Weathering the changes

Climate Change in Ontario

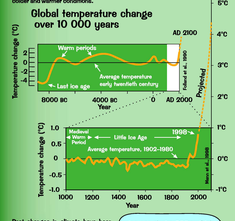
The climate system — a balancing act

What is climate?

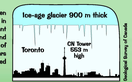
The main elements of the climate system include the Sun (source of heat energy), atmosphere (providing a protective blanket), oceans (helping to distribute heat through its currents), water (as rain, snow, or ice), and land (reflecting or absorbing energy from the Sun). Changes to any of these elements affect the balance of the entire system.

Climate has always changed

Earth's climate is naturally variable. Warming and cooling trends are part of normal climate cycles. Climate conditions vary within a single year, from one year to the next, and over decades, centuries, and millennia. Historically, there have been frequent changes in climate, with repeated fluctuations between colder and warmer conditions.



Past changes in climate have been sufficient to cause major shifts in global ecosystems, with significant impacts on natural habitat and human development. At the peak of the last Ice Age (about 20 000 years ago), what is now Toronto was buried under about 900 metres of ice!



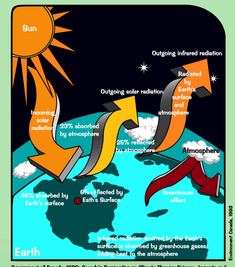
Mann, M.E., Bradley, R.C., and Hughes, M.K., 1999: Northern hemisphere temperature during the past millennium: Inferences, uncertainties, and limitations: in Geophysical Research Letters, V. 26, no.6, p. 759-762.

Balancing the budgets

The solar energy budget

Of the total amount of radiation received from the Sun, roughly one third is reflected back into space by clouds and the Earth's surface. The remainder is absorbed by the Earth and its atmosphere. Some of this heat is radiated back into space, but most of it is trapped by our atmosphere, which acts like a large insulating blanket. The 'greenhouse effect' refers to the heat-trapping quality of the atmosphere created by gases known as 'greenhouse gases'.

Without this insulation, Earth would be about 33°C colder than it is now, making it inhospitable to life. When the amounts of these gases change, the capacity of the atmosphere to trap heat also changes.



Government of Canada, 1999: Canada's Perspective on Climate Change: Science, Impacts and Adaptation (online: http://www.ec.gc.ca/cop5/CPSCIEN/english/index.htm).

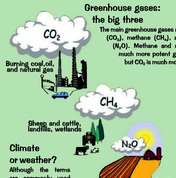
Folland, C.K., Karl, T.R., and Vinnikov, K., 1990: Observed climate variations and change: in Climate Change: the IPCC (Intergovernmental Panel on Climate Change) Scientific Assessment, Cambridge University Press, London, United Kingdom, p. 195–238.

The carbon balance

Carbon is naturally present in the atmosphere (as CO_2) and in the oceans. Huge amounts of carbon are also stored within the Earth in fossil fuels and sedimentary rocks, and in vegetation and soils. Before the Industrial Revolution, additions of CO_2 and other greenhouse gases to the atmosphere were largely balanced by removals by the oceans and vegetation.

Greenhouse gases: the big three

The main greenhouse gases are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). Methane and nitrous oxide are much more potent greenhouse gases, but CO_2 is much more abundant.



Climate or weather?

Although the terms are commonly used interchangeably, there is an important distinction between 'weather' and 'climate'. The term 'weather' describes the day-to-day and hour-by-hour changes in atmospheric conditions at a given location. 'Climate' describes the synthesis of these day-to-day variations into a set of average or expected conditions. Traditionally, it has been assumed that the climate we have experienced in recent history will be the climate we will experience in the future. Many of the decisions we make as a society depend on this assumption.

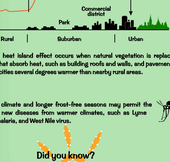
Did you know?

Although instrumental temperature records only date back about 150 years, scientists can establish temperatures back tens of thousands of years by analyzing the gases found in ice cores from the Arctic and Antarctica.

Environment Canada, 1993: A matter of degrees: a primer on global warming: The Environmental Citizenship Series, Environment Canada, Ottawa, Ontario, 89 p.

Future climate

The current scientific consensus is that Earth's climate in the twenty-first century will not be the same as it has been in recent history.



Although a number of uncertainties about the rate and timing of change remain, the fact is that Earth is experiencing a warming trend. The average global temperature has increased by approximately 0.5°C over the past 100 years. In Canada, the average temperature has increased by 0.9°C since 1948.

Environment Canada, 1998: Climate change: National Environmental Indicator Series: State of the Environment Bulletin No. 98-3.

Hengeveld, H.G., 2000: Projections for Canada's climate future: a discussion of recent simulations with the Canadian Global Climate Model: Environment Canada, Climate Change Digest 00-01, 27 p.

Upsetting the balance

Primarily as a result of our use of fossil fuels, human activities over the last 100 years have increased the amount of greenhouse gases in the atmosphere. This 'enhanced' greenhouse effect has the potential to warm the planet at a rate never before experienced in human history.

Ontario's climate in the twenty-first century

Scientists now estimate that Ontario will warm an average of 2°C to 5°C within the next 75 to 100 years. Temperature increases will be greater in the winter than in the summer and the frequency and severity of extreme weather events are likely to increase.

Did you know?

Venus has an atmosphere that is 98% CO_2. Due to the extreme greenhouse effect, temperatures reach 430°C. Similar conditions would exist on Earth if all the carbon stored in rocks and vegetation was released as CO_2.

Smith, J.V. , Lavender, B., Auld, H., Broadhurst, D., and Bullock, T., 1998: Adapting to climate variability and change in Ontario: Volume IV of the Canada Country Study: Climate Impacts and Adaptation; Environment Canada, 117 p.

Modelling future climate

Powerful computer simulations called general circulation models or global climate models (GCMs) are the primary tools for estimating the future climate. These models are complex mathematical approximations of processes that underlie the global climate system. The complex elements of the climate system – such as oceans, land masses, the atmosphere, ice and snow, and many other influencing factors – are reproduced by the GCM. The model then allows scientists to estimate future conditions based on the manipulation of various elements of the climate system within the model.

Tanner, R.J.M. and Clegan, J.J., 1999: Temperature rising: climate change in southwestern British Columbia: Geological Survey of Canada, Miscellaneous Report 67.

Where we live

Where we live, work, and play

how and what we build, and how we travel are all affected by weather events and climate. Many decisions we make routinely every day are affected by the weather: what we wear, how we travel, and how we use our recreational time. Many things we depend on in our day-to-day lives are affected by climate: the design capacity of our sewer systems, the energy efficiency of our houses, and the delineation of hazardous areas such as flood plains, for example.

Shorter winters will likely mean lower maintenance and snow-removal costs for our roads and railways, a shorter winter recreation season, and a longer summer recreation season.

More frequent freezing rain events could affect energy transmission and road and airline safety. More frequent freeze-thaw cycles could speed up the weathering process on our buildings and roadways.

Francis, D. and Hengeveld, H., 1998: Extreme weather and climate change: Climate Change Digest, Environment Canada, 31 p.

Managing extremes

Ontario falls prey to a number of natural hazards: drought, heat waves, floods, rain, snow and ice storms, tornadoes, and hurricanes (although rare). Small changes in average climate conditions are expected to generate significant changes in extreme events.

Experts anticipate:

- fewer extremely cold days and more extremely hot days;
- more severe thunderstorms, which can cause injury and property damage;
- more frequent freezing rain events.

Number of climate-related disasters per year in Ontario, 1991–1999

The total number of weather-related disasters per year that cause death or injury or involved evacuation has increased significantly since 1911. These statistics indicate that we have become more vulnerable to damage from extreme weather events.

Haley, D., 1999: Perspectives from the Toronto and Region Conservation Authority, Atmospheric Change in the Toronto-Niagara region: Towards an Integrated Understanding of Science, Impacts and Responses, (ed.)R. Mills and L. Craig: in Proceedings of a Workshop held May 27-28, 1998, University of Toronto: Environment Canada.

Did you know?

The ice storm of January 1998 deposited about twice the amount of freezing rain than previous ice storms on record. Stretching from as far west as Kitchener, through eastern Ontario, western Quebec, and the Eastern Townships to the Fundy coasts of New Brunswick and Nova Scotia, the storm caused

- at least 25 deaths, many from hypothermia;
- about 100 000 households to lose power in Ontario, 900 000 in Quebec;
- 16 000 troops to be deployed to help with clean up, evacuation, and security;
- the destruction of millions of trees, 120 000 km of power lines and telephone cables, 130 major transmission towers each worth 1100 000, and about 30 000 wooden utility poles each costing 12000.

Phillips, D., 1998: The Worst Ice Storm in Canadian History?: Environment Canada (online: http://www.msc-smc.ec.gc.ca/education/icestorm98/icestorm98_the_worst_e.cfm).

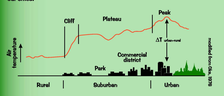
Our health

As with all things, our health is influenced by climate: temperature, humidity, and even atmospheric pressure can effect how we feel.

Turning up the heat

Global climate models suggest that over the next 50 years, southern Ontario is likely to experience more frequent, more intense, and longer heat waves. An increase in the number of hot days (over 35°C) could increase the risk of heat-stress-related health problems, especially in the very old, the very young, and those with chronic lung diseases such as asthma.

Right now in southern Ontario, the average number of days over 35°C is 10 per year. This may increase to as many as 46 per year by the middle of the next century. The urban heat island effect will exacerbate this situation in many of our cities.



The urban heat island effect occurs when natural vegetation is replaced by surfaces that absorb heat, such as building roofs and walls, and pavement. This can make cities several degrees warmer than nearby rural areas.

A warmer climate and longer frost-free seasons may permit the spread of new diseases from warmer climates, such as lyme disease, malaria, and West Nile virus.

Did you know?

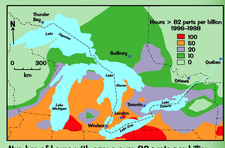
One third of the carbon dioxide emissions generated by human activities comes from transportation. Furthermore, in urban areas, vehicles produce up to three quarters of the pollutants that combine to form ground-level ozone, the main ingredient of smog.

Auld, H., MacIver, D., and Taylor, M., 1999: Climate change and the conservation challenge: Environment Canada.

Oke, T.R., 1978: Inadvertent modification of the city atmosphere and the prospects for planned urban climates: in Proceedings, Symposium on Meteorology Related to Urban and Regional Land-Use Planning, Asheville, North Carolina: World Meteorological Organization, Geneva, Switzerland, p. 151-176.

Bad air days

Since the creation of smog depends on a mix of urban pollutants, temperature, and solar radiation, warmer daytime temperatures will likely increase the frequency and extent of smog problems in our cities.



Number of hours with ozone over 82 parts per billion

One of the highest concentrations of smog in Canada is in the Windsor to Quebec corridor. Permanent lung damage can occur in healthy adults who spend four hours in air with ozone levels of 82 ppb (parts per billion).

Did you know?

Winter and summer temperature extremes are responsible for more deaths than are more violent weather events such as tornadoes, blizzards, or floods.

The Great Lakes

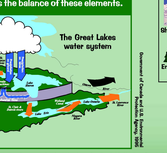
The Great Lakes play a vital role in the social and economic well being of Ontario. Climate affects both the quantity and quality of water in the Great Lakes. At the same time, the Great Lakes have a significant influence on Ontario's climate. As a result of their influence, instead of having a climate similar to that of the Prairies, Ontario's climate has far less extremes in temperatures and greater precipitation.

What the models tell us ...

GCM results suggest that by 2050, lake levels will be lower than they are now and perhaps by more than one metre. Models also suggest a smaller and earlier spring runoff. This could have a significant impact on fisheries and existing biological systems.

A lesson from the past

Because of their sensitivity to climate, the Great Lakes have not always looked the way they do now. Scientists have recently found evidence of submerged beaches that suggest the water level in the lakes (represented by the yellow lines) was below the level of their outlets (represented by the red lines) due to warmer and drier climate conditions about 7500 years ago. For reference, the current shorelines are shown in white.



Did you know?

The Great Lakes system is the largest system of fresh, surface water on Earth. Only 1% of the Great Lakes volume is renewed on an annual basis. In other words, using more than 1% of the volume in a year will reduce the lake levels beyond natural renewal.

As the climate changes so too does the balance of these elements.

Government of Canada and U.S. Environmental Protection Agency, 1995: The Great Lakes: an environment atlas and resource book: Environment Canada.

Smith, J.V. , Lavender, B., Auld, H., Broadhurst, D., and Bullock, T., 1998: Adapting to climate variability and change in Ontario: in Volume IV of the Canada Country Study: Climate Impacts and Adaptation; Environment Canada, 117 p.

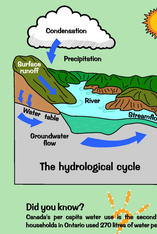
Tanner, R.J.M. and Clegan, J.J., 1999: Temperature rising: climate change in southwestern British Columbia: Geological Survey of Canada, Miscellaneous Report 67.

Our water

Inland lakes, rivers, and streams

Water is an intricate and vital part of the climate system. Water is also critical to every aspect of our lives including our health, energy production, industry, and transportation. Change the air temperature and the rate of evaporation and precipitation changes, altering the balance of the entire system and everything that depends on it.

As the climate gets warmer and drier, demand for water used for irrigation of farms and watering household lawns and gardens will increase. This, combined with greater levels of evaporation, will reduce the amount of water in streams and lower the water table, leaving less and warmer water for us to use. Warmer water may be great for swimming, but will likely lead to problems with water quality – microbes and algal blooms like warmer water too.



Did you know?

Canada's per capita water use is the second highest in the world. In 1996, households in Ontario used 270 litres of water per person per day.

Who will be affected?

Water levels like these are likely to happen more often and for longer periods.

Our forests

The opportunities

As CO_2 is the main fuel for photosynthesis, our forests are likely to become more productive in the long term. Marginal soils, particularly in the clay belt of northeastern Ontario, may become more productive, where drought is not a limiting factor, as the rate of litter decomposition may rise with rising temperatures.

Did you know?

Although most communities that depend entirely on the forest industry are in the north, thousands of jobs in southern Ontario also depend on forest products such as paper, lumber, and firewood.

The threats

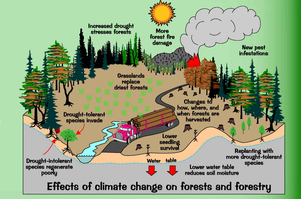
Existing forest species will have to decline and die before new species, better suited to the altered climate, can get established. Until this new equilibrium is established, forests will undergo a period of significant disruption. As a result, the way we manage these resources and the wildlife they support will need to be adjusted.

As with agriculture, the health and productivity of our forests are intricately linked to climate. Because trees have such long life cycles, forests are particularly vulnerable to long-term change. There will be both opportunities and threats for forests in different regions of the province.

Forests will also be subject to more frequent, extreme storms and wind damage, greater stress due to drought, and more frequent and severe fire and insect disturbances.

Did you know?

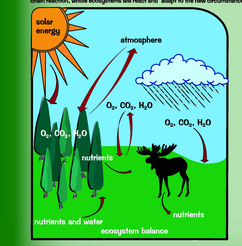
Every year in Ontario, about 1500 forest fires destroy over 290 000 hectares of forest.



Colombo, B.J. and Brain, L.J. (ed.), 1998: The impacts of climate change on Ontario's forests: Ontario Forest Research Institute, Ontario Ministry of Natural Resources, Forest Research Information Paper Number 143.

Our natural heritage

The relationships between climate and plant and wildlife species are complex. Each species and its habitat has a unique set of tolerances to climate. When the climate changes, each species will react differently: some will thrive and some will diminish or migrate as habitats change. Like a chain reaction, whole ecosystems will react and adapt to the new circumstances.



What's good for the goose...

Snow goose numbers have increased 200% since the 1960s. Warmer central arctic temperatures have meant earlier springs and higher nesting success. Colder temperatures in northeast Hudson Bay have encouraged these birds to nest and spend the summer in southwest Hudson Bay, instead of stopping briefly to feed in the spring on their way north. Thus, marshes of southwest Hudson Bay, that used to have the summer to recover from the spring goose feeding frenzy now suffer from hundreds of days of extra goose use.

Fish in hot water?

Warm-water fish, such as black bass, sunfish, white bass, and white perch, will thrive as the water warms. Cold-water species, such as lake trout and lake whitefish, may disappear from southern Ontario as their habitat changes.

Deer, moose, and polar bear

White-tailed deer are expected to flourish in the southern parts of the province, whereas experts expect that the distribution of moose, easily stressed by heat, will shift northward. As the season for ice/shore sea ice is reduced, polar bears, who depend on this ice in spring and fall to hunt seals, may suffer.

Did you know?

The cold temperature of Lake Superior water creates favourable conditions for a number of arctic-alpine plant species, including the common butterwort, which would not otherwise grow so far south. Warmer water temperatures could jeopardize this and several dozen other arctic-alpine plant species and vegetation communities.

How do we measure up?

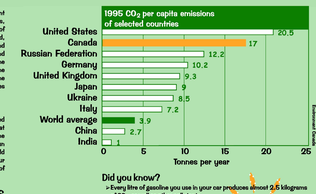
Our challenge...

Our climate dictates that we use a significant amount of energy to heat and cool our houses, offices, and schools. We have a high standard of living, compared to many parts of the world, which means we have larger houses to heat and cool, larger and more cars, televisions, and computers, and we also travel more. All the things we buy and the trips we take consume energy. For these reasons, Canada is one of the largest per capita emitters of greenhouse gases in the industrialized world.

Did you know?

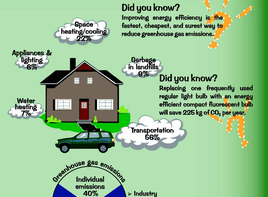
In washing machines, 92% of the energy is used by the hot water heater to heat water, and only 8% of the energy is actually used to run the machine. Using cold water to wash and rinse our clothes save up to 225 kg of CO_2 a year.

Each of us is responsible for the choices we make.



Did you know?

- Every litre of gasoline you use in your car produces about 2.5 kilograms of CO_2, as well as other pollutants.
- Fifteen seconds of idling a car engine uses more fuel than restarting it.
- "Jackrabbit" starts can increase about 60% more fuel than if you accelerate gradually.
- Purchasing locally produced food and other products reduces transportation emissions.



Did you know?

Replacing one frequently used regular light bulb with an energy efficient and compact fluorescent bulb will save 225 kg of CO_2 per year.

Our farms

Agriculture is perhaps the sector where the effects of climate on productivity and operations are most obviously felt. Quite often we get seasons with too much or too little rain, too much or too little heat, a spring thaw that arrives too late or a flood that arrives too early.

Warmer year-round temperatures and greater variability and predictability of precipitation, particularly in the winter months, will present farmers with new opportunities and new challenges.

The opportunities

Warmer temperatures and earlier and longer frost-free periods (longer by as much as five weeks) will extend the growing season and increase the potential yield of heat-loving crops such as corn, soybeans, and tomatoes. It is also possible that farmers may cultivate these crops farther north, depending on the suitability of the soil and the frequency and severity of drought. In southern Ontario, the potential for growing specialty fruits and vegetables may increase.

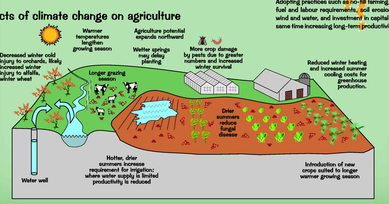
The challenges

Less rainfall at different times could mean farmers would need more irrigation in southwestern Ontario, particularly on drought-prone soils and for shallow-rooted crops such as potatoes. Warmer winters with less consistent snow cover are likely to lead to an increase in injury damage to over-wintering crops in some areas.

Did you know?

Adopting practices such as no-till farming, can reduce fuel and labour requirements, and erosion from both wind and water, and investment in capital while at the same time increasing long-term productivity.

Impacts of climate change on agriculture



Smith, J.V., Lavender, B., Auld, H., Broadhurst, D., and Bullock, T., 1998: Adapting to climate variability and change in Ontario: in Volume IV of the Canada Country Study, Climate Impacts and Adaptation; Environment Canada, Ottawa, Ontario, 117p.

Where do we go from here ? It's up to us

Think globally

Climate change is a global issue requiring international action and co-operation. In 1997, as part of an international initiative to address climate change, 160 nations negotiated an international climate change agreement, the Kyoto Protocol. This agreement identified targets for reduction of GHG emissions. It also requires that countries pursue refinements to the understanding of climate change and development of strategies to adapt.

Opportunity knocking?

Responding to climate change is presenting us with many opportunities for economic growth. Jobs, increased trade and technological advancement, reduced levels of pollution, and a cleaner, healthier environment for many Canadians.

Did you know?

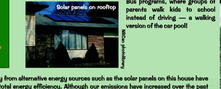
In order to stabilize atmospheric concentrations of greenhouse gases where they are today, global CO_2 emissions would have to be cut by 50 to 60%.

Act locally

Reducing GHG emissions will be a significant challenge for Canada. The fact is that even with a 20 to 25% reduction in emissions, the climate will still change, but at a somewhat slower pace. For this reason we need to start developing strategies to adapt to the new climate conditions now. The longer we wait to take action, the fewer options may be available to us.

Increasing use of energy from alternative energy sources such as the solar panels on this house have helped to increase our total energy efficiency. Although our emissions have increased over the past years, they have not increased at the same rate as our economic growth. This means we are improving the efficiency of our energy use.

Tanner, R.J.M. and Clegan, J.J., 1999: Temperature rising: climate change in southwestern British Columbia: Geological Survey of Canada, Miscellaneous Report 67.



Many communities in Ontario have initiated Walking School Bus programs, where groups of parents walk kids to school instead of driving — a walking version of the car pool!

Weathering the changes – Climate change in Ontario

Geological Survey of Canada, Miscellaneous Report 73, 2001

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Hydro One Inc.
Greenest City
Ontario Ministry of Environment
Ontario Ministry of Natural Resources
Ontario Ministry of Agriculture, Food, and Rural Areas
Ontario Soil and Crop Improvement Association
Toronto Atmospheric Fund

This poster is one of a series of posters on climate change in Canada. The posters are available from Geological Survey of Canada bookstores:
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