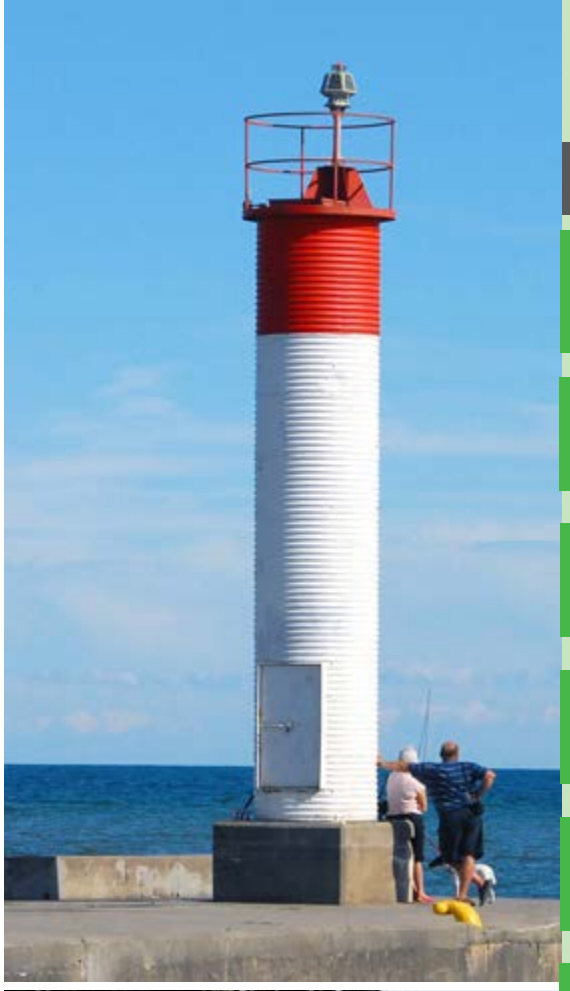
Town of Oakville

climate change primer

Version 1.1



OAKVILLE

climate change primer

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Message from the

mayor

We are proud of the Town of Oakville's many environmental initiatives and policies which work to enhance our community's resilience to a changing climate. For years we've been acting to mitigate the town's contribution to climate change. We've developed and implemented an Active Transportation Master Plan, greenhouse gas reduction targets, an Anti-Idling By-Law, Health Protection Air Quality By-law, Sustainable Purchasing and Green Fleet Procedures, tree protection by-laws and we've set a progressive tree canopy cover target.

As Oakville continues to do its part to mitigate climate change, we must learn from the past and be prepared for the future. The ice storm in December 2013 and the microburst windstorms in July 2013 are examples of extreme weather events that remind us of the importance of being proactive. Oakville's Climate Change Primer is a tool that will help residents be more resilient when dealing with changing weather patterns and extreme weather events.

Pruning trees, preparing an emergency evacuation plan and/or having a stocked emergency preparedness kit can make all the difference when confronted by extreme weather. Oakville's Climate Change Primer provides this information to residents and informs residents about retrofitting incentive programs available in Halton.

The Climate Change Primer supplements Oakville's Climate Change Adaptation Strategy, which details the effects of climate change on town operations and the actions that the town will be taking to increase our community's climate change resiliency.

I encourage everyone to read the primer and implement the strategies that work best for you and your family. With your help, we can all be better prepared for any further climate change the future may bring.

Sincerely,

Mayor Rob Burton

Introduction

"It is not the strongest of the species that survives, nor the most intelligent that survives. It is the one that is the most adaptable to change."

-Charles Darwin

Climate change is fast becoming a critical issue both globally and locally. Recent events in Oakville such as the 2013 ice storm and microburst events as well as several flooding events over the past few years highlight the need to be prepared for ongoing challenges. Changing temperature and precipitation patterns, more extreme weather events and the resulting impacts to our environment will require us to adapt and the Town of Oakville is committed to building resiliency to these changing and **extreme weather** patterns. In Oakville, we are proud of our community's history of rising to meet these challenges.

In 2005, Town Council approved the first Environmental Strategic Plan (ESP), updated in 2011, with goals to improve waste diversion rates and local air quality, protect and enhance green space, lower **greenhouse gas (GHG) emissions** and reduce natural resource consumption.

A guiding principle of the ESP is to "ensure that our local actions contribute to the resolution of regional and global environmental issues." To help achieve this, the town has taken many actions, including:

- Developed a Conservation and Demand Management Plan to reduce the town's energy use and greenhouse gas emissions

The development and endorsement of this primer and the associated Climate Change Strategy – Technical Report continues this commitment to further advance the resiliency of our community.

The town's Climate Change Strategy - Technical Report provides a detailed resource for town operations. This primer was created for residents and provides a complementary resource to assist the public to better understand the challenges we are facing and what we can all do to successfully prepare. In this Primer you will find:

- An overview of climate change science and its effects
- A detailed look at how climate change is expected to impact Oakville
- Specific information and links to programs and incentives that will help you increase your personal resilience to the impacts of climate change
- A glossary of climate change terminology used in this document in *Appendix a*

Please let us know how you are using the information and any additional information you would like to see included by emailing environment@oakville.ca.

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The International Panel on Climate Change (IPCC) defines:

Mitigation as an anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases.

Adaptation as the process of adjustment to actual or expected changes, in order to moderate harm or exploit beneficial opportunities.

Climate change objectives

In keeping with the goals laid out in the Environmental Strategic Plan (ESP) the town joined the national **Partners for Climate Protection** (PCP) program in 2005. PCP is a network of over 240 municipal governments, which equates to over 80 per cent of Canada's population. Each of these municipalities is committed to reducing greenhouse gas emissions and taking action to reduce climate change. Through PCP's five-milestone framework, Oakville has created a greenhouse gas inventory, set reduction targets, and developed a corporate greenhouse gas reduction plan. For more information on these corporate actions please refer to Oakville's Climate Change Strategy – Technical Report, which is available on the **town's website**.

Following from this work, the town's joined **ICLEI's Building Adaptive and Resilient Communities** (BARC) framework in 2011 as one of the first 12 signatories involved in launching the new national program.

The town's Climate Change Strategy- Technical Report was developed using ICLEI's BARC methodical municipal five-milestone process.

The Climate Change Strategy – Technical Report lays out impacts, goals and actions to adapt town operations to a changing climate. These goals and actions are organized under a set of objectives and strategies as described below.

Vision:

To build the town's resiliency to the impacts of a changing climate.

Objectives:

Objective 1: To increase the town's capacity to protect against and respond to projected climatic changes.
- Comply with current legislation
- Provide input on proposed and existing legislation
- Build mitigation and adaptation considerations into existing and new plans, policies and projects
- Embed climate change considerations in staff reports and purchasing processes

Objective 2: To educate staff and residents through effective and efficient means of communication.
- Be timely and proactive using a multimedia approach
- Participate in internal and external outreach and educational events
- Encourage training and continous education through webinars, conferences and courses

Objective 3: To monitor the implementation of adaptation actions and goals in order to make continuous operational improvements.
- Identify and use available funding and partnerships to support actions
- Support innovation and research on best management practices and new technologies
- Initiate and implement best management practices (BMP)
- Review vulnerabilities annually

The creation of this primer and the public outreach provided by the town on climate change and extreme weather are intended to satisfy the objectives.

Climate change and the climate system

What exactly do we mean when we talk about Earth's climate system and climate change?

Climate change refers to a long-term shift in weather conditions. It is measured by changes in a variety of indicators including temperature, precipitation, wind and water levels. The data gathered depicts the changes in both average and extreme conditions, and may vary drastically across regions. For example, climate change is expected to affect Africa and Canada differently.

Climate change is a term that is often used to refer only to the surface temperature record of Earth, but there are more components to the climate system. The climate system is complex and includes the atmosphere (air), hydrosphere (water), cryosphere (snow and ice), lithosphere (rocky surface of Earth), and biosphere (plants and animals). The complexity of this system makes climate change more significant than simply overall warming. That is why this document will not refer to global warming but uses the more accurate term, climate change.

Figure 1 shows the Earth's different spheres, split between the living biosphere and the non-living spheres that make up the geosphere. Each sphere has an influence on, and shows impacts from, climate change.

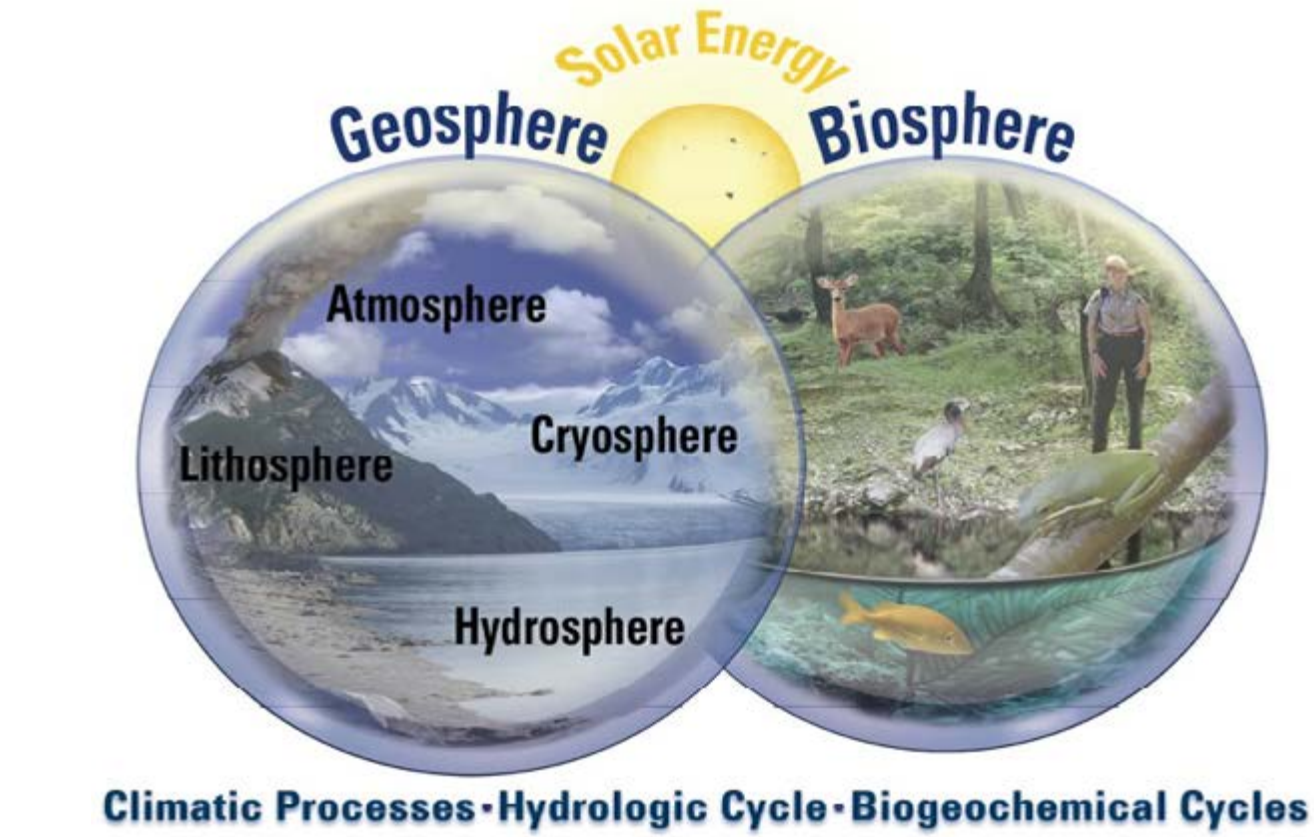


Figure 1: Components of Earth's climate system, includes the biosphere, or life-forms, on the right, and the geosphere, or non-living components on the left.

Each component of the climate system shows evidence of a changing climate. Table 1 describes examples of changes to each climate component as well as the cause of this change.

Table 1: Impacts that greenhouse gases and climate change have on each component of the climate system.

Climate component	Impact	Cause
Atmosphere	Average global air temperature has increased by about one degree Celsius since the early 20th century.	Atmospheric concentrations of **carbon dioxide (CO_2)** and other greenhouse gases have increased.
Hydrosphere	Rising sea levels and decreasing freshwater levels, as well as changes in groundwater hydrology. Changes in pH causing ocean acidification and impacts on sensitive species such as coral reefs.	Less water is stored in glaciers and ice. Changing precipitation patterns. Increasing ocean and freshwater temperatures.
Cryosphere	Melting glaciers, loss of Arctic sea ice, and decreases in winter ice cover in lakes.	Increasing average global and regional temperatures.
Biosphere	Ranges of many plants and animals are extending northward or diminishing. There are serious concerns that this will lead to significant losses of **biodiversity** across the biosphere as some species are unable to respond to these changes.	Changing regional climates that make habitats unsuitable, especially for plants and animals with specific habitat requirements.

Each of these components will experience complex interlinked impacts as the climate changes. This complexity is discussed in more detail in the section *"The complexity and cost of climate change"*

Greenhouse gases and the greenhouse effect

Greenhouse gases (GHGs) are gases that are naturally present in the atmosphere which absorb and emit radiation in the form of heat. They consist mainly of water vapour, carbon dioxide, **methane (CH_4)**, **nitrous oxide (N_2O)**, and **ozone (O_3)**, and although they get a bad reputation they are not entirely bad. Without them, the Earth's average surface temperature would be about 33 degrees Celsius colder, rendering the Earth uninhabitable.

Greenhouse gases are released through natural processes such as vegetation decay and **forest** fires as well as through **anthropogenic** activities like **land-use changes** and industrial processes. When greenhouse gases are produced by natural means they contribute to the natural greenhouse effect which is responsible for heating our planet and keeps Earth from looking like Mars. However, when these gases are produced from anthropogenic sources they increase the concentration of greenhouse gases in the atmosphere, which amplifies the natural greenhouse effect. Anthropogenic greenhouse gases and their enhancement of the greenhouse effect are the primary drivers of climate change.

Greenhouse gases insulate the Earth from cold surrounding space. They absorb heat from the sun and emit it back to the Earth, warming the surface. As the surface of the Earth increases in temperature it emits heat back into the atmosphere. Some of this is absorbed again by greenhouse gases. Part of this absorbed heat is then re-emitted back to the Earth's surface and it is this bounce-back action that can create problems. As the concentrations of greenhouse gases in the atmosphere increase, so does the amount of heat that is bounced back to the Earth's surface and as a result the Earth warms.

This effect is like adding multiple blankets while you're sleeping. While the first blanket might keep you warm and sleepy, the fourth blanket (or more) will make it so warm that it is hard to sleep. This is not because your body is producing more heat. Rather it is because each additional blanket prevents more body heat from escaping into the surrounding room. It is the same for the Earth. It is not that the sun is producing more energy; instead, increasing concentrations of greenhouse gases are 'blanketing' the Earth. As a result the Earth warms more rapidly. Both the natural and enhanced greenhouse effects are depicted in Figure 2, below.

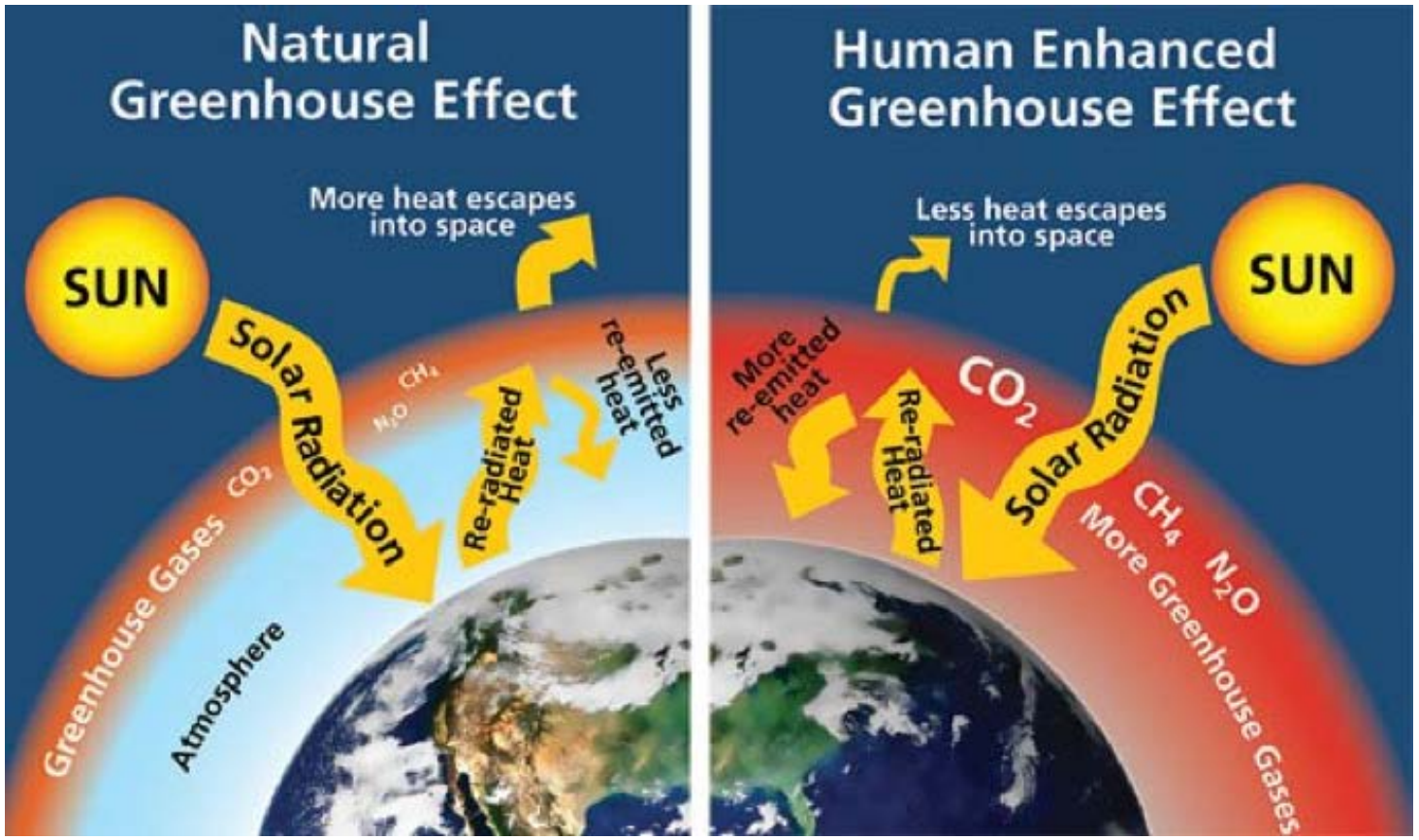


Figure 2: Depicts the natural greenhouse effect and enhanced greenhouse effect due to human activities.

The greenhouse effect is the cause for many of the climate change impacts that are being experienced around the world, including: rising average annual temperatures, increased intensity and frequency of storms, changes in precipitation patterns and water systems, and poorer air quality. Each of these impacts can and does result in further sub-impacts such as **drought**, food shortages, population displacement and health conditions such as asthma and Lyme disease.

Some greenhouse gases exist in large concentrations while others are present in low concentrations but influence climate change more. The atmospheric concentration of a greenhouse gas is less important than its interactions with the climate system and its ability to influence climate change. For example, water vapor is the most abundant greenhouse gas and is a major interface between the hydrosphere and the atmosphere. Despite this, changes in water vapor concentrations are reactive to changes in atmospheric temperature. As discussed in *"Appendix f: misconceptions about climate change"*, water vapor only amplifies the warming that is already occurring.

As the global population increases, so do the overall emissions of greenhouse gases, particularly carbon dioxide. Rapid increase in carbon dioxide causes an increase in temperature, resulting in warmer air that is able to hold more water vapor. As a powerful greenhouse gas, water vapor increases the warming effect of carbon dioxide. Thus, most greenhouse gases do not act alone. When they are released into the atmosphere from anthropogenic or natural sources, they interact with one another and with the climate system. For more information, see the section titled *"The complexity and cost of climate change"*

According to the Intergovernmental Panel on Climate Change (IPCC) fourth assessment report, "human activities – primarily burning of fossil fuels and changes in land cover-are modifying the concentration of atmospheric constituents or properties of the surface that absorb or scatter radiant energy" and "most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic GHG concentrations."

Carbon dioxide is the primary anthropogenic greenhouse gas; the warming potential of other greenhouse gases are expressed as a factor of carbon dioxide warming. Like the other gases, carbon dioxide is a naturally occurring gas in the atmosphere and is in constant circulation between the oceans, soils, plants and animals.

In the Earth's natural **carbon cycle**, CO_2 is released to the atmosphere by plant and **microbial respiration** and through air-sea gas exchange in the oceans. This natural cycle is altered by human activities and industrial processes. Over the course of Earth's history, carbon has been **sequestered** beneath the planet's surface in the form of petroleum, coal, and natural gas. Humans have tapped this natural resource in order to obtain fuel, which is burned to provide power for transportation, electricity generation, and many other human activities. This process of removing carbon, refining it, and burning it transfers carbon from the lithosphere (rocks) into the atmosphere in the form of carbon dioxide. Atmospheric CO_2 concentrations have increased by about 30 per cent from preindustrial values .

Anthropogenic emissions are not just a problem in the atmosphere. During the last decade, only about 48 per cent of global anthropogenic emissions have stayed in the atmosphere, with the remainder being taken up by the oceans and terrestrial **ecosystems**. This has had global impacts. For example, the dissolution of CO_2 into the oceans results in a change in pH or acidity of the water. This has led to bleaching of coral reefs and negative effects on other sensitive organisms.

Atmospheric nitrous oxide (N_2O) has increased globally by about 10% from preindustrial levels. N_2O is produced naturally through ocean and soil processes, while humans increase nitrous oxide production by burning biomass, and through the combustion of **fossil fuels** and use of fertilizers.

Methane (CH_4) is produced naturally by a wide variety of anaerobic (oxygen lacking) processes, for example through natural wetland processes. Methane is removed from the atmosphere by reaction with **hydroxyl radicals** in the lowest part of the Earth's atmosphere, which produces water vapor – also a greenhouse gas. Atmospheric methane concentrations have increased globally by almost 200 per cent from preindustrial levels, with a 30 per cent increase globally in the last 40 years. Methane is produced by anthropogenic activities like rice farming, cattle farming, biomass burning, and from landfills. (Data from the **IPCC 5th Assessment Report**)

Greenhouse gas emissions in Canada

According to the International Energy Agency, Canada's greenhouse gas emissions in 2009 amounted to about 2 per cent of global emissions. The global emissions contributed by Canada and other developed countries is projected to decrease in coming years relatively, as developing countries rapidly increase their emissions. Canada's emissions are also slowly decreasing as policies are put in place to limit emissions in the transportation and energy sectors. Between 2005-2010 GHG emissions dropped by 6.5 per cent despite a 6.3 per cent increase in the Canadian economy. This shows a change in the relationship of emissions and economy, their changes previously paralleled one another. Today, due to changes in regulations and consumer behaviour, emissions are being decoupled from economic growth. This indicates that Canadian manufacturers and consumers are becoming more climate aware. For more information on greenhouse gases in Canada see *"Appendix b: government action"*.

Carbon dioxide, as seen in Figure 3, is Canada's highest released greenhouse gas contributing to climate change. The data in this section is from **Canada's Emissions Trends, 2013** and from Environment Canada's **National Inventory Report - Greenhouse Gas Sources and SInks in Canada 1990-2012.**

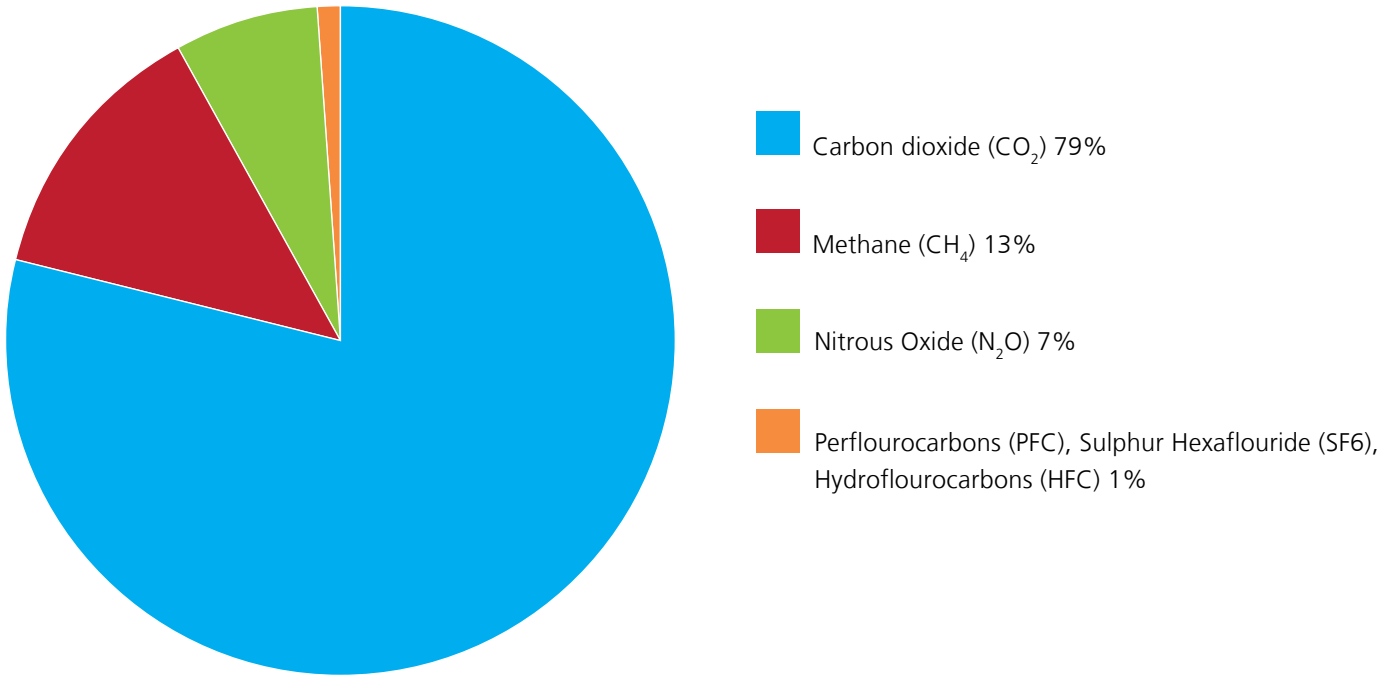


Figure 3: The chemical make-up of greenhouse gas emissions in Canada as measured in 2012.

Available data on Canada's greenhouse gas emissions is usually broken down by type of gas as well as by sector. Figure 4 depicts which industrial sectors are contributing the most to the release of greenhouse gases in Canada. This information is valuable for advising policymakers and others on where to focus emissions reduction efforts in order to maximize results and limit costs. For example, 65 per cent of electricity generation in Canada is already from hydro and other non-emitting sources. Although we can do more to improve our electricity generation, we are already maximizing efforts and it may be worthwhile to focus attention on other sectors that are operating less efficiently. The Government of Canada is following a sector-by-sector approach, which will reduce emissions where it makes the most sense to do so. For more information on actions employed by the Government of Canada see *"Appendix b: government action."*

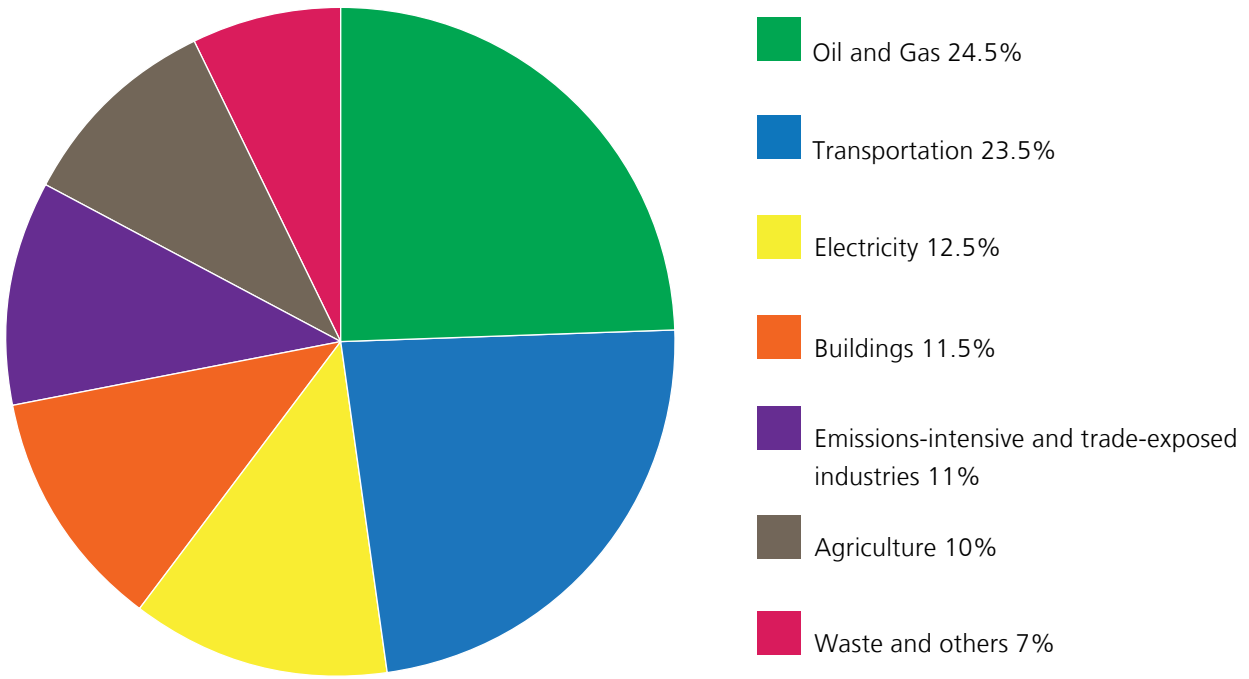


Figure 4: Sources of greenhouse gas emissions in Canada by sector, 2012.

The complexity and cost of climate change

The complexity of climate change

Earth's climate system is comprised of multiple components which have complex interlinked relationships. Each is affected by changes in other components. For example, carbon dioxide emissions from your car lead to increasing atmospheric temperatures which lead to increased evaporation of water from the hydrosphere which becomes water vapor in the atmosphere. As noted previously, water vapor is a potent greenhouse gas. It absorbs more heat from the sun, which causes increased temperatures in the atmosphere and more evaporation, and so the cycle continues.

Examples like this would ultimately lead to a runaway greenhouse effect if left unchecked. A runaway greenhouse effect is a process that increases the greenhouse effect until a planet's oceans boil away. Too much of a greenhouse effect and Earth would look like Venus, while too little and it would look like Mars. Clearly, managing greenhouse gases presents complications.

The earlier discussion of the components and complexity of the climate system outlined examples of climate change impacts. Climate change is more than just an increase in the global average surface temperature, but it is difficult to 'see' all of these changes.

First, there is the spatial scale. Climate change is occurring across the globe with different impacts and appearance in each region. To make things even more confusing, not all of these changes are bad. A changing climate might bring water to a region with little or lengthen the growing season as it is doing here in Southern Ontario. However, it can also cause and exacerbate droughts, wildfires and heatwaves, and threaten coastal cities as the sea level rises.

Secondly, there is the temporal scale. Climate is long-term patterns measured over decades rather than year to year, which makes it difficult to distinguish natural variation from climate change.

Figure 5 illustrates the climate-related impacts occurring around the world. This map represents a short period in which droughts, wildfires, extreme rain and flash floods caused landslides, melting ice caps, death and displacement of populations, and food shortages across the world,. If you imagine this increasing over a period of decades you can see the complexity more clearly. Climate change is visible in all components of the Earth's climate system and across different regions.

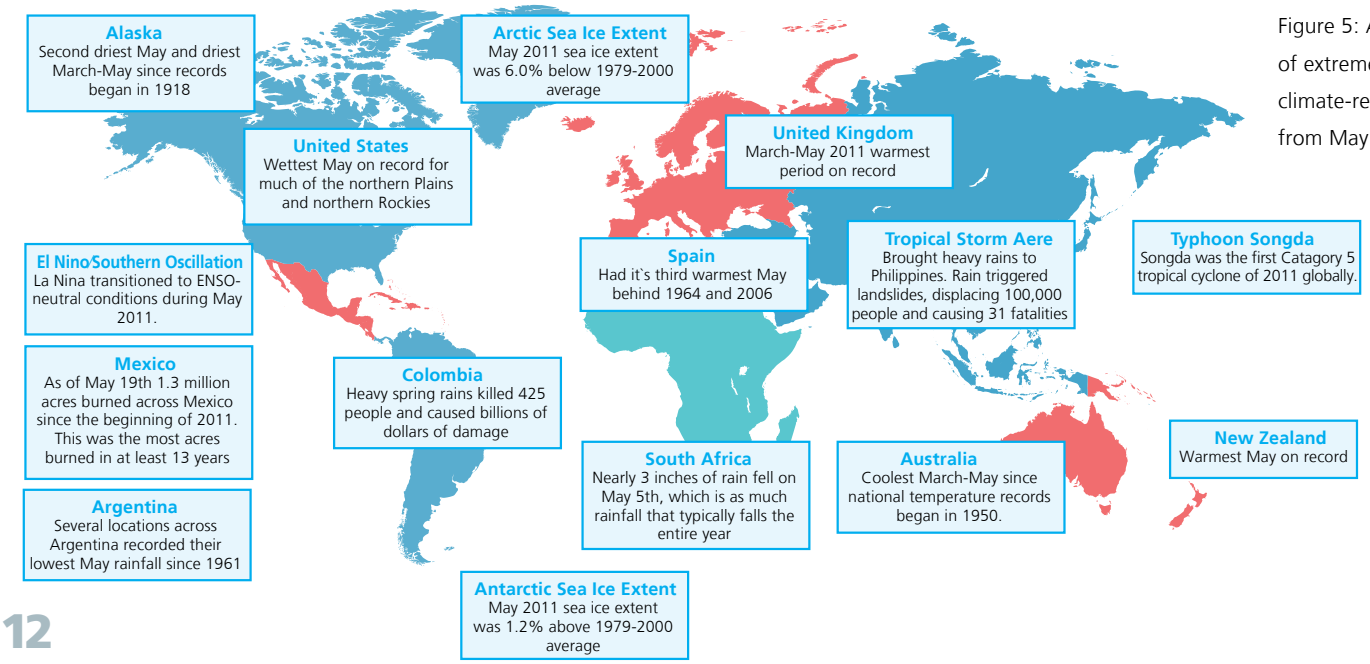


Figure 5: A global map of extreme weather or climate-related events from May 2011.

A more detailed look at climatic changes and impacts in Canada (Figure 6) shows a situation in which multiple changes and impacts occurred across the country over the past decade.

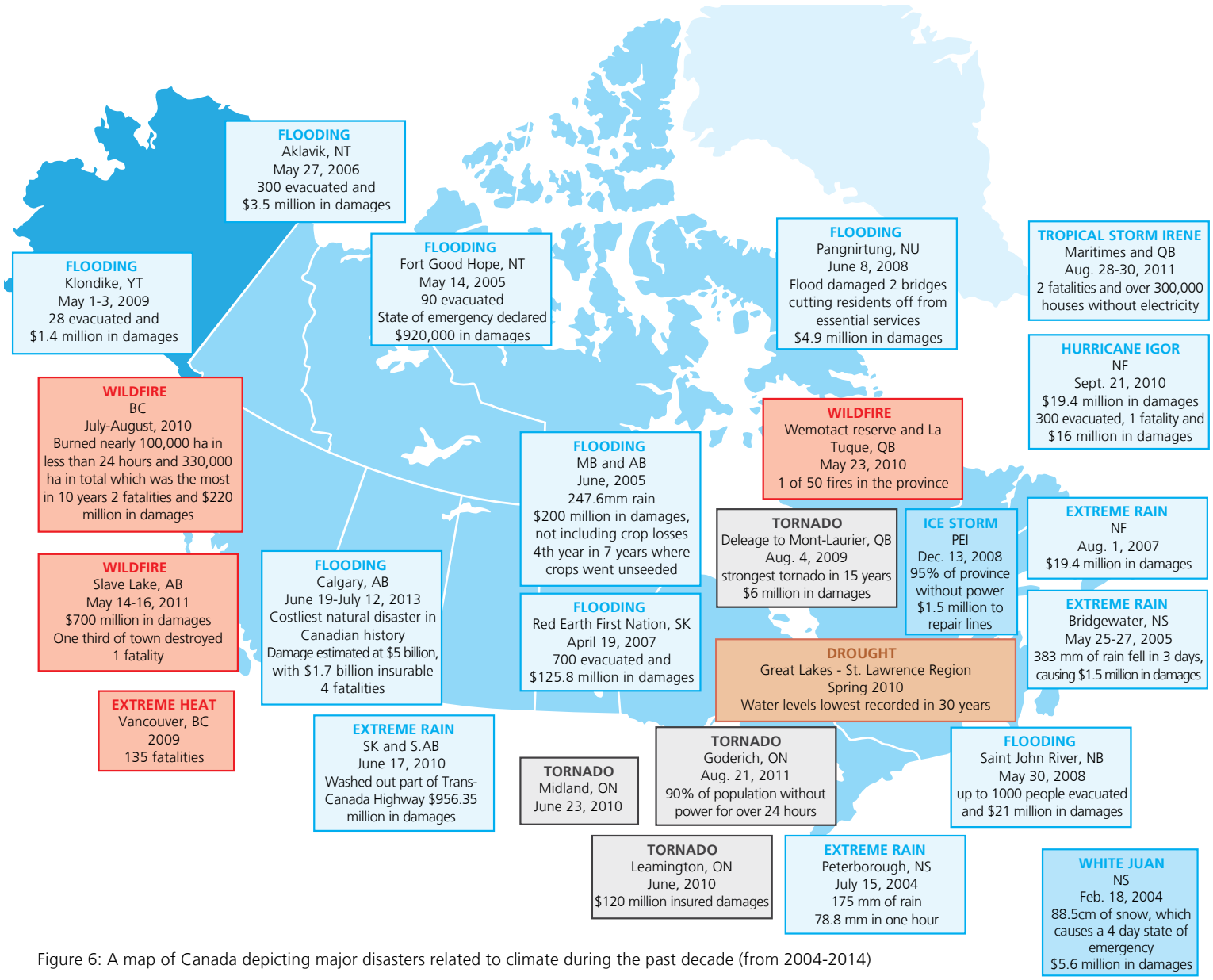


Figure 6: A map of Canada depicting major disasters related to climate during the past decade (from 2004-2014)

The damage represented in **Figure 5** and Figure 6 comes with a cost that is not always financial. The next section refers to the 'cost of climate change' including costs related to the impacts on our environment, health and safety, leisure activities, tourism and built environment.

The cost of climate change

Calculating the cost of climate change is challenging as it can include economic, environmental, human health and wellness considerations. This section attempts to provide a better understanding of those impacts for which it is possible to attach a monetary value.

Shipping and the movement of goods is one area where the effect of an environmental impact results directly in an economic cost. The load carried by a shipping vessel is calculated based on the type of vessel and current water levels. As water levels lower in the Great Lakes due to increased evaporation, proportionately less cargo can be carried via ship across the Great Lakes. Vice President of Southwestern Sales in Windsor ON, Jack Frye, estimates that the current low water levels cost shipping companies up to $20,000 per freighter, or an average for each company of $500 million per year, in lost revenue. This lost revenue is transferred to market goods, driving up prices.

Another direct cost of environmentally based climate changes experienced by individual homeowners relates to overland flooding. In a recent survey, it was found that 70 per cent of Canadians believe they are covered for overland flooding in their homeowner insurance policies. However, private insurance against overland flooding is not available in Canada. Overland flooding comprises all flooding caused by overland, coastal, groundwater, or riverine flooding. In Ontario , private insurance is only available for damage caused by sewer backup, or in parts of the country for things like damage caused by groundwater pooling against the foundation of a house (in Quebec). As surface water flooding becomes more of a problem for Canadians, it is important to be aware of what your insurance policy will cover and compare this to the potential for damage to your home. It is worthwhile to take steps to reduce that risk where insurance is not provided.

More local impacts include recent extreme weather events such as ice and wind storms. In July of 2013, Oakville's annual Midnight Madness event was interrupted by a series of microburst wind storms that were powerful enough to carry away vendors' tents and bend the metal posts holding up transit signs. On December 20-22, 2013 Oakville and other parts of central and eastern Canada were struck by a severe ice storm. The storm caused a buildup of freezing rain on surfaces which weighed down branches, split and uprooted trees and downed power lines. In Oakville, 45,000 of Oakville Hydro's 65,000 customers were without power at some point during the storm. The town also sustained damage to its urban forest, with the forestry section responding to over 11,000 storm-damaged trees on the public road allowance and in public parks. Town staff estimates there were two to three times this number of trees damaged on private property.

Figure 7: A map of the Greater Toronto Area depicting major disasters related to climate during the past decade (from 2004-2014).

Figure 7 illustrates additional significant disasters that have occurred throughout the GTA over the past ten years. These events all carried significant financial costs, impacted social activities and in some cases inflicted environmental and infrastructure damage. While we hear about hurricanes, wildfires and flooding across the globe related to climate change, as demonstrated in Figure 7, residents of Oakville and surrounding areas are also beginning to experience an increase in destructive weather related events. For more detailed examples see **Table 3** in *"Appendix c: examples of extreme weather events."* It is imperative to increase our resiliency to climate changes, in order to reduce the risks and costs associated with these impacts. Ways to increase your personal resiliency to climate change impacts are detailed in the following section *"Oakville's changing climate: local impacts and actions."*

Oakville's changing climate: local impacts and actions

Oakville's changing climate

Climate change is occurring around the world and affecting different countries and municipalities in different ways, depending upon their location. In Oakville, climatic changes can be expected to have significant effects on human health, the local economy, and our built and natural environment.

Observed and projected climate trends

The data presented in this Primer comes from **Climate Ontario**, the **International Panel on Climate Change (IPCC)** and **Environment Canada's Canadian Climate Change Scenarios Network (CCCSN)**.

Environment Canada has an extensive number of observation stations collecting climate data throughout the country. Observation stations with at least 70 per cent available data are selected by the CCCSN to create Localizer Reports. Oakville's nearest observation station with at least 70 per cent available data is located at the Halton Region Water Pollution Control Plant (WPCP) in south east Oakville. Oakville's Localizer Report, last generated on May 14, 2014 can be found in *"Appendix a: localizer report."*

Table 2 provides an overview of the climate change impacts expected for Oakville including an increase in annual averages for temperature, precipitation and the occurrence of extreme weather events.

Table 2: Town of Oakville's observed and expected climate change impacts

Climatic change	Degree of change		Possible impacts	
	Observed	Projected		
1.0 Temperature	An increase of 1.3°C to the annual average occurred between 1976 and 2006. The period of ice cover on the great lakes has been shortened on average by approximately one to two months over the last 100 to 150 years.	A further increase of 2.6°C by 2050. Lake ice is expected to decrease another half metre by 2050. Freezing rain is expected to increase 10-20% on average – northern Ontario to expect more than southern Ontario.	1.1 1.2 1.3 1.4	Northerly migration of **invasive species** and disease. Longer, warmer and more variable growing season. Changing winter precipitation. Increased freeze/thaw cycles.
2.0 Precipitation	A 12% increase to the annual average occurred in last 50 years.	A further increase of 5.1% is projected by 2050.	2.1 2.2	Increased mosquito breeding grounds and West Nile Virus activity. Potential for increases in other water or mosquito borne diseases. Precipitation falling in winter with periods of drought in summer months.

3.0 Extreme weather a. High wind	In the past, on average 12 tornadoes were reported to Environment Canada each year in Ontario. More recent numbers include: 2006=23, 2009=29, 2013=22	Eight tornadoes confirmed in the Greater Toronto Area by July, 2014 Possible that rising air and water temperatures will result in more tornado activity.	3.1 3.2	Increased risk of personal safety and property damage. Increased risks and delays associated with transportation.
3.0 Extreme weather b. Precipitation, Lightning and Winter storm events	Tropical storms: in the past occurred on average once every 11 years. Four have occurred between 2003 - 2009 Thunderstorms: 30 or more occurred each year between 1971-2000 Winter storm events: the annual average snowfall for Toronto is 122cm, distributed over 40.9 days.	Warmer temperatures and a rise in atmospheric water vapour will cause an increase in thunderstorm activity. The occurence of freezing rain is expected to increase 10-20% on average - northern Ontario to expect more than southern Ontario.	3.3 3.4 3.5	Increased closures and risks to users of parks, trails and sports fields and at special events. Increased instances of power outages and rolling blackouts. Increased instances of extreme temperature and poor air quality alerts.
3.0 Extreme weather c. Temperature and air quality	16 extreme heat days were experienced between 1971-2000 Oakville experienced 30 extreme heat days in 2005 alone	These numbers could more than triple by 2080.	3.6 3.7	Decrease in water quality from overland run-off and **erosion**. Increased risks to recreational users of town harbours and Lake Ontario

Although the expected climatic changes may not seem that extreme on their own, the magnitude of the impacts can be seen when combined with existing and increased environmental stressors including water, land and air pollution, industrial and residential development, invasive species and electricity generation.

Local impacts and actions

This section provides further details on the impacts listed in Table 2 and the actions that residents can take to **build personal resiliency** in order to reduce the risks associated with each impact. Actions taken by the town are also noted under the heading of **Building the town's resiliency** and more detail can be found in the companion document **Climate Change Strategy – Technical Report.**

1.0 Increase in annual average temperatures

Through recent experience and predicted models, warmer winters ON AVERAGE are projected despite the unusually cold winter of 2013-2014 which had 13 cold alerts spanning 41 days in Halton Region. This section covers a discussion on variable temperatures and not extreme temperatures (hot or cold). Extreme temperature refers to individual extreme temperature events, and is discussed in section 3.0.
An increase in annual average temperatures refers to both summer and winter temperatures, and the expected impacts of more highly variable temperatures are reviewed below.

1.1 Northerly migration of invasive species and disease

An increase in annual average temperatures of over 2 degrees over the next 35 years may seem insignificant but the implications to the natural environment and biodiversity are broad.

Oakville is home to many threatened, endangered, invasive and noxious species. As our local climate changes, so do the migration patterns of disease vectors and plant and wildlife species. Native plants and animals will likely suffer as the conditons to which they are adapted change, while invasive species better adapted to the new conditions will spread northward to replace them. It is anticipated that some of these will cause personal health and wellness issues as well as environmental impacts such as disrupted ecosystems.

Invasive species

The presence of emerald ash borer (EAB), gypsy moth, garlic mustard or other invasive species in Oakville may not have a direct link to climate change, but as temperatures increase these invasive species will likely migrate even farther north, to places that were previously too cold for them. Not only will their migration patterns change, these species may live longer each season which will increase the amount of damage done each year. These extended seasons and changing migration patterns will alter native species, most likely in a negative way.

Figure 8: (a) and (b): the Emerald Ash Borer is depicted in Figure (a). Figure (b) depicts a Green Ash leaf, showing 7 leaflets that are arranged opposite one another on the stem. Black, White and Green Ash are all common in Ontario.

Building your resiliency

- Refer to **Conservation Halton's invasive species webpage** to learn about the problematic species in our area.
- Visit the Town of Oakville's **Canopy Club facebook page**, **@OakCanopy Club** on twitter or the **town's website** for information on the identification, treatment and removal of ash trees impacted by EAB and other tree health information.
- Join the town's community-based forest monitoring group. Contact the town's Forestry department for further details and how to join.
- Refer to the town's **forestry maps** to locate ash trees and the EAB in Oakville.
- Be aware that species currently causing issues and devastation in other parts of North America have the potential to infest Oakville as temperatures warm.
- Plant native and drought resistant species that are more tolerant and will not weaken under the stress of warmer temperatures. Once vegetation is stressed due to illness, poor pruning or low nutrient levels (including water) they become more vulnerable to invasive species.
- Ensure proper pruning and maintenance of trees on your property.
- For information on wildlife in Oakville, visit the town's **Wildlife and Biodiversity page**.

Building the town's resiliency

- Refer to the theme: **Natural Environment and Biodiversity** in the Climate Change Strategy.

Disease vectors

The migration of the blacklegged tick, formerly known as the deer tick, is being closely monitored by climate change and public health scientists. Blacklegged ticks are known to transmit Lyme disease through their bites. Not all blacklegged ticks carry Lyme disease and a tick must remain on its host for 36 - 48 hr in order to transmit the disease. **Ontario's Ministry of Health** states that, "blacklegged ticks that are infected with Lyme disease are more common in the United States along the Atlantic seaboard (from Maine to Virginia), and in the Midwest (Minnesota and Wisconsin), than they are in Ontario." But blacklegged ticks are present in several parks across the province and the Ministry admits, "it is possible for people to encounter blacklegged ticks, or to be infected with Lyme disease from the bite of an infected blacklegged tick, almost anywhere in the province."

Figure 9: (a) and (b): the lifecycle and size of blacklegged ticks found in Ontario is depicted in (a). The 'bull's-eye' type rash (b) develops after an infected bite. The rash does not always appear and does not necessarily mean you have contracted Lyme disease.

Warmer seasonal temperatures will allow blacklegged ticks that carry Lyme disease to migrate north and allow a longer active season. Increased annual temperatures may also allow for a longer more active season for these blacklegged ticks and mosquitoes that have the potential to carry West Nile Virus (WNV). Other insects that carry diseases may also expand beyond their native ranges as changing temperatures and habitat conditions allow for their survival.

On a positive note, the increase in annual temperatures would increase **evaporation** and this would decrease standing water sites that are breeding grounds for mosquitoes that carry WNV.

Building your resiliency

Prior to camping or visiting provincial parks refer to the **Ontario Ministry of Health's website** to view the locations of blacklegged ticks in the province.

To repel ticks and mosquitoes the Halton Regional Health department suggests:

- Wear light-coloured, long-sleeved shirts and pants. The light colours will help you see whether there are any ticks on your clothing.
- Spray clothing and exposed skin with an insect repellent that contains DEET. Read and follow the manufacturer's directions for safe use.

To take extra precaution against ticks:

- Tuck your shirt into your pants and your pant legs into your socks to help keep ticks away from your bare skin. Wear shoes that cover your entire foot (avoid sandals or open shoes).
- After finishing your outdoor activity, check your clothing and your entire body for any ticks, especially the groin, armpits, and hairline. Check your pets regularly for ticks.

Building the town's resiliency

- Refer to the themes: **Health and Wellness** and **Built Environment** in the town's Climate Change Strategy.

On the brighter side, the increasing annual temperatures may allow for later and/or multiple plantings and harvesting of fruits and vegetables per season. Also it may be possible to grow a wider variety of fruit and vegetables in our gardens.

1.2 Longer, warmer and more variable growing season

Variable temperatures introduce the potential for earlier springs and warmer winters which will impact local vegetation in a few different ways, described below.

- Vegetation may emerge early, bloom in the unseasonably warm spring and die off when confronted with a cold snap. This can be detrimental to healthy new growth, buds, blooms, fruits and vegetables.
- Vegetation may be stressed by warmer temperatures and drier soils so it is crucial to care for newly planted vegetation to ensure its survival.
- Changes may occur to those species of plants that can survive new and less stable conditions.

Building your resiliency

At home:

- Refer to Halton Region's **Plant Selection and Design webpage** for a list of recommended native and drought resistant species.
- Monitor plant survival and die off rates.
- Visit the **town's website** for proper care and maintenance tips for newly planted vegetation. Tips include ensuring vegetation is watered regularly, roots are shaded and that soil conditions are appropriate.

In your community:

- Support Halton Region farms! Location of farms and harvest details can be found at **Simply Local**.
- Connect with local community groups such as **Oakville Sustainable Food Partnership** as well as the **Oakville Horticultural Society** to learn about their efforts to support local food.
- Join **PlantWatch**, a national volunteer monitoring program designed to help with the identification of ecological changes with the goal of helping scientists to understand how and why our environment is changing.

Building the town's resiliency

- Refer to the themes: **Natural Environment and Biodiversity** and **Health and Wellness** in the town's Climate Change Strategy.

1.3 Changing winter precipitation

Increased annual temperatures can also cause warmer winters which will result in winter precipitation in the form of ice, sleet and freezing rain rather than snow. Experts predict that lake-effect snow will increase in the short to medium term as lake temperatures rise and winter temperatures are still cool enough to produce snow. However, by the end of the 21st century, snowfall will likely be replaced by heavy lake-effect rain events due to the higher temperatures.

Winter precipitation events can have devastating impacts on urban forests, human health and wellness, and electrical distribution and transportation systems. The Town of Oakville, along with several other municipalities faced the 2013 Ice Storm that impacted electricity distribution to 45 000 of Oakville Hydro's 65 000 customers. Mayor Rob Burton relates, "this ice storm was the most significant storm experienced by the town in the last 35 years."

This event not only impacted electrical distribution, it also devastated the town's urban forests, downing trees and tree limbs causing safety issues across town. For more information on the cost of the damage incurred from this storm see **Table 3** in *"Appendix c: examples of extreme weather events."*

Building your resiliency

- Ensure your home and car are equipped with an emergency preparedness kit. Refer to *Appendix d* for examples of items to include.
- Print off Halton Region's **Personal Emergency Preparedness Guide** and keep it on hand for emergency situations.

At home:

- Always check the **Weather Network** for current and predicted weather conditions before heading out.
- Keep deicers on hand to maintain your driveway, sidewalks and pathways. Instead of salt, check for 'eco' products that are safe for pets, wildlife and the environment.
- It is always recommended to stay indoors when poor and dangerous conditions are predicted. If you absolutely need to venture out in poor weather there are a few actions noted below that can help you through it.

On the road:

- Take public transit instead of driving if you must leave the house.
- Register for a winter driving course – **Young Drivers of Canada** or **Skid Control School** offers courses.
- Ensure your vehicle is properly maintained, including fluid top-ups, tire inflation and the installation of winter tires.

Building the town's resiliency

- Refer to the theme **Health and Wellness** and **Built Environment** in the Climate Change Strategy.

1.4 Increased freeze/thaw cycles

Warmer more variable temperatures will increase the number of annual freeze thaw cycles. Freeze thaw cycles can take a toll on both the natural and built environments in several ways.

> One way we can benefit from increased precipitation is to increase our capacity for year round rain water capture and storage by using rain barrels or under and above ground cisterns. This is discussed in more detail in Impact 2.1.
>
> Halton Region holds four rain barrel sales for residents each spring. For information on dates and locations, visit **Halton Region's Website**.

Snow melt and ice jams

Typically in Southern Ontario we experience a single spring melt, and the majority of the winter snow accumulation melts. During this period rivers, creeks, channels and stormwater systems are at capacity, and if overwhelmed can cause potentially dangerous situations. Lately it has been observed that with the more variable temperatures, spring melt is not necessarily happening all at once and not necessarily happening only in the spring.

Melting and freezing of water is known to cause ice jams which can cause flooding of natural creeks, channels and stormwater systems. This presents health and safety risks and can result in property loss, environmental damage, insurance claims, costly repairs and maintenance. Warmer winters and variable temperatures make winter activities even more unpredictable and dangerous. For more information on flooding in Oakville refer to *Section 3.0: Increased frequency and severity of extreme weather* in this Primer.

Building your resiliency:

- Stormwater ponds and infrastructure are built to handle stormwater and prevent flooding. Recreational use of these facilities can impact their ability to function properly and can pose safety risks as this is not their intended purpose.
- It is always advisable to stay a safe distance away from the bank of any water body, especially after a heavy rainfall or during snow melt conditions.
- Refer to the **Town of Oakville** and **Conservation Halton's website** for flood warnings and ways to protect yourself.

Building the town's resiliency

- Refer to the themes: **Natural Environment and Biodiversity**, **Health and Wellness** and **Built Environment** in the Climate Change Strategy.

Stressed concrete

Repeated freeze thaw action on concrete and asphalt materials can cause stress cracks and fractures and eventually compromise the safety and performance of that structure. When concrete is saturated with water and then frozen, there is not enough room for the water to expand into ice and therefore the concrete fails. Driveways, sidewalks, the foundation of houses, and public infrastructure such as bridges and roads will all experience greater stress as freeze thaw cycles increase.

Building your resiliency:

- Check your foundation for cracks or dampness. Spring is a good time to check as the concrete has been through a winter/early spring freeze thaw cycle which is known to make existing fractures worse or cause new ones.
- Slope your eavestrough's downspouts away from your house to avoid the melt water from your roof draining close to the foundation.
- Report roadway and sidewalk fractures to ServiceOakville by dialing 311.

Building the town's resiliency

- Refer to the theme: **Built Environment** in the Climate Change Strategy.

2.0 Increase in annual average precipitation

An increase in annual average precipitation does not necessarily mean more rainfall in the summer months when it is needed most. An increase in average temperatures in combination with an increase in precipitation is expected to result in a 10 – 20 per cent increase in winter precipitation.

As referenced in **Table 2**, an annual average increase of 5.1 per cent is projected to occur by 2050 which will brings with it its own impacts and opportunities.

2.1 Increased mosquito breeding and West Nile Virus (WNV) activity

Increased annual precipitation in combination with rising temperatures will increase WNV activity in Southern Ontario. Mosquitoes that carry WNV, the adult ***Culex pipiens*** mosquito (the common house mosquito), lay their eggs on the surface of standing water and live their adult lives in weeds, tall grass and brush.

Halton Region in partnership with the municipalities of Burlington, Oakville, Milton and Halton Hills leads the WNV surveillance program tracking all WNV activity in the region. Mosquito larvicide is applied to stormwater ponds and catch basins, which tend to hold standing water, throughout the WNV season. Residential concerns are forwarded to municipalities for action.

Building your resiliency

Around your home:

- Remove all standing water sites on your property; this includes bird baths, children's toys, unopened pools, eavestroughs, drains, wading pools and wheel barrows.

Mosquitoes only need one inch of water to lay their eggs.

- Remove swampy or brush areas on your property where mosquitoes may be living.
- Report standing water on public and private property. Dial 311 and you will be directed to the appropriate department.

To protect yourself Halton Region suggests to:

- Wear light coloured clothing, long pants and sleeves, and remember to apply insect repellent.
- Avoid being out in early mornings and early evenings as this is when mosquitoes are most active.
- Refer to **Halton Region's WNV webpage** for historical and up-to-date information on the number and location of treated sites, positive mosquito pools and probable human cases.

Building the town's resiliency

- Refer to the themes: **Natural Environment and Biodiversity** and **Health and Wellness** in the town's Climate Change Strategy.

2.2 Precipitation falling in winter with periods of drought in summer months

In Southern Ontario we enjoy a seasonal climate, with distinct summers and winters. As the climate changes, our summers will likely become drier because increases in precipitation will be unable to compensate for the increasing evaporation due to higher temperatures. It is more likely that increases in precipitation will be apparent during the winter months, with summers experiencing drier soils and more droughts compared to baseline data.

During hot, dry summers water use can increase by as much as 50 per cent. It is likely that as summers become hotter and drier we will see increased restrictions on water use. It is important to make sure that water remains available for emergency and essential services like firefighting and flushing toilets, especially since during droughts fires are more common.

Building your resiliency

- Plant more native drought-resistant trees that will be able to survive and grow in drier soils and will require less watering.
- Ontario's **Grow Me Instead** is a guide to non-invasive plants to include in your garden.
- Halton Region's **Selection and Design** page also provides information on native and drought-tolerant species as well as methods of garden design that are more sustainable and conserve water.

On a positive note, increased temperatures will increase evaporation which will decrease standing water sites in some areas. Increased wind action would also help to accelerate evaporation.

- Halton Region restricts water use when water levels are low. The region always recommends careful use of water, but may restrict activities like: watering of lawns/gardens, filling pools, washing cars, and more. To view the three levels of restrictions and to see which level is currently employed visit Halton Region's **Outdoor Water Use Program.**
- Install a rain barrel like those offered for sale each spring at Halton Region's **rain barrel sales.** Rain barrels capture water that can then be used to water gardens and lawns without straining the region's water supplies.
- Switch to a water-efficient **WaterSense** certified toilet and take advantage of Halton Region's **Toilet Rebate Program**. The program offers $75 for one toilet per family, but in addition to this, when compared to less efficient older toilets a WaterSense certified toilet can save several hundred dollars on water costs per year.

Building the town's resiliency

- Refer to the theme: **Natural Environment and Biodiversity** in the town's Climate Change Strategy.

3.0 Increased frequency and severity of extreme weather events

The impacts of climate change are complex and interrelated. Rising average temperatures and increasing precipitation may cause an increase in the frequency and severity of extreme weather events including: high winds, extreme precipitation, lightning storms, and extreme temperature or poor air quality events. Ontario has experienced significant increases in the number of each of these events in the past decade, as displayed in **Table 2**.

Southern Ontario has recently been hit a number of times with severe storm events. Luckily most have bypassed Oakville, but Mississauga, Burlington, Toronto and Hamilton have experienced significant and costly impacts resulting from extreme weather. For example, since the 2005 Finch Street washout Toronto has had to recover financially from five other extreme weather events including an ice storm, high wind events and other instances of extreme precipitation. For more information on extreme weather events and their impacts in Canada, refer to the section *The complexity and cost of climate change*

and to **Table 3** in *Appendix c: examples of extreme weather events.*

This section details several types of extreme weather events including: high winds/tornados, severe storms (extreme precipitation, lighting), and extreme temperatures/poor air quality. Following this is a discussion on the potential impacts to you and your family that may result from these events, as well as measures that you can take to increase your resiliency to these events. Visit Oakville's page on **Emergency Planning** for more information on how to prepare for emergency situations.

High winds

High winds can have devastating impacts on our natural and built environments while jeopardizing individual health and safety. Environment Canada issues a wind warning when wind speeds reach 60 – 70 km/hour or wind is gusting at 90 km/hour or more. Environment Canada warns that winds over 70 km/hour will:

- Cause difficulty balancing and walking against the wind;
- Turn any loose item into a dangerous projectile; flying glass and debris pose the greatest danger to human safety;
- Make steering your vehicle difficult;
- Cause damage to trees, breaking limbs and branches.

In the past an average of approximately 12 tornadoes were reported in Ontario per year. In 2013, 22 tornadoes were reported in Ontario. Environment Canada accounts for this increase in part due to population growth and urban sprawl – there are more people in more places to report such occurrences. But there is also scientific evidence that states that rising air and water temperatures will contribute to more tornado activity in areas not previously prone to this type of activity. Interesting to note, Environment Canada confirms that Ontario experienced 19 tornadoes in 2014, with the first five occurring on a Tuesday. Tornado season typically lasts until early October.

According to the Insurance Bureau of Canada (IBC), wind damage is covered under most Canadian policies, and damage to vehicles from water is usually covered by a comprehensive auto insurance policy or if 'all perils' coverage has been purchased. Purchasing this coverage is not mandatory, so check your policy.

Environment Canada warns that to stay safe during a tornado or high winds you should:

- Monitor Environment Canada watches and warnings and keep an eye on the sky – tornadoes can develop very rapidly. Before high winds hit remain at home or indoors if possible.
- When a tornado threatens, take shelter immediately, preferably in a lower level or basement. Mobile home residents should go to their shelter area.
- If caught outdoors with no shelter available, lie flat in a ditch, ravine or other low lying area and shield your head with your arms.
- Put away loose objects such as outdoor furniture, garbage cans and put your car in the garage.
- When a tornado watch is issued, ensure that all doors and windows are closed. Tornado winds that find their way into a building through open doors and windows can lead to greater damage due to the built up pressure.

Severe storms (extreme precipitation)

Similar to high wind, extreme precipitation can have devastating effects on our natural and built environments, health and safety as well as recreation and tourism. Observation of changing weather patterns and data projections indicate that more precipitation will fall in shorter periods of time causing personal safety risks, environmental impacts and property damage.

Environment Canada defines extreme rainfall in Ontario as: when 50 mm or more of rain is expected within one hour.

The IBC states, 'In general, overland flooding resulting in water entering a home is not covered. Overland flooding usually occurs when bodies of water, such as rivers, dams and other watercourses, overflow onto dry land and cause damage to residential areas. Overland flooding and seepage can not be covered by home insurance because it is only a risk for the small percentage of the population who live in a flood plain. Since the purpose of insurance is to spread risk among many policyholders, flood insurance for those at risk would be unaffordable.' Did you know that a recent study by the IBC found that over 70 percent of Canadians believe they are covered for overland flooding, when in actuality they are not?

The IBC also clarifies that, 'Water damage in a basement due to a sewer backup is only covered if specific sewer backup coverage has been purchased.'

Severe storms (lightning)

According to Environment Canada, lightning flashes occur in Canada over two million times a year, including about once every three seconds during the summer months. In Canada, lightning strikes kill up to 10 people each year and seriously injure about 164 others. Lightning can ignite

up to 4,000 forest fires per year in Canada. A reminder from Environment Canada states, 'When thunder roars, go indoors! – When you can hear thunder, you are within striking distance of lightning.'

Environment Canada advises that during a lightning storm you should:

- Get to a safe place. A safe location is a fully enclosed building with wiring and plumbing. Sheds, picnic shelters, tents or covered porches do NOT protect you from lightning. If no sturdy building is close by, get into a metal-roofed vehicle and close all the windows.
- Do not handle electrical equipment, telephones or plumbing. These are all electrical conductors. Using a computer or wired video game system, taking a bath or touching a metal window frame all put you at risk of being struck by lightning. Use battery-operated appliances only.
- If on water, get to shore as quickly as possible. The high waves and strong gusts of wind associated with sudden fast-moving storms can make it difficult for swimmers, boaters and water skiers to reach shore safely. Lightning that hits water travels well beyond its point of contact. Small boats with no cabin provide less protection than boats with enclosed cabins.
- If caught outdoors far from shelter, stay away from tall objects. This includes trees, poles, wires and fences. Take shelter in a low-lying area but be on the alert for possible flooding.

Extreme temperatures and poor air quality

In the baseline period of 1971 – 2000, Oakville experienced only 16 extreme heat days in 30 years. Oakville experienced 30 extreme heat days in 2005 alone and it is predicted that these numbers could more than triple by the 2080s. An increase in the frequency and duration of extreme temperature events such as heat, often accompanied by smog, and extreme cold events pose health and safety risks to town staff and residents. It is important to be aware of appropriate actions and safety measures to take during extreme heat events or on days of poor air quality.

Environment Canada issues a heat alert for extreme temperatues when the temperature is expected to reach 30C or more and humidex value is expected to reach 40°C or more, or when temperature is 40°C or greater.

During Heat Alerts and in warm weather the following is recommended:

- Drink lots of water (avoid caffeinated and alcoholic beverages)
- Check regularly on children, neighbours, the elderly, and persons with disabilities and chronic illnesses.
- Stay in an air-conditioned place (if possible) and only go outdoors during the coolest part of the day.
- Limit outdoor exercise.
- Avoid the sun by wearing loose-fitting clothing, hat and sunglasses and apply sunscreen 20 to 30 minutes before going outside.

Previous messaging on heat and air quality information targeted the young, the elderly, and those with respiratory illnesses, but it is becoming apparent that the 18-24 year old outdoor worker is now the most impacted or vulnerable population.

During Smog Alerts the following is recommended:

At home:

- Protect those most affected (e.g., children, elderly, etc.).
- Those with breathing and heart problems should pay special attention to increased symptoms.
- Avoid strenuous exercise in the heat of the day.
- Stay indoors if you can — a cool, moist atmosphere is best.
- Avoid oil-based products such as paints, solvents etc. — they contain volatile organic compounds (VOCs) which contribute to smog.
- Don't use the barbecue and limit air conditioning.
- Avoid driving; take public transit, walk or cycle as able.
- Do not let engines idle for long periods.
- Restrict your use of gasoline-powered equipment.

At work:

- Take public transit, or better yet, walk or cycle to work as able.
- If you use a car, car pool.
- Consider teleconferencing instead of travelling to meetings.
- Turn down the air conditioning and put a casual summer dress code in place.

3.1 Increased risk of personal safety and property damage including basement flooding

Personal safety should be of utmost concern when confronted by extreme weather and proper precautions should be taken. Finding a safe location to protect you and your family from the elements should be a priority. In the case of extreme weather, being prepared and informed while slightly altering some behaviours can help us respond to these changes.

For example, historically Southern Ontario experienced insurance claims primarily related to fire and wind damage, but now flooding claims are the most common. The Insurance Bureau of Canada (IBC) states that in general, "losses from natural catastrophes in Canada are rising. Claim payouts from severe weather have doubled every five to ten years since the 1980s." Basement flooding is a risk for every home, and this risk increases as changing precipitation patterns include increasing extreme precipitation events. See **Figure 7** for examples.

Generally, houses have been built to withstand the usual types of weather expected for southern Ontario, but as the climate changes the types and intensities of the storms that we receive are also changing. Some simple adjustments to our homes can be the difference between extensive and minimal property damage.

Building your resiliency

- Check the **Weather Network** or the **Government of Canada's Weather website** for weather conditions.
- Be aware of the appropriate safety measures to take before heading out into any extreme weather event. Refer to **Environment Canada** for more information of these safety measures.
- Refer to *Appendix d: emergency preparedness* for ways you can weather proof or storm proof your house.
- Be sure to review your insurance policies – call your insurance professional if you have questions about your coverage or call IBC's Consumer Information Centre at 1-800-377-6378.
- Check out the **IBC's website** for more information on basement flooding and the **kinds of water damage** that are covered by insurance.
- Periodically check for foundation cracks and refer to the **Sump and Sewage Pump Manufacturers Association** for pump maintenance and basement flooding protection tips.
- Refer to the town's **Flood Mapping and Prioritization Study** to see whether your home is at risk of flooding.
- If warranted, take advantage of Halton region's $2,750 per home Basement Flooding Prevention Subsidy program.
- View Halton Region's **Guide to Flooding** for information on flooding. Or view the region's **Basement Flooding** page for a comprehensive discussion on flooding, stormwater, sewers, and how you can determine your home's risk.

Figure 11: Improper and proper stormwater connections.

- Increase the amount of permeable surface on your property to allow water to infiltrate into the ground by planting trees to absorb and impede the flow of water or by installing a rain barrel like those offered at **Halton Region's Annual Rain Barrel Sale** held each spring in each Halton municipality.

Building the town's resiliency

- Refer to the themes: **Natural Environment and Biodiversity**, **Recreation and Tourism**, **Health and Wellness** and **Built Environment** in the Climate Change Strategy.

3.2 Increased risks and delays associated with transportation

If possible, stay indoors during an extreme weather event. If traveling is absolutely necessary, take public transit. However, whether on public transit or in your own car, transportation delays are likely to occur during extreme weather events.

Building your resiliency

- Take **Oakville Transit** or **Go Transit** if you need to get somewhere.
- Register for a winter driving course – **Young Drivers of Canada** and the **Skid Control School** offer these types of courses.
- Ensure your vehicle is properly maintained, including fluid top-ups, tire inflation and the installation of winter tires.
- Refer to *Appendix d: emergency preparedness* to see what should be included in your car emergency preparedness kit.
- Investigate if your company has a work from home or extreme weather policy.

Building the town's resiliency

- Refer to the theme: **Built Environment** in the Climate Change Strategy.

3.3 Increased closures and risks to users of parks, trails and sports fields

During and after both the wind storm and ice storm in 2013, town parks and trails were closed for an extended period of time. The risks posed to trail and park users after the ice storm including fallen and falling tree branches, ice accumulation on overhead wires and trees, and slippery conditions near open water and on paths and roadways. Damage to turf sports fields during and after extreme precipitation events can be high if the fields are used. Often fields that have poor drainage will be closed.

Building your resiliency

- Always check the **Weather Network** or the **Government of Canada's Weather website** for current and predicted weather conditions before heading out.
- Visit the **Town of Oakville's website** for a list of park, trail and field closures or call Service Oakville at 311.

Building the town's resiliency

- Refer to the theme: **Natural Environment and Biodiversity** in the Climate Change Strategy.

3.4 Increased instances of power outages and rolling blackouts

Electrical disturbances can be caused by extreme weather conditions. High winds can cause tree limbs to fall on wires and extreme temperatures can cause rolling blackouts and outages due to transformer station overloading.

During the ice storm in 2013 several areas of the GTA were without power for hours, days and even weeks over the winter holidays.

Over 110 calls to Oakville Fire and Halton Region EMS were attributed to carbon monoxide poisoning during the ice storm. Without power, BBQs and gas powered generators were brought indoors and used for warmth - a dangerous, unacceptable practice.

Beginning in January 2015, Oakville Hydro and the town's forestry department partnered to provide proactive **hydro line clearing** to reduce power outage due to fallen trees. Electrical disturbances also cause unplanned financial impacts. Many people lose a freezer's worth or more of food and this can be very costly. The potential for food poisoning is increased during extended periods without power, since residents may try to consume food that should have otherwise been discarded. The Government of Canada's **Get Prepared website** has emergency preparedness checklists and advice related to power outages.

Building your resiliency

- Participate in Oakville Hydro's **Save on Energy** and **PeakSaver** energy conservation programs.
- Investigate the potential of renewable energy. The Province's **MicroFIT** program offers incentives for residential installations. Solar water heating is another option to reduce household energy consumption.

The Ontario Ministry of Health advises the following:

- A full upright or chest freezer will keep everything frozen for about two days, while a half-full freezer will keep food frozen for one day
- Your refrigerator section will keep food cool for four to six hours, depending on the temperature in your kitchen.

Tips to keep your food safe during a power outage include:

- Keep your refrigerator and freezer doors shut as much as possible.
- Store your food in a friend's or neighbour's freezer.
- Use ice to help keep your refrigerator and freezer cold.
- If your frozen food has thawed, it can be re-frozen if it still contains ice crystals or feels refrigerator-cold.
- Discard any thawed food that has risen to above 4°C (40°F) and remained there for two hours or more. Immediately discard any food with a strange colour or odour. When in doubt, throw it out.
- Refer to *Appendix d: preparing for a storm* for ways you can weather proof or storm proof your house and for emergency preparedness checklists for your home and car.

Building the town's resiliency

- Refer to the themes: **Natural Environment and Biodiversity**, **Health and Wellness** and **Built Environment** in the Climate Change Strategy.

3.5 Increased instances of heat, cold and poor air quality

Extreme temperatures can strike in any season; in Oakville we have experienced heat and cold alerts in all four seasons. Oakville already has smog, heat, and extreme weather protocols that are implemented on days when the local air quality and extreme weather may impact health.
Included in the town's protocols are extended hours of warming/cooling centres and increased communication to the public via website, newspaper articles and public information kiosks at town facilities.

As the climate changes, the town will need to implement these protocols more frequently. Figure 12 shows the number of heat, cold and smog alerts that have impacted Halton Region over the past 10 years.

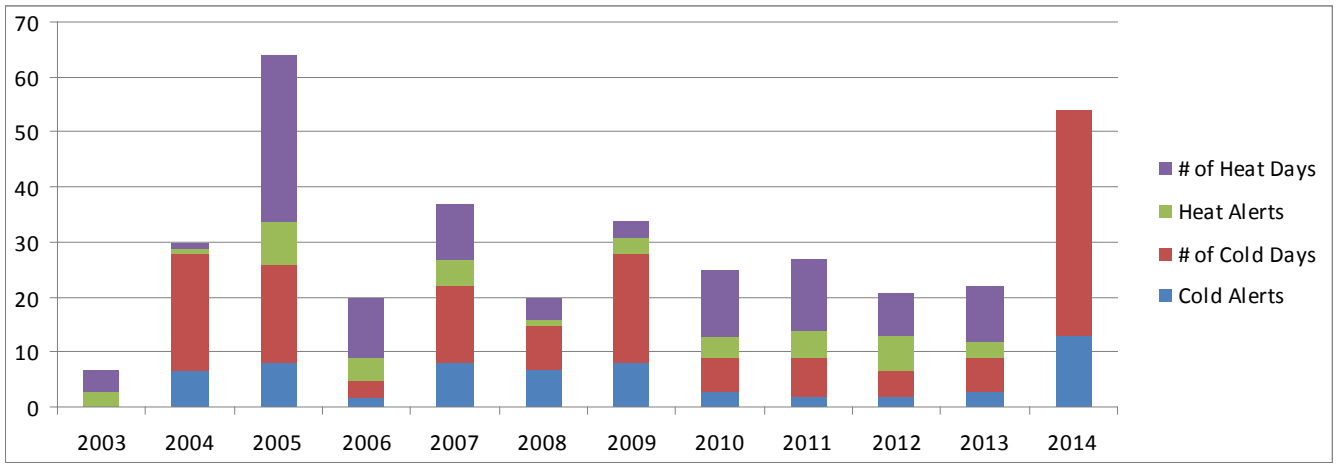


Figure 12: Number of heat, cold and smog alerts in Halton Region since 2003.

Building your resiliency:

- Always check current and forecasted weather prior to heading outside.
- Sign up for the **Province of Ontario's Smog Alert program** to receive an email when an air quality alert is issued.
- Take advantage of the town's **Heat Alert protocol** and visit a pool or community centre with extended hours of operation.
- Refer to Health Canada's **Air Quality Health Index**.
- Planning an event outdoors in the summer? Request the use of the town's water bar through the water bar lending program. Portable water bars are provided for free by the town to combat the effects of extreme heat at public events.
- Use public transit.

Building the town's resiliency

- Refer to the theme: **Health and Wellness** in the Climate Change Strategy.

Figure 13: Map showing the locations of cooling centres throughout Oakville.

3.6 Decrease in water quality from overland runoff and erosion

An increase in precipitation, especially heavy downpours will increase the amount of overland **runoff**. Overland runoff is any precipitation that does not channel into a stormwater system including natural creeks and ditches. This overland runoff degrades water quality as it carries with it natural debris, litter, sediment, motor oil, fertilizers, pesticides, animal feces and contaminants.

Increased wind and wave action will also impact shorelines along the lake and at the outlets of creek systems, causing degradation of water quality with sediments from erosion. Uprooted trees from wind or rain and rushing water from a large winter melt event or extreme precipitation event will accelerate erosion and degrade local water quality.

There are many actions that residents can implement on their own properties that can reduce the surface water runoff in Oakville and actions are listed below.

Building your resiliency:

- Do not mow close to shorelines. Reduce fertilizer use and keep planted buffer zones to reduce stormwater runoff and improve water quality.
- Increase the amount of permeable surface on your property to allow water to infiltrate into the ground, plant trees to absorb water and impede its flow, install a rain barrel like those offered at **Halton Region's Annual Rain Barrel Sale** held each spring in each Halton municipality to capture rainwater for reuse.
- Halton Region monitors the water quality of beaches within the region. Visit **Beach Water Monitoring Results** for information about which beaches are currently recommended for swimming.

Building the town's resiliency

- Refer to the theme: **Natural Environment and Biodiversity** in the Climate Change Strategy.

3.7 Increased risks to recreational users of town harbours and Lake Ontario

Oakville's location on the north shore of Lake Ontario provides residents and tourists many benefits and opportunities but it also poses some risks under extreme weather conditions.

The **Town of Oakville's Water and Air Rescue Force** (TOWARF) is a Canadian Coast Guard Auxiliary Unit and provides marine search and rescue services. Started by Oakville's past Police Chief Fred Oliver in 1954 in partnership with the local boating community and with more than 75 trained volunteers, TOWARF has been patrolling western Lake Ontario with the primary goal of saving lives at risk.

The importance of checking local weather conditions when boating in town harbours and on Lake Ontario cannot be stressed enough.

Building your resiliency:

- Always check the **Weather Network** or the **Government of Canada's Weather website** for current and predicted weather conditions before heading out.
- Refer to the town's **Safe Boating webpage** for useful links and safety tips.
- Always be sure you are licensed and capable of properly operating your watercraft.
- Be sure your watercraft is stocked with the appropriate number of lifejackets as well as a bailing bucket, whistle and all of the required safe boating equipment.
- TOWARF is on duty 32 hours a week and on call 24/7 at the Rescue Centre and through the Halton Regional Police Service during the boating season.
- For information on boating laws view Transport Canada's **Safe Boating Guide** and visit **Oakville's Harbours** page for information on Oakville's Harbours By-law.

Building the town's resiliency

- Refer to the theme: **Natural Environment and Biodiversity** in the Climate Change Strategy.

Conclusion

The changing climate impacts the natural environment, health and wellness, infrastructure, and recreation in a variety of ways. While the importance of reducing human impacts on the environment is often discussed, it is becoming more apparent that communities like Oakville must also look at ways to adapt to the impacts of climate change. Working together locally and at all levels of government is the best and most economical way to build the resiliency of our livable community of Oakville. Thank you for doing your part!

For more information on the Town of Oakville's response to climate change please refer to **Oakville's Climate Change Strategy – Technical Report** or contact us at **environment@oakville.ca**.

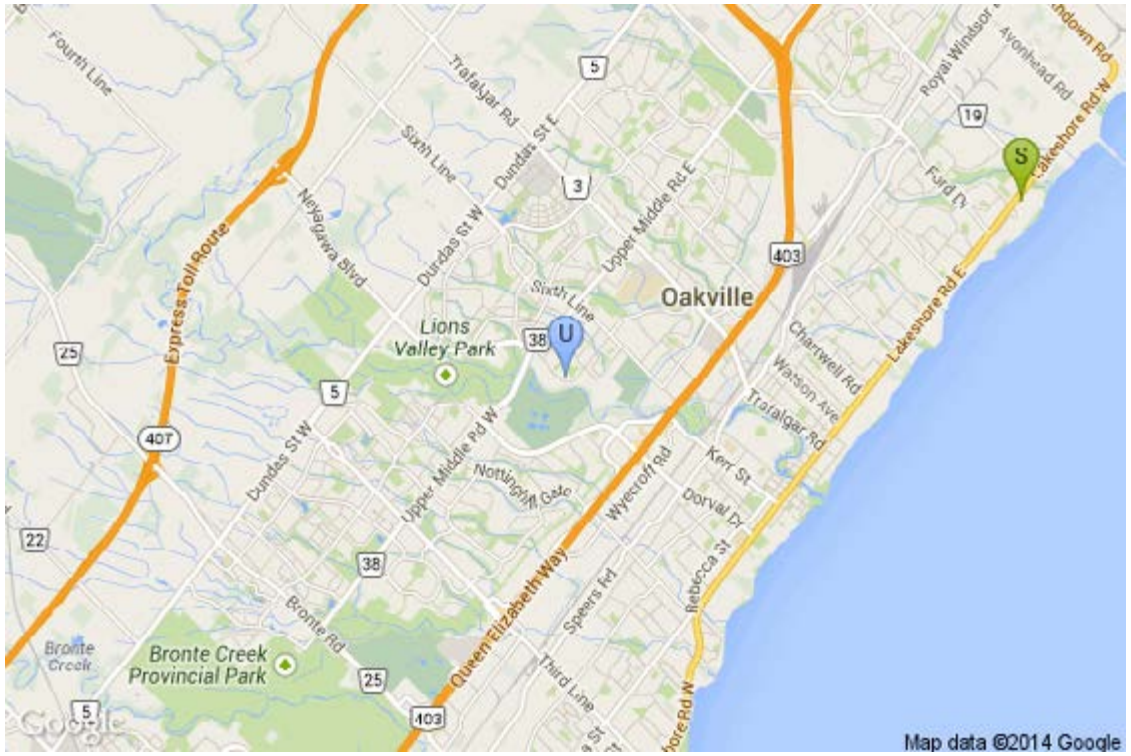
Appendix a

Localizer
CCCSN.CA
CCCSN - RCSCC

This document was created on Wed May 7 14:45:05 2014 by CCCSN

Parameters

* User location: Oakville, ON (43.46N 79.71W) [U]
* Nearest climate station (with at least 70% available data[note]): Oakville Southeast Wpcp (id: 615N745) (43.48N 79.63W) [S] (distance: 7.25 km)



Localizer
CCCSN.CA
CCCSN - RCSCC

Background Information

The Localizer is a quick way of determining the multi-model mean projected change of temperature and precipitation on a monthly, seasonal and annual timescales for hundreds of locations across Canada. Your entered location is checked against the extensive Environment Canada network of observation stations during the period of 1971-2000, and the closest station (with at least 70% available data) is selected automatically. Note in some areas, even the closest station (with at least 70% available data) could be distant due to station density. This is particularly true in northern Canada. The localizer will indicate how far away your entered location and the observation station selected are from one another.

The Localizer uses the climatology of the observation station for the period of 1971-2000 as the baseline climate in all cases. The model projected changes between 1971-2000 and the future time periods (2020s, 2050s and 2080s) are then added to the observed baseline. This results in a projected future scenario which is 'bias-corrected' to the location. Monthly, seasonal and annual projected values of temperature and precipitation are calculated from the ensemble of models.

The number of models used for the ensemble varies with experiment: (A2-High Emission Scenario = average of 20 models; A1B-Medium Emission Scenario = average of 24 models; B1-Low Emission Scenario = average of 21 models). Research has indicated that the use of multi-model ensembles is preferable to the selection of a single or few individual models since each model can contain inherent biases and weaknesses (IPCC-TGICA, 2007). The use of the ensemble projection from the family of global modelling centres is likely the most reliable estimate of climate change projections on a large scale (Gleckler et al, 2008). Further refinement of climate change at individual locations (not using grid cell change) is possible using statistical downscaling techniques, but this methodology requires software and properly formatted input data to compute. Statistical downscaling software and input data for a few models (not the full suite of 24 models) is available elsewhere on CCCSN/RCSCC (www.cccsn.ec.gc.ca).

There are several steps used to obtain the multi-model ensemble mean. First, the average model values are calculated for each of the four time periods. The results from each model are then interpolated to a common resolution and grid projection. The common grid corresponds to the NCEP (National Centers for Environmental Prediction) resolution of approximately 200 x 200 km at mid-latitudes. The approximate

size of the grid cell can be seen on the output page where sample annual temperature and precipitation change maps for the 2050s are shown. Your selected location is marked by the '+' symbol in the middle of the map. The proximity to other grid cells is indicated along with the approximate change for those neighbouring cells.

The changes between the model baseline period (1971-2000) and the future time periods are then calculated for each of the models. This differencing method corrects for model biases, since only the change between baseline and the future is considered. The average ensemble change of the models (for monthly temperature and precipitation) are then added to the station observed baseline values. The standard deviation indicates the degree of certainty in the future projected value for each location. Locations with low standard deviations indicate those areas where there is good model agreement in the projected change. Conversely, locations with high standard deviation values indicate locations with large inter-model variability. Assuming a normal distribution, the ± 1 standard deviation value indicates that 68% of the models fall within that estimated range.

The values presented in the Localizer allow users to quickly obtain climate change projections from an ensemble of Global Climate Models, from which to base further study. CCCSN/RCSCC assumes no liability for the use of this tool or data. Use of this information should be credited as seen in this statement. Feedback is always welcome at: cccsn_info@ec.gc.ca.

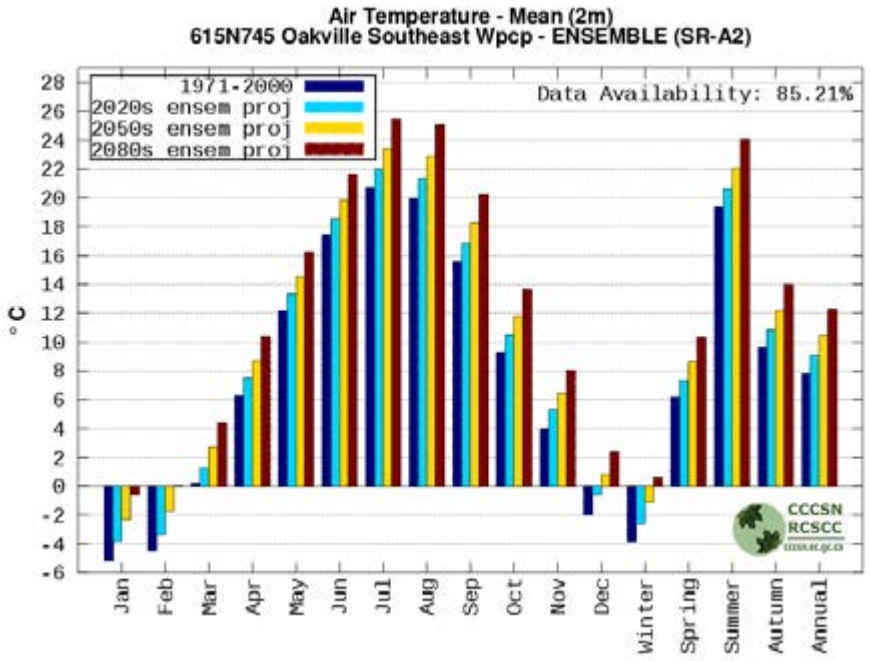
References

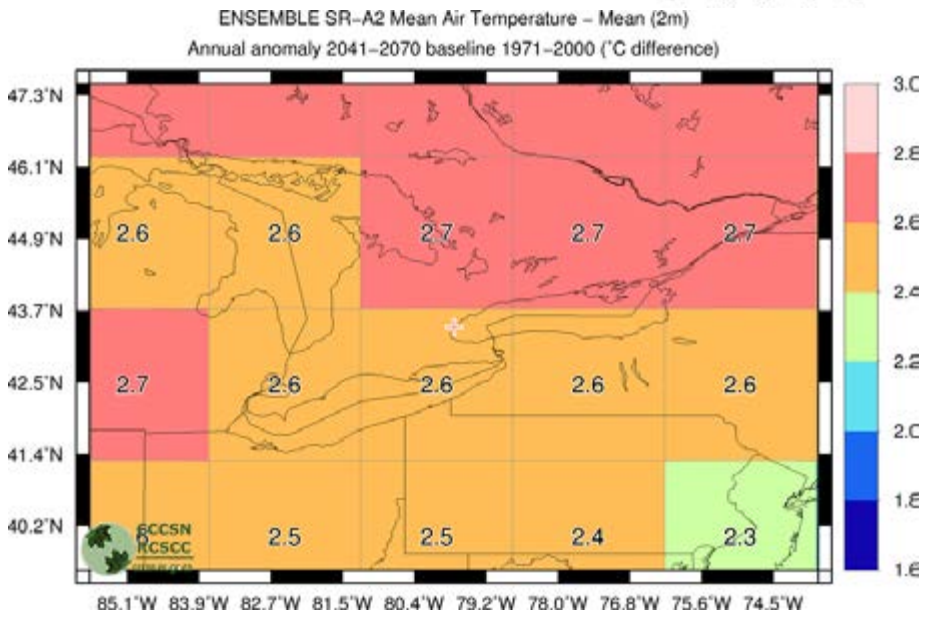
* IPCC-TGICA, 2007: *General Guidelines on the Use of Scenario Data for Climate Impact and Adaptation Assessment*. Version 2. Prepared by T.R. Carter on behalf of the Intergovernmental Panel on Climate Change, Task Group on Data and Scenario Support for Impact and Climate Assessment, 66pp.

* Gleckler, P. J, K. E. Taylor, and C. Doutriaux (2008) Performance metrics for climate models. Journal of Geophysical Research. Vol. 113. D06104.

SR-A2 Air Temperature - Mean (2m)

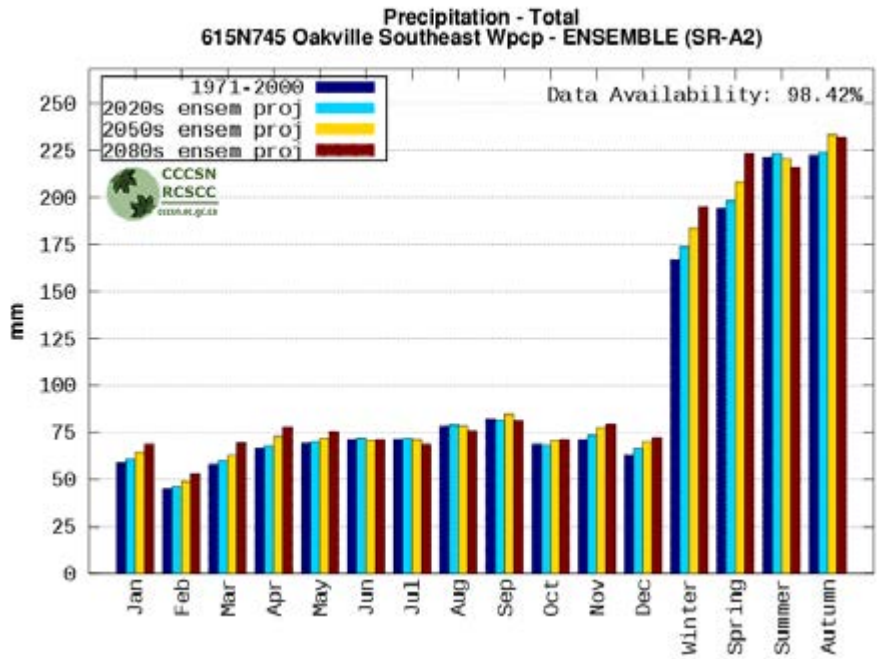
°C	annual	winter	spring	summer	autumn
1971-2000	7.8	-3.9	6.2	19.4	9.6
2020s	9.1 ± 0.3	-2.6 ± 0.5	7.4 ± 0.5	20.6 ± 0.4	10.9 ± 0.3
2050s	10.5 ± 0.6	-1.0 ± 0.7	8.7 ± 0.7	22.1 ± 0.8	12.1 ± 0.5
2080s	12.2 ± 1.0	0.6 ± 1.0	10.3 ± 1.0	24.1 ± 1.5	14.0 ± 0.9

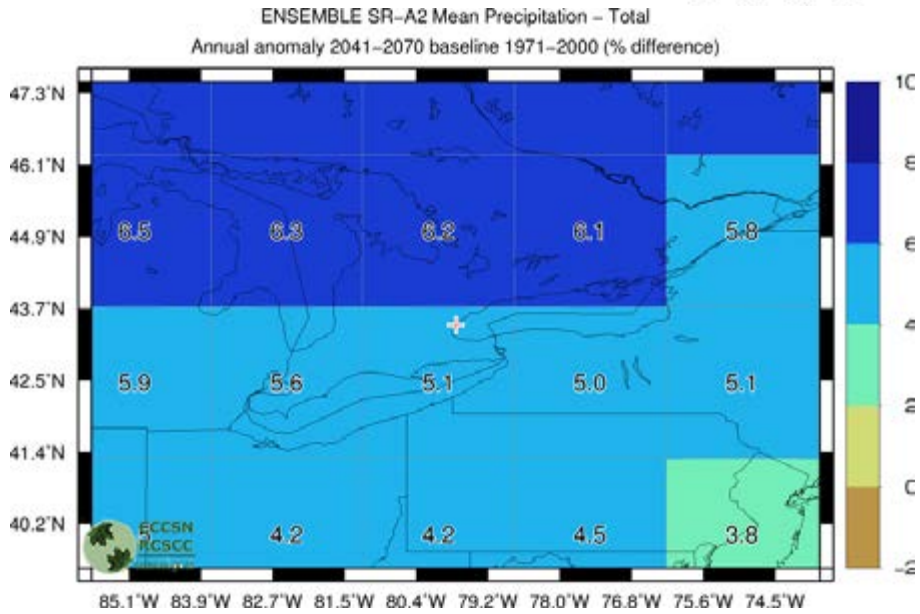




SR-A2 Precipitation - Total

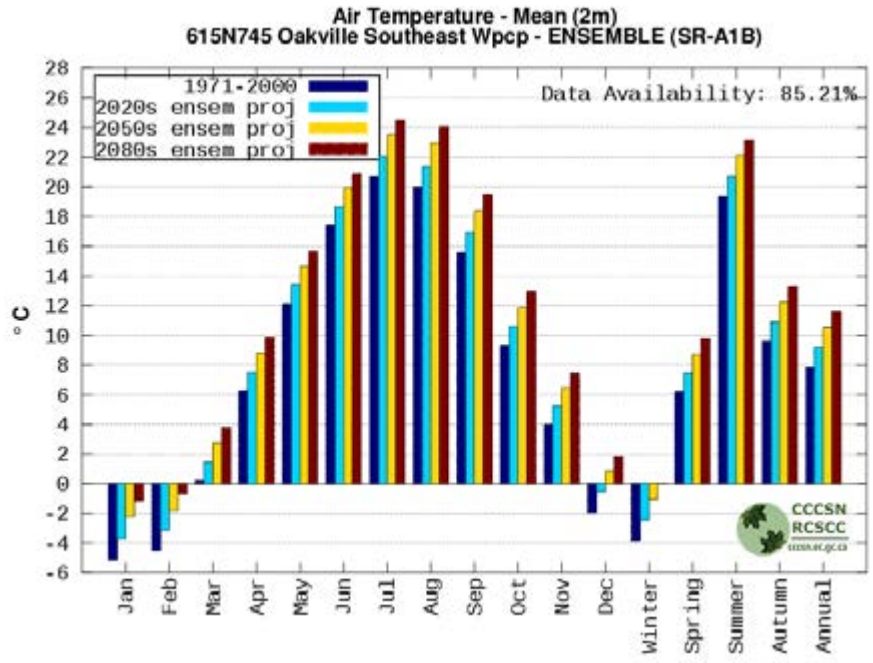
mm	annual	winter	spring	summer	autumn
1971-2000	803.9	166.9	193.9	221.1	222.1
2020s	818.8 ± 26.1	173.7 ± 7.6	198.0 ± 10.9	223.2 ± 12.9	223.3 ± 14.2
2050s	845.1 ± 40.1	183.5 ± 10.3	208.3 ± 13.7	219.4 ± 22.0	233.2 ± 15.0
2080s	869.7 ± 71.0	195.0 ± 15.0	223.4 ± 25.7	215.4 ± 34.8	232.6 ± 24.0

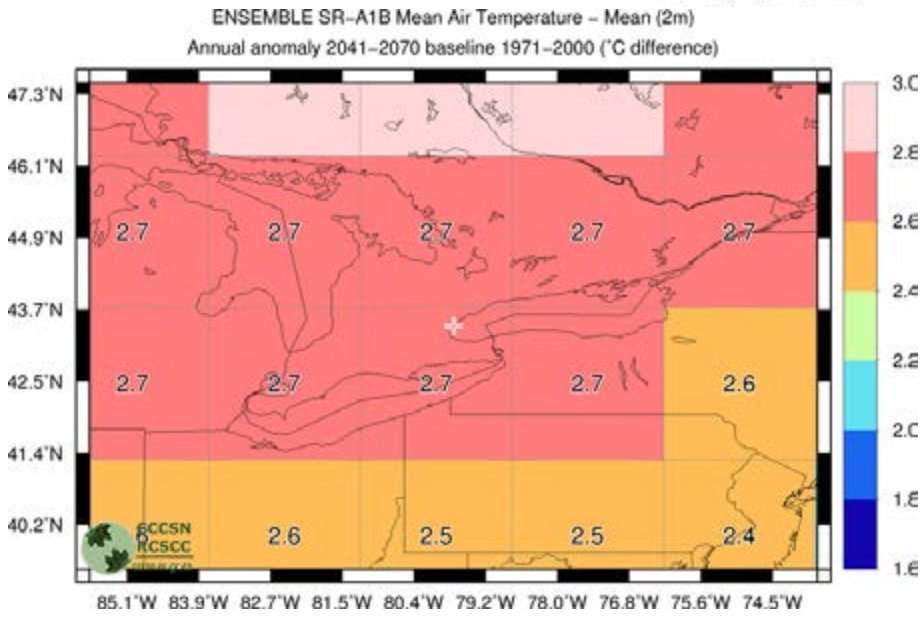




SR-A1B Air Temperature - Mean (2m)

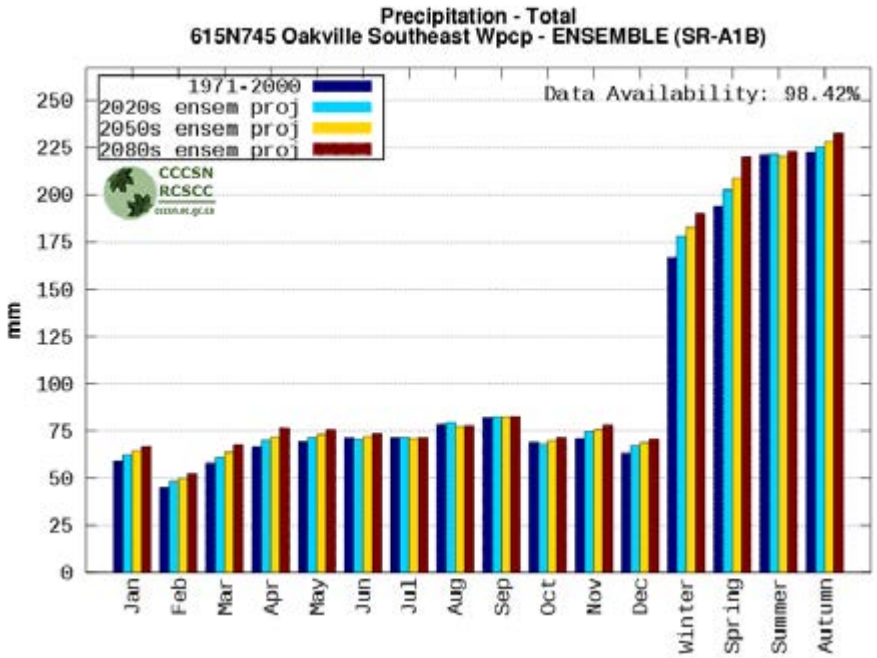
°C	annual	winter	spring	summer	autumn
1971-2000	7.8	-3.9	6.2	19.4	9.6
2020s	9.2 ± 0.3	-2.4 ± 0.5	7.5 ± 0.4	20.7 ± 0.5	10.9 ± 0.3
2050s	10.5 ± 0.7	-1.0 ± 0.7	8.7 ± 0.8	22.1 ± 0.9	12.2 ± 0.8
2080s	11.6 ± 1.0	0.0 ± 1.1	9.7 ± 1.0	23.1 ± 1.2	13.3 ± 1.0

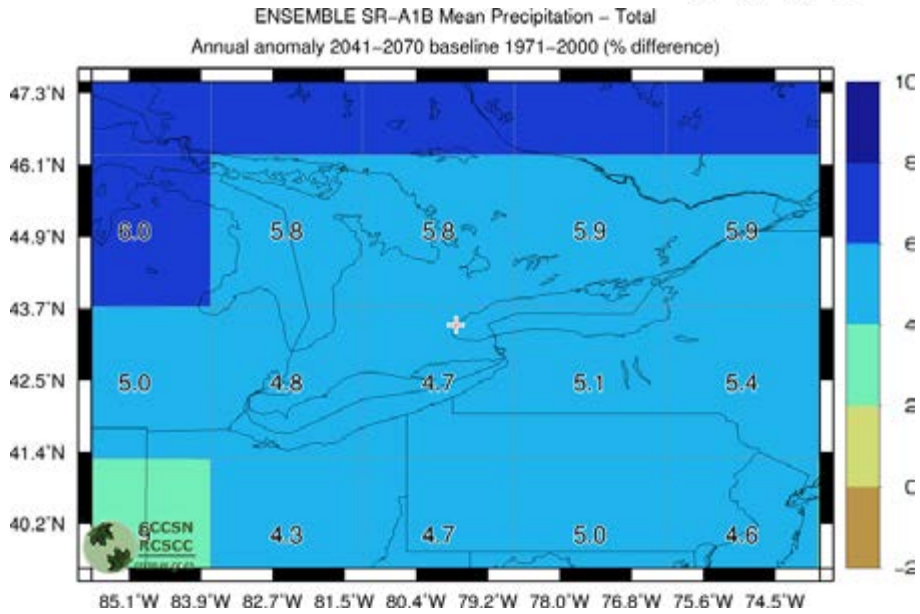




SR-A1B Precipitation - Total

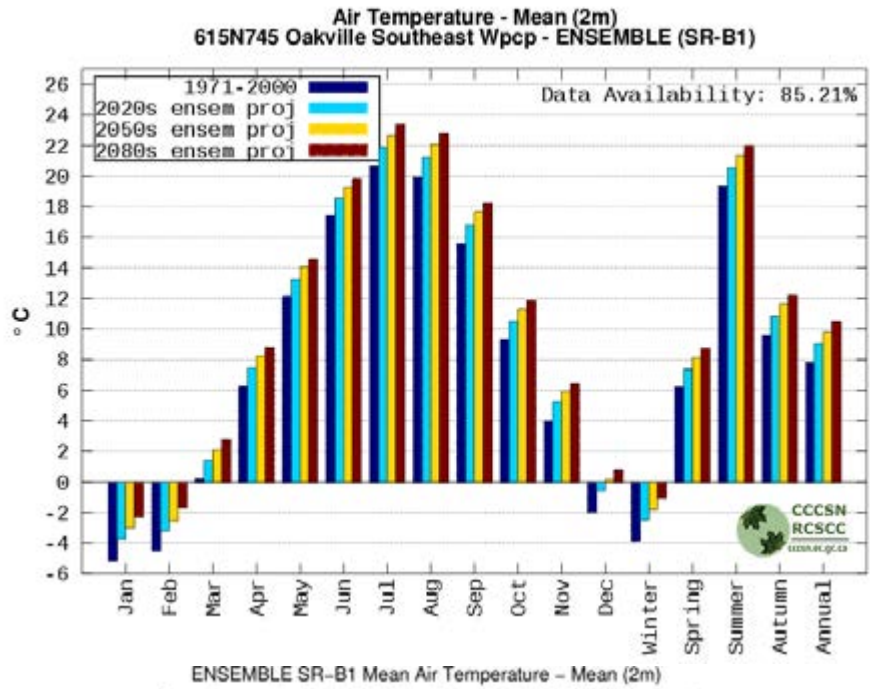
mm	annual	winter	spring	summer	autumn
1971-2000	803.9	166.9	193.9	221.1	222.1
2020s	828.4 ± 25.7	178.3 ± 6.0	202.8 ± 9.3	220.2 ± 15.1	225.7 ± 14.3
2050s	841.8 ± 35.9	182.9 ± 8.5	208.9 ± 15.5	220.3 ± 20.8	228.2 ± 16.0
2080s	868.9 ± 46.0	190.4 ± 9.8	220.3 ± 18.7	222.3 ± 24.8	233.2 ± 21.1

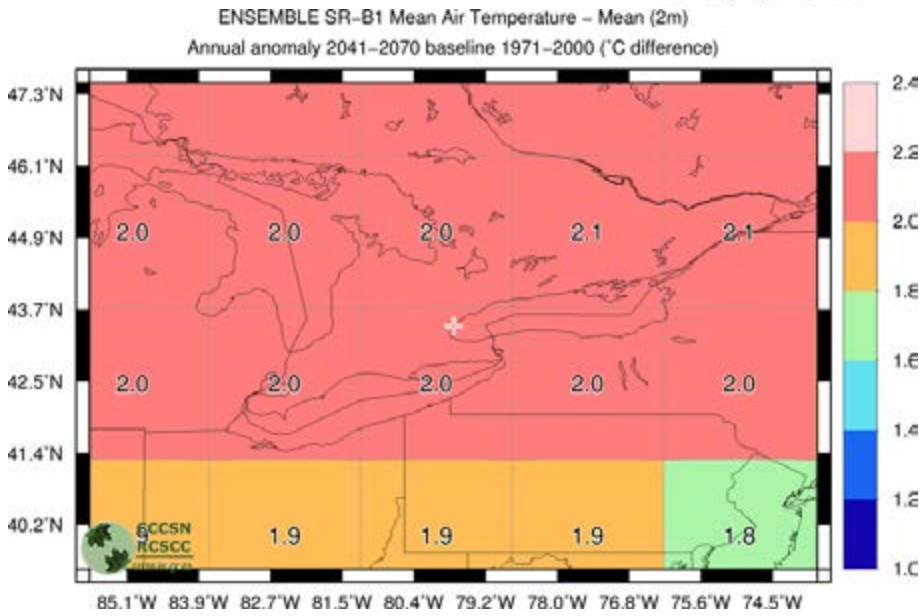




SR-B1 Air Temperature - Mean (2m)

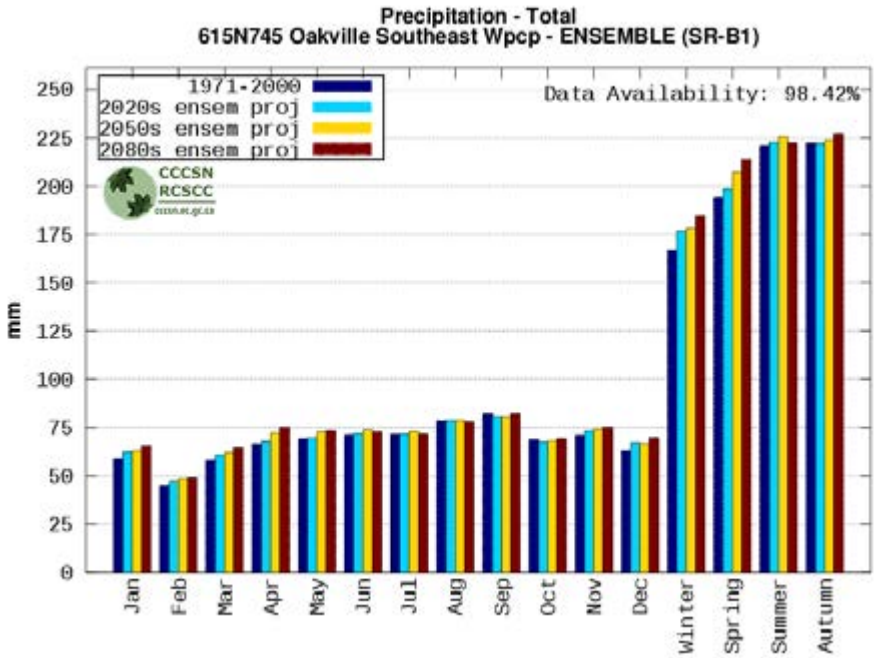
°C	annual	winter	spring	summer	autumn
1971-2000	7.8	-3.9	6.2	19.4	9.6
2020s	9.1 ± 0.3	-2.5 ± 0.5	7.4 ± 0.4	20.6 ± 0.4	10.9 ± 0.3
2050s	9.8 ± 0.5	-1.8 ± 0.5	8.1 ± 0.6	21.3 ± 0.6	11.6 ± 0.6
2080s	10.5 ± 0.6	-1.1 ± 0.7	8.7 ± 0.6	22.0 ± 0.7	12.2 ± 0.7

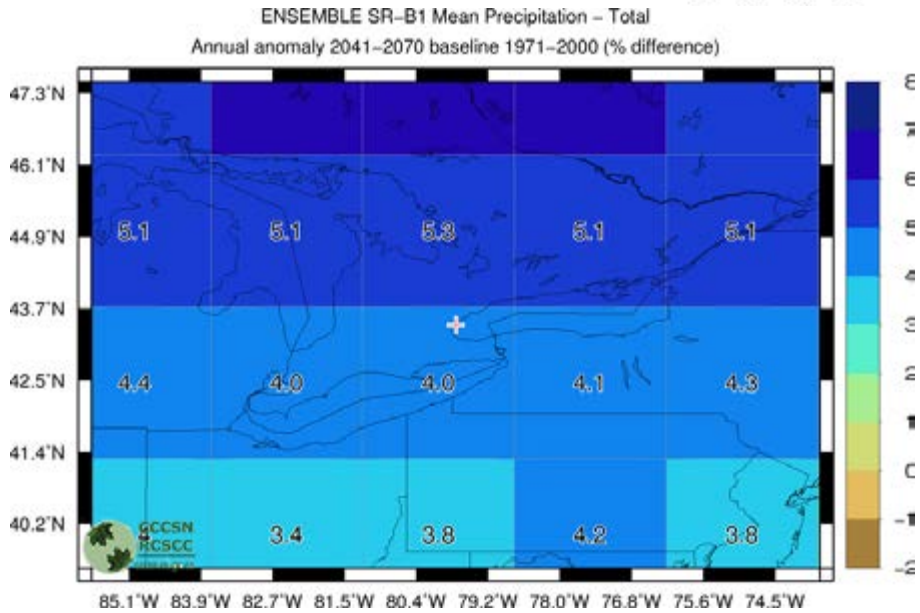




SR-B1 Precipitation - Total

mm	annual	winter	spring	summer	autumn
1971-2000	803.9	166.9	193.9	221.1	222.1
2020s	820.2 ± 26.0	176.6 ± 7.3	198.4 ± 10.0	222.7 ± 14.2	221.6 ± 13.9
2050s	836.4 ± 30.7	178.3 ± 8.6	206.8 ± 9.5	226.2 ± 17.6	223.6 ± 16.0
2080s	850.7 ± 32.5	184.2 ± 8.7	213.8 ± 14.0	222.3 ± 17.8	226.6 ± 15.3





Appendix b

Government action

Both mitigation and adaptation actions are important for governments to implement. Mitigation actions include activities that will reduce current greenhouse gas emissions, for example biking to work or taking advantage of the Ministry of Transportation's hybrid incentives. Adaptation refers to adapting to changes from climate change, for example taking advantage of Halton Region's Basement Flooding Prevention Subsidy Program to protect your home from future flooding. Current concentrations of greenhouse gases are high enough in the atmosphere that even if all anthropogenic emissions were to stop today the effects of the increased gas concentrations are significant enough that societies will still need to adapt to continuing changes.

It is important to mitigate climate change by reducing human-made GHG emissions thereby reducing the amount that society needs to adapt. In the past human development did not significantly influence past climates, and adaptation is now required to reduce the vulnerability of our society to a changing climate. More frequent and severe extreme weather events, rising sea levels, and changing temperature and precipitation patterns all make adaptation a necessity. How much adaptation society will ultimately require will depend on how quickly we mitigate and adapt to climate change.

All levels of governments are currently involved in various climate change actions.

International action - IPCC

The International Panel on Climate Change (IPCC) was established by the United Nations Environment Program in 1988 and is responsible for assessing and compiling current scientific research on climate change.

The IPCC does this in a series of assessments reports which are used as the foundation of worldwide climate change policy making. The IPCC has produced its fifth report,which includes a Summary for Policy Makers to help guide governments in identifying their impacts, risks and vulnerabilities related to climate change.

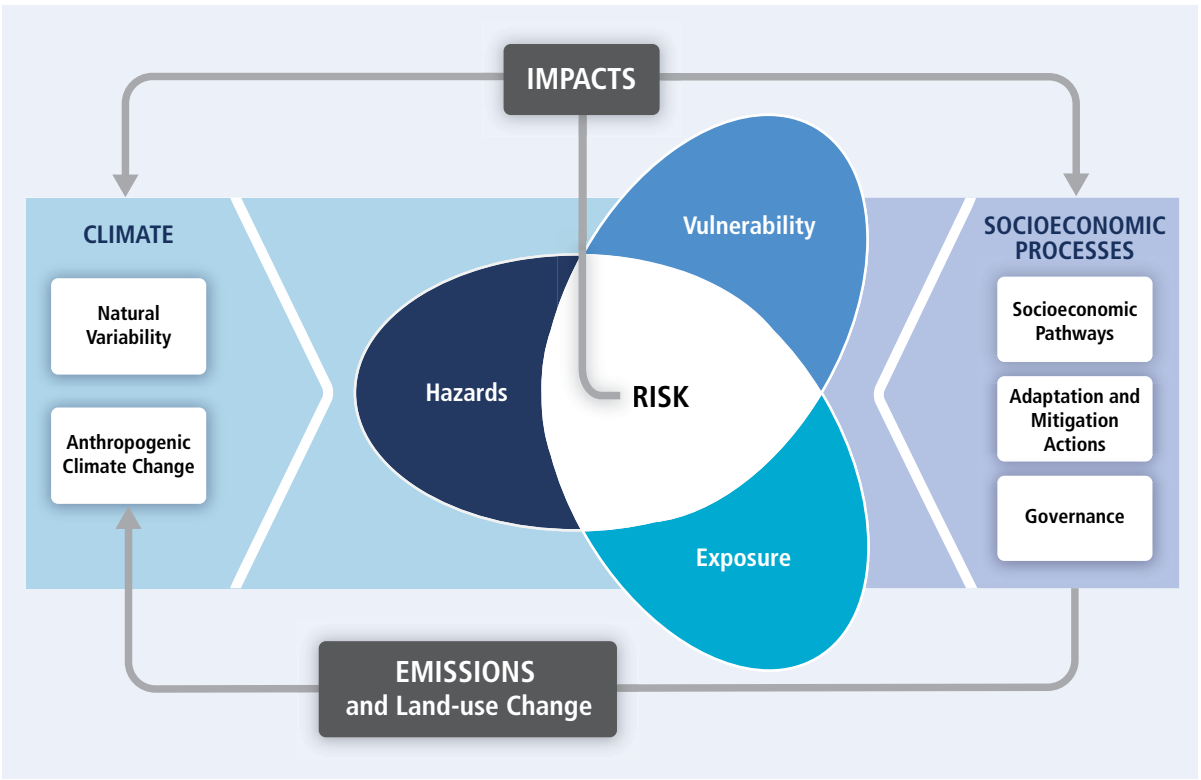


Figure 14: Depicts the core concepts of the **IPCC Assessment Report 5**. Risk of climate-related impacts results from the interaction of climate-related hazards with the vulnerability of human and natural systems. Changes in both the climate system (left) and socioeconomic processes including adaptation and mitigation (right) are drivers of hazards, exposure and vulnerability.

Canadian government

The Government of Canada has placed new restrictions on the energy and transportation sector to help lower GHG emissions. By implementing these restrictions and other climate change mitigation practices, Canada is halfway to meeting its Copenhagen Accord reduction target.
The Copenhagen Accord is a document signed by 140 nations that are responsible for approximately 85% of global greenhouse gas emissions. It emphasizes that a strong political will is required to combat climate change. Each nation pledges to reduce greenhouse gas emissions by a certain percentage by the year 2020. Canada aligned its 'quantified economy – wide emission target' with that of the United States in order to maximize greenhouse gas reductions while maintaining a competitive economy. Canada set their reduction target at 17% lower than that of 2005 emissions by 2020.

Figure 15: Canadian emissions from 1990-2011 in relation to Canada's Copenhagen emission reduction target of 17% reduction from 2005 levels by 2020. Graph from **Canada's Emissions Trends, 2013**.

Emissions trends predict that with current actions Canada's carbon emissions in 2020 will measure 128 megatonnes lower than emissions in a scenario with no action taken. However, another 122Mt reduction in carbon emissions is necessary by 2020 in order to reach the Copenhagen Target.

Since 2010 the Government of Canada has taken several actions to reduce greenhouse gas emissions further in accordance with the Copenhagen Target. Figure 16 describes some of these actions.

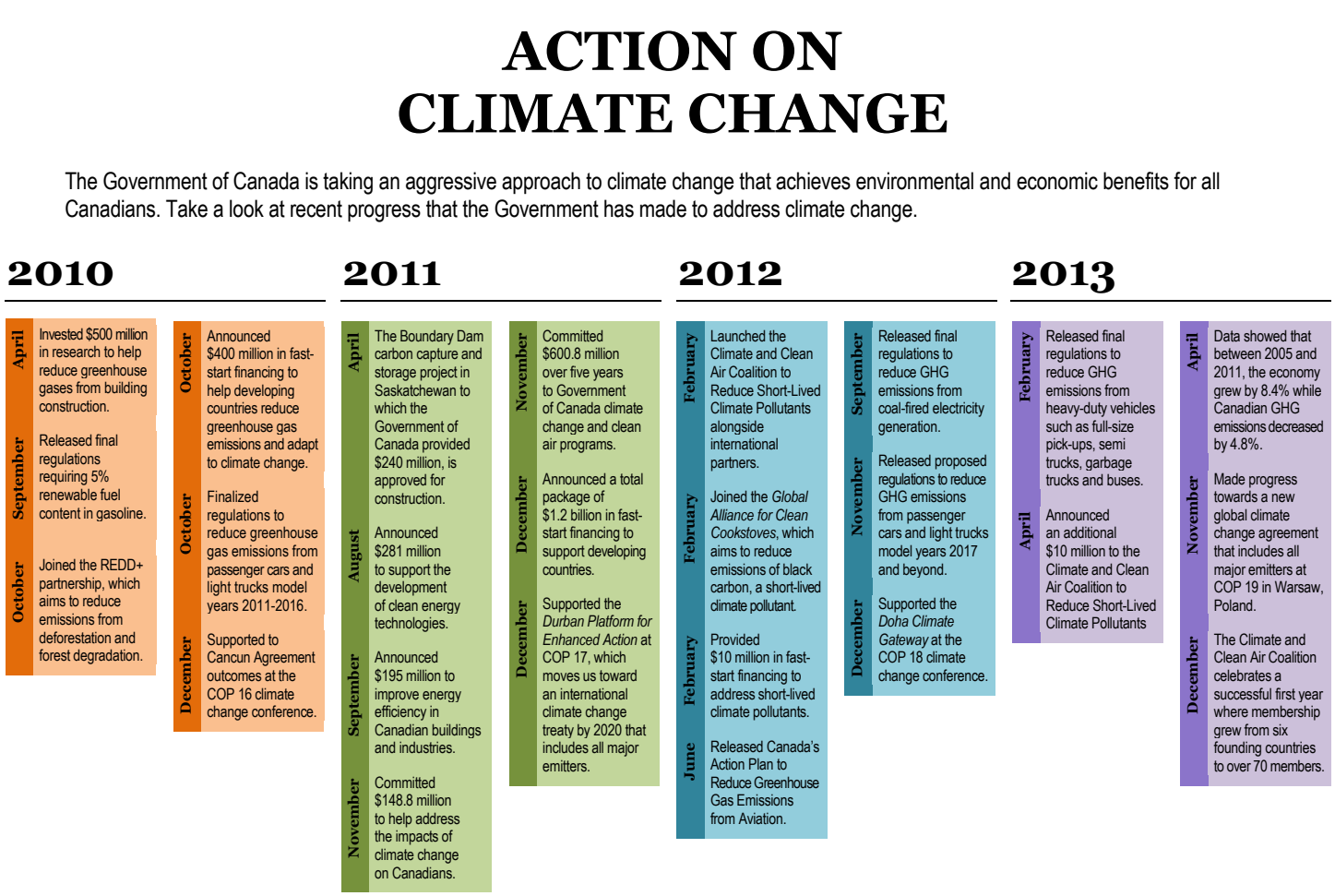


Figure 16: An overview of the Government of Canada's action to address climate change. Diagram from **Canada's Action on Climate Change**.

Ontario government

The government of Ontario has taken steps to adapt to the changing climate. In 2007 Ontario introduced its Climate Change Action Plan, which included greenhouse gas emissions targets of 15% below 1990 levels by 2020 and 80% below 1990 levels by 2050. While Ontario is taking measures to reduce emissions, the government has also produced Climate Ready: Ontario's Adaptation Strategy and Action Plan 2011-2014 in response to the need to adapt to the unavoidable impacts of changing climate patterns.

Natural Resources Canada partnered with the Ontario Ministry of the Environment, as well as other non-government, government, and academic groups in order to produce the Ontario Regional Adaptation Collaborative, a series of projects that give communities and decision-makers knowledge and tools to reduce risks associated with climate change through adaptation actions. The program worked to address vulnerabilities in the areas of extreme weather, risk management, water management, and community development planning.

The government of Ontario also considered climate change vulnerabilities and risks when developing the Growth Plan for Northern Ontario, 2011 and when developing programs to protect Ontario's drinking water sources or programs to prioritize water conservation and efficiency such as the Ontario Drinking Water Stewardship Program. This program was developed in 2007, and provides landowners with technical and financial assistance in protecting municipal drinking water sources.

Provincial Policy Statement (PPS)

The 2014 Provincial Policy Statement (PPS) under the Planning Act provides municipalities with provincial direction and minimum standards related to climate change previously not included in the 2005 PPS. The 2014 update requires the consideration of potential climate change impacts and supports the reduction of greenhouse gas emissions through energy efficiency, improving transit and active transportation, green **infrastructure** and stricter storm water management requirements.

Appendix c

Examples of extreme weather events

Table 3 below goes into more detail on some of the disasters depicted in figure 7 in the section on the 'Cost and Complexity of Climate Change', including details on the cost of the disaster in human health and safety, financial costs, damages to infrastructure and interference with regular operations.

Table 3: Extreme weather events throughout Southern Ontario from 2004-2014.

	On August 20, 2009 Southern Ontario experienced a tornado outbreak. This event consisted of nineteen tornadoes, which makes it the longest single-day outbreak in Ontario history and the largest in Canadian history. This series of storms resulted in one death, several injuries and devastated orchards and crops as well as hundreds of homes. Over 10 million people (1/3 of Canada's population) were under tornado watches or warnings at one point during this event.
	In October of 2012 Post-Tropical Storm Sandy hit Ontario and Quebec, and was responsible for two deaths in Ontario. 25 percent of all flights were cancelled out of Pearson Airport and the storm caused an estimated $100 million in damages throughout Ontario and Quebec.
	On July 8, 2013 there was flooding throughout Mississauga and Toronto following a severe thunderstorm. The Insurance Bureau of Canada estimated property damages of this storm at greater than $850 million, which set the record for the province's most expensive natural disaster. The storm also set a record for the greatest amount of rainfall recorded in a single day in Toronto – 126mm, which is almost twice the 71mm average rainfall for the entire month of July.
	On July 19, 2013 a microburst storm ended Oakville's annual Midnight Madness event early as severe winds spun tents and tables down the street. This short-lived but intense storm cost community groups, businesses and vendors in lost revenue and damages.
	From December 20-23, 2013 a severe ice storm left over 800,000 people without power throughout the GTA, with 45,000 of those in Oakville. 70% of Oakville Hydro's customers were without power at some point during or after the storm. Oakville Hydro spent over $550,000 responding to the storm, and the town's forestry section estimated their costs at over $350,000. Oakville's Roads and Works Operations Department used approximately 2,300 tons of salt to improve road conditions—equal to about five times the normal amount of salt used during a storm. Overall, damage and clean-up costs of the storm are estimated in Oakville at between $3 and $3.5 million.

Over the past decade there have been, on average, 785 natural catastrophes in the world per year. In 2010, there were 950 natural catastrophes, nine-tenths of which were weather-related events such as storms and floods. These climatic changes are becoming more extreme and their impacts are proving to be very costly to individuals, insurers, municipalities, and the environment. Global insured losses from natural catastrophes range between $10B and $50B/ year over the past 10 years.

Appendix d

Emergency preparedness

Car Survival Kit Checklist

Try to keep your car's gas tank at least half-full at all times. Assemble the supplies in a portable container and store it in your trunk.

Your kit should contain:

- ❑ Cell phone
- ❑ Booster cables
- ❑ First aid kit
- ❑ Road maps
- ❑ Methyl hydrate to de-ice the fuel line
- ❑ Ice scraper and brush
- ❑ Sand (or kitty litter)
- ❑ Blankets
- ❑ Candles in a deep can
- ❑ Waterproof matches
- ❑ A tow chain
- ❑ Warning light or flares
- ❑ Flashlight
- ❑ Extra hats, coats and footwear
- ❑ Rain wear
- ❑ Food bars (granola, chocolate, etc.)
- ❑ Fire extinguisher

Halton Region
Dial 311 or 905-825-6000
Toll free 1-866-442-5866
TTY 905-827-9833
www.halton.ca

www.halton.ca/beprepared

72 hours... Is your family prepared?

Prepare Now, Emergency Survival Checklist Learn How...

- ❑ Flashlight and batteries
- ❑ Radio and batteries or crank radio
- ❑ Spare batteries (for radio or flashlight)
- ❑ First-aid kit
- ❑ Candles and matches/lighter
- ❑ Extra car keys and cash
- ❑ Important papers (identification)
- ❑ Food and bottled water
- ❑ Clothing and footwear
- ❑ Blankets or sleeping bags
- ❑ Toilet paper and other personal items
- ❑ Medication
- ❑ Backpack/duffel bag (to hold all of the emergency survival kit items)
- ❑ Whistle (to attract attention, if needed)
- ❑ Playing cards

Ensure that you have a three-day supply per person.

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Appendix e

Climate change terminology

Most of the terms described below are that of the International Panel on Climate Change (IPCC) and taken directly from their on-line Glossary. Any that are not have been produced specifically for this report.

Adaptation is an adjustment in natural or human systems to a new or changing environment. Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation.

Anthropogenic are the results from or produced by human beings.

Biodiversity refers to the numbers and relative abundances of different genes (genetic diversity), species, and ecosystems (communities) in a particular area.

Carbon dioxide (CO_2) is a naturally occurring gas, and also a by-product of burning fossil fuels and biomass, as well as land-use changes and other industrial processes. It is the principal anthropogenic greenhouse gas that affects the Earth's radiative balance. It is the reference gas against which other greenhouse gases are measured and therefore has a Global Warming Potential of 1.

Carbon cycle is the term used to describe the exchange of carbon (in various forms, e.g., as carbon dioxide) between the atmosphere, ocean, terrestrial biosphere and geological deposits.

Carbon Sequestration: a natural or anthropogenic process in which carbon dioxide is captured from the atmosphere and held in long-term storage. Sequestration is a part of the natural carbon cycle, for example the chemical weathering of rocks or the transfer of carbon dioxide from the atmosphere into the oceans.

Climate is usually defined as the "average weather", or more rigorously, as the statistical description of the weather in terms of the mean and variability of relevant quantities over periods of several decades (typically three decades as defined by WMO). These quantities are most often surface variables such as temperature, precipitation, and wind, but in a wider sense the "climate" is the description of the state of the climate system.

Climate change (FCCC usage) is a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.

Drought is the phenomenon that exists when precipitation has been significantly below normal recorded levels, causing serious hydrological imbalances that adversely affect land resource production systems.
An **ecosystem** is a system of interacting living organisms together with their physical environment. The boundaries of what could be called an ecosystem are somewhat arbitrary, depending on the focus of interest or study. Thus, the extent of an ecosystem may range from very small spatial scales to, ultimately, the entire Earth.

In the climate change context, **emissions** refer to the release of greenhouse gases and/or their precursors and aerosols into the atmosphere over a specified area and period of time.

Erosion is the process of removal and transport of soil and rock by weathering, mass wasting, and the action of streams, glaciers, waves, winds, and underground water.

Evaporation is the process by which a liquid becomes a gas.

An **extreme weather event** is an event that is rare within its statistical reference distribution at a particular place. Definitions of "rare" vary, but an extreme weather event would normally be as rare as or rarer than the 10th or 90th percentile. By definition, the characteristics of what is called extreme weather may vary from place to place. An extreme climate event is an average of a number of weather events over a certain period of time, an average which is itself extreme (e.g., rainfall over a season).

A **forest** is a vegetation type dominated by trees. Many definitions of the term forest are in use throughout the world, reflecting wide differences in bio-geophysical conditions, social structure, and economics.

Fossil fuels are carbon-based fuels from fossil carbon deposits, including coal, oil, and natural gas.

A **Greenhouse gas** is a gas that absorbs radiation at specific wavelengths within the spectrum of radiation (infrared radiation) emitted by the Earth's surface and by clouds. The gas in turn emits infrared radiation from a level where the temperature is colder than the surface. The net effect is a local trapping of part of the absorbed energy and a tendency to warm the planetary surface. Water vapour (H_2O), carbon dioxide (CO_2),nitrous oxide (N_2O), methane (CH_4) and ozone (O_3) are the primary greenhouse gases in the Earth's atmosphere.

Hydroxyl radicals are highly reactive and short-lived hydroxide ions that are produced in the atmosphere by the reaction of excited atomic oxygen with water. It's often referred to as the 'detergent' of the Earth's atmosphere as it reacts with many pollutants like the greenhouse gases methane and ozone, and helps to remove them.

Infrastructure describes the basic equipment, utilities, productive enterprises, installations, institutions, and services essential for the development, operation, and growth of an organization, city, or nation. For example, roads; schools; electric, gas, and water utilities; transportation; communication; and legal systems would be all considered as infrastructure.

An **invasive species** is an introduced species that invades natural habitats.

Land use refers to the total of arrangements, activities, and inputs undertaken in a certain land cover type (a set of human actions). The social and economic purposes for which land is managed (e.g., grazing, timber extraction and conservation). Land-use change is a change in the use or management of land by humans, which may lead to a change in land cover. Land cover and land-use change may have an impact on the albedo, evapotranspiration, sources, and sinks of greenhouse gases, or other properties of the climate system, and may thus have an impact on climate, locally or globally.

Methane (CH_4) is a hydrocarbon that is a greenhouse gas produced through anaerobic (without oxygen) decomposition of waste in landfills, animal digestion, decomposition of animal wastes, production and distribution of natural gas and oil, coal production, and incomplete fossil-fuel combustion. Methane is one of the six greenhouse gases to be mitigated under the Kyoto Protocol.

Microbial respiration refers to the production of carbon dioxide through the respiration of soil organisms. It is a key ecosystem process that releases carbon from where it is stored in the soil into the atmosphere.

Mitigation is an anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases.

Nitrous oxide (N_2O) is a powerful greenhouse gas emitted through soil cultivation practices, especially the use of commercial and organic fertilizers, fossil-fuel combustion, nitric acid production, and biomass burning. One of the six greenhouse gases to be curbed under the Kyoto Protocol.

Ozone (O_3) is a gas that is present in the atmosphere. It exists at higher concentrations in what is known as the 'ozone layer' where it works to block UV radiation. However, ozone in the lower levels of the atmosphere is considered a pollutant and potent respiratory hazard.

Resiliency is the ability to return to the original form, or the ability to recover from an adverse event.

Surface runoff is the water that travels over the soil surface to the nearest surface stream; runoff of a drainage basin that has not passed beneath the surface since precipitation.

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

Appendix f

Misconceptions about climate change

Misconception	Reality
Climate change is caused by changes in the output of energy from the sun	Satellites have monitored the energy output of the sun for thirty years and it hasn't increased
The climate has changed before	Climate history shows that rapid and extreme climate change has happened before.
It's not bad if the world gets warmer	Negative impacts to agriculture, health and the environment outweigh any positives
Climate change stopped in 1998/the world is cooling	The past decade 2000-2009 was the hottest on record
Animals and plants have adapted before and can do so now	Climate is changing rapidly. These changes will cause mass extinctions as animals and plants are unable to adapt on such a short-term time scale
CO_2 rose after the warming that ended ice ages in the past, thus showing that it wasn't the cause of that warming	This is particularly concerning to scientists. Earth's ice age history is caused by wobbles in the planet's rotation which affects the input of radiation from the sun. These movements of the planet both begin and end ice ages. When the ice ages in the past have ended, the warming was caused by these wobbles. Today the warming is caused by CO_2, which means there is no clear end to it. Additionally, natural warming due to planetary rotation causes CO_2 to increase as vast natural stores of carbon in glaciers and the oceans are thawed. This rise further increases warming, which further increases natural CO_2 emissions in a positive feedback cycle.
Climate change is caused by the ozone hole	Climate change is caused by increasing amounts of greenhouse gases in the atmosphere due to increases in anthropogenic emissions of these gases. A hole in the ozone layer allows increased amounts of UV radiation to reach the surface of the Earth, but while this does present a health risk it isn't responsible for a significant change in temperature or climate.
Weather and climate are the same	Weather is short-term day-to-day variations in the conditions of the atmosphere, while climate is the long-term averages of daily weather

Misconception	Reality
Water vapor is the greenhouse gas responsible for climate change	Although water vapour is the most abundant greenhouse gas and has a high heat capacity, meaning that it can hold a large amount of heat, due to the short residence time in the atmosphere it isn't responsible for climate change. If water vapor were the only determining factor for climate change, excess amounts of it would simply exit the atmosphere in the form of rain. Instead, water vapor amplifies the effects of CO_2. As the amount of CO_2 rises and increases temperatures, more water is evaporated from the oceans and thus enters the atmosphere. There, due to the high heat capacity of water vapor, it amplifies the warming caused by CO_2. This works backwards as well—as CO_2 decreases water vapor condenses and rains out of the atmosphere, thus amplifying the effects of decreasing CO_2.
It's too late to stop climate change	Any efforts that we make now will have an impact. Putting off actions until later will make it more difficult and expensive to mitigate and adapt to climate change in the future.
Technology will solve the problem	Technology hasn't solved the problem yet. Options like removing CO_2 or other GHGs from the atmosphere are not currently available, whereas reducing our emissions now is possible for us to do.
This winter is cold; the climate can't be changing	Climate change doesn't necessarily mean everywhere will get warmer. Some regions of the Earth may warm while others may cool. Part of the complexity of climate change is that we don't necessarily know which region will do what. Just because the winter in Canada has stayed cold, or possibly gotten colder and harsher, doesn't mean that the climate isn't changing. In fact, it means that the climate is changing. We don't expect that everywhere will end up looking like the tropics… The concern is that the changes that the Earth is experiencing are occurring too rapidly for most plants and animals to adapt to (including humans!) and we risk losing over 30% of the world's biodiversity as well as other associated risks.

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climate change primer