has not adjusted certain factors to take into account what users of this



information need to know about a changing climate. The density of the rainfall monitoring network and the level of effort required to analyze collected data and produce information about how often intense rainfall occurs have not been adjusted.

#### **Exhibit 2.6 Building and upgrading of sewers based on outdated climate information**

Many existing standards and codes depend on statistics based on historical weather data to determine specifications for infrastructure design. A good example is stormwater management. Practices used in stormwater management have evolved; however, the underlying assumptions about the climate are still usually based on historical climatic conditions, including for the frequency of intense rainfall events. Data on the frequency of intense rainfall events is derived from rainfall observation and is used to design infrastructures such as sewer systems and culverts. For example, a “25-year storm” is a rainfall event of an intensity that is expected once every 25 years, averaged over a long period, or that has a four percent chance of occurring in any given year. The upgrading of aging infrastructure to handle more intense events has significant financial implications, and climate-related data is essential to designing the upgrades. Managing aging infrastructures or building new ones on the assumption that the climate is static can have significant impacts on the eventual cost.



Intense rainfall exceeding the capacity of storm sewers can lead to flooding.

Source: La Presse

#### **More information on regional climates needs to be made available for distribution**

**2.46** Because adaptation often happens at a regional scale, there is an increasing need to better understand the processes that determine regional climate and to obtain information on regional climate change. This information is produced by two main methods: statistical analysis that brings the results of a global model down to a regional scale, or a regional climate model.

**2.47** In the 2002 Climate Change Plan for Canada, the federal government identified as priorities the provision of climate information on a regional scale and further work on developing a model to provide this information. Environment Canada also made this a commitment in its third sustainable development strategy. Access to a good global climate model is a prerequisite to the work on a regional scale, and Environment Canada has been an international leader in global climate modelling.

**2.48 Distribution of regional climate information is restricted.** Environment Canada is collaborating with the Canadian Regional Climate Modelling Network in regional climate modelling. Academia



leads the work of the network. Although the Department has access to the information produced by the regional model, its ability to distribute this information to the public is restricted by contractual arrangements, including intellectual property rights. Consequently, the information the Department currently provides about possible future climate conditions on a regional scale is limited in the type, time period, and regions covered. The government's commitments to provide this information have yet to be fulfilled.

### **Better access to information and to expert advice on adaptation is needed**

**2.49 Limited access to information about possible climate conditions in the future.** Environment Canada and academia have developed a Web site designed for disseminating information about possible future climate conditions on a national and regional scale. Environment Canada manages this effort, referred to as the Climate Change Scenarios Network. Currently, the Web site contains very little regional information, and not all the regional Web sites envisaged to be included in the network have been set up. Meanwhile, users can be expected to need more from the network, including new and improved tools for obtaining information at a regional scale and access to additional climate change data, particularly on climate extremes.

**2.50** As already noted, information about possible future climate conditions based on regional climate models can be obtained from Environment Canada's climate modelling group. However, the information is available only in a format that is more amenable to use by the scientific community.

**2.51** Environment Canada believes that implementation of a mechanism to facilitate the exchange of information between producers and users of climate change information would be beneficial for both users and producers of results from climate models. However, setting up such a program is not within the current mandate of Environment Canada's modelling group. (See Exhibit 2.7 for an example of a means to distribute information and tools to support adaptation.)

**2.52 Access to technical expertise on adaptation varies considerably across the country.** Canada's federal government is involved in a variety of initiatives that provide access to information and technical expertise on climate adaptation tailored to the needs of their stakeholders (see Exhibit 2.8 for an example of one such initiative). This type of service is currently available to members of research groups, such as the Prairie Adaptation Research Collaborative, or to participants in a research project, such as the study

of sea-level rise that Natural Resources Canada is conducting with the municipality of Delta, British Columbia. Access to information and technical expertise on climate adaptation varies considerably across the country.

**2.53** In summary, although the federal government made a commitment in 1992 to support adaptation, it has not yet organized its activities in climate science to make sure that those who will need to adapt, including federal departments and agencies, can obtain required information to identify potential impacts and vulnerabilities. The federal government has developed knowledge through research on impacts and adaptation, and it supports initiatives that involve working with decision makers to develop adaptation solutions. There is sufficient information for adaptation to proceed. However, access to information and technical expertise on climate adaptation varies considerably across the country. Much remains to be done.

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#### **Exhibit 2.7 A United Kingdom program provides information and tools to support adaptation**

The United Kingdom Climate Impacts Programme (UKCIP) intends to help organizations assess how they might be affected by climate change so they can prepare for its impact. Set up in April 1997, UKCIP is funded by the Department for Environment, Food & Rural Affairs (Defra) and is based at the University of Oxford. The program works with its stakeholders and co-ordinates research on the impacts of climate change at regional and national levels. UKCIP provides support and guidance to both stakeholders and researchers throughout the process, and serves as a bridge between researchers and decision makers in government organizations and business. The program has been the catalyst for a range of regional and sectoral studies on the impacts of climate change. UKCIP is part of a wider program of research on climate change that Defra has undertaken.

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#### **Exhibit 2.8 Ouranos is developing information to support adaptation**

The Ouranos Consortium was created in 2002 to bring together key partners in Quebec who have an interest in obtaining information and advice on adaptation issues. The value of long-term commitments at the disposal of the Ouranos Consortium in the form of pooled human, financial, technical, and computer resources is about \$12 million annually, nearly 40 percent of it representing cash contributions from Ouranos' partners. Environment Canada contributes in-kind resources, mostly in the form of several scientific staff. The combination of technical and financial resources allows the development of specialized expertise to meet the needs of the partners. For example, Quebec's Ministry of Transportation is a partner in the two-year Ouranos research project on the sensitivity of coastlines and the vulnerability of communities on the Gulf of St. Lawrence to climate change.



Coastal communities need adaptation options to cope with more intense and more frequent storms.

Photo: François Morneau, Ministry of Public Security of Quebec

**2.54** In federal climate science, Environment Canada is leading the co-ordination of efforts among federal departments and agencies. In research on impacts and adaptation, Natural Resources Canada manages the largest federal government program. Impacts and adaptation research and climate science, including climate monitoring and modelling, are both needed to support the development of adaptation strategies. Co-ordination between the two areas will be necessary to develop information and initiatives. Environment Canada and Natural Resources Canada have an important role to play in this co-ordination.

**2.55** Considering that several stakeholders outside the federal government and federal departments and agencies, other than Environment Canada and Natural Resources Canada, will be the users of the information and initiatives developed for adaptation, it is important to involve them in the identification of needs.

**2.56 Recommendation.** Working with other federal departments and agencies producing or using information needed for adaptation efforts and with other levels of government and stakeholders, Environment Canada and Natural Resources Canada should

- identify and fill gaps in the needed information, including results of impacts and adaptation research and results from climate science; and
- identify the demand for initiatives that provide decision makers with access to information and technical expertise on adaptation tailored to their needs. Based on that work, they should strengthen existing initiatives and establish others, as required.

**Departments' response.** Environment Canada and Natural Resources Canada recognize the need to work with other departments and agencies within the federal government and will continue to do so, to identify information needed for adaptation efforts. Both departments recognize the necessity to consult users and decision makers, in particular other levels of government and stakeholder organizations across Canada.

The recommendations of the Commissioner of the Environment and Sustainable Development will be considered by the Government of Canada in developing its Made-in-Canada environmental agenda for reducing air pollution and greenhouse gas emissions.

## Conclusion

**2.57** Since its commitment in 1992 to address the impacts and adaptation aspects of climate change, the federal government has made limited progress in setting priorities and developing adaptation strategies to support Canadians. It has also made limited progress in organizing its activities to obtain information needed to identify potential impacts and address vulnerabilities. As a result, much remains to be done to ensure that Canadians are ready to deal with a changing climate.

**2.58** Key elements of planning to adapt to climate change are identifying priorities and expected results, and developing strategies for adaptation. We found that the federal government, provinces, and territories have not jointly identified expected results. At the federal level, the government has made only limited progress in identifying expected results in adaptation. It has not clarified to what extent it intends to deal proactively with the potential impacts on its own or with other levels of government and those who will need to adapt. Nor has it clarified the roles of departments.

**2.59** Some of the departments included in this audit have started to identify priorities and develop their own adaptation strategies, but these have not been approved. Public Safety and Emergency Preparedness Canada has been working on an approach to deal with natural hazards. Indian and Northern Affairs Canada and Natural Resources Canada are developing strategies on a regional or sectoral basis for activities under their responsibility. Health Canada has initiated an assessment of risks to health from climate change. However, there is limited use by the government of available information to assess the potential implications of the changing climate for federal policies and programs.

**2.60** The federal government has not yet organized its activities in climate science to ensure that those who will need to adapt, including federal departments and agencies, can obtain required information to identify the potential impacts of climate change. The government has developed knowledge through research on impacts and adaptation; however, without identified expected results in adaptation, it is difficult for the federal government to determine where to focus adaptation research efforts and how it should plan to contribute. Access to information and technical expertise on adaptation varies considerably across the country.

**2.61** During the audit, we heard about various factors that could have contributed to the limited progress of adaptation efforts in Canada and elsewhere. These factors include the following:

- Until recently, both the international and domestic policy focus was on whether to ratify the Kyoto Protocol and the rules that would govern its implementation.
- It was believed that focussing on adaptation would distract from the mitigation discussion.
- Adaptation as a policy issue is in its infancy.

**2.62** The failure to make significant progress on adaptation efforts exposes Canadians' social and economic well-being to risk. Canada's North is already seeing far-reaching impacts on its economy, culture, and biodiversity; in the south, existing and new urban infrastructure may be unable to handle more frequent and intense weather events; and the largely negative impacts of a changing climate on agriculture and forestry illustrate how our resource economy is at risk. Taking steps now to adapt to a changing climate can help protect Canadians and their assets and reduce the potential economic, social, and environmental costs.

## About the Audit

### Objectives

Our audit objectives were the following:

Determine whether the federal government, in co-operation with other levels of government and key stakeholders, as appropriate,

- has set priorities based on the identified risks to Canadians posed by climate change and developed a climate change adaptation strategy and action plans to manage the risks; and
- is implementing the climate change adaptation strategy and action plans, and is assessing, on a regular basis, the progress it has made in implementing adaptation measures.

Determine whether the federal government has organized itself to obtain, analyze, and disseminate sufficient and appropriate information to help identify the potential impacts on and risks to Canadians posed by climate change.

### Scope and approach

Our audit focussed on whether Environment Canada and Natural Resources Canada have adequately assessed the impacts of climate change on Canadians and developed and implemented an appropriate adaptation strategy and action plans consistent with Canada's commitments under the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol.

Other departments that we looked at in our audit to capture specific roles in program delivery, program design, or knowledge management related to setting priorities include

- Agriculture and Agri-Food Canada,
- Health Canada,
- Indian and Northern Affairs Canada, and
- Public Safety and Emergency Preparedness Canada.

This audit did not include a review of federal activities related to supporting developing countries in managing their impact and adaptation activities, a commitment under the UNFCCC. We have also excluded from the scope of this audit Federal House in Order issues (for example, assessing the impact of climate change on federal government buildings and other infrastructure and possible adaptation measures). In addition, we excluded climate change impacts and adaptation on the international front (for example, impacts on foreign policy, tourism, and international water management agreements).

## Criteria

Given the accountability focus of our audit objectives, our audit criteria were the following:

### a) Identification of priorities and development and implementation of action plans

We expected that the federal government would

- analyze and assess the risks identified;
- rank and prioritize the risks identified;
- design cost-effective risk prevention, reduction, or avoidance control measures;
- develop control procedures to minimize the risks identified;
- develop and publish national and, where appropriate, regional programs containing measures to facilitate adequate adaptation to climate change;
- implement, regularly update, and publish national and, where appropriate, regional programs containing measures to facilitate adequate adaptation to climate change;
- take into account climate change considerations, to the extent feasible, in its relevant social, economic, and environmental policies and actions, and use appropriate methods to minimize adverse effects on the economy, public health, and the quality of the environment of projects or measures undertaken to adapt to climate change; and
- clarify, document, and follow respective roles and responsibilities of federal and provincial governments and other organizations involved in implementing the climate change adaptation strategies/action plans and ensure that reporting requirements are clearly specified.

### b) Information to identify and address potential impacts and risks

We expected that the federal government would promote and co-operate in scientific, technological, technical, socio-economic, and other research; systematic observation; and development of data archives related to the climate system and intended to further the understanding of the causes, effects, magnitude, and timing of climate change and the economic and social consequences of various response strategies, and to reduce or eliminate the remaining uncertainties about them.

We expected that the federal government would

- identify the potential perils, factors, and types of risk to which government and Canadian assets, program activities, and interests are exposed;
- promote and co-operate in the full, open, and prompt exchange of relevant scientific, technological, technical, socio-economic, and legal information related to the climate system and climate change;
- identify high priorities for additional observations focussed on data-poor regions, poorly observed parameters, regions sensitive to change, and key measurements not made often enough; and
- implement data management systems that facilitate access, use, and interpretation of climate monitoring data and products.

We expected that departments and agencies would meet their performance expectations as set out in their sustainable development strategies.

### **Audit work completed**

Audit work for this chapter was substantially completed on 14 June 2006.

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## Appendix List of recommendations

The following is a list of recommendations found in Chapter 2. The number in front of the recommendation indicates the paragraph number where it appears in the chapter. The numbers in parentheses indicate the paragraph numbers where the topic is discussed.

Recommendation	Government's response
<b>Priorities and adaptation strategies</b>	
<p><b>2.31</b> Environment Canada and the Privy Council Office should identify the responsibilities and accountabilities of the federal departments and agencies that are to be involved in a federal adaptation effort. Those departments and agencies should then clarify how the Government of Canada will manage adaptation to a changing climate, including</p> <ul style="list-style-type: none"> <li>• identifying the extent to which the federal government intends to work with other levels of government and stakeholders, and what it will contribute; and</li> <li>• developing and implementing a federal adaptation strategy to address federal priorities. The strategy should include an assessment of the implications of a changing climate for federal policies and programs.</li> </ul> <p>(2.16–2.30)</p>	<p>Recommendation accepted. The Government of Canada is developing a Made-in-Canada environmental agenda for reducing air pollution and greenhouse gas emissions. This approach will establish integrated and effective measures that will achieve tangible and realistic results. The recommendations of the Commissioner of the Environment and Sustainable Development on adapting to the impacts of climate change will be considered in developing the agenda.</p>

Recommendation	Government's response
<p><b>Information to support adaptation</b></p> <p><b>2.56</b> Working with other federal departments and agencies producing or using information needed for adaptation efforts and with other levels of government and stakeholders, Environment Canada and Natural Resources Canada should</p> <ul style="list-style-type: none"> <li>• identify and fill gaps in the needed information, including results of impacts and adaptation research and results from climate science; and</li> <li>• identify the demand for initiatives that provide decision makers with access to information and technical expertise on adaptation tailored to their needs. Based on that work, they should strengthen existing initiatives and establish others, as required. (2.32–2.55)</li> </ul>	<p><b>Departments' response.</b> Environment Canada and Natural Resources Canada recognize the need to work with other departments and agencies within the federal government and will continue to do so, to identify information needed for adaptation efforts. Both departments recognize the necessity to consult users and decision makers, in particular other levels of government and stakeholder organizations across Canada.</p> <p>The recommendations of the Commissioner of the Environment and Sustainable Development will be considered by the Government of Canada in developing its Made-in-Canada environmental agenda for reducing air pollution and greenhouse gas emissions.</p>

# Report of the Commissioner of the Environment and Sustainable Development to the House of Commons—2006

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