# QUÉBEC IN ACTION GREENER BY 2020

## 2013-2020 Government Strategy for Climate Change Adaptation

**A collective effort to strengthen the resilience of Québec society**
**June 2012**

A PLAN FOR QUÉBEC

Québec

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# Message from the Premier

Climate change will have major consequences for our society at the environmental as well as social and economic levels. Immediate and concerted action must therefore be taken to avoid or minimize the human and financial costs stemming from the effects of this phenomenon.

The 2013-2020 Climate Change Adaptation Strategy expresses the government's vision for tackling this challenge. Several Québec departments and agencies were involved in devising the strategy in order to ensure the coherence and complementarity of the government initiatives to be taken.

Québec is fortunate to have a diversified economy and a number of research institutions specializing in climate science. These institutions are helping us gain a better understanding of the effects of climate change so that we can choose the best strategies for dealing with them.

The 2013-2020 Climate Change Adaptation Strategy will enable us to transform this challenge into opportunities to innovate and take action to ensure the well-being of Québec society, preserve the soundness of its public finances and, in turn, provide future generations with more options for building their future.

Jean Charest

# Message from the Minister

Our efforts to fight climate change over the past several years have helped make Québec a leader in North America.

These initiatives have proven to be crucial, especially since climate change is occurring at an ever increasing pace. Our actions to limit its progress must therefore continue and it is essential now more than ever to link them to an adaptation approach that will mobilize Québec society as a whole.

The 2013-2020 Government Strategy for Adapting to Climate Change embodies this determination to involve all stakeholders. The government will set the example by integrating the adaptation goals that Québec has adopted into its policies and management tools.

With the cooperation of communities and civil society, we will be able to truly strengthen our capacity to adapt to climate change, minimize its impacts on all segments of our society and take advantage of new opportunities that will arise as a result. In this regard, the government is especially counting on the commitment of the municipal and regional sectors. Their expertise in a broad range of fields combined with their extensive knowledge of the territory and needs of their communities make them key partners.

Ensuring the health and safety of individuals, continuing economic activities, safeguarding the sustainability of our infrastructure and maintaining essential ecological services are all issues to be considered in the adaptation approach we are taking. This determination is echoed in the 2013-2020 Climate Change Action Plan (CCAP 2020), which includes measures pertaining to such areas as sustainable land management, research and monitoring, integrated and effective risk management and support for companies and the most vulnerable sectors. An envelope of $200 million has been set aside for implementing these measures that will contribute to strengthening our adaptation to climate change.

Each challenge we will face in pursuing our objectives is an opportunity to apply our spirit of innovation and creativity. Québec has many assets for meeting the challenge of climate change, including a well-developed green economy, an active and educated population, recognized research centres and a diverse natural environment.

Our strategy is intended to pave the way for the Québec of tomorrow. It is rooted in our belief that investing in action today will increase our resilience to climate change.

Minister of Sustainable Development, Environment and Parks

Pierre Arcand

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# INTRODUCTION

## UNAVOIDABLE GLOBAL CHANGE

The fact of global warming is now beyond question, and its effects, already observed, will intensify in future. The climate scenarios provided by the Intergovernmental Panel on Climate Change (IPCC) show clearly that climate change will accelerate through the 21st Century. As agreed by all the scientists of the IPCC, even if everything possible were done to reduce and stabilize emissions of greenhouse gases (GHGs), climate change would continue for centuries due to feedback effects and the lifetime of GHGs in the atmosphere.

In every region of the world, climate disruption has negative effects on ecosystems, on the built environment, on the health and safety of populations, and on many economic sectors. Québec too will face enormous challenges. Yet climate change will also create new business opportunities.

As the indispensible complement to Québec's achievements in lowering GHG emissions, climate change adaptation will help to protect both natural and built environments, while reducing the vulnerability of present and future generations to the impacts of climate change.

Due to the diversity and variability of climate change impacts, and the fact that the best adaptation measures will depend on local or regional conditions, it will be crucial for municipal and regional bodies to play a major role in public interventions for climate change adaptation.

## THE 2013-2020 GOVERNMENT STRATEGY FOR CLIMATE CHANGE ADAPTATION

The present strategy sets out a broad-based plan for government intervention to strengthen the resilience of Québec society to climate change. It defines the Government's strategic directions and priorities on the principal risks posed by climate change to different sectors of society. And it informs Quebecers and local and regional authorities about the issues at stake, and about major initiatives for climate change adaptation that will mobilize the Government of Québec and its partners over the coming years.

# 1 PRESENT AND PROJECTED CLIMATE

In the last few decades, Québec's climate has changed significantly. Daily mean temperatures in southern Québec have risen by 0.2°C to 0.4°C per decade, with minimum temperatures rising more than maximums, and greater change inland than in maritime regions.

**Generally, the climate will grow warmer over the entire territory of Québec, more dramatically in winter than in summer, and more in the North than the South**. In winter, by 2050, temperatures are expected to be 2.5°C to 3.8°C higher in southern Québec, and 4.5°C to 6.5°C higher in the North. Summer temperatures are expected to rise by 1.9°C to 3.0°C in the South and by 1.6°C to 2.8°C in the North.

**More abundant precipitation is expected in winter and in Nord-du-Québec**. Increases in winter precipitation of 8.6% to 18.1% in the South, and 16.8% to 29.4% in North, are expected by 2050. The rise in winter precipitation will lead to deeper accumulations of snow in the North. In southern Québec the opposite is expected: less snow accumulating through the winter due to higher temperatures and a shorter cold season. Summer precipitation is expected to rise by 3.0% to 12.1% in the North, with no significant change expected in the South.

**Climate change will result in extreme weather events (winter storms, violent winds, torrential rains, etc.) becoming more frequent and more intense**. In turn, such events will sometimes lead to flooding, erosion, landslides and so on.

Changes in temperature and precipitation will also affect many other climate-related phenomena; some of them are well understood, and their changes can be predicted with a high degree of certainty. Thus, it is highly probable that coming decades will see the following:

- A shrinking of the ice cover, with winter ice forming later and melting earlier;
- Winters becoming shorter;
- Less intense and less frequent cold waves;
- Permafrost melting at an increasing rate;
- Hotter and more frequent heat waves;
- Extreme storm surges in coastal areas.

There is also reason to believe that the following will occur as well[1]:

- More frequent winter warm spells;
- More extreme fluctuations in water levels (higher flood levels and lower low-water levels), with increased erosion of shorelines;
- A northward shift of storm trajectories;
- Greater numbers of tropical storms and more intense hurricanes;
- Longer summer droughts.



1 Based on historical trends and less certain scientific understanding.

# 2 EXPECTED IMPACTS[2]

Climatic conditions have always had a determining influence on natural ecosystems and human societies. In natural environments, climate is the principal factor determining the distribution and abundance of plant and animal species. Climate is also fundamental to many socioeconomic activities, and has much to do with the cultural identity of peoples.





2 The information presented in this and the previous section is largely drawn from a publication by the Ouranos Consortium, Learning to Adapt to Climate Change (2010). For more information about climate change and its impacts, see the Ouranos website at www.ouranos.ca.

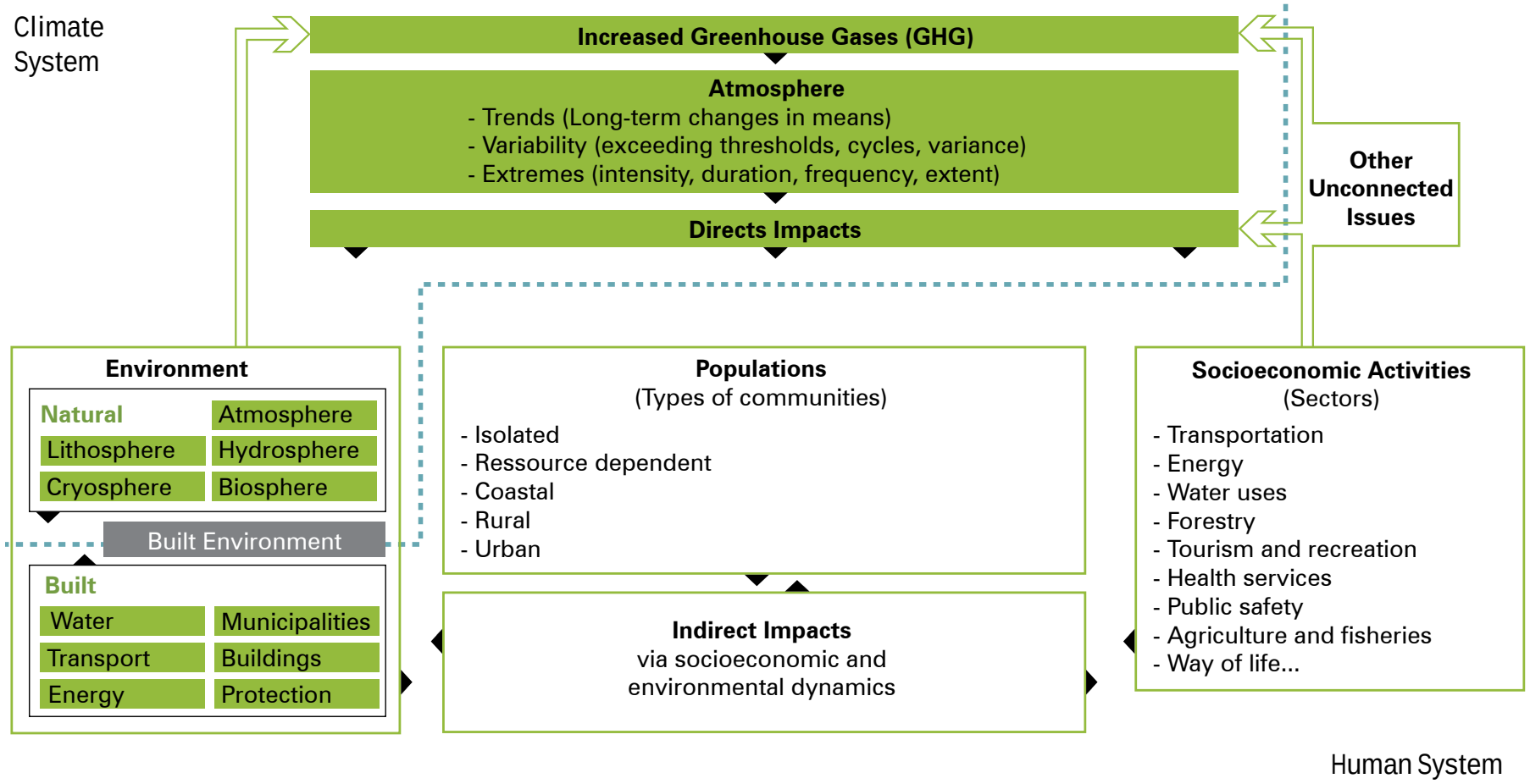


**Figure 1. Direct and indirect impacts of climate, its variability and extremes on the natural and built environment, populations and socioeconomic activities (Ouranos, 2010)**

## 2.1 POPULATION AND COMMUNITIES

While no one will be immune to the impacts of climate change, its negative effects will cause greater suffering to those who are most vulnerable, such as people in poor health or who live in poor-quality housing, the homeless, low-income families, and outside workers exposed to the weather. Young children and the elderly, expected to be 25% of Québec's population by 2031, are also particularly vulnerable to the effects of climate change.

Other factors contribute to the vulnerability of all Quebecers: urban sprawl, development in areas prone to flooding and other hazards, natural environments altered by human activities, built environments devoid of natural spaces, our dependency on essential systems (electricity, transportation, telecommunications) and the aging of our public and private infrastructures.

### Hotter and more frequent heat waves

The increasing frequency and intensity of heat waves will primarily affect communities in southern Québec, particularly in large urban centres, which are prone to the formation of heat islands. Urban heat islands present significant risks to the health of those who live in them. A 2010 study in Montréal showed that during heat waves, mortality is higher in such areas.

Heat waves also have indirect effects on health and quality of life. The increasing frequency of heat waves will lower the quality and abundance of water resources, and the generally warmer conditions will be conducive to the spread of zoonotic diseases (diseases that can be transmitted from animals to humans). It should also be noted that heat waves amplify the adverse health effects of air pollution, by increasing the harmfulness of pollutants and reducing the body's resistance to them.

Atmospheric concentrations of ragweed and other pollens will also rise with the increasing temperature and humidity. Plants respond to warmer conditions by prolonging their growing season, extending their distribution range and increasing pollen production. In Québec, allergy to ragweed pollen is estimated to affect 17.5% of the population, or more than a million individuals. That has a substantial cost to Québec society, in terms of absences from work, consultations with health professionals and medication expenses.

It is estimated that in Québec, every year air pollution causes some 246 700 person-days of asthma symptoms, 9500 cases of child bronchitis, and nearly 1970 early deaths. Future climate simulations suggest that concentrations of atmospheric pollutants will rise, e.g. of ozone and of suspended particles from forest fires.

### Greater frequency and intensity of extreme weather events

Other phenomena due to climate change will also present a real danger for the well-being of Québec's population and communities. Heat waves, droughts, forest fires, torrential rains, storms in both summer and winter, all will become more common, frequent or intense in coming decades. Rising sea levels and the shrinking ice cover, combined with changes in cyclone activity and more frequent freeze-thaw cycles, will aggravate the risks of coastal erosion, marine submersion and flooding in coastal areas. The seasonality of certain hazards could also be altered; for example, instead of (or along with) spring flooding due to ice dams, we could see winter flooding caused by frazil ice.

Extreme weather events will also cause stress and social and psychological tensions in populations living in risk zones.

### Disruptions in Nord-du-Québec

Climate change will not spare Nord-du-Québec, where many villages will have to grapple with permafrost degradation, ice dams, avalanches, violent winds and uncertain ice. Ice roads will need to be rerouted, some communities may have to relocate, hunting and fishing activities will be modified, as will access to traditional food resources. Town planning will become more complex in certain villages in Nunavik, and for all northern communities, climate change will add to the many other challenges (housing, transportation, waste management, drinking water) that have come with rapid increases in population.

Recent natural disasters have demonstrated the magnitude of the damage that can be done by extreme weather events. Consider the social, economic and environmental repercussions of the flooding along the Rivière Richelieu in spring 2011; the repeated marine incursions and flooding in parts of eastern Québec in December 2010; the torrential rains that pounded Rivière-au-Renard in Gaspésie in August 2007; the ice storm that devastated southwestern Québec in 1998; and the massive rains, dam failure and flood of July 1996 in Saguenay–Lac-Saint-Jean.

## 2.2 ECONOMIC ACTIVITIES

With a gross domestic product of nearly $318 billion in 2010, Québec's economy is the 44th largest in the world. Stronger for being diverse, it ranges from high technology to financial services, from cultural products to the exploitation and transformation of natural resources. The economy's sensitivity to climate change depends on the degree to which each sector suffers or benefits from climate change. For example, Québec's electricity is mostly produced by hydroelectric plants, which require abundant water and are therefore sensitive to climate variations. In turn, a host of sectors and economic activities depend on electricity, making them indirectly vulnerable to climate change.

The economic effects of climate change will not be distributed uniformly across Québec. In some communities, adapting to new climatic conditions could present a serious challenge, while for others it could mean new prosperity.

## Vulnerability of sectors dependent on natural resources and climate

While the service industries seem only moderately vulnerable to climate change, agriculture, forestry, hydroelectricity production, mining and raw materials transformation are much more vulnerable, and hundreds of Québec communities depend on them. The same is true for the tourism industry, which is highly sensitive to climate both in winter and summer. For example, hunting, fishing, skiing, snowmobiling, restaurants and resorts, nautical tourism and agritourism are important generators of income in many regions of Québec.

In the agricultural sector, temperature has a great influence on the yield and quality of both crops and livestock. Rising average temperatures will probably exacerbate problems with crop pests, expanding their distribution range and allowing invasion by new pests. Changes in water regimes, affecting both water levels and water quality, could lead to conflicts over water use for domestic, agricultural and aquaculture purposes. Extreme weather events will intensify erosion and possibly decrease the quality and agronomic potential of soils.

In the forest sector, climate change could alter natural disturbance regimes, biodiversity, growth and the structure and composition of forest stands. This in turn could impinge on seasonal work, forest potential, the quality of trees harvested, and wood supply for processing plants. For the mining sector, permafrost degradation will threaten the stability of buildings and infrastructures for ore extraction and processing, and of waste rock piles and tailings sites. Prolonged low-water periods would reduce the amount of water available for mining activities, requiring investment in water recycling technologies. Conversely, extreme precipitation would require greater pumping capacity at mine operations, while causing tailings pond overflows and increasing the risk of dike collapse.

## Impacts of climate change on the vitality of enterprises

Climate change could have a dramatic impact on the vitality of many enterprises. Already, extreme weather events and the more gradual effects of climate change are affecting their infrastructures, supply and distribution chains, operations, profitability, customer traffic and employee absenteeism.

Studies in North America reveal that when businesses undergo any sort of disaster, 43% never open again, while 29% of the rest close their doors in the next two years. Experience in the United States has shown that disaster can lead to a drop in earnings of more than 40%. From a logistical point of view, businesses that are heavily dependent on transportation infrastructures, water, energy and agri-food resources are more vulnerable to climate change. The same applies to those located in risk zones, such as flood plains, coastal regions and areas susceptible to landslides. Climate change can also reduce the demand for certain goods and services, or hamper the activities of particular enterprises.

## Emergence of new business opportunities

New business opportunities could arise as the result of climate change, particularly in the form of products or services to ease the adaptation to climate change of various segments of society. Québec's economy could benefit from other opportunities from climate change, such as gains in the productivity of forests and farms, greater hydroelectric potential in certain regions or periods of the year, easier access to natural resources in Nord-du-Québec, a longer summer tourism season, and a longer navigation season upriver from Montréal and in Nord-du-Québec. Lower heating costs would also be positive for both enterprises and households, though the higher summer temperatures will increase air conditioning needs.

## 2.3 BUILT ENVIRONMENT

Québec's built environment, including buildings, infrastructures and the equipment comprising the transportation, energy and telecommunications networks, was designed on the basis of historical weather data and the assumption of a stable future climate. Infrastructures built to last for decades could face different climatic conditions than what they were designed for, potentially shortening their useful lifetime. Other factors can make infrastructures vulnerable to climate change, including aging, lack of maintenance and inadequate planning and management.

The built environment plays a crucial role in Québec society. Our dependence on infrastructures and networks, and the interdependence of both, exacerbate our vulnerability to breakdowns and failures. Infrastructure failures threaten public safety and the stability of the local economy, isolating communities, limiting the mobility of people and merchandise, and compromising emergency services as well as access to them. The impacts of climate change on all elements of the built environment will be different in each region.

### Permafrost degradation in Nord-du-Québec

In Nord-du-Québec, climate warming will lead to permafrost degradation and its dramatic repercussions, including subsidence, slumping, erosion and landslides, putting buildings and infrastructures at risk of collapse or deformation. Airport runways, ice bridges and marine infrastructures, essential for supply and communications at numerous northern villages, could suffer accelerated degradation and require more frequent maintenance and redevelopment.

Northern and coastal areas will experience more intense and frequent storms, exposing buildings and infrastructures to unprecedented high water levels.

### Erosion in coastal areas of the Gulf and Estuary of the St. Lawrence

In coastal areas of the Gulf and Estuary of the St. Lawrence, as well as Ungava Bay, Hudson's Bay and Hudson's Strait, roads, buildings and public infrastructures will be exposed to rising sea levels, shrinking ice cover, more frequent freeze-thaw cycles, and changing storm regimes. These phenomena could together intensify the natural processes of shoreline erosion, prematurely weakening marine infrastructures and limiting the access to some sections of road. Port infrastructures in the St. Lawrence could also be affected due to wide fluctuations in sea level.

### Floods, droughts and freeze-thaw cycles in southern Québec

In southern Québec, the changing temperatures and precipitation regimes will affect all infrastructures. The increasing duration, frequency and intensity of rainfall events will lead to more frequent overloading of sewer systems (with attendant side-effects: sewer backups, urban flooding), while also intensifying surface erosion. These phenomena could also interfere with drinking water intakes and municipal infrastructures for urban drainage.

More frequent freeze-thaw cycles and winter warm spells will accelerate the deterioration of road infrastructures, including pavements, supporting structures and retaining walls. More intense and frequent torrential rains will place heavier demands on drainage systems (storm drains and culverts), increasing the risk of flooding at interchanges, tunnels, etc. Extended droughts will lower soil moisture content, leading to local subsidence and instability that could weaken infrastructures. Flood and ice control structures will be subjected to increased abrasion by river ice and the effects of more frequent ice jams and mid-winter breakups.

Road closures due to flooding, forest fires and other causes related to climate change will inevitably affect the transportation sector, as will the interruption of roadwork during heat waves (to protect workers from heatstroke) and disruptions of air travel in bad weather.

## 2.4 NATURAL ENVIRONMENTS

Climate and ecosystems influence each other and evolve in parallel. The ecosystems we know today are the product of a long evolution of plant and animal communities in response to climatic conditions. In return, all ecosystem components that participate in biogeochemical cycles have an influence on climate.

The decades to come will be characterized by much faster climatic changes than the Earth has ever seen in the past. Those changes will therefore constitute a profound disturbance to which plant and animal species, both in natural and developed ecosystems, must adapt if they are to survive.

### Species adaptation uncertain

Due to the accelerating pace with which climate change is expected to happen, some species may not be able to evolve and adapt. The results for biodiversity and species distribution cannot yet be predicted. For example, the distribution range of white-tailed deer could expand further north, while that of moose could contract. In the same manner, native species from southern Québec, along with exotic invasive species, could spread northwards at the expense of the northern species we know today. With the exotic species, new pathogenic agents could also arrive, causing zoonotic and other diseases that could affect not only plants and wildlife but human populations and livestock.

### Destabilization of ecosystems

The milder winters and warmer, more humid summers expected in southern Québec will increase evaporation from natural waterways, destabilizing aquatic ecosystems and disrupting the natural disturbance regimes that have shaped the ecosystems we know today. Numerous threatened species with fragmented habitats and poor habitat connectivity, already under multiple stresses, will be at ever-increasing risk of disappearing from Québec. Indeed, the structure of our northern ecosystems is already changing, due to permafrost degradation, the formation of thermokarst lakes and basins, and the expansion north of shrubby species.

Natural environments provide society with a wide array of services, including provisioning (water, food, materials), regulation (climate, disease control), cultural and immaterial benefits (recreation, tourism, aesthetic qualities) and basic support (the water cycle, oxygen production, soil formation). Ecosystems also play essential roles in the safety and well-being of populations, e.g. by regulating water flow, protecting us from floods and water shortages. Consequently, many of the potential effects of climate change on terrestrial and aquatic ecosystems could in turn have an impact on societies and their socioeconomic activities. It will therefore be critical that we attempt to maintain, as much as possible, ecosystem functions and the benefits they provide.

### The capital importance of Québec's water resources

The services provided by aquatic ecosystems play an unparalleled role in Québec. Across the province and throughout our history, abundant water resources have benefited us socially, economically and environmentally. But climate change will bring changes to the precipitation regime, which in turn will have repercussions on the intensity, duration and frequency of droughts and floods. The conservation and protection of our water and aquatic ecosystems are therefore of capital importance.

# 3 ADAPTING TO CLIMATE CHANGE

Climate change adaptation refers to any action that diminishes the negative impacts of climate change, or conversely, that derives benefit from opportunities created by that change. Successful adaptation does not mean an absence of negative impacts, but rather that exposed sectors are less vulnerable than if no action had been taken.

To mitigate the negative impacts of climate change, we must:

1. reduce the vulnerability of sensitive elements that are exposed to the deleterious effects of climate change (individuals, communities, the built environment, economic activities, the natural environment);
2. strengthen the resilience of every segment of society to climatic stress factors.

**Resilience**:

the ability of an ecosystem, community or society exposed to potential hazards to adapt, through change or resistance, so that it can establish and maintain the structures it needs and an acceptable level of functioning (Morin, 2008).

Over the course of history, human societies have displayed a great capacity to adapt to different climates, lessening their exposure to hazards and heightening their resilience. Ecosystems too have adapted to variations in climate. But such "spontaneous" adaptations tend to be accompanied by significant costs and losses. The purpose of a strategy for adaptation is to attempt to reduce such costs and losses, while if possible benefiting from new situations. Planning adaptation therefore demands that we do the following:

- determine and understand priority issues;
- develop knowledge about hazards that climate change may create or amplify;
- assess the vulnerabilities of society and the environment;
- acquire data and disseminate information needed by the actors of adaptation;
- design and put in place the most effective techniques and technologies;
- adapt administrative tools (laws, regulations, policies, strategic directions) and organizational structures.

Planning and intervention for climate change adaptation must take into account the uncertainty inherent in climate forecasts, and the implications for natural and human systems. In view of that uncertainty, the present strategy proposes a flexible and iterative approach, one that would progressively modify government action as knowledge improves about climate change impacts and as social and environmental conditions continue to evolve.

# 4 A PROCESS WELL UNDERWAY

Since the early 2000s, Québec has been engaged in a proactive process to improve our understanding of climate change impacts and develop adaptation measures to reduce our vulnerabilities and the potential risks.

In 2001, the Government of Québec joined with other partners to create the Ouranos Consortium on Regional Climatology and Adaptation to Climate Change. Since then, the Consortium has developed advanced expertise in the study and modeling of regional climate, which it has brought to bear in exploring the biophysical and socioeconomic impacts that climate change could have on the most vulnerable sectors of Québec society, and in analyzing different adaptation solutions. Combined with work in the universities and by departments and agencies of the Government, the Consortium's multidisciplinary research has been providing knowledge essential to informed decision-making.

At the same time, thanks to the 2006-2012 Climate Change Action Plan multiple departments have been working on laying the groundwork for future governmental action. With a budget of $99 million, foundational actions have been taken toward climate change adaptation. They include:

- research on preventing and mitigating climate change impacts on public health and safety;
- consolidating Québec's monitoring networks for climate, water resources and air quality, and strengthening management regimes for air quality and water;
- research on permafrost degradation, coastal erosion and potential means of adaptation;
- determining the vulnerability of Québec's forests and the forestry sector, and exploring the implications for forest management;
- complementary financial support for Ouranos.

Armed with the experience gained over recent years, in its 2009-2014 strategic plan the Ministère du Développement durable, de l'Environnement et des Parcs set out to develop a government strategy for climate change adaptation. Moreover, under the 2013-2020 Climate Change Action Plan (2020 CCAP) an amount of $200 million is reserved for actions aimed at adapting Québec society to the impacts of climate change.

## An approach based on collaboration

The present strategy lays the foundation for the next action plan on climate change, covering the period from 2013 to 2020. It defines the areas of intervention for which specific adaptation actions are announced in the 2020 CCAP.

This strategy is the product of an interdepartmental working group under the coordination of the Ministère du Développement durable, de l'Environnement et des Parcs. The other departments and agencies that contributed to its development are as follows:

- Ministère des Affaires municipales, des Régions et de l'Occupation du territoire,
- Ministère de l'Agriculture, des Pêcheries et de l'Alimentation,
- Ministère du Développement économique, de l'Innovation et de l'Exportation,
- Ministère de l'Éducation, du Loisir et du Sport,
- Ministère de la Famille et des Aînés,
- Ministère des Ressources naturelles et de la Faune,
- Ministère de la Santé et des Services sociaux,
- Ministère de la Sécurité publique,
- Ministère du Tourisme,
- Ministère des Transports,
- Institut national de santé publique du Québec,
- Ouranos,
- Hydro-Québec.

To determine the issues and impacts of climate change for which the Government must prioritize intervention, eleven discussion workshops were held in spring 2010. The workshops brought together professionals, government managers and university researchers. Consultations were also held in autumn 2010 with representatives from environmental organizations, associations and professional orders, industrial circles, municipal bodies and northern communities, to hear their concerns about climate change and their proposals for adaptation. Representatives of these same groups were again consulted in September 2011, in workshops and bilateral meetings, to obtain their comments and suggestions on key elements of the strategy. Lastly, the text of the strategy was submitted for public consultation online, in February 2012.

# 5 THE STRATEGY

## 5.1 VISION

In view of the speed with which climate change is being seen already, and the necessity of preparing ourselves appropriately, it is crucial that Québec have an integrated strategy to that end. The Government therefore intends to lead the way, mobilizing Québec society to meet and overcome this daunting challenge.

**Government that strengthens the resilience of québec society through commitment and action.**

By bringing together departments and agencies around common objectives, and by emphasizing partnership and the complementarity of different actions, the 2013-2020 Government Strategy for Climate Change Adaptation seeks to change our ways of doing things. Setting the priority on the resilience of Québec society, the Government will implement concrete and coherent actions to limit the social, economic and environmental impacts arising from climate change.

The strategy is founded on the vitality, prosperity and economic diversity of Québec society, on the rich variety of our natural environment, the need for integrated and effective management of the risks associated with climate change, on sustainable land use, and on the necessity of having durable infrastructures and buildings. Its success depends on citizens being well informed, motivated to deal with the profound changes coming, and on the participation of municipal, community and business circles.

## 5.2 GUIDING PRINCIPLES

The 2013-2020 Government Strategy for Climate Change Adaptation takes into account the sixteen principles of sustainable development set out in the Sustainable Development Act. Of those principles, fourteen are directly related to the present strategy: health and quality of life; social equity and solidarity; protection of the environment; economic efficiency; participation and commitment; access to knowledge; subsidiarity; intergovernmental partnership and cooperation; prevention; precaution; protection of cultural heritage; preservation of biodiversity; respect for ecosystem support capacity; and lastly, responsible production and consumption.

## 5.3 ISSUES

This strategy focuses on four fundamental issues facing the sectors of Québec society that are the most vulnerable to climate change. They are:

- The well-being of the population and communities
- The continuity of economic activities
- The safety and durability of buildings and infrastructures
- The maintenance of essential ecological services

Here we must underscore the cross-cutting nature of the issues listed above. There are close and complex connections between the human, socioeconomic and natural systems underlying all of them. For example, no less than economic prosperity, essential ecological services contribute to the well-being of people and communities. Consequently, it is important to understand that interventions to maintain ecological services, for example protecting aquatic environments, can also have a positive impact on human well-being, such as by reducing the risk of floods.

# 6 STRATEGIC DIRECTIONS AND OBJECTIVES

The 2013-2020 Government Strategy for Climate Change Adaptation is structured around eight strategic directions and seventeen underlying objectives that will be realized partly thanks to actions in the CCAP 2020. Four of the eight strategic directions are cross-cutting, since they apply to all issues in the strategy, while the remaining four are each specific to one issue.

| ISSUE 1 | ISSUE 2 | ISSUE 3 | ISSUE 4 |
|---|---|---|---|
| **The well-being of the population and communities** | **The continuity of economic activities** | **The safety and durability of buildings and infrastructures** | **The maintenance of essential ecological services** |

**STRATEGIC DIRECTION 1**
**Integrate climate change adaptation into the public administration**

**STRATEGIC DIRECTION 2**
**Develop knowledge and know-how**

**STRATEGIC DIRECTION 3**
**Build awareness and provide training**

**STRATEGIC DIRECTION 4**
**Modify land use and manage risks to reduce vulnerabilities**

| STRATEGIC DIRECTION 5 | STRATEGIC DIRECTION 6 | STRATEGIC DIRECTION 7 | STRATEGIC DIRECTION 8 |
|---|---|---|---|
| **Maintain the health of individuals and communities** | **Preserve economic prosperity** | **Improve the safety and longevity of buildings and infrastructures** | **Conserve biodiversity and the benefits of ecosystems** |

## 6.1 CROSS-CUTTING STRATEGIC DIRECTIONS

### STRATEGIC DIRECTION 1

**Integrate climate change adaptation into the public administration**

**As is its role, the Government defines the broad strategic directions and action priorities that will give direction to all sectors of activity over the years to come. In a coherent vision of sustainable development, and to ensure that interventions are consistent with societal objectives, the present strategy aims for a thorough integration of climate change adaptation concerns into the public administration. Since effective adaptation measures demand collaboration by all actors of Québec society who will be involved in achieving them, the Government must mobilize its partners and ensure the coherence of their actions.**

#### Objective 1 Modify the content of laws, regulations, policies, strategies and planning tools

In all sectors of activity concerned, existing legislative and regulatory tools must be examined and efforts made to describe and prioritize the most appropriate revisions, adaptations and updates. Where appropriate, the Government must also include climate change adaptation concerns in the preparation of new legislative instruments and policies.

Certain laws already incorporate concepts related to climate change adaptation. Notable examples include the Act to affirm the Collective Nature of Water Resources and Provide for Increased Water Resource Protection (known as the "Water Act"); the Dam Safety Act; and the Québec Strategy for Drinking Water Conservation. Other laws and policies are being revised or prepared that will include provisions on climate change, including the Civil Protection Act; the Québec Civil Protection Policy; and the Sustainable Regional and Local Land Use Planning Act.

Planning tools and decision aids must also be adapted to the reality of climate change. Thus, Québec's environmental assessment procedures for southern Québec and northern regions (for major projects that could disturb the environment) must include the question of climate change adaptation in the design, analysis and authorization of projects. In the same vein, civil protection actors should be invited to integrate climate change, systematically, into their planning and decision-making for risk management and disaster prevention.

#### Objective 2 Mobilize partners and ensure the coherence of their actions

The magnitude and diversity of the issues surrounding climate change and the adaptation of Québec society require not only that this concern be adopted and addressed by all departments and agencies concerned, but that their interventions be planned with an eye toward coherence, complementarity and interdepartmental cooperation. Thus, the governmental strategic directions on health, civil protection, land use, environmental protection, biodiversity and economic development must be made consistent with the present strategy for climate change adaptation.

However, the Government cannot succeed alone in this challenge. Depending on their mission and responsibilities, the departments and agencies will need to work with a great number of local, regional, national and international partners – in government, municipalities, the private sector, industry, the economic sector, aboriginal communities, associations, community groups and organized labour. Note as well that the support of the federal government is important to Québec's efforts toward developing knowledge about climate change adaptation.

Additionally, there are several existing bodies for government coordination and cooperation that could contribute to achieving the present objective: the Comité interministériel sur les changements climatiques (interdepartmental committee on climate change); the Organisation de sécurité civile du Québec (Québec civil protection organization); the Comité interministériel de développement durable (interdepartmental committee on sustainable development); the Comité interministériel de la recherche et de l'innovation (interdepartmental committee on research and innovation); and the Comité de coordination interministérielle sur la démarche de renouvellement des orientations gouvernementales en matière d'aménagement du territoire (interdepartmental coordinating committee on the renewal of governmental strategic directions on land use planning). Also, existing forums for elected representatives, such as the Table Québec-municipalités (TQM) and the Table Québec-régions (TQR), could provide a liaison with municipalities and regions.

Such partnerships will be facilitated by creating meeting places for exchange and sharing; by encouraging stakeholders to network with each other when developing climate change adaptation projects; by promoting shared cost initiatives; by making scientific and technical expertise available; and by providing assistance to sectors and communities in incorporating climate change adaptation into their practices.

**A joint planning approach to land use problems in the northern village of Salluit**

In 2004, researchers from the Centre d'études nordiques (CEN) of Université Laval discovered that accelerated climate warming was threatening the village of Salluit in Québec's far north. They worried that permafrost degradation could make it impossible for the village to remain where it was. In 2007, realizing the complexity of the land use problems caused by soil instability, the community of Salluit and the Kativik Regional Government (KRG) approached the Government of Québec to find a viable solution. In response, an interdepartmental committee was set up consisting of eleven departments and agencies, with a technical committee of representatives from the village of Salluit, the other northern villages, the KRG and the Ministère des Affaires municipales, des Régions et de l'Occupation du territoire. The committee worked closely with private engineering and planning firms, the Centre d'études nordiques and the community of Salluit. The latter was placed at the centre of decision-making, ensuring that the solution chosen would respect its needs and aspirations.

In the end, recent studies have shown that the community can remain where it is, and even expand into areas identified by permafrost experts as being suitable for construction. The community was able to select an expansion zone and plan its use with a vision of the future and land use principles determined by the community.

# STRATEGIC DIRECTION 2

## Develop knowledge and know-how

**Though our understanding of climate change and its impacts has progressed considerably over the last few years, gaps remain in our knowledge and know-how. Adaptation interventions need to be based on the most recent and reliable knowledge about the risks of climate change to health, safety, the economy, infrastructures and the environment. Advanced expertise in studying and modeling climate, and better knowledge about the impacts and vulnerabilities of society, are both essential for a well-planned adaptation process and enlightened decision-making.**

### Objective 3 Identify, analyze and evaluate the risks associated with climate change

Further work is needed to develop knowledge and know-how in support of the initiatives of departments and agencies. Financial support must also continue to Ouranos and university research centres, for specific projects in climatology and on impacts, vulnerabilities and adaptation. This will help to ensure that qualified expertise remains in Québec.

The Intergovernmental Panel on Climate Change (IPCC) recognizes that climate change will increase the frequency and intensity of extreme weather phenomena and other hazards. A major challenge will be to try to predict the evolution of these phenomena so we can assess the magnitude of future risks and of course their implications. Climate modeling will therefore be an essential tool in our efforts to adapt to climate change. Consequently, the Government will continue the work of monitoring and knowledge building on climate, air quality and precipitation. It is also essential that statistical tools be created for assessing potential climate change impacts and their associated uncertainties. Already, work by the Ouranos Consortium has given us new methods of complex statistical analysis and modeling.

**Consolidation of the monitoring networks for climate, air quality, water resources and groundwater**

To better assess potential risks to water resources and to better predict and monitor their impacts, our monitoring stations, parameters and instruments must all be upgraded. Thanks to the 2006-2012 Climate Change Action Plan, many stations have been modernized and added to the system, which includes the climate and air quality monitoring network, the piezometric network, the hydrometric network for southern Québec, and the new hydrometric stations north of the 50th parallel. In northern Québec, the foregoing are joined by the SILA network of permanent environmental and climate change observatories, set up by the Centre d'études nordiques of Université Laval with financial support from the Government of Québec.

While support for research has enabled progress in understanding social vulnerabilities and biophysical impacts due to climate change, so far there have been few studies of economic impacts. Additionally, there has been no cost-benefit analysis of potential adaptation measures. Such evaluation is essential for interventions to be prioritized effectively. For this reason, further research must be done to better document the social and economic impacts of climate change.

## Objective 4 Identify and disseminate best practices for adaptation in Québec and abroad

Planning, implementing and evaluating climate change adaptation measures must all be carried out through an ongoing iterative process. To identify best practices, repeated evaluation is necessary, monitoring the results of different adaptation solutions over time. Knowledge about the costs, benefits, effectiveness and environmental impacts of interventions already being applied will help us to determine the best and least costly solutions.

It will also be important to encourage pilot projects at the regional, municipal and community levels, and to support stakeholders on the ground. Support must also be given to developing knowledge, methods and standards to foster the adoption of good practices in design, construction, planning and management. Knowledge transfer projects should also be supported, to bring scientific and technical advances from the research community to stakeholders on the ground.

On the international scene, publicizing Québec achievements in developing and applying good adaptation practices will serve two ends, celebrating the work of those responsible and encouraging them to continue, while inspiring others to engage in similar initiatives of proven utility and effectiveness.

Mechanisms for sharing scientific knowledge, with partnerships between researchers here and abroad, will strengthen Québec's adaptation capacity while enhancing our international reputation.

The Ministère de la Santé et des Services sociaux has launched a website entitled "Mon climat, ma santé" (www.monclimatmasante.qc.ca), which brings together in accessible form a great amount of research, from Québec and abroad, on the effects of climate change on health. Also presented are numerous concrete examples of adaptation.

# STRATEGIC DIRECTION 3

## Build awareness and provide training

Mobilizing the people and players of Québec society will require more widespread understanding of the issues around climate change and the means by which we may adapt to it. The adaptation capacity of a community depends largely on the empowerment of its citizens, on giving them responsibility for adaptation. It also depends on how knowledge is communicated, on the availability of decision support tools, and on the willingness of stakeholders to act in an effective and timely manner.

## Objective 5 Encourage the promotion, integration and transfer of knowledge and know-how to the general public and to communities, institutions and enterprises

**General public**

Several tools are being considered for building awareness and conveying information in order to mobilize citizens to tackle the challenges of climate change adaptation. One initiative seen as essential is the creation of a dedicated web portal. It would enable the broad dissemination of a wealth of materials of all kinds, for both the general public and key players, including statistics, research reports, plain language information, guides, lists of resources, and discussion forums.

The Government will also encourage the design and dissemination of other types of tools for building awareness about climate change, including guides, discussion forums and training materials for different segments of society. For example, to prevent conflicts over water use the Government will promote new practices for water management and conservation, using online video capsules addressed to the general public, municipalities and enterprises.

Activities for exchange and dialogue between the scientific community, government stakeholders and civil society will be encouraged and supported. Innovative approaches could bring together scientists and the public to discuss the issues around climate change adaptation.

**Communities and institutions**

For concrete adaptation improvements to happen, it must be made easy for communities to appropriate knowledge and know-how, a task best achieved with a participative, mobilizing approach. To that end, the Government could support community participation in research projects, creating mechanisms for information sharing and collaboration to make it easier to structure and coordinate adaptation efforts. Aboriginal communities in particular will be supported in their efforts toward climate change adaptation. Greater networking among stakeholders from different organizations will improve information sharing about climate change scenarios, their associated risks, and adaptation solutions of proven effectiveness. Forums and partnerships between researchers and professionals working on the ground will stimulate collaboration and the circulation of information. Other concrete measures are also being considered, such as the development and publication of guides to good practices, the provision of second-line services and tools to aid decision-making, and technical assistance for projects in the regions.

Studies conducted under the 2006-2012 Climate Change Action Plan have revealed the necessity of updating certain health care practices, modernizing infectious disease surveillance, monitoring the use of certain prescription medicines, and modifying standards and ways of doing things when buildings are renovated. These tasks could be achieved in part through ongoing training for health sector employees and knowledge transfer programs for professionals, managers and elected representatives outside the health network (retirement homes, municipalities, government employees).

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**Enterprises**

Building awareness among people in business about the risks of climate change for their region or sector would encourage some hard thinking about business continuity. To ensure the continuance of economic activities in the event of disaster (Strategic Direction 6), enterprises must be shown how important it will be to adapt to changing climatic conditions, to set a priority on risk management, and to have solid business continuity plans.

For the business community to get on board, it must have access to accurate and relevant information about the risks of climate change, geographic vulnerabilities, effective adaptation solutions and potential business opportunities.

## Objective 6 Incorporate the issues and concepts of climate change into future academic curricula

Climate change and adaptation concepts should also become part of school curricula. To that end, tools must be developed to help teachers incorporate these concepts into portions of the primary and secondary general education programs.

At the college and university level, joint efforts could be made with government departments and agencies to incorporate climate change adaptation concepts into the appropriate courses, such as urban planning, land use, engineering and civil protection. Research, guides and tools produced by governmental actors could be widely disseminated throughout the education system to encourage the appropriation of climate change issues and adaptation solutions.

Lastly, in adult education it will be necessary to build awareness and obtain collaboration among the professional orders, unions and other organizations involved.

# STRATEGIC DIRECTION 4

## Plan land use and manage risks to reduce vulnerabilities

**Land use planning and risk management are key areas of intervention in climate change adaptation. Decisions and interventions here have a major impact on the health and safety of populations, as well as on economic activities, the built environment and ecosystems. To limit risks and vulnerabilities and increase the resilience of Québec society, climate change adaptation concerns must become an integral part of land use planning practices and risk management. To that end, the Government will need to guide and assist municipalities in the adaptation process, facilitating the implementation of local and regional solutions.**

## Objective 7 Take climate change adaptation into account in decisions on land use and urban planning

The present strategy particularly concerns the municipal sector, for it is directly concerned by the consequences of climate change and adaptation solutions. Therefore, municipalities must be given effective tools so they can apply the most appropriate solutions while meeting citizens' needs and expectations. Several factors place land use planning at the centre of climate change adaptation, including the effects of asphalt and cement in urban environments, the degradation of natural environments, and the presence or absence of zones excluded from construction for public health and safety reasons or to protect shorelines, littoral zones and flood plains.

Numerous adaptation solutions can contribute to sustainable land use. Noteworthy examples include the development of green belts for effective absorption of rainwater and to counter the formation of urban heat islands; the use of infrastructures, facilities and equipment that reduce the impact of particular hazards; and the adoption of a regulatory framework for land use in risk zones.

**Rehabilitation project: ecological parking and revegetation at Habitations Jeanne-Mance – Phase I**

With funding obtained under the 2006-2012 Climate Change Action Plan, Éco-quartier Saint-Jacques and the Corporation d'habitation Jeanne-Mance undertook a major project for the ecological rehabilitation of a parking lot and the revegetation of Habitations Jeanne-Mance. Phase I of the project, conducted in 2010, was to landscape the periphery of the buildings and create Montréal's first ecological parking lot with a bioretention basin. The basin captures runoff from the parking lot, filtering out pollutants and letting water return gradually to the natural environment.

In collaboration with the Ministère du Développement durable, de l'Environnement et des Parcs and the Ministère des Affaires municipales, des Régions et de l'Occupation du territoire, in January 2010 the Ouranos Consortium published a guide entitled Climate change adaptation plans: guide for municipalities, to help municipalities incorporate adaptation measures into their land use planning.

Among all the solutions available to municipalities, land use and urban planning mechanisms (regulations, programs, planning documents, etc.) are essential levers for adapting to climate change. With that in mind, the Government intends to support municipalities in their efforts to identify vulnerabilities and manage risks, and will help them to integrate climate change adaptation into their municipal planning.

**Revision of the Act respecting Land Use Planning and Development and government strategic directions on land use planning**

The Ministère des Affaires municipales, des Régions et de l'Occupation du territoire has undertaken an extensive revision of the Act respecting Land Use Planning and Development. The framework provided by the Act includes every level of stakeholder concerned: the provincial government, metropolitan communities, regional county municipalities (MRCs) and local municipalities. A draft bill on sustainable regional and local land use planning, which incorporates matters of climate change adaptation, was tabled in December 2011.

The in-depth revision of the Act will update all governmental strategic directions on land use planning. It is a privileged opportunity for the Government to formulate certain expectations toward all Québec stakeholders who engage in such planning, and to prepare technical guides on climate change adaptation.

## Objective 8 Reduce the risks and limit the repercussions of disasters stemming from climate change

There is a close and unavoidable connection between civil protection and climate change adaptation. In many respects the two share the same issues, have numerous actors in common, and often make use of the same means. They also share common goals and challenges, including those that contribute to:

- reducing society's vulnerability to natural hazards;
- protecting people, safeguarding property and preserving the natural environment;
- managing risks and integrating prevention into development processes.

To be coherent and effective, these matters should be handled through a comprehensive, integrated approach. Specifically, wherever it makes sense to do so, adaptation measures should be woven into the sequence of civil protection actions, using existing means and structures while updating planning and risk management accordingly. The need for adaptation should also result in changes to the strategic directions, training materials and tools provided to civil protection workers.

**Reform of civil protection to include natural risks due to climate change**

In response to the increase in risks and disasters over recent decades, in 2009 a civil protection reform was launched to strengthen the resilience of Québec society to future challenges and catastrophes. As part of this reform, the Government is working toward the adoption of a Québec policy on civil protection. One objective of the policy is to reduce our vulnerability to hazards whose frequency and intensity are likely to increase as an effect of climate change.

In the same spirit, the Government will take advantage of the revision of the Civil Protection Act to introduce provisions on climate change. All actions stemming from the reform should promote the systematic consideration of climate change in the planning and implementation of civil protection measures, at all levels of Québec society.

**Increasing the resilience of essential systems**

In civil security, essential resources are defined as being those on which we are so dependent that even the shortest period of unavailability could threaten the life, health, safety or well-being of a person or community; the viability of a business; the effective functioning of the Government and its institutions; or the maintenance of essential ecological services. The principal resources on which Québec society depends are drinking water, electricity, food, telecommunications, health care, emergency services, financial services and transportation. Our essential systems are those that produce, supply and distribute essential resources. The interdependence of these systems heightens their vulnerability to hazards of all kinds, including those resulting from climate change. The Government must ensure the constant availability of essential resources to the population. Since the provision of these resources depends on the proper functioning of essential systems, and the latter are vulnerable to so many hazards (in large part because of their interdependence), it is imperative that we improve their resilience.

In 2007, the Organisation de sécurité civile du Québec (OSCQ) launched an initiative to strengthen the resilience of Québec's essential systems. Partnership was crucial to this effort, and representatives from governmental and paragovernmental bodies, municipalities, private enterprise and academic circles all got involved. As the principal manager of several essential systems, and in view of the oversight it provides in various sectors of activity, the Government must play a major role in dealing with these concerns, which is why it intends to support such initiatives.

Since disaster can disrupt the activities of businesses and organizations that supply the population with essential resources, measures must be taken to prevent, as much as possible, any interruption of the activities of such businesses, or at least to facilitate their swift and effective recovery (Strategic Direction 6).

**Preventive measures for risk reduction**

At the local and regional level, several types of preventive measures could be taken to minimize disaster risks. Among the most important are insightful land use planning, revegetation of urban spaces, and management of the occupation of risk zones. Other effective preventive measures include inspection and maintenance programs; monitoring, forecasting and early alert systems; and structural measures like retention basins for rainwater. Lastly, relocating people and property away from risk zones, generally done only when there is imminent danger, could also be considered for the sake of prevention. However, this option would only be chosen when no other preventive or preparatory measures present a viable solution.

**Preparatory measures for effective action in the event of disaster**

No matter how effective, prevention cannot eliminate all risks. Consequently, preparatory measures must also be taken in each community to strengthen our capacity to respond when disaster strikes. This could include, for example, disaster response protocols, warning and mobilization procedures, emergency measures to protect the physical integrity of citizens, services for disaster victims, and public information mechanisms for use both during and after a disaster.

**Public safety and marine coastal erosion**

The Ministère de la Sécurité publique (MSP) is working to prevent and mitigate certain effects of climate change that threaten vulnerable communities, particularly those affected by marine coastal erosion. Since 2009, and in collaboration with the Institut des sciences de la mer de Rimouski, the MSP has been working to set up an observation network on ocean and climate conditions in the Gulf and Estuary of the St. Lawrence. The MSP believes that with a better understanding of this environment, and an emphasis on prevention and sustainable development, innovative and efficient solutions may be found to the problems raised by coastal erosion.

Additionally, in July 2008 government funding enabled the creation of a research chair in coastal geoscience at the Université du Québec à Rimouski. To evaluate the impacts and issues of erosion and marine submersion, the chair studies the dynamics of coastal evolution in the Gulf and Estuary of the St. Lawrence. Ultimately, this research will (among other things) provide the Government, MRCs and municipalities with cartographic tools that will help to strengthen the adaptation capacities of coastal communities.

## 6.2 SPECIFIC STRATEGIC DIRECTIONS

### STRATEGIC DIRECTION 5

**Maintain the health of individuals and communities**

**Maintaining public health in the face of climate change requires that preventive action be taken, based on knowledge about the risks and vulnerabilities of different segments of society. Prevention can help save lives, avoid injury and disease, and limit the social impacts of climate change. Preparation ensures that appropriate and effective intervention can be taken when extreme weather events, or other effects of climate change, threaten the health of individuals and communities.**

### Objective 9 Prevent excess disease, injury and death due to climate change

The new climatic conditions will affect public health through the increased prevalence of various health problems, including zoonotic, vector-borne and water-borne diseases, skin cancer and food poisoning. In these areas it will be important to continue the research and surveillance efforts initiated under the 2006-2012 Climate Change Action Plan. In the present strategy, certain risks are given higher priority due to their biophysical and socioeconomic repercussions, e.g. the health effects of high heat and air pollution. Other themes on which less is known, like infectious diseases, preventive behaviors and mental health, will also receive attention, but more in terms of monitoring, developing knowledge and conducting pilot projects (see Strategic Direction 2).

Through the 2006-2012 Climate Change Action Plan, projects to control urban heat islands, preserve urban forests and upgrade both private dwellings and public buildings, were carried out and evaluated in many Québec municipalities. One example was discussed earlier, the rehabilitation project for ecological parking and revegetation at Habitations Jeanne-Mance. This initiative had an educational component, offering basic horticultural instruction to residents and building citizen awareness about environmental and health issues related to urban heat islands.

A number of practices are available to Québec for countering urban heat islands. Tree plantings, shady areas, reflective construction materials, green roofs, and the ecological management of rainwater, are all effective ways of correcting or avoiding heat islands, as are measures to preserve existing cool areas and to upgrade housing and health establishments. Such measures bring additional benefits, including lower energy demand and a reduction at source of air and water pollution, all of which help to reduce greenhouse gas emissions. Green spaces also encourage physical exercise, thereby mitigating the problems associated with sedentary lifestyles and obesity.

The projects conducted under the 2006-2012 Climate Change Action Plan to control urban heat islands were highly successful. In view of that success, and the way the program enabled municipal authorities to act so effectively, the Government of Québec intends to continue in that direction, supporting similar interventions in small and medium municipalities through specialized teams and financial incentives.

A pilot project for personalized warning calls, conducted under the 2006-2012 Climate Change Action Plan, appears to hold promise for encouraging the adoption of health-protective behaviours in periods of smog, which often occur during heat waves. The results show that personalized calls work better than public notices in the media, prompting participants to act preventively in critical situations.

The mortality and heat-related illnesses that occur during heat waves can be reduced through various interventions. In 2010, existing emergency plans, vigorous intervention by authorities and a new system for monitoring and preventing health impacts during extreme weather events[3], all contributed to limiting the impact of that year's heat wave. In light of that experience, the Government will maintain a high level of preparedness for climate-related emergency situations, and will seek improvement in ways of doing things. Special attention must be paid to vulnerable populations to ensure that they have access to the services available. One approach would be to set up personalized, automated warning systems (by telephone and Internet) to encourage preventive measures and health-protective behaviors among those who are most exposed.

Pilot projects to mobilize communities against ragweed are already under way thanks to the 2006-2012 Climate Change Action Plan. An undeniable success, these projects will help shape future initiatives to control this plant effectively throughout Québec.

Better air quality helps to prevent unnecessary illness and cardiorespiratory distress among sensitive individuals (children, the elderly, persons with cardiac disorders, etc.). Since high temperatures and air pollution combine to exacerbate many health problems, specific interventions should be taken to reduce the effects of air pollution during heat waves. Given that more frequent and intense smog episodes, as with unnecessary cardiorespiratory distress due to air pollution, will not be exclusive to heat waves, continued attention must be paid to air quality in general.

As mentioned earlier, the prevalence of ragweed pollen allergy could increase in response to climate warming. To support province-wide efforts to control ragweed and slow its advance, the Government intends to continue its monitoring and control activities, in concert with municipalities and large institutional landowners.

## Objective 10 Maintain the continuity of emergency and health measures during disasters caused by climate change

Depending on specific geographical risks and vulnerabilities, different actions must be taken to improve the effectiveness of existing emergency measures and ensure that health services are maintained during natural disasters. Upgrading the physical plant of certain health establishments will allow them to function independently over extended periods and ensure the safety of users. On that subject, a guide for health network administrators entitled Changements climatiques: vulnérabilité et adaptation des immeubles was published in 2011 by the Ministère de la Santé et des Services sociaux. A project to revise emergency plans was also begun under the 2006-2012 Climate Change Action Plan, as were projects to develop monitoring/alert systems for major hazards such as floods and storms. These decision support tools will be completed, installed promptly and made freely accessible.



3 The new system is a decision support tool called SSUPREME, an acronym for Système de surveillance et de prévention des impacts santé des événements météorologiques extrêmes. It was developed under the 2006-2012 Climate Change Action Plan.

## Objective 11 Limit the psychosocial impacts associated with climate change

Disaster victims often suffer great distress due to the human, material and financial losses caused by floods and other events. Without adequate psychological support, some could develop serious psychological problems. Post-traumatic stress disorder (PTSD) is the psychosocial impact most often observed after extreme weather events that have caused major damage. It therefore seems essential to ensure that assistance and psychosocial support are provided in the wake of such events.

More studies will be conducted to assess the real psychosocial impacts of natural disasters and to identify the most effective ways of supporting victims. There is a need for swifter recognition of those in need of specialized services, for more awareness among medical staff, and for easier access to effective psychological help. To that end, the Government plans to set up projects on mental health screening for disaster victims, and on the effectiveness of different psychological interventions. Particular attention will be paid to vulnerable populations, such as the homeless and those with fragile mental health.

At the same time, zoning changes and post-event rebuilding can give rise to social conflicts and personal and familial disruption. The Government will work to better predict and manage such situations with regard to health and public safety. It will also improve the tools, training and information offered to the general public, organizations and elected officials.

According to recent studies, urban green spaces have a significant positive effect on physical and mental health. Particularly among children, solitary elders and the socioeconomically disadvantaged, they act to lower levels of stress, distress, anxiety and depression. Consequently, the Government will encourage the preservation and increase of urban green spaces (wetlands, forests, urban parks, water courses, etc.).

# STRATEGIC DIRECTION 6

## Preserve economic prosperity

**Many factors determine the degree of vulnerability of economic activities, including where they are conducted, the sector of activity, the resources they depend on and their clientele. Whether directly or indirectly, all economic activities in Québec will be affected by climate change. To preserve economic prosperity, Québec's economic players must be guided and supported in their efforts to adapt to climate change. They should also be encouraged to innovate and to take advantage of new business opportunities.**

## Objective 12 Improve guidance and support for vulnerable economic actors

To diminish their vulnerability to climate change, some enterprises will have to invest in renovating infrastructures and diversifying or even relocating activities. Since most small to medium enterprises (SMEs) expect a return on investment in two to five years, these changes have to pay off in the short to medium term. Their adaptation capacity will therefore be largely dependent on financial incentives offered by the market. Some businesses will be struck by disaster despite prevention efforts, and their struggle to carry on will continue for years after the event itself. In such situations, the Government will continue to support the resumption of economic activities by optimizing its interventions toward that end.

Though all economic sectors in Québec are vulnerable to climate change, some are more vulnerable than others, particularly those that are directly dependent on natural resources or climatic conditions. This is the case with tourism, agriculture, forestry and mineral exploitation.

**Tourism**

To mitigate the expected impact of climate change on tourism enterprises, the latter must adapt their products to the new conditions (milder winters, longer summers) or develop new products around the theme of Québec's nordicity for example. Creativity and innovation will be needed to adapt profitably to climate change, and the Government will assist the tourism industry in its efforts to do so.

**Agriculture**

Agriculture holds great importance for Québec's economy. The Green Paper on bio-food policy highlights the contribution of agriculture to Québec's economic growth, particularly in terms of sustainable development. In that perspective, it is crucial that the agricultural sector be able to adapt to new environmental challenges such as those expected with climate change. Adaptation solutions involving agronomy, physiology, plant health and water management can all help to reduce agriculture's vulnerability to climate change. Soil conservation practices could preserve and improve Québec's farmland, while water management upstream and downstream of farm operations could safeguard the water supply for agriculture and aquaculture as well as for communities. To that end, the Government will provide financial assistance to projects aimed at conserving resources and strengthening the resilience of the agricultural sector. Farm insurance and income protection programs will be modified to take account of new knowledge, new market opportunities and growing practices aimed at climate change adaptation. Farm income diversification is also a privileged solution for the agricultural sector. Lastly, in accordance with the 2011-2021 Québec Plant Health Strategy, the Government will promote improvements in the control and prevention of crop and aquaculture pests. To help the sector adopt optimal strategies for plant protection, projects are already under way to increase knowledge about the effects of climate change on certain crop pests.

**Forestry**

In the forest sector, the Government intends to continue knowledge development efforts begun under the 2006-2012 Climate Change Action Plan. It will document the effects of climate change on tree growth, soil fertility and forest biodiversity. The knowledge obtained will be used to adjust calculations of forest potential, and will be transferred and explained to decision-makers and regional stakeholders for integration into forest planning. Additionally, since climate change will be gradual and cumulative, forest management will be modified by the adoption of: 1) preventive measures in anticipation of future climatic conditions; 2) adaptive measures in response to changes in progress; and 3) reactive measures in the event of forest catastrophes. A risk management process will be developed to guide the choice of measures proposed. Lastly, current practices of natural disturbance management (prevention, response and recovery) will be revised using an integrated risk management approach, with ecological, social and economic components. The new approach, combined with the Canadian Wildland Fire Strategy, will lead to adjustments in both operating practices and disturbance management.

**Forest adaptation to climate change impacts**

In implementing the 2006-2012 Climate Change Action Plan, the Ministère des Ressources naturelles et de la Faune carried out several projects on the effects of climate change on forests. In 2011 an atlas of climate scenarios for Québec forests was published by Ouranos. With these scenarios, estimates were produced of the potential distribution of 139 tree species in Québec and the eastern United States by 2050 and 2080. Other work focused on how forest soils would react to climate warming and longer growing seasons. Seed transfer models were also developed so that reforestation could take into account the expected effects of climate change. Since trees live a very long time, it is important to plant varieties that will do well in a changing climate.

**Mining sector**

In the mining sector, climate change adaptation will mean analyzing vulnerabilities and their associated risks, revising laws and regulations affecting the sector, and funding programs for research and development. It will also be important to ensure that tailings sites are managed diligently with regard to the potential effects of climate change.

## Objective 13 Encourage innovation and seize economic opportunities related to climate change

Adapting to climate change means more than simply arming ourselves against the deleterious effects of certain changes; it also means seizing the new opportunities they present. Climate change speaks to our creativity and innovation, challenging us to develop new products and practices to facilitate adaptation by Québec society. To some extent, our ability to do so will depend on the quality of our knowledge about the evolution of climatic conditions.

The economic opportunities arising from climate change will be different in each area of economic activity, and will be discovered in part through vulnerability studies. For example, in the manufacturing sector there are opportunities in the need for new, more resistant construction materials, while winter-related production must be adapted and diversified. Most manufacturers of winter equipment (snowmobiles, snowblowers, etc.) have already diversified into summer equipment for roadwork and the agricultural and forest sectors. In the marine transportation sector, the shrinking or disappearance of ice cover could open the St. Lawrence for year-round navigation into the Great Lakes. This could result in greater port activity and new opportunities for shipyards offering shipbuilding and repair services. The warming of Nord-du-Québec will also facilitate access to new mineral and forest resources, while tourism opportunities will increase as summers become longer.

Through the services it currently offers, the Government of Québec actively supports innovation by Québec enterprises. Financial and advisory support are offered to Québec businesses that wish to demonstrate a technology, develop a new product or diversify their activities. Given the necessity of climate change adaptation, that support will continue, ensuring that Québec will be ready to seize the opportunities presented by climate change.

# STRATEGIC DIRECTION 7

## Improve the safety and longevity of buildings and infrastructures

Elements of the built environment that support essential systems must be given special attention. Options to consider include compensating for climate change impacts in the design, management and maintenance of infrastructures and buildings; protecting them physically from the effects of hazards; or relocating them to safer places. The renovation or redevelopment of aging elements of the built environment are also unique opportunities for adapting now to the climatic conditions of tomorrow.

### Objective 14 Strengthen the resilience of infrastructures

**Supply and distribution of drinking water**

Low-water periods, when water levels can fall dramatically, threaten sources of drinking water supply. Considering the risks associated with low river levels, the positioning of some water intakes should be re-evaluated. Additionally, the Québec Strategy for Drinking Water Conservation (MAMROT, March 2011) includes several measures for cutting back on water consumption, particularly by municipalities, businesses and health and education establishments. This strategy will also lead to better knowledge about our water distribution networks, so that crucial interventions can be identified and executed. A governmental strategy for the protection of drinking water sources (currently being drafted) will improve the control and management of water as climate conditions change.

**Municipal infrastructures for urban drainage**

Municipal infrastructures for urban drainage could also be affected by climate change, particularly during flash floods and torrential rains. There is a need for rainwater management measures that provide better collection, greater infiltration and more dependable retention. Such measures will help to control the quantity and quality of wastewater before it is discharged into receiving environments. The new guide from the Ministère des Affaires municipales, des Régions et de l'Occupation du territoire, La gestion durable des eaux de pluie (sustainable rainwater management), proposes a variety of innovative approaches to avoid having to re-dimension or over-dimension drainage networks. Additionally, for project authorizations under section 32 of the Environment Quality Act, the Ministère du Développement durable, de l'Environnement et des Parcs has produced a guide setting out new requirements for rainwater management measures. Both quantitative and qualitative, they include the reduction of rainfall runoff volumes, the limiting of overflows, the control of peak flows and erosion in water courses, and the improvement of runoff quality.

**Public dams**

The Government of Québec manages nearly 800 public dams and ensures the safety of some 5500 dams of all kinds. All of them were designed, and until now have been managed, on the basis of historical data on precipitation and water flows. Since climate change is likely to alter water regimes and increase the potential for water use conflicts, certain elements of the plan and strategy on dam management will be modified.

**Resilience of electricity transportation and distribution networks**

In Québec, the design and management of the electricity transportation and distribution networks are handled entirely by Hydro-Québec. This public corporation has the mandate and the expertise to respond to any eventuality concerning electricity services. During the 1998 ice storm, many transportation and distribution lines collapsed, particularly in Montérégie, depriving hundreds of thousands of consumers of electricity. Hydro-Québec shouldered the management of this crisis quite well.

Drawing on the lessons learned from that event and others, Hydro-Québec has improved its electricity transportation and distribution networks, which today stand among the most solid, technologically advanced networks in North America. Other improvements are planned to the networks and their management, and further research and development are in progress thanks to the Institut de recherche d'Hydro-Québec (IREQ) and the Ouranos Consortium's "Energy Resources" program.

Due to the integration of the continent's electricity market, Hydro-Québec must meet North American standards for reliability in the management, safety and quality of its electricity transportation network. These standards contribute to the maintenance of reliable service in Québec.

**Climate change and transportation infrastructures**

Under the 2006-2012 Climate Change Action Plan, the Ministère des Transports du Québec (MTQ) launched a variety of research projects on the impact of climate change on transportation infrastructures in Nunavik and along the Gulf and Estuary of the St. Lawrence.

In Nunavik, projects have examined the vulnerability of airports, roads and marine infrastructures, and the applicability of different adaptation methods particularly with respect to permafrost degradation. To learn more on this subject, go to:

www.inframaritimes-nunavik-cc.mtq.gouv.qc.ca/English/Pages/default.aspx.

Research was also done on the vulnerability of roads and protective works to coastal erosion (and potential adaptation solutions), in the regions of Bas-St. Laurent, Côte-Nord and Gaspésie–Îles-de-la-Madeleine, where the national road network runs along the coast.

**Transportation infrastructures**

The useful lifetime, proper functioning and safety of transportation infrastructures, including roads, railways, ports, bridges, culverts and protection works, are also likely to be affected by climate change. In view of the importance of transportation infrastructures for the safety of users and the mobility of people and merchandise, preventive measures and effective interventions to reduce the impacts of natural hazards are essential. To identify and prioritize adaptation solutions, a risk management approach should be applied. This will require knowledge development to reduce uncertainties and predict the evolution of climate hazards. As a first step, a methodology must be defined for diagnosing the vulnerability of transportation infrastructures and evaluating the effectiveness and resistance of protection works (riprap, toe walls, groins, breakwaters, submerged dikes, etc.). The adaptation of existing infrastructures and calculations on the useful life of new infrastructures should take into account the increasing frequency of extreme weather phenomena. Additionally, since weather-related damage to infrastructures can be expected to increase, more frequent and extensive maintenance and rehabilitation will be required. Preference will be given to progressive adaptation solutions that are reviewed periodically, to ensure that they remain effective and efficient as the climate evolves. To mitigate the impacts of natural hazards like submersion, floods and the erosion of coasts and riverbanks, and as a complement to changes in land use planning, the Government will establish intervention solutions that focus on the use of hydraulic structures. And lastly, to avoid having to repeatedly reinforce an infrastructure that is constantly subjected to a hazard, the Government may reconsider the location of certain transportation infrastructures.

## Objective 15 Protect buildings

**Education system**

Facilities in the education system must be adapted to ensure the safety and continuity of educational activities during extreme weather. Such adaptation must take into account not only the nature of particular hazards but the vulnerability of school populations. To that end, the Government will develop construction, renovation and management criteria based on knowledge acquired about climate change and adaptation solutions, in collaboration with the establishments concerned.

**Health and social services networks**

The Government also intends to contribute to the discussion on designing adaptation solutions for land and buildings in the health and social services networks. These interventions will be an opportunity to improve user comfort and reduce urban heat islands.

**Private real estate**

For populations vulnerable to climate warming, there is also a need to improve private real estate in urban environments. Consequently, the Régie du bâtiment du Québec will collaborate in the development of criteria, codes, guides and other tools necessary for adapting the built environment to climate change and its associated risks.

# STRATEGIC DIRECTION 8

## Conserve biodiversity and the benefits of ecosystems

**Through the diversity of their species and functions, ecosystems provide a host of ecological services that contribute greatly to human well-being, the quality of our communities and Québec's economic prosperity. Inasmuch as climate change is certain to affect the structure and composition of terrestrial and aquatic ecosystems, and thus their ability to provide the ecological services on which society depends, the conservation of biodiversity and ecological services becomes crucial. To that end, the Government will accord particular attention to the conservation of water resources and the preservation of ecosystem resilience.**

## Objective 16 Give priority to the conservation and protection of water resources

Water is an essential resource for Québec society, the economy and the environment itself. It is also a crucial issue in matters of climate change adaptation. The potential changes in the quality and availability of water will have subtle or dramatic repercussions on aquatic ecosystems and our uses of them, including drinking water supplies, hydroelectric production, navigation and recreational activities.

**Management of water resources**

Responsible for water management, the Government of Québec sees to the conservation and protection of water resources through an array of laws, regulations, policies and programs. It is therefore the Government's task to prepare interventions based on expected changes and future climatic conditions. Such interventions must be supported by an adequate knowledge of water availability. Forecasting systems and monitoring networks for both surface and groundwater are essential for the conservation and optimal use of water. Through the Water Act and the present strategy, the Government of Québec will support the transition to practices that minimize water consumption. Also necessary will be changes to effluent discharge standards for wastewater treatment facilities and industry, based on the expectation of more severe and more frequent droughts. In agriculture, areas deemed vulnerable to erosion must be identified, and soil and water management practices must be adapted proactively to changing climatic conditions.

In view of the risk of more severe droughts and of water use conflicts due to the diminished availability of water resources, interventions are planned to secure water supplies. Adopted in 2009, the Act to affirm the Collective Nature of Water Resources and Provide for Increased Water Resource Projection (the "Water Act"), gives the Government the necessary powers to strengthen the framework for water withdrawals. It also includes provisions for water withdrawal allocation that will come into play in the arbitration of water use conflicts. As for the Québec Strategy for Drinking Water Conservation, adopted in March 2011, its objectives are to lower water consumption, curtail leakage from water distribution systems, and increase the reuse and recycling of water. Implementation of the strategy will require investments to obtain better data on our water distribution systems, identify sections most in need of intervention, and perform the necessary corrections.

The Great Lakes-St. Lawrence River Basin Sustainable Water Resources Agreement provides for the implementation of a water conservation program throughout the region covered. The program will eventually be applied to other parts of Québec.

**Protection of wetlands**

Wetlands are increasingly considered a determining element in any strategy for the conservation and protection of water resources. Of great importance in the hydrological cycle, wetlands accumulate over-abundant water during periods of heavy rainfall, gradually releasing it in drier periods. They thus provide a natural protection against flooding, landslides and erosion. Wetlands are natural retention basins that also act as treatment facilities, removing dissolved and particulate contaminants from the water. It must also be remembered that wetlands are a key ingredient in the biodiversity of aquatic ecosystems. Protecting these environments must therefore be made a priority, not only in rural and wild regions but in urban areas as well.

**Hydrological modeling platform for water management adaptation**

Under the 2006-2012 Climate Change Action Plan, the Ministère du Développement durable, de l'Environnement et des Parcs developed a new hydrological modeling platform. As a decision support tool for watershed management, it was specifically designed to facilitate climate change adaptation. Essentially, the platform produces a profile and an analysis of watershed hydrology that can be projected over time using different assumptions. It thus completes the role of the hydrometric monitoring network by exploring the effects of possible futures, climatic conditions that are as yet unobserved. For example, it can calculate and display the climatic drifting of various hydrological indicators commonly used in water management, such as flood flows, low-water flows and ecological flows. Beyond those basic applications, the hydrological modeling platform will be an extremely useful tool for developing water management scenarios across entire watersheds.

## Objective 17 Preserve the resilience of ecosystems

The resilience of an ecosystem has to do with its capacity to maintain or recover its normal functioning and development after a major disturbance. Such resilience is associated with biological diversity, i.e. the diversity of species and varieties in an ecosystem. The more a biological community is diversified, the greater the likelihood that some of its members are already suited to the new conditions created by the disturbance. Such species keep the ecosystem going and enable it to recover fully in spite of disturbances, be they rare, recurring or long-term. The conservation of biological diversity is therefore key to any attempt to preserve the resilience of ecosystems. Since natural and developed ecosystems provide numerous ecological goods and services that are beneficial to Québec society, the Government protects them through various tools for intervention.

**Protected area network**

By creating protected areas in both terrestrial and aquatic environments, the Government preserves representative samples of biodiversity and landscapes, and safeguards vulnerable or exceptional habitats. Québec's network of protected areas also serves to alleviate anthropic pressure on certain plant and wildlife populations, strengthening their tolerance of climate change. Québec has set a goal to place 12% of the province within protected areas by 2015. Climate change must be taken into account in the design and management of this network. As much as possible, protected areas will be joined by ecological corridors, maintaining connectivity across the landscape so that species can access their preferred habitats. Furthermore, by 2035 the Government intends to exclude 50% of the territory covered by Plan Nord from all industrial activity, placing a priority on protecting the environment and safeguarding biodiversity. Despite these conservation efforts, some disturbances expected from climate change could seriously threaten some species whether they are in protected areas or not. We must therefore develop greater knowledge about conservation solutions and the response of ecosystems to climate change.

**Conservation of plant and animal species**

Intervention strategies for the protection of threatened species already incorporate climate change considerations. However, many populations with no particular status could also undergo deteriorating circumstances. Consequently, a thorough inventory should be taken of sensitive species, and they should be monitored carefully over the medium to long term. It could also be worthwhile to increase the size and quality of natural habitats in urban and peri-urban areas, to maintain biodiversity. Lastly, harvested wildlife will not be immune from the effects of climate change; these should be considered in the conservation and management of species exploited for hunting, trapping and sport fishing, as well as those harvested commercially.

Climate change could inflict severe stresses on species and their habitats. To understand those stresses, work should be done toward predicting changes in distribution ranges and population dynamics. Management approaches should be adapted to reduce anthropic pressure on populations whose survival or health could become problematic. Special attention should also be paid to exotic invasive species, to prevent their introduction, monitor their advance and intervene rapidly when control is necessary. Risk analyses of exotic invasive species and zoonotic diseases will help improve existing monitoring systems and determine whether new systems should be set up.

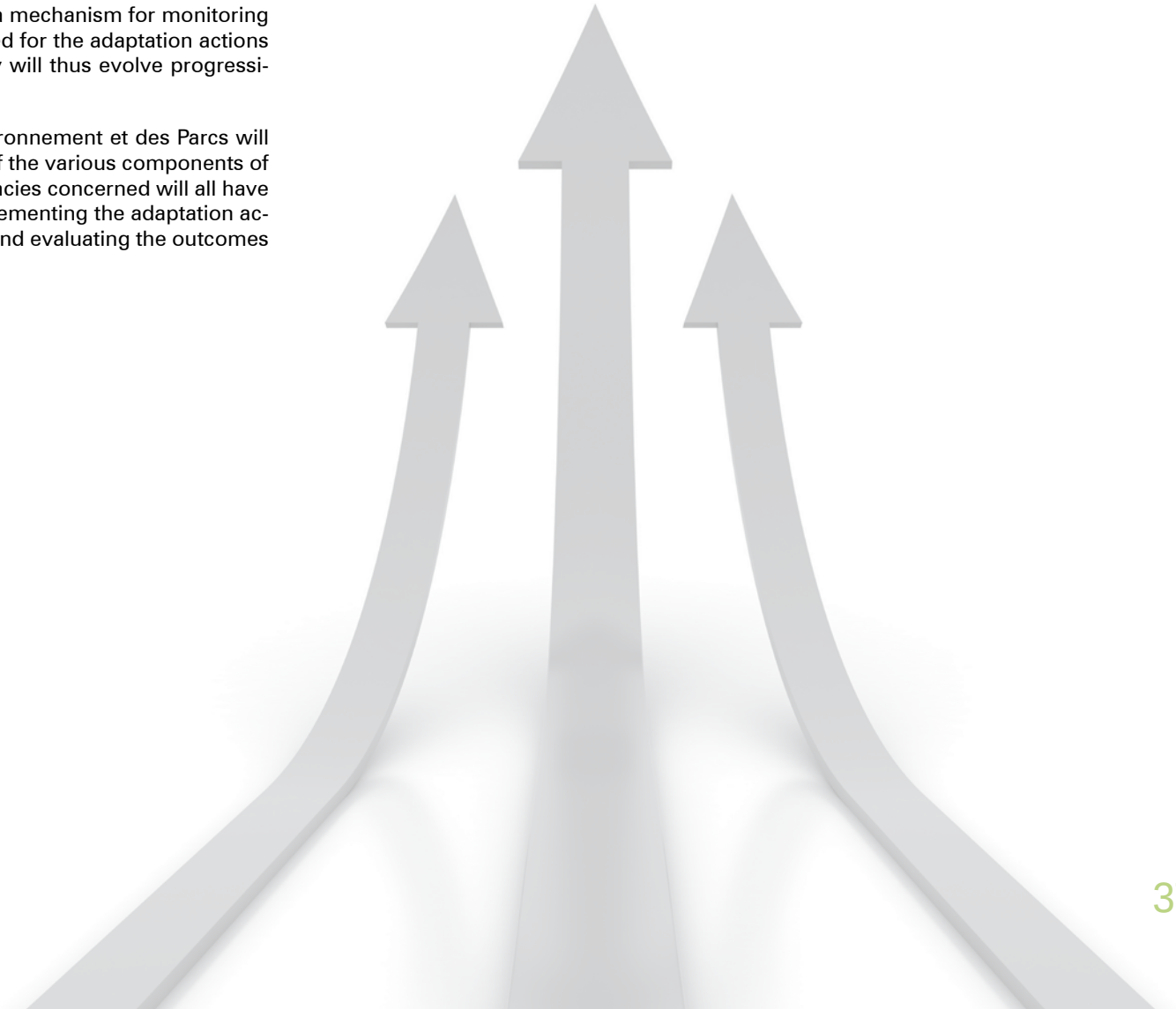
To document the response of different species to climate change, a biodiversity monitoring system is needed. To that end, work is under way to create a methodological framework. Also being done is research on northern biodiversity, which will be important in the implementation of Plan Nord. All of the knowledge obtained will be put to use in adapting species conservation measures and preserving the resilience of ecosystems.

# 7 IMPLEMENTATION

The Strategy for Climate Change Adaptation sets out the main priorities for government intervention over the next ten years, establishing a solid, coherent foundation for the actions contained in the 2013-2020 Climate Change Action Plan.

In addition, the Government intends to put in place a mechanism for monitoring and evaluating the strategy, using indicators designed for the adaptation actions in the next climate change action plan. The strategy will thus evolve progressively through a process of ongoing revision.

The Ministère du Développement durable, de l'Environnement et des Parcs will coordinate the development, renewal and revision of the various components of this strategy. The government departments and agencies concerned will all have roles in monitoring and evaluating the strategy, implementing the adaptation actions in the 2013-2020 Climate Change Action Plan, and evaluating the outcomes and effectiveness of those actions.



# Conclusion

Climate change poses complex environmental and socioeconomic challenges that cut across multiple and highly interdependent domains and areas of jurisdiction. Thus, the adaptation strategic directions must take into account the very close links between human, built, ecological and socioeconomic systems. The cross-cutting nature of the issues, combined with the multitude of actors and their varied powers and responsibilities, make it all the more complex to reach decisions about adaptation.

The 2013-2020 Government Strategy for Climate Change Adaptation proposes concrete and realistic intervention priorities that emphasize a comprehensive, collaborative approach, working closely with all partners and always seeking sustainable development. By adopting preventive adaptation solutions, we will reduce the costs of climate change and may even, in some cases, profit by turning the effects of climate change into new opportunities.

In many cases, climate change adaptation could be planned with existing structures and with processes already under way. How urgent it is to take action will depend on specific vulnerabilities and expected changes, and on the adaptation capacity of communities.

Though the challenges of climate change adaptation are considerable, and fraught with uncertainty, Québec is well equipped to deal with them. The availability of useful data, our effective monitoring and tracking systems, the strong collaboration among researchers, government experts and stakeholders on the ground, and our governmental leadership, will all contribute to ensuring our success.

If all actors share a common vision and are mobilized to respond to climate change, implementing the present strategy can only lead to a stronger Québec and a more resilient Québec society.

# Glossary

| | |
|---|---|
| **Adaptation capacity** | The capacity of communities and ecosystems to adjust to climate change so as to minimize its negative effects and benefit from its advantages. |
| **Drought** | Phenomenon that occurs when precipitation is significantly lower than normal, resulting in major hydrological imbalances that can be deleterious to production systems and land resources. Drought can be defined in different contexts (agricultural, meteorological, hydrological...). A severe drought is both prolonged and widespread, lasting much longer than normal (a decade or more). |
| **Flood flow** | High flow due to heavy rains, melting snow or a combination of both. |
| **Flood level** | High water mark for a given flood flow. |
| **Frazil ice** | Loose, randomly-oriented crystals or fragments of ice in turbulent, supercooled water that can lead to the formation of ice bridges and subsurface obstructions. |
| **Hazard** | Phenomenon, physical manifestation or human activity that can cause injury or loss of life, property damage, social and economic disturbance, or environmental degradation. For a given location, each hazard has a given intensity and probability of occurrence. |
| **Heat island** | Urban zone characterized by higher ambient temperatures than those around it due to the absorption of solar energy by asphalt and dark construction materials. |
| **Protected area** | A geographically defined area of land, wetland or marine environment set aside for the protection and maintenance of biological diversity and the natural and cultural resources present. Such geographical spaces must be legally designated, regulated and administered by effective legal or other means. |
| **Resilience** | Ability of a system, community or society to adapt to potential hazards by resisting or changing, so as to establish and maintain essential structures and an acceptable level of functioning. |
| **Sensitivity** | Degree to which an exposed entity is affected, favourably or unfavourably, by climate change or climate variability. |
| **Storm surge** | An off-shore rise of water associated with a low pressure weather system, caused by persistent high winds, low barometric pressure and shallow water. When a storm surge occurs during high tide the result is a storm tide, which can cause a marine incursion (flooding) and the attendant dangers to people living along the coast. Negative storm surges (causing extremely low tides) can also occur, causing serious problems for shipping. |
| **Thermokarst** | Irregular land surface characterized by numerous small depressions caused by the melting of ice lenses or the collapse of pockets of ground due to melting permafrost. |
| **Vulnerability** | Condition due to physical, social, economic or environmental factors that predisposes persons or things to be exposed to a hazard and harmed by it. Climatic vulnerability is the product of three parameters: exposure to hazards (climatic events), sensitivity to them and adaptation capacity. |
| **Zoonotic disease** | A disease that can be passed from animals to humans. |

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