

TEACHERS GUIDE

Canada in a Changing Climate: Society and the Economy



A Lesson Plan for Grade 9 and 10 Geography and Science Classes



CANADA SCIENCE AND TECHNOLOGY
MUSEUMS CORPORATION
SOCIÉTÉ DES MUSÉES DE SCIENCES
ET TECHNOLOGIES DU CANADA



Canada 

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Overview

This teachers guide is designed to accompany the Natural Resources Canada report called *Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation* (2014), available at www.nrcan.gc.ca/environment (Climate Change > Impacts and Adaptation). This report addresses current sensitivities to climate, as well as the risks and opportunities that climate change presents. The report also discusses adaptation options, approaches, and planning. It aims to inform the public and decision-makers about the importance of employing both adaptation and mitigation measures to significantly reduce the risks and magnitude of climate change.

By participating in activities like the ones in this module, students will develop a better understanding of the factors that contribute to climate change; and of the effects of climate change on society, the economy, and the environment. They will also explore the notion of adapting to climate change — both its existing effects and expected ones — to not only mitigate risks but also take advantage of possible opportunities.

The activities in this module aim to develop a variety of 21st-century skills such as critical thinking, creativity, collaboration, and communication. Teachers can present the activities as a module or individually.

Teacher Backgrounder¹

Climate Change: A Definition

What is climate change?

The term climate change refers to significant changes in average weather patterns (i.e., precipitation, temperature, wind, and other indicators) that persist within a climate system, caused directly or indirectly by human activity.² Climate change can involve both changes in *average conditions* and changes in *variability*, including extreme events. While there has always been variation in the Earth's climate, there is consensus in the scientific community that since the Industrial Revolution, human activity has increased the amount of greenhouse gases being released into the atmosphere; and that this is leading to a statistically significant increase in the Earth's temperature — hence the expression “global warming.” **Climate change is happening now.**

¹ Most of the information in this section, unless otherwise noted, is taken from the report *Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation*, F.J. Warren and D.S. Lemmen, editors (2014); Government of Canada, Ottawa, ON. <http://www.nrcan.gc.ca/environment>

² The Intergovernmental Panel on Climate Change uses the term “climate variability” for changes in weather patterns due to natural causes, and reserves “climate change” for shifts due to direct or indirect human activity.

³ <http://www.climatechange.gc.ca/default.asp?lang=En&n=65CD73F4-1>

It is this human-induced enhancement of the greenhouse effect that is of concern. Ongoing emissions of greenhouse gases have the potential to warm the planet to levels that have never been experienced in the history of human civilization.³

How does climate change affect us?

Researchers agree that we are seeing the impacts of climate change in Canada in various areas, including the following.

- **Natural resources development (forestry, energy, mining):** Climate change exacerbate climate extremes (e.g., extreme heat, cold, precipitation) and the resulting impacts and hazards. It also leads to gradual changes, such as permafrost degradation, sea level rise, and plant species migration — all of which affect the forestry, energy, and mining sectors. Climate change will also present new opportunities for the natural resource sectors, particularly in relation to northern economic development.
- **Industry:** Industrial activity is sensitive to variations in weather and to extreme events. The type of impacts and their extent depend on the industry, but production, operations, and revenue among and within sectors can be affected.
- **Human health:** Climate-sensitive diseases and disease vectors are moving northward into Canada (e.g., Lyme disease) and will likely continue to expand their range. In addition, new research suggests climate change will exacerbate health issues related to air pollution in some parts of Canada.
- **Water resources and infrastructure:** Well-maintained infrastructure is more resilient to a changing climate. This is especially true with respect to gradual changes in temperature and precipitation patterns. But there are key vulnerabilities associated with extreme weather events, which can overwhelm the capacity of water infrastructure.
- **Food production:** The impacts of climate change differ significantly between agriculture, fisheries, and non-commercial food supply, but common effects include increased losses from invasive pests and diseases, and risks to the transportation systems these sectors rely on.
- **Biodiversity:** Climate-related shifts in species distributions have already been documented for plants and animals in Canada. In many areas, shifts in species range are likely to result in novel ecosystems that have different species combinations, structural attributes, and ecological functions than existing ones.

Adaptation and Mitigation Measures

A changing climate presents both risks and opportunities for Canada's regions and resource sectors. In this vast country with its diverse climate and economy, addressing climate change requires targeted and collaborative action that reduces greenhouse gas emissions (mitigation) and helps us adapt to climate impacts (adaptation).

Adaptation	Mitigation
<p>Adaptation involves modifying our decisions, activities, and ways of thinking to adjust to a changing climate. Here are some examples of adaptation measures to deal with climate change:</p> <ul style="list-style-type: none"> • modifying building codes to ensure that buildings can withstand flooding and/or other extreme events • protecting coastal development with structures such as seawalls, dikes, beach nourishment, sand dunes • regulating building development and taking measures against hazards (e.g., flood-proofing, flood hazard maps, flood warnings) • expanding crops northward as the weather warms (e.g., sugar maple for maple syrup production) • adjusting seeding and harvesting times 	<p>Mitigation aims to reduce the causes of climate change. It is designed to reduce greenhouse gas emissions at the source or to support “sinks” that absorb or eliminate greenhouse gases. Here are some examples of mitigation measures:</p> <ul style="list-style-type: none"> • improving energy efficiency in all economic sectors to reduce our dependence on fossil fuels • participating in a carbon tax scheme to incite industries to find creative ways to reduce greenhouse gas emissions • increasing local agricultural capacity to avoid the transportation of food over long distances • limiting deforestation, and/or replanting • converting agricultural land to forests

There can be co-benefits, or synergies, between these two responses to climate change: in some cases, actions taken to adapt also serve to reduce greenhouse gas emissions, or mitigation actions also reduce vulnerability to climate change (see Figure 1). For example, green roofs — where vegetation is planted on the roofs of buildings — have adaptive benefits (e.g., moderated stormwater runoff, reduced urban-heat-island effect, and improved air quality) as well as mitigative value (e.g., reduced energy consumption, reduced greenhouse gas emissions, and increased carbon dioxide absorption). However, there is also the potential for conflict between adaptation and mitigation, where adaptation choices can increase greenhouse gas emissions. Using air conditioners to deal with higher temperatures, for example, means increased energy use and related emissions.

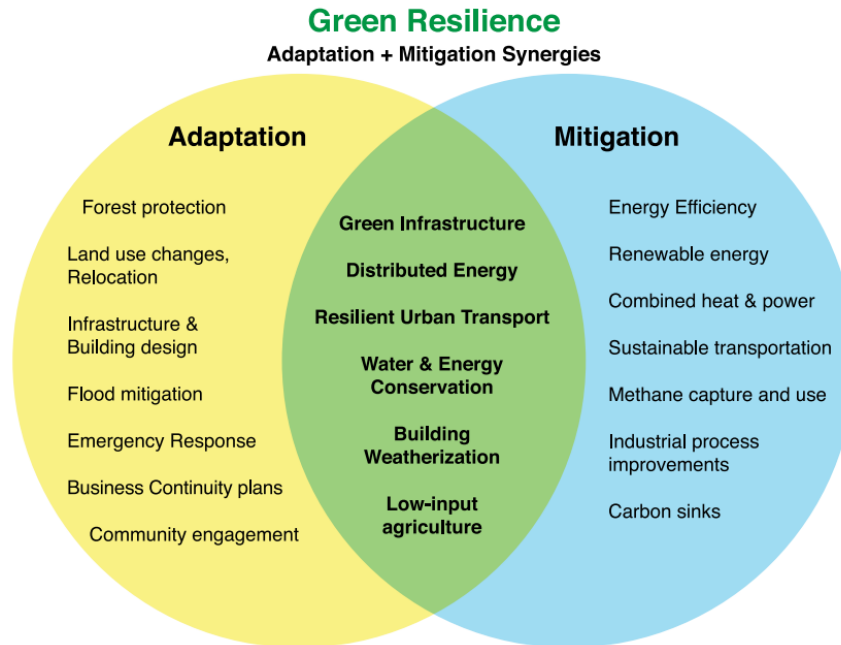


Figure 1. Examples of adaptation, mitigation, and overlap between the two approaches. Source: Canada's Marine Coasts in a Changing Climate, D.S. Lemmen, F.J. Warren, T.S. James, and C.S.L. Mercer Clarke, editors (2016); Government of Canada, Ottawa, ON, p. 257. (Image courtesy of the Centre for Clean Air Policy.)

Climate change is happening now, which is why government, industry, and social enterprises around the world are actively engaged in developing adaptive strategies to reduce the negative impacts to society and the environment.

Glossary and Key Vocabulary

Adaptation measure: Any action that reduces the negative impacts of climate change or allows us to take advantage of new opportunities resulting from climate change.

Biodiversity: The variety of species and ecosystems and the relationships between them.

Climate change: A significant change in the Earth's climate. The Earth is currently getting warmer because people are adding heat-trapping greenhouse gases to the atmosphere. The term "global warming" refers to warmer temperatures, while "climate change" refers to the broader set of changes that go along with warmer temperatures, including changes in weather patterns, the oceans, ice and snow, and ecosystems around the world. (epa.gov)

Crop management and planning: Planning and managing agricultural crops in order to optimize the use of soil nutrients.

Ecosystems: Community of living organisms (plants, animals and microbes) that interact with the physical components of their environment (air, water, soil).

GHG sink: Mechanism which is natural (e.g. photosynthesis) or man-made (e.g. underground carbon capture and storage) and which absorb atmospheric GHG (usually carbon or methane).

Greenhouse gas emissions (GHG): Gases that allow the Sun's rays to reach the Earth, but which absorb the infrared radiation reflected back by the surface of the Earth. They trap a portion of the solar energy, which reheats the planet's surface sufficiently to maintain life. The accumulation of greenhouse gas emissions due to human activity amplifies the natural "greenhouse effect" and is the main contributor to global warming. (NRCan)

Issues: Things that can be gained or lost in terms of money (economic), society (social), laws (political), or the environment (environmental).

Mitigation measure: Action designed to reduce greenhouse gas (GHG) emissions in the atmosphere or to support GHG sinks.

Definitions attributed to "NRCan" were taken or adapted from the Natural Resources Canada glossary, found at <https://cfs.nrcan.gc.ca/terms>.

Suggested Resources

Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation

F.J. Warren and D.S. Lemmen, editors (2014); Government of Canada, Ottawa, ON

<http://www.nrcan.gc.ca/environment>

Canada's Marine Coasts in a Changing Climate

D.S. Lemmen, F.J. Warren, T.S. James, and C.S.L. Mercer Clarke, editors (2016); Government of Canada, Ottawa, ON

<http://www.nrcan.gc.ca/environment>

Climate Change: What Is Happening and How Do We Know?

Katherine Hayhoe (Nov. 12, 2016); Presentation at the Science Teachers Association of Ontario conference (start at 4:00 minutes)

<http://youtu.be/-9LKaPWmaMc?t=246>

Natural Resources Canada glossary

<https://cfs.nrcan.gc.ca/terms>

Adapting to climate change

Quebec Centre for Biodiversity Science website

<http://qcbs.ca/research/research-contracts/adapting-to-cc/>

Intergovernmental Panel on Climate Change – See most recent Synthesis Report (indicators, impacts, adaptation and mitigation options)

https://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml

Climate change

Natural Resources Canada website, Forest Topics

<http://www.nrcan.gc.ca/forests/climate-change/13083>

(effects, impacts, mitigation, and adaptation),

Adaptation Library: Resources for Climate Adaptation

<http://www.adaptationlibrary.com>

Impacts and Adaptation

Natural Resources Canada website, Climate Change

<http://www.nrcan.gc.ca/environment/impacts-adaptation>

Forest pest management

Natural Resources Canada website, Forest topics (includes videos)

<http://www.nrcan.gc.ca/forests/fire-insects-disturbances/pest-management/13361>

Facing the Change: 5 Canadian Communities Threatened by Climate Change Now

CBC Radio

<http://www.cbc.ca/radio/day6/five-canadian-communities-threatened-by-climate-change-now-1.3776341>

Strategic Planning by Province

AB	Climate Leadership Plan https://www.alberta.ca/climate-change.aspx
BC	Climate Leadership Plan http://climate.gov.bc.ca/
PEI	Prince Edward Island: Climate Change https://www.princeedwardisland.ca/en/topic/climate-change-0
MB	Climate Change and Air Quality http://www.gov.mb.ca/sd/climate/
NS	Climate Change Nova Scotia https://climatechange.novascotia.ca/
NB	New Brunswick: Climate Change http://www2.gnb.ca/content/gnb/fr/ministeres/egl/environnement/content/changements_climatiques.html
NV	Climate Change Centre http://www.climatechangenunavut.ca/
ON	Ontario: Climate change https://www.ontario.ca/page/climate-change
QC	Quebec: 2013-2020 Climate Change Action Plan (French) http://www.mddelcc.gouv.qc.ca/changements/plan_action/strategie-adaptation2013-2020.pdf
SK	Climate Change Policy http://www.saskatchewan.ca/business/environmental-protection-and-sustainability/climate-change-policy
NFL	Climate Change http://www.ecc.gov.nl.ca/climate_change
NWT	Northwest Territories: Climate Change http://www.enr.gov.nt.ca/programs/nwt-climate-change
YK	Climate Change and Yukon http://www.env.gov.yk.ca/air-water-waste/climatechange.php

Learning Outcomes in Geography and Science

Canadian National Standards for Geography, grades 9 and 10 (2001) ¹
<p>The World in Spatial Terms</p> <ul style="list-style-type: none"> • Use maps and other geographic representations to analyze world events and suggest solutions to world problems. • Use map projections to identify common factors that affect the development of spatial understanding and preferences. • Use mental maps to answer geographic questions.
<p>Places and Regions</p> <ul style="list-style-type: none"> • Evaluate how humans interact with physical environments to form places. • Identify human and physical changes in regions and explain the factors that contribute to those changes. • Interpret the connections between and within the parts of a regional system. • How individuals view places and regions on the basis of their stage of life, gender, social class, ethnicity, values, and belief systems. • Use regions to analyze geographic issues and answer geographic questions.
<p>Physical Systems</p> <ul style="list-style-type: none"> • Describe the ways in which Earth's physical processes are dynamic and interactive. • Describe how physical processes affect different regions of the Canada and the world. • Evaluate ecosystems in terms of their biodiversity and productivity
<p>Human systems</p> <ul style="list-style-type: none"> • Analyze population issues and propose policies to address such issues. • Classify and describe the spatial distribution of major economic systems and evaluate their relative merits in terms of productivity and the social welfare of workers. • Analyze how cooperation and conflict influence the development and control of social, political, and economic entities on Earth.
<p>Environment and Society</p> <ul style="list-style-type: none"> • Explain the global impacts of human changes in the physical environment Analyze examples of changes in the physical environment that have reduced the capacity of the environment to support human activity. • Explain the ways in which individuals and societies hold varying perceptions of natural hazards in different environments and have different ways of reacting to them.
Canadian Common Framework of Science Learning Outcomes, grades 9 and 10 ² (1997)
<p>Nature of science and technology</p> <ul style="list-style-type: none"> • Illustrate how science attempts to explain natural phenomena
<p>Relationships between science and technology</p> <ul style="list-style-type: none"> • Apply the concept of systems as a tool for interpreting the structure and interactions of natural and technological systems
<p>Social and environmental contexts of science and technology</p> <ul style="list-style-type: none"> • Compare examples of how society supports and influences science and technology • Defend a decision or judgement and demonstrate that relevant arguments can arise from different perspectives • Describe possible positive and negative effects of a particular scientific or technological development, and explain why a practical solution requires a compromise between competing priorities • Explain how society's needs can lead to developments in science and technology • Identify and describe science- and technology-based careers related to the science they are studying • Provide examples of Canadian contributions to science and technology • Provide examples to illustrate that scientific and technological activities take place in a variety of individual or group settings • Provide examples of how science and technology affect their lives and their community • Provide examples of how Canadian research projects in science and technology are funded
<p>Skills: Initiating and planning</p> <ul style="list-style-type: none"> • Identify questions to investigate that arise from practical problems and issues • State a prediction and a hypothesis based on available evidence and background information
<p>Skills: Performing and recording</p> <p>Select and integrate information from various print and electronic sources or from several parts of the same source</p>
<p>Skills: Analysing and interpreting</p> <ul style="list-style-type: none"> • Interpret patterns and trends in data, and infer and explain relationships among the variables • Compile and display evidence and information, by hand or computer, in a variety of formats, including diagrams, flow charts, tables, graphs, and scatter plots • Identify and evaluate potential applications of findings • Identify new questions or problems that arise from what was learned • Provide a statement that addresses the problem or answers the question investigated in light of the link between data and the conclusion

Skills: Communication and teamwork

- Communicate questions, ideas, and intentions, and receive, interpret, understand, support, and respond to the ideas of others
- Communicate questions, ideas, intentions, plans, and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language, and other means
- Develop, present, and defend a position or course of action, based on findings
- Evaluate individual and group processes used in planning, problem solving, decision making, and completing a task
- Identify multiple perspectives that influence a science-related decision or issue

Grade 10 Life Science (Sustainability of ecosystems)

- Illustrate the cycling of matter through biotic and abiotic components of an ecosystem by tracking carbon, nitrogen, and oxygen
- Explain why different ecosystems respond differently to short-term stresses and long-term changes
- Explain various ways in which natural populations are kept in equilibrium and relate this equilibrium to the resource limits of an ecosystem
- Explain how the biodiversity of an ecosystem contributes to its sustainability
- Analyse the impact of external factors on an ecosystem
- Describe how soil composition and fertility can be altered and how these changes could affect an ecosystem

Grade 10 Earth And Space Science (Weather dynamics)

Describe and explain heat transfer within the water cycle

- Describe and explain heat transfer in the hydrosphere and atmosphere and its effects on air and water currents
- Describe how the hydrosphere and atmosphere act as heat sinks within the water cycle
- Describe and explain the effects of heat transfer within the hydrosphere and atmosphere on the development, severity, and movement of weather systems
- Analyse meteorological data for a given time span and predict future weather conditions, using appropriate methodologies and technologies

¹Canadian National Standards for Geography:

http://www.cangeoeducation.ca/resources/learning_centre/docs/Canadian_Geography_Standards.pdf

²Common Framework of Science Learning Outcomes (CMEC): <http://science.cmec.ca/index.en.html>