TEACHER'S GUIDE

A TEACHING TOOL FOR THE REGIONAL CLIMATE CHANGE POSTER SERIES

Funded in part by the Government of Canada Climate Change Action Fund

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Canada

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Welcome to our new Climate Change Posters Teacher's Guide. In it, you will find:

- A general introduction to climate change
  - the science of climate change
  - an overview of national potential impacts

- What's the scoop for your province or territory?
  - An overview of potential regional impacts
  - some general curriculum links for teaching climate change for each province and territory

- An interactive lesson plan for high school students, using the Government of Canada Climate Change Poster series, including linkages for the Pan Canadian Science Curriculum grade 10 learning outcomes.

- A list of references including useful links on the Internet, and additional educational and informational material available to teachers across Canada

PREFACE

The federal government's Climate Change Action Fund (CCAF) sponsored the development of a series of regional posters on the general science and regional impacts of climate change. Led, or co-led, by Natural Resources Canada (NRCan), the development of these posters was done in close collaboration with provincial and territorial counterparts and stakeholders. NRCan is grateful to its partners who are listed at the back of this guide.

This guide is intended to accompany the poster series, and material found in this guide comes directly from them.

INTRODUCTION TO TEACHER'S GUIDE

Kyoto. We've all heard that word, and it reminds us as Canadians that we are committed to reducing greenhouse gas emissions. It also reminds us that the

growing threat of climate change is real and will affect all of us in many different ways.

The Government of Canada Climate Change Action Fund (CCAF) sponsored the development of a series of posters that introduce climate change in terms of the science and specific issues that affect the entire country, as well as regional issues for a specific province or territory.

Climate change is a tremendously important issue that can be explored through a variety of science and social science learning opportunities. It can be easily identified and delivered within the context of provincial and territorial curricula, and is certainly something that allows learners to learn about and stay on the cutting-edge science on a current issue.

We are well aware of teachers' challenges as they search for materials to suit their ever-changing curriculum demands. To ask you to address issues that **do not** reflect that curriculum is unacceptable. This guide is based on material from the series of posters and will outline a lesson that is directly linked to the Pan Canadian Science curriculum so there will be no question as to the use and value of the posters and the guide. All attempts to consider provincial or territorial curricula learning outcomes have been made. The guide offers some general climate change information as well as the lesson plan and a variety of extensions and other ideas to make use of the poster in your class.

The lesson is targeted at the grade 10 level. However, as a teacher you can see that it is easily adapted to a variety of grade levels. We encourage you to tailor the lesson to suit your students' needs and interests.

Words of importance or significance have been **bolded**.

More detailed information can be found on the posters themselves, on the poster website at http://adaptation.nrcan.gc.ca/posters, or you can visit the Government of Canada website at www.climatechange.gc.ca, the NRCan website at www.climatechange.nrcan.gc.ca, or Environment Canada's climate change website at www.ec.gc.ca/climate.

Good luck as you begin to explore the world of climate change in Canada

AN INTRODUCTION TO CLIMATE AND CLIMATE CHANGE

The Science of Climate Change

The first thing to understand is that some level of change in climate is natural and has been experienced several times over the course of history. The greenhouse effect is also a natural phenomenon and is what keeps Earth habitable — without it, the temperature of this planet would probably hover about 33ºC colder than it is now.

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

In simple terms, Earth's climate is controlled and balanced by a number of variables, the sun, atmosphere, oceans, water, and land. The "**greenhouse effect**" refers to the heat-trapping quality of the atmosphere and is created by **greenhouse gases (GHGs)**. These gases, **which include water vapour (H_20), carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O),** are part of a complex natural system that influences our climate. Within this system, other elements, such as trees and oceans, play an important role by absorbing and storing atmospheric CO_2.

Human activities, particularly those that consume energy derived from the combustion of fossil fuels, are large sources of the **greenhouse gases (GHGs)**. Once in the atmosphere, these gases trap energy emitted by the Earth and reduce the loss of heat to space. The increasing emissions of GHGs are threatening to raise temperatures and change the planet's climate. This 'enhanced' greenhouse effect, commonly referred to as 'climate change' or 'global warming', has the potential to warm the planet at a rate never before experienced in human history.

The United Nations Framework Convention on Climate Change defines **climate change** as "*a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.*"

In other words, climate change is an overall change in weather patterns as a result of what we, as humans, do. We drive cars, burn wood, cut trees, build roads — all these activities create increases in greenhouse gases and affect climate change.

National overview of potential impacts

According to recent research, the Earth has warmed an average of 0.5ºC over the past 100 years. Climate change projections suggest that over the next

century, further warming of 1ºC to 3.5ºC will occur with the largest warming expected to occur in the high latitudes. Here at home, analysis of temperature data in Canada reveals an increase of 0.9ºC in the mean annual air temperature since 1948. This is an annual and national average. The warming has been greater in western Canada than in eastern Canada. General circulation models (GCMs) project an increase in our average annual temperature of about 4ºC by the end of this century, with some regions warming more than others. Current projections have northern regions warming by as much as 7ºC. It really doesn't seem like that big a change when we have variations in temperatures of 10ºC to 20ºC in a day - but when this range is applied to the annual average, it becomes apparent that there will be changes in the climate we are now familiar with. What impact does that have on Canada's natural environment, and then our own human environment?

Canada is blessed with a wide variety of **ecosystems** within its borders, which are influenced by climate. Some sectors of the Canadian economy are based on this ecosystem wealth in natural resources. Changes in regional climate patterns may have positive and negative effects on these important ecosystems and resources.

_ In the north, thawing of **permafrost** may cause massive terrain slumping, drainage of small lakes, and increased sediment loads in rivers. Warming and thawing of permafrost has important implications for many landscape processes and hazards such as increased terrain, slope, and coastal instability. These changes as well as associated alterations to surface hydrology, groundwater regimes, and surface vegetation have consequent socio-economic impacts for ecosystems, infrastructure, and development.

_ There may be **longer growing seasons** and the extension of agriculture farther north (depending on the quality of the soil), but there will be real risks to agriculture such as moisture deficits, pests, disease, and fires.

_ **Water levels** in lakes could change. This may threaten valuable shoreline and **wetland habitats**, have an impact on shipping and fisheries, and affect shoreline property values. Bottom-dwelling organisms contributing to healthy lakes could be threatened because it would take longer for lakes to be stratified, resulting in longer late-season periods of low oxygen conditions, which will damage fish populations.

_ The number of **heat-related deaths** could rise because of higher summer temperatures, particularly in southern urban areas. Those with heart disease, respiratory conditions, the elderly, the very young, the poor, and the homeless would suffer most.

_ Changes in temperature and precipitation may increase **insect (vector)-borne diseases**, causing increases or invasions into Canada of diseases such as West Nile virus, Lyme disease, and malaria.

_ Canada's wetlands are important for **fish and wildlife habitats**, **water storage**, and as **staging areas during migration of waterfowl**. The ecology of these wetlands is very susceptible to water-level changes and could be seriously affected.

_ In regions susceptible to spring flooding, changes in late winter-early spring thaw and precipitation patterns could result in **increased frequency of ice jams and flooding**. Damages caused by these events have already cost Canadians an estimated $60 million annually, and this cost will only increase

_ Climate change could alter the carbon cycle so that there is **less dissolved organic carbon in surface waters**. This would reduce a sort of 'water sunscreen', making the aquatic ecosystem more susceptible to impacts from ultraviolet (UV) radiation.

_ There are projected changes in the occurrence and severity of **extreme events** (winter snow and ice storms, floods and droughts), which would have serious implications for the security and integrity of Canada's natural resources, social systems, and infrastructure with subsequent implications for the insurance industry and supporting public sectors.

REGIONAL ASPECTS OF CLIMATE CHANGE

BRITISH COLUMBIA

Climate change will have significant impacts on British Columbia, including increased flood dangers in some areas, drought in others, and widespread disruption of forests, fisheries, and wildlife.

Sea levels are expected to rise up to 30 cm on the northern coast of the province. This could cause increased sedimentation, coastal flooding, and permanent inundation of some natural ecosystems. This will place low-lying homes, docks, and port facilities at risk. You can expect a significant impact on insurance rates.

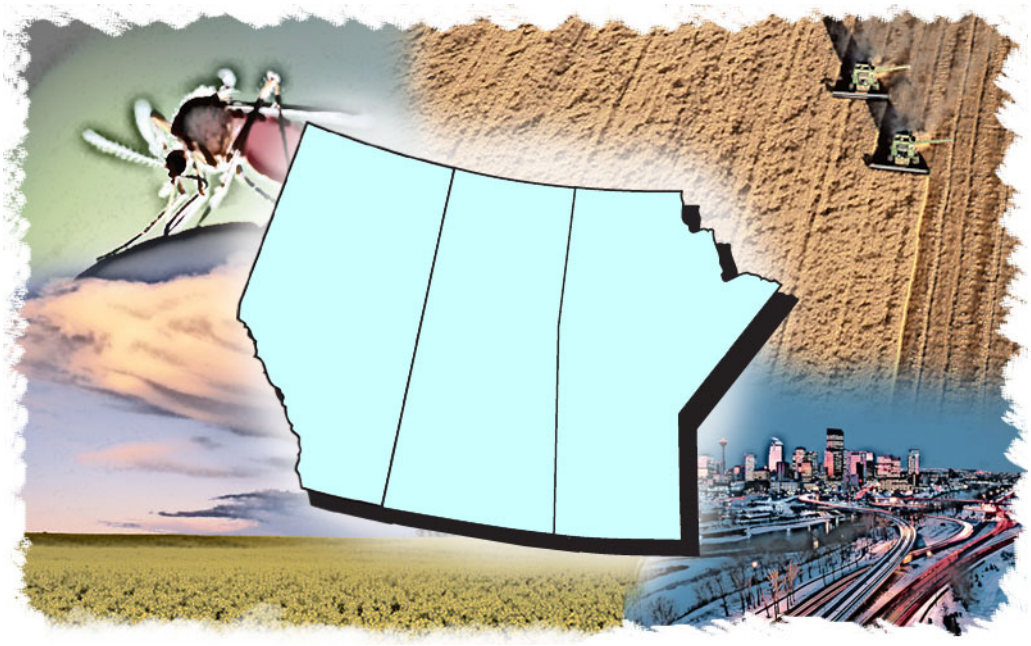
Potential regional impacts

- There will be some **changes in fisheries populations** in the oceans, from cold-water-dependent salmon to species more tolerant of warm water, such as tuna and mackerel.
- **Salmon may migrate to northern rivers** in search of colder water.
- Some **tree species will extend their ranges northward** and to higher elevations.
- Drought-tolerant species will be favoured (Douglas fir and Ponderosa pine), and in fact **grasslands may replace some Douglas fir** stands.
- **Changes in forest composition**, tree growth, fire frequency, and insect infestation will affect how and where trees will be harvested and planted. This will have a significant impact on the forest industry in British Columbia.
- **Flood damage could be more severe on the coast** and throughout the interior of British Columbia, and existing flood-protection works may no longer be sufficient.
- A rise in water level **may drown the Fraser River delta tidal marshes**, or squeeze them against the sea dykes, changing the entire ecology of the marshes.

Curriculum linkages

Earth science, Grade 11
Atmospheric science, Grade 11

The Prairie Provinces (Alberta, Saskatchewan, Manitoba)



According to Environment Canada, the yearly average temperature in the Prairie Provinces has warmed about 1.2ºC over about the last 50 years — but winter temperatures have warmed about 3.0ºC, and summer temperatures have only increased about 0.2ºC. Since 1948, seven of the ten warmest years in the Prairies have occurred after 1981.

Most of the climate change scenarios that have been projected for the Prairie Provinces suggest that the southern Prairies can expect an increase in the frequency and length of droughts. This region could experience deficiencies in soil moisture by the end of the century. However, not all parts of the Prairie Provinces will experience the same effects. Some scientists suggest that, despite the increased frequency of droughts anticipated for most of the southern Prairies, this may not occur in southern Alberta.

Potential regional impacts

- **Extreme events such as severe thunderstorms, tornadoes, hailstorms, and heat waves** may become more prevalent in the Prairies.
- The average **potential crop yields could fall** by 10% to 30% by the end of this century, due to higher temperatures and lower soil moisture.
- **Higher temperatures could lengthen the growing season** in some places, and may increase crop production (and the production of more valuable crops) in northern regions where suitable soils exist.
- **Increased demand for water pumping and summer cooling** because of drought, and decreased winter demand for heating due to higher temperatures, could push electrical utilities into a summer peak-load position. At the same time, hydropower production will be reduced by decreased water flow. This could result in increased thermal power production with an increase in fossil fuel consumption and greenhouse gas emissions. Expect changes in your fuel bill!
- **Semi-permanent and seasonal wetlands could dry up**, leading to reduced numbers of waterfowl and other wildlife species that are dependent on wetland environments.
- A reduction in glacier-derived mountain streamflow could already be having an impact on native bull trout populations.
- A decrease in growth rate and timber production in southern forests is expected along with an expansion of grassland.
- Climate change may bring on more variation in the size of extreme flows in prairie rivers, leading to higher peak flows and lower low flows.

Curriculum linkages

Alberta

Science

UNIT D: Energy flow in global systems
(STSE and Knowledge outcomes)

- Explain how climate profoundly affects the lives of people and other species in many ways, and explain the societal need to investigate climatic change.
  - Describe, in general terms, the responses of human and other species to extreme climatic conditions.
  - Describe the role of science in furthering the understanding of climate and climate change through international programs.
  - Describe the role of technology in furthering the understanding of climate and climate change.
  - Describe how rapid climatic change will result in population shifts and economic turmoil.

- Analyze the impact of change in global energy transfer systems on humans and the biosphere.
  - Analyze the impact of human actions on energy transfer in biomes and their potential impact on climate.
  - Describe and analyze the evidence for and against rapid climatic change brought on by human activity.
  - Assess, from a variety of perspectives, the risks and benefits of human activity and its impact on the biosphere and climate.

Social studies

Interdependence in the global environment
Theme III: Quality of life c) Quality of life is increasingly affected by environmental issues of global concern.

Theme IV: Alternative futures: possibilities for change c) There are potential solutions to global concerns.

Manitoba

Science
Sustainable ecosystems, Weather dynamics
Sustainable development, II
(The new science curriculum courses that are not yet implemented will link directly with the Pan Canadian general and specific learning outcomes.)

Saskatchewan

Science
Core unit A: Earth/Environmental

A1 Water Quality:	The Role of Humans in the Biosphere – Chapter 3 - Pollution and Environmental Stress, p. 76 Chemistry in Industry – Chapter 15 - Acid Rain & Our Environment, p. 458
A2 The Green House Effect	Health Science Connections - 6.2 Altering the Environment, p.170

Ontario

In Ontario, average annual air temperature could be 3ºC to 8ºC higher by the latter part of the twenty-first century, leading to fewer weeks of snow, a longer growing season, less moisture in the soil, and an increase in the frequency and severity of droughts.

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 (higher than 35ºC) 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.

Warmer temperatures and earlier and longer frost-free periods (longer by as much as five weeks) will extend the grazing season and increase the potential yield of heat-loving crops, such as corn, soybeans, and tomatoes.

The level of the Great Lakes may be reduced by up to one metre from present levels by 2050. Levels this low could have negative impacts on shipping, fisheries, water quality, water intake infrastructure, and shoreline property.

Potential regional impacts

- There will be likely increases in the **frequency and severity of forest fires**.
- **Water levels in the Great Lakes could decline by more than 1 m** by 2050, disrupting navigation routes and reducing shipping capacity.
- A decrease in rainfall will mean that **farmers would need more irrigation** in southwestern Ontario, particularly in drought-prone soils and for shallow-rooted crops such as potatoes.
- **Cold-water fish species,** such as lake trout and lake whitefish**, may disappear from southern Ontario** as their habitat changes.
- The **warmer weather will encourage white-tailed deer to flourish**, whereas experts expect that the **distribution of moose, easily stressed by heat, will shift northward**.
- **More frequent freezing rain events** could affect energy transmission and road and airline safety.
- **A warmer climate may permit the spread of new diseases from warmer climates**, such as Lyme disease, malaria, and West Nile virus.

Curriculum linkages

Biology: The sustainability of ecosystems (academic)

- (Relating science to technology, society, and the environment) Assess the impact of technological change and natural change on an ecosystem.
- Identify and evaluate Canadian initiatives in protecting Canada's ecosystems.

Earth and space science: Weather dynamics (academic)

- (Relating science to technology, society, and the environment) Explain the role of weather dynamics in environmental phenomena and consider the consequences to humans of changes in weather.

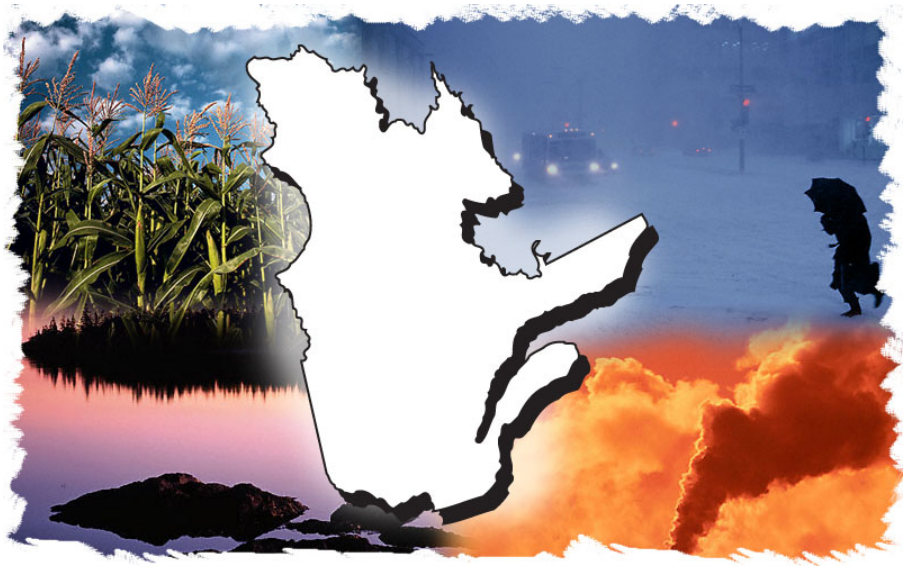
Biology: Ecosystems and human activity (applied)

- (Developing skills of inquiry and communication) Select and integrate information from various sources, including electronic, print, and community resources, to answer the questions.
- Analyze the data and information gathered to clarify aspects of the concern or issue.
- Communicate the results of the investigation using a variety of oral, written, and graphic formats.
- (Relating science to technology, society, and the environment) Assess the impact of technological change on an ecosystem.

Earth and space science: Weather systems (applied)

(Relating science to technology, society, and the environment) Identify the impact of climate change on economic, social, and environmental conditions.

Quebec



If atmospheric carbon dioxide levels were to double, Quebec would experience average temperature increases of 1ºC to 4ºC in the south and 2ºC to 6ºC in the north by the end of this century. Precipitation would likely remain the same or decrease slightly in the south, while increasing 10% to 20% in the north.

Even over the past 100 years, Quebec has experienced significant climate changes. A slight decrease in average temperatures between 1940 and 1970 was followed by the 10 hottest years of the century in the 1980s.

Potential regional impacts

- Climate change **may increase the number of severe summer storms** that occur in the hotter, more humid climate. Events such as the 1996 Saguenay flood may become more frequent.
- As water levels fluctuate in the St. Lawrence River, opportunistic flora and fauna may **disrupt sensitive ecosystems**.
- More humid, moist weather conditions favour the proliferation of some bacteria and moulds, **threatening public health**.

- Under a warmer climate, certain species of trees and animals may extend their ranges farther north, **competing with indigenous species**.
- Since maple syrup production depends on spring cycles of freeze and thaw, the **volume of production could change significantly**.
- Permafrost is extremely sensitive to temperature change and its thawing could **affect water drainage and road stability** in the far north of the province.

Curriculum linkages

Secondary school Physical science course

Terminal objective 1.0: To describe the main characteristics of the Earth's atmosphere.

- To demonstrate through experiments
  - the greenhouse effect
  - the black body effect.

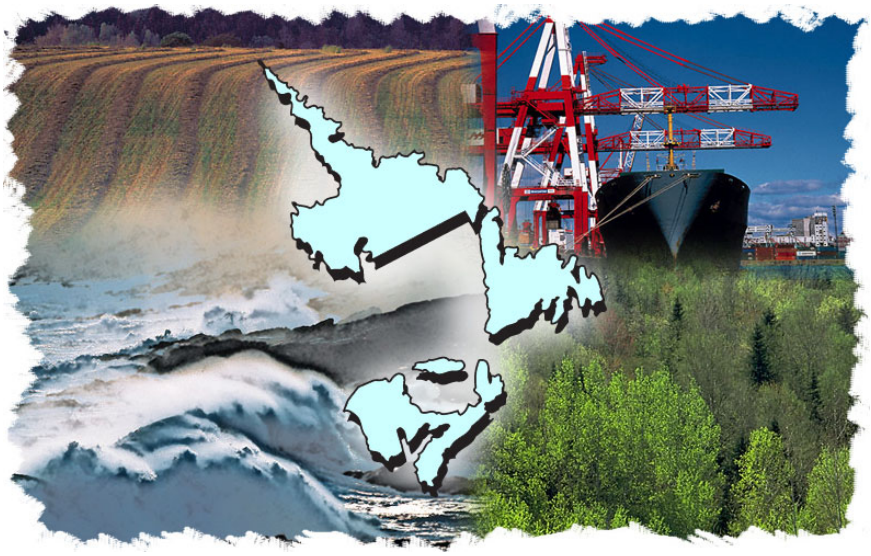
Terminal objective 1.2: To describe the various phase changes of water vapour.

- To identify the various environmental factors that make the evaporation of water possible.
- To establish the different between the various natural changes of water in the atmosphere.

Terminal objective 1.3: To explain the direct effect of the wind on air circulation and weather systems.

- To illustrate air movement due to local topography.
- To determine the direction and speed of the wind by observing certain elements in the environment.

Atlantic Provinces (Newfoundland and Labrador, New Brunswick, Nova Scotia, and Prince Edward Island)



Climate change in the Atlantic region has not followed the national warming trend of the past century and, in fact, a slight cooling trend has been experienced over the past 50 years.

Atlantic Canada is particularly vulnerable, however, to rising sea levels. The significant impacts could include greater risk of floods, coastal erosion, coastal sedimentation, and reductions in sea and river ice.

Much of the coast of Atlantic Canada is highly sensitive to the effects of sea level rise. The most sensitive coasts are commonly low-lying, with salt marshes, barrier beaches and lagoons. They will experience such effects as increased erosion, rapid migration of beaches, and flooding of coastal freshwater marshes.

There are some serious concerns for agriculture in Atlantic Canada and the greatest concern may result from a trend toward more extreme weather events, which could increase both in frequency and intensity. There might be more storms, floods, hail, and droughts. These could damage crops and livestock, and also hydro-power generation and power lines on which farms rely.

Potential regional impacts

- **The temperate forest zone will extend northward** into Atlantic Canada; however, soil conditions and life cycles limit rates of forest migration. Existing forests will undergo significant disruption before a new equilibrium is established.
- **Tree blowdown may increase in forests**, as storms may become more frequent and intense.
- **Gypsy moth infestations may increase** because of potential warmer winter temperatures. This may have an impact on the hardwood forest, and therefore those people who depend on the forest for employment.
- The Churchill River will have a **higher spring flow and lower summer flow** than today. Turbines will be unable to deal with the high spring flow and water will have to be spilled from the reservoir, leaving less water in the summer. This will mean reduced potential for summer energy sales to the large United States market.
- Many coastal communities in Atlantic Canada may face increased flooding as a result of storm surges overflowing dykes and sea walls.
- Icebergs that drift south in the Labrador Current may melt sooner as the southern melt limit moves farther north.
- **Changes in ice-free days could allow easier transportation by sea** and reduce the risk of iceberg impact on offshore structures.
- With the sea level rise anticipated in this region in the future, **storm surges may flood areas never flooded before**. A storm surge can be defined as an abnormal rise in water level caused by wind and pressure forces of a hurricane. The wind and pressure 'push' the water into the continental shelf and onto the coastline. It can act like a giant bulldozer, sweeping everything in its path.

Curriculum linkages

Sustainability issues in an ecosystem

331-6	Analyze the impact of external factors on the ecosystem
214-3, 213-7	Select, compile and display evidence and information from various sources, in different formats, to support a given view in a presentation about ecosystem change.
215-1	Communicate questions, ideas and intensions and receive, interpret, understand, support & respond to the ideas of others in preparing a report on ecosystem change.
214-15, 118-5	Propose alternative solutions to the problem of acid rain, assess each and select one.
331-6, 213-8, 212-4	Plan changes to, predict the effects of, and analyze the impact of external factors on an ecosystem.

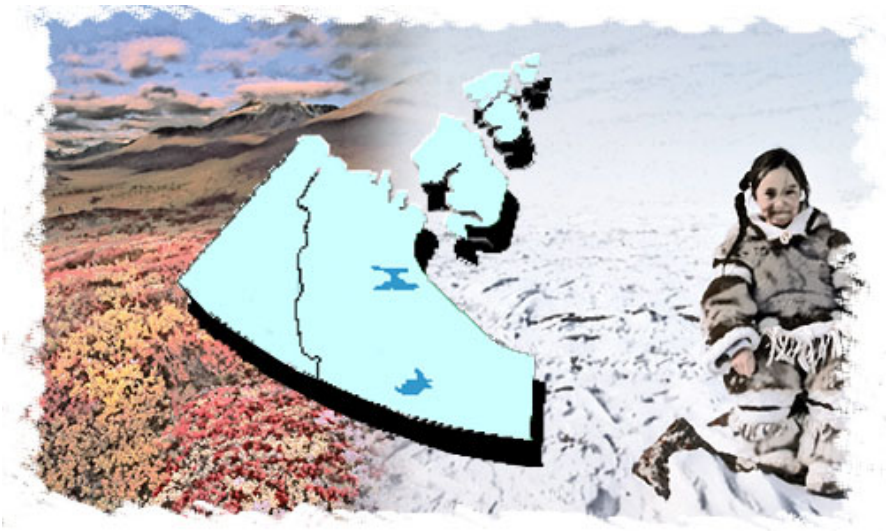
Weather Dynamics:

115-6	Explain how scientific knowledge evolves about changing weather patterns with new evidence about changes in ocean temperature.
213-7, 214-3, 215-5	Select and integrate information about weather from a variety of sources Compile and display this information to illustrate a particular hypothesis about weather in Atlantic Canada
115-2, 331-2	Using scientific theory, describe and explain heat transfer and its consequences in both atmosphere and hydrosphere, relating this science to natural phenomenon
118-2	Identify the impact of severe weather systems on economic, social and environmental conditions.

EXTENSION:

118-9, 215-4, 118-5	Propose and defend a course of action on a multi-perspective social issue.

Northwest Territories and Yukon Territory



Over the last 100 years, average annual air temperatures in the western Arctic have increased by about 1.5ºC. General circulation models project that mean annual air temperatures for the Yukon Territory and the Northwest Territories will be 2ºC to 5ºC higher by 2050 than they were during the last 30 years of the twentieth century.

Permafrost, or permanently frozen ground, can be found in a significant portion of the Northwest Territories and the Yukon Territory and much of it is at temperatures within a few degrees of 0ºC. If mean annual air temperatures increase by up to 5ºC in the next 50 to 100 years, seasonal thaw will increase, and permafrost will become thinner or ultimately disappear. Thawing of ice-rich permafrost soils can results in settlement of the ground surface and this can cause foundations for buildings and other infrastructure to become unstable.

Potential regional impacts

- The **body condition of caribou may decrease** as they spend more energy digging for food beneath deeper snow packs. This makes it difficult for cows to acquire enough energy to give birth and raise their young. A reduction in the caribou population may

result and this could have severe impacts on the communities that depend on them for food and maintenance of traditional lifestyles.

- The vegetation in northern Canada is well adapted to current climate. The **Arctic Tundra zone will likely shrink** in response to climate-warming and the **treeline will shift northward**.
- The **species composition of forests will probably change** as will the habitat for wildlife and this could lead to a **change in the distribution of animal species.** In addition, insects now found in southern Canada would move into northern Canada. Parasites and pests would also move northward and this could have adverse affects on plants and wildlife, as well as on the people living there.
- Under a warmer climate, **there may be opportunities for agriculture** in the central and upper Mackenzie valley region.
- The effects of climate warming on stream flow are not known with certainty. Increased precipitation could lead to an **increase in stream flow**, but this may be balanced by increased evaporation. Earlier and longer spring melt will result in changes in the timing and amount of spring runoff. A decrease in summer water levels could make navigation difficult.
- **There may be a decrease in sea ice extent** and an increase in the length of the melt season. **Earlier breakup of ice may have adverse effects on seal and polar bear populations**.
- **Coastal erosion may increase** as the frequency of damaging ice storms increases because of decreases in the amount of sea ice in the Beaufort coastal region in summer.
- **Drier conditions and an increase in lightning storms** are expected to result in an increase in forest fires in the Boreal Forest.
- Peat lands within the permafrost region provide important storage of carbon. **Thawing or burning of permafrost-affected peat lands may result in an alteration of the carbon cycle** and the concentration of atmospheric greenhouse gases.

Curriculum linkages

See Alberta curriculum linkages, as well as the Innuuqatigiit curriculum linkages in the following Nunavut section.

Nunavut

Climate change varies greatly within the Canadian North. The west has been warming, with the greatest temperature increases occurring in the winter and spring. The east, however, has experienced a general cooling trend, with the greatest temperature decreases occurring during the winter and spring.

Changes in the variability of climate or in the frequency of extremes may be as important to life in Nunavut as long-term warming or cooling trends.

Current climate in Nunavut reflects this variability. For southern Nunavut, the winter of 2000 was warmer. However, northern areas along the eastern Arctic Islands were cooler. Also, the precipitation conditions were wetter than normal, which is contrary to the rest of Canada.

Summer sea ice conditions vary from year to year. In 1998, the warmest year in Canada since 1951, sea ice extent for the Arctic Islands was a record minimum.

The Canadian Arctic is expected to experience more substantial changes than southern regions. In the west, temperature increases of 5ºC to 7ºC are predicted, whereas in the east, warming is predicted to be much less. Temperature changes will also differ between seasons with more overall warming occurring in the winter months.

Potential regional impacts

- Sea level rise, more extreme weather, and a loss of sea ice will contribute to **more erosion and flooding along vulnerable Arctic shorelines**. Higher sea levels with less ice cover will expose more of the coast to both normal waves and more powerful storm waves.
- **Loss of sea ice will have a profound effect on northern life.** Traditional northern activities such as travel, hunting, and fishing depend upon the presence of solid sea ice whereas, on the other hand, less sea ice in the North would make access to the communities easier by boat and create longer shipping seasons.
- **Glaciers may melt and decrease in size** with increased temperatures in the Arctic. Where a glacier has formed a lake by blocking river drainage, the dam may melt and cause flooding downstream.
- Traditional knowledge is used to predict ice conditions and guide hunters in travel and work at the floe edge. **Change in land-fast ice behaviour has made predicting ice conditions more difficult**, and caused dangerous situations in recent years, such a number of students being stranded on sea ice in 1997.
- **Warming may extend waterfowl nesting periods**, provide more food for young birds, and decrease chick mortality.
- However, in the southern regions, warming may reduce breeding and forage habitats.
- **Sea level rise may damage important shoreline nesting areas**, and increased storms during the nesting season could destroy essential nesting efforts, eggs, and chicks.
- Changes in the range and abundance of animals may mean local **adjustments to traditional hunting and harvesting strategies**, as well as possible changes in traditional diet.
- **The meat quality is expected to decline**, and this may affect the nutritional health of people dependent on country food.

Curriculum linkages

Science
Unit D Global systems

Innuuqatigiit curriculum

Water — Values: An appreciation of the importance of water to Inuit life should be taught.

Ice — Objectives: Understand the relationships between ice, weather, tides current and the land. Key experiences/Activities: Observe salt water and fresh water ice during freeze up and breakup. Notice the differences. How long does it take to freeze, melt, break up? Do they follow a pattern? Is it the same every year?

Weather and weather predicting — Values: Recognition that weather controls humans and that humans do not control weather is encouraged. Objectives: Learn about long-term climate changes.

Sky — Attitudes: Students will be encouraged to look at the sky and always be conscious of the changing weather; learn from the elders how to read the sky to predict the weather.

Bears — Knowledge and traditions: When bad weather prevailed over a long period of time, women would burn a piece of bear skin hoping to change the weather.

LESSON PLAN — The heat is on

SPECIFIC LEARNING OUTCOMES

NOTE: The following are taken directly from the Pan-Canadian Science Framework document. They are nationally recognized learning curriculum outcomes.

Science, technology, society, and the environment (STSE): 115-2, 115-6 , 118-2

Skills: 212-1, 212-4, 213-6, 215-1, 215-5

Knowledge: 331-5, 331-6

Attitudes: 440, 445, 447, 448, 450

EXPLORATION

1. Introduce the climate change poster (or posters) to the class.

2. Ask the students to take a few minutes to write down five things that they know or have read/heard about climate change. Have them consider the following questions:

    - What is weather?
    - What is climate?
    - What is global warming?
    - What is the greenhouse effect? And what are greenhouse gases?
    - Why do you think that climate change and global warming is in the news so much today?
    - What are some potential national, regional, and local issues?
    - What are some social and cultural implications of climate change?
    - What is 'wrong' with the current trend in global warming?
    - Why is climate change an issue for us today when climate has changed in the past, and can be expected to change now and in the future?

3. Ask the students for their ideas that they listed in number two. Generate a list on the blackboard or flip chart. Once you are done listing the ideas, organize them into categories or themes, such as impacts on agriculture, forestry, why climate is changing now, etc.

4. Briefly introduce each of the panels illustrated on the poster. Ask the students to identify those commonalities between their contributions and those found on the poster. *(Depending upon the size of class, teachers may choose to prepare brief overheads for each panel to assist in the introduction of each theme.*

Alternatively, teachers may choose to have the students came up in groups to review the poster and various themes.)

5. Divide the students into groups on the basis of the categories or themes they have identified. Have each group select a theme for research.

6. Each group will complete research on their particular theme, as it relates to climate change. (The level of research will depend upon the time you wish to spend on this activity.) Students can use the information from the poster for a basic level of research. The groups can also use both the poster and the school library. Finally, an in-depth level of research could be undertaken using the Internet and other technical research opportunities such as print and electronic materials available from Environment Canada, Natural Resources Canada, David Suzuki Foundation, etc.

7. As the students carry out their research, ask them to consider how climate change will affect their theme **on a local level**. For example, they may have explored the impact of climate change on agriculture. If any of the students are from farming communities, what impact would climate change have on their local farm? Would a small increase in temperature affect plant species able to grow? If there is no direct impact, there certainly would be an indirect effect at the grocery store, reflected in increased prices or unavailability of certain products. Students would need to consider fertilizer use and nitrous oxide, livestock, feedlots and methane production, reduction of watershed, spring runoff, and droughts.

DEVELOPMENT

8. Explain to each group the concept of a **Futures Wheel**. This is a versatile tool used to study implications and relationships in any situation. It reveals the many effects on interrelationships of a single decision or situation. It can be used to highlight these interactions and more clearly understand the relationships among them. (An example Futures Wheel has been enclosed for your reference as **Attachment A**.)

9. Have each group describe their own central statement on climate change and begin to explore the results using the Futures Wheel. Example questions might be

    - Tree species extend their ranges northward and to higher elevations.
    - Polar bears spend more time on shore, rather than out on sea ice.
    - White-tailed deer populations will increase significantly.
    - Permafrost begins to thin over the next 50 years.

    Students can explore the impacts of their central statement by listing at least five first-level implications and project out at least three levels of implications.

10. Have each group work co-operatively to present and explain their Futures Wheel. They must be prepared to defend their decisions or judgments they have reached in their Futures Wheel and demonstrate that relevant arguments can arise from different perspectives They must also be prepared to answer questions from their peers.

LESSON EXTENSIONS

1. Challenge the class to create a new climate change poster. Each group will be responsible for the text and graphics describing their researched theme or category. Using the results of the Futures Wheel and questions, have each group create the text and graphics for a separate panel and together create a new class climate poster.

   (There is an opportunity for your class to compete in a national poster contest. The winning poster from each province or territory will be posted on the NRCan website.)

2. Have your class prepare a climate change information session for an audience. Students can present their findings from their research, as well as describe their projections for climate change on their Futures Wheels. The audiences may include other classes at the school; elementary students in local schools also studying climate change; community/parent information night; etc.

   This can also be linked with Earth Day, National Forest Week, or other community environmental education initiatives.

EXAMPLE CLIMATE CHANGE FUTURES WHEEL

THERE IS A TEMPERATURE INCREASE OF 2.5ºC.

There will be an increase in extreme weather events.

This will affect forest survival and regeneration.

This may negatively affect the forest industry.

This will result in a negative change in local employment.

There will be a change in the types of forest species.

This will result in a detrimental change in the forest industry.

There will be a lost in the soil humidity

This will result in grasslands replacing forests.

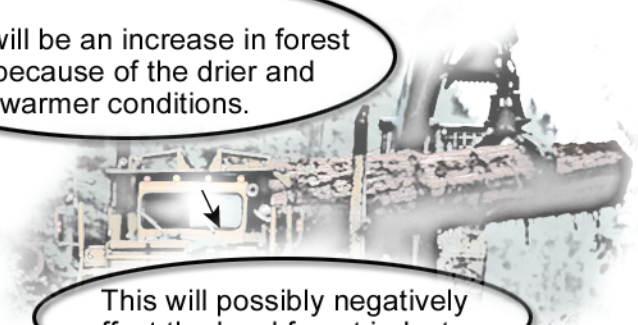
There will be more and different insect invasions (because previously controlled by cold weather).

This may result in forest fire conditions.

There would be a loss of species and biomass.

There will be a loss of soil stability.

There will be an increase in forest fires because of the drier and warmer conditions.



This will possibly negatively affect the local forest industry.

This will result in a change in species distribution.

ADDITIONAL REFERENCES

Climate Change Websites

Government of Canada:
www.climatechange.gc.ca

Natural Resources Canada:
www.climatechange.nrcan.gc.ca

Environment Canada:
www.ec.gc.ca/climate

Health Canada:
www.hc-sc.gc.ca

Climate Change Solutions:
www.climatechangesolutions.com

Environment Canada Atlantic Region — Climate Change Workbook
www.ns.ec.gc.ca/co2/worksheet.html

David Suzuki Foundation
www.davidsuzuki.org/Campaigns_And_Programs/Climate_Change

Environmental Protection Agency (USA)
www.epa.gov/globalwarming/

United Nations — Earthwatch
www.unep.ch/earthw.html

Teacher resources

Canadian Forestry Association — National Forest Week Kit 2001
www.canadianforestry.com

Clean Nova Scotia
www.clean.ns.ca

FEESA/Destination Conservation — National Education Initiative on Climate Change
www.dc.ab.ca

Global Change Game The Global Change Game
www.gcg.mb.ca

Greater Vancouver Regional District: *Temperature rising; Climate change in southwestern British Columbia*
www.climatechangecanada.org

Green Teacher — Meeting the Challenge
www.greenteacher.com

The Institute for Global Environmental Strategies — 12 lessons on climate change for high school students
http://www.strategies.org/climate.html

Pembina Institute — Climate Change Teacher Support Program
www.pembina.org

Society Environment and Energy Development Studies — Creating a Climate of Change
www.greenschools.ca/seeds/

Sustainable Development Resource Institute — Climate Change Calculator
www.climcalc.net

Toronto Atmospheric Fund Cool Schools Program (Toronto only)
www.city.toronto.on.ca/taf/cool_school.htm

Union of Concerned Scientists "Curriculum Guide for High School Courses in Biology, Environmental Science, Geography, Earth Science and other focusing on the society-environment interface"
http://www.climatehotmap.org/curriculum/index.html

The following is a list of the partners and major contributors to each of the regional posters:

Temperature rising — Climate change in southwestern British Columbia

Natural Resources Canada
Geological Survey of Canada
Environment Canada, Pacific and Yukon Region
Simon Fraser University, Earth Sciences
Other participating agencies
Agriculture and Agri-Food Canada, Pacific Agri-Food Research Centre
B.C. Hydro
British Columbia Ministry of Environment, Lands and Parks
British Columbia Ministry of Forests
Canadian Institute for Climate Studies
David Suzuki Foundation
Environment Canada, Environmental Adaptation Research Group
Fisheries and Oceans Canada, Pacific Biological Station
Fisheries and Oceans Canada, Institute of Ocean Sciences
Greater Vancouver Regional District
Natural Resources Canada, Canadian Forest Service
Pembina Institute for Appropriate Development
Royal British Columbia Museum
Sea to Sky Outdoor School of Environmental Education

The winds of change — Climate change in the Prairie Provinces

Natural Resources Canada
Geological Survey of Canada
Agriculture and Agri-Food Canada
Alberta Agriculture, Food and Rural Development
Alberta Conservation Association
Alberta Environment
Destination Conservation
Environment Canada, Meteorological Service of Canada
Environment Canada, National Water Research Institute
Emergency Preparedness Canada
Manitoba Conservation
Manitoba Geological Survey
Manitoba Hydro
Natural Resources Canada, Canada Centre for Remote Sensing
Natural Resources Canada, Canadian Forest Service
Pembina Institute
Saskatchewan Research Council
SEEDS Foundation
Soltek Solar Energy Ltd.

Weathering the changes — Climate change in Ontario

Natural Resources Canada
Geological Survey of Canada
Agriculture and Agri-Food Canada
Canadian Forest Service, Natural Resources Canada
Carleton University
Emergency Preparedness Canada
Environment Canada
Fisheries and Oceans Canada
Health Canada
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

A change in the wind — Climate change in Quebec

Natural Resources Canada
Canadian Forest Service
Environment Canada
Fisheries and Oceans Canada
Agriculture and Agri-Food Canada
Sécurité publique du Québec, Direction de la sécurité civile de l'Est and office of the Associate Deputy Minister
Environnement Québec, Direction des changements climatiques and Direction des communications
Transports Québec
Ressources naturelles Québec, Secteur des forêts
Société de la faune et des parcs du Québec, Direction de la recherche sur la faune
INRS – EAU
Laval University
University of Montreal

The tides of change — Climate change in Atlantic Canada

Natural Resources Canada
Geological Survey of Canada
Agriculture and Agri-Food Canada
Department of Fisheries and Oceans
Environment Canada
Memorial University of Newfoudland

Degrees of variations — Climate change in Nunavut

Natural Resources Canada,
Geological Survey of Canada;
Balanced Environments Associates
Canada-Nunavut Geoscience Office
Other participating agencies:
Canadian Ice Service;
CANMET;
Department of Sustainable Development, Nunavut;
Environment Canada;
Inukshuk Secondary School, Iqaluit;
Meteorological Service of Canada;
Nunavut Research Institute;
Qarmartalik School, Resolute Bay;
Ummimak School, Grise Fiord

Taking the chill off? Climate change in the Yukon and Northwest Territories

Natural Resources Canada
Geological Survey of Canada
Aurora College
Department of Fisheries and Oceans
Environment Canada
Parks Canada
Gwich'in Renewable Resource Board
Yukon College
Northern Climate Exchange
Government of Yukon
Government of N.W.T.