Canada Science and Technology Museum

Teacher's guide

Society and economy

Canada in a changing climate

A lesson plan for grade 9 and 10 geography and science classes

Ingenium

CANADA SCIENCE AND TECHNOLOGY MUSEUM
MUSÉE DES SCIENCES ET DE LA TECHNOLOGIE DU CANADA

Canada

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 http://bit.ly/3OXI0V3 (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 backgrounder

Note: 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://bit.ly/3OXI0V3

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. **Note:** 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.

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.**

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 (https://www.canada.ca/en/environment-climate-change/services/climate-change/causes.html).

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

- 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:
- 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

Mitigation

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:

- 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.

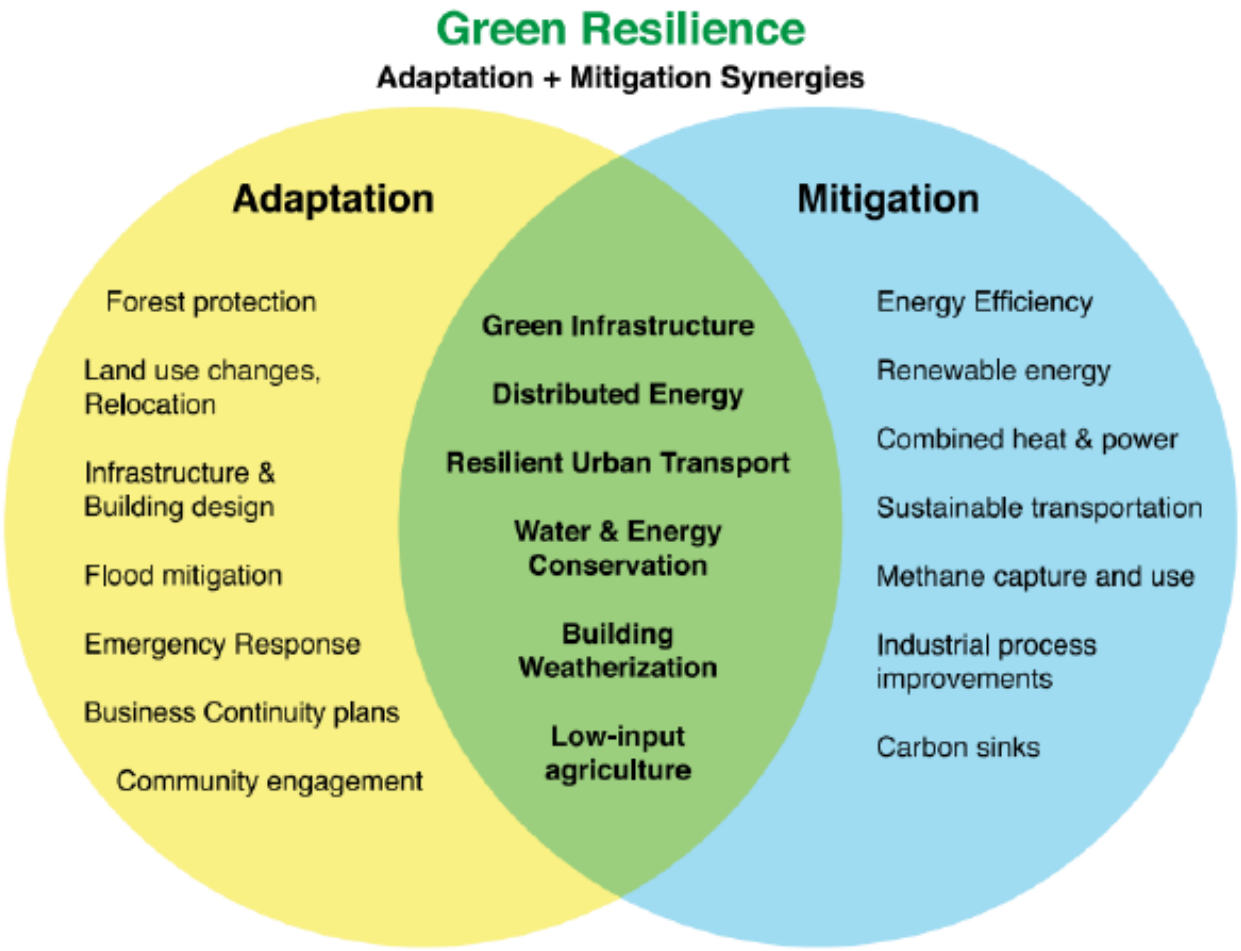


Figure 1. Examples of adaptation, mitigation, and overlap between the two approaches. Source: Canada's Marine Coasts in a Changing Climate, D.S. Lemmen, F.J. Warren, T.S. James, and C.S.L. Mercer Clarke, editors (2016); Government of Canada, Ottawa, ON, p. 257. (Image courtesy of the Centre for Clean 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://bit.ly/3OXI0V3
- **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://bit.ly/3EWEaXM
- **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 https://qcbs.ca/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 (effects, impacts, mitigation, and adaptation)
  http://www.nrcan.gc.ca/forests/climate-change/13083
- **Adaptation Library: Resources for Climate Adaptation**
  http://www.adaptationlibrary.com
- **Impacts and Adaptation**
  Natural Resources Canada website, Climate Change
  https://www.nrcan.gc.ca/climate-change/21442

- **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 www.alberta.ca/climate-change.aspx
- BC-Climate Leadership Plan www.climate.gov.bc.ca
- PEI-Prince Edward Island: Climate Change www.princeedwardisland.ca/en/topic/climate-change-0
- MB-Climate Change and Air Quality
  https://www.gov.mb.ca/sd/environment_and_biodiversity/air_quality/index.html (EN only)
- NS-Climate Change Nova Scotia climatechange.novascotia.ca/ (English only)
- NB-New Brunswick: Climate Change
  http://www2.gnb.ca/content/gnb/fr/ministeres/egl/environnement/content/changements_climatiques.html
- NV-Climate Change Centre www.climatechangenunavut.ca/ (English only)
- ON-Ontario: Climate change www.ontario.ca/page/climate-change
- QC-Quebec: 2013-2020 Climate Change Action Plan (French)
  www.mddelcc.gouv.qc.ca/changements/plan_action/stategie-adaptation2013-2020.pdf
- SK-Climate Change Policy https://bit.ly/3ul1auM (English only)
- NFL-Climate Change www.ecc.gov.nl.ca/climate_change (English only)
- NWT-Northwest Territories: Climate Change www.enr.gov.nt.ca/programs/nwt-climate-change
- YK-Climate Change and Yukon 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)

Note: The Canadian Geography Learning Framework: https://sites.google.com/rcgs.org/learningframework/homeaccueil?pli=1

The world in spatial terms

- 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.

Places and regions

- 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.

Physical systems

- 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

Human systems

- 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.

Environment and society

- 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 (1997)

Note: Common Framework of Science Learning Outcomes (CMEC): https://science.cmec.ca/index.en.htm

Nature of science and technology

- Illustrate how science attempts to explain natural phenomena

Relationships between science and technology

- Apply the concept of systems as a tool for interpreting the structure and interactions of natural and technological systems

Social and environmental contexts of science and technology

- 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

Skills: Initiating and planning

- Identify questions to investigate that arise from practical problems and issues
- State a prediction and a hypothesis based on available evidence and background information

Skills: Performing and recording

- Select and integrate information from various print and electronic sources or from several parts of the same source

Skills: Analysing and interpreting

- 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

Activity 1a: What do you know about climate change?

Climate change Adaptions-Society and Economy

Summary

This first brainstorming activity is designed to encourage students to activate their prior knowledge of climate change from an objective point of view and to get a better understanding of the overall knowledge shared by the group. It is important to remember that while more than 97% of scientists who publish work in academic journals agree that it is highly likely that human activity is responsible for global warming (and this number continues to rise), there will always be skeptics and those who deny this reality. To see a list of scientific groups that agree that humans are contributing to global warming, visit the NASA's climate change website at https://climate.nasa.gov/scientific-consensus/.

Duration: 60 minutes

Learning outcomes

- Describe the various ways that human activity and technology impact both balance and interactions in the environment
- Describe the effect of human activity on greenhouse gas (GHG) emissions
- Define the vocabulary associated with climate change

Competency outcomes

- Critical thinking
- Research
- Communication
- Collaboration

Material:

- 3 packs of sticky notes in 3 different colours (e.g. 4 green, 4 yellow and 4 red per student)
- Sharpie-style markers (1 per student)
- Climate change infographic
- Adapting to our Changing Climate in Canada poster (also available on the Natural Resources Canada website > Climate change publications, at http://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/earthsciences/images/assess/2016/adaptation_poster_e.jpg)
- Computer with Internet access and projector
- Internet access for students (optional)
- Copies of the Student BLM: What are Greenhouse Gases (GHG) and what do they do?

What to do:

1. In order to help students think objectively, ask them the following question:
   Over the last several years, we've seen that while there are many people who are concerned about the alarming effects of climate change and its impact on our environment, others still argue that climate change is an exaggerated phenomenon and that there is no reason to panic. What do you think about this?
2. In order to answer this question in detail, students must first answer the question: What do you know about climate change? (It is important that they give their personal interpretations regarding what they have seen or heard themselves).
3. Hand out 3 to 4 sticky notes in each colour to the students so that they can note down everything that they have seen or heard about climate change. They may note down as many statements about climate change as they like, but just one statement per sticky note:
   - Green sticky notes: "factual" statements (with explanations as to why they have no doubts about their veracity);
   - Yellow sticky notes: statements that they are not sure about or which are unproven (with explanations); and
   - Red sticky notes: statements about things they have seen or heard which they believe to be false (with explanations).

4. Divide the table or wall into three distinct sections (columns: the green column should contain "factual statements", the yellow column "unproven statements" and the red column "false statements"). Explain to the students that they can come up and stick their Sticky notes in the appropriate column once they've finished writing their climate change statement.
5. Once all students have finished writing down their statements and have stuck the sticky notes in the appropriate columns, take a look at the distribution of the colours on the table or wall and ask the students what their first impressions are.
    - Are there more yellow, green or red notes?
    - What do you notice?
6. **With the students**, try to create new categories for more sticky notes (e.g. causes, effects, consequences, actions). Assign a few sticky notes to groups of two students and ask them to put those notes into different categories.
7. Ask them to take it in turns to read some of the explanations given for the climate change statements and initiate a class discussion regarding the various explanations that the class has come up with for each category (green, red, yellow statements).
8. In order to connect the students' explanations to current information on climate change, hand out student notebooks to each student. Ask them to each note down 1 to 2 statements in each category that they would like to learn more about.
9. To help them with their research, show them:
    - The collection of infographics included in this kit
    - The *Adapting to our Changing Climate in Canada* poster (also available on the Natural Resources Canada website > Climate change publications, at http://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/earthsciences/images/assess/2016/adaptatio n_poster_e.jpg)
    - A video illustrating what climate change is, such as *How does climate change affect biodiversity?* (California Academy of Sciences) https://www.youtube.com/watch?v=XFmovUAWQUQ
    - The website Skeptical Science (https://skepticalscience.com) which explores the concepts that people are skeptical about.
    - Copies of the **Student BLM: What are Greenhouse Gases (GHG) and what do they do?**

10. Finally, ask students the following: Based on your observations and explanations, what conclusions can we come to?

How are falsehoods spread? The Serengeti Strategy

In the same way that a group lions will attempt to isolate a zebra on the outskirts of its group so that they can capture it more easily, a scientist may be targeted by individuals who mobilize their resources to attack and weaken him or her. The fight to defend themselves will take up a lot of the scientist's energy and resources.

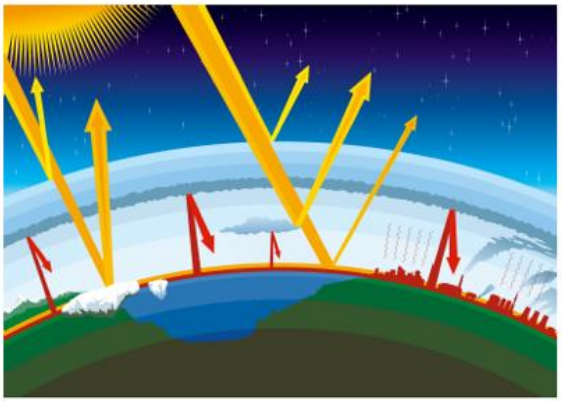
The strategy succeeds not only in isolating a scientist from his or her colleagues (easier to attack an individual than to attack a group), but also serves as a warning to other scientists seeking to make their studies public. This strategy has been used to discredit Rachel Carson (effects of DDT on the environment) as well as the scientists who revealed the truth about the harmful effects of tobacco consumption.

Mann, M. E. (2015). The Serengeti strategy: How special interests try to intimidate scientists, and how best to fight back. *Bulletin of the Atomic Scientists*, *71*(1), 33-45. http://www.meteo.psu.edu/holocene/public_html/Mann/articles/articles/MannBullAtomSci15.pdf

Name:

Date:

Activity 1a–Student BLM: What are greenhouse gases (GHG) and what do they do?



a) Look at the picture above. In your own words, describe the role played by greenhouse gases on the Earth.

b) Are GHGs good for life on Earth or not? Explain.

c) Research the following greenhouse gases and note where they come from.

Greenhouse gas	**Natural sources**	**Man-made/anthropogenic sources (caused by humans)**
Carbon dioxide (CO_2)		
Methane (CH_4)		
Water vapour		
Nitrous oxide (N_2O)		
Chlorofluorocarbon (CFC)		

Activity 1b: Our actions matter – Do all actions have the same impact?

Summary

Each student will complete Mission Zero to help them consider how individual action can help mitigate climate change. It will allow them to discover that while all actions are important some actions have a bigger climate impact than others. Students will learn that even though mitigating climate change comes with a cost to our society as a whole, individual action can be taken without adding to family expenses.

Duration: 60 minutes

Learning outcomes

After participating in the activity, students will able to:

- Discover that though many of our actions contribute to our climate footprint, some actions have a much larger impact than others
- Consider various individual actions to mitigate climate change
- Describe various costs associated with the mitigation of climate action

Competency outcomes

During this activity, students will develop or improve these abilities:

- Critical thinking
- Communication

Materials

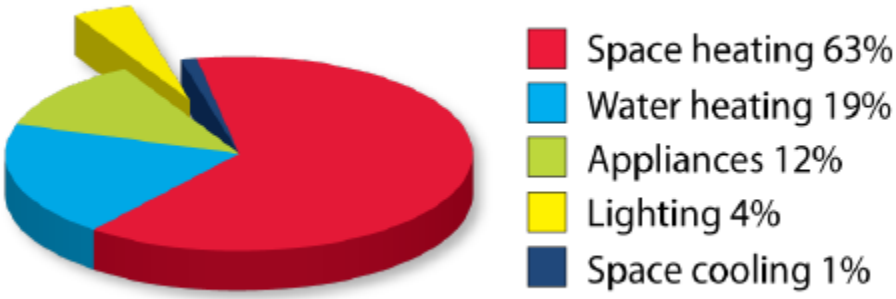
- Access to devices with internet access for students to each complete Mission Zero https://mission-zero.ingeniumcanada.org
- Copies of the Student BLM: Our Actions Matter – Do All Actions Have the Same Impact?

What to do

1. Each student should complete Mission Zero https://mission-zero.ingeniumcanada.org
2. Have students complete Student BLM: Our Actions Matter! Do All Actions Have the Same Impact?

Impact of our actions

It may come as a surprise that some of the most common actions we tell students to do in order to be more energy efficient and pollute less do not have as large of an impact as we think. The 'low-hanging fruit' of shutting off lights or switching to LED bulbs is a beginning action. However, if lighting in the average Canadian home only makes up for 4% of energy use, the impact this switch has is minimal in comparison to larger changes to efficiency in heating and cooling water and air inside of your house (https://www.nrcan.gc.ca/energy/products/categories/lighting/13730).



The higher-impact items on our list may need to be unpacked more with your students as they are often bigger picture than individual students can accomplish themselves. For example, if you live in a province that has more non-renewable resources used in the power grid, making the switch to clean energy sources—either by a power utility or generating your own electricity with solar panels—will make a much bigger difference. Preventing heat loss through basement and roof insulation will help prevent energy-intensive winter heating from being wasted.

The climate change mitigation action of having fewer children may be a controversial idea with your students. It can also be a reminder to them that each person's total carbon footprint is substantial when added up. Students may not feel like it is a reasonable or viable solution. The author of the originating study factored in the total emissions per person living to an average of 80 years, divided in half as they are one parent, and accounting for a smaller ratio of all of a child's descendants (e.g. a quarter for the grandchild, and an eighth of a great-grandchild) (http://iopscience.iop.org/article/10.1088/1748-9326/aa7541).

By the end of this activity, students should begin to connect to the most important actions they can take to reduce greenhouse gas emissions and their carbon footprint, at home and at school. While smaller steps—such as shutting off lights when not in use—are still important to take and good habits to form, students should be reminded of the larger impact actions they can work towards and advocate for.

By encouraging action, climate anxiety can be reduced. Furthermore, individual action can influence what collective actions are made. Your actions influence those around you. Involvement in organizations, government, and the community can influence the actions of others on a larger scale.

Some actions that can be discussed include:

1-Change your habits (bike more, eat less meat, shop local, etc.).
2-Spread the word with your friends, family, and classmates.
3-Keep up political pressure.
4-Join environmental organizations or groups.

5-Participate in programs (governmental, community, school, etc.) against climate change.
6-Join clean-up drives; participate in tree planting, garbage picking, or recycling programs.

Costs of Action vs. Non-Action

Students will have the opportunity, through the activities in this lesson plan, to discover the costs associated with adapting to climate change. It is also critical to consider the costs associated with mitigating climate change and comparing the two.

Not taking action against climate change comes with rising sea levels, extreme weather, impacts on life and health due to heat and pollution, damage to infrastructure, loss of biodiversity, diminishing agricultural productivity, and more. Projections of these costs, if we continue on our present course, are over 100 trillion dollars over the next 50 years. Swift action to zero out GHG emissions by 2050, however, is estimated to come with positive growth to the global economy over the same period.

While the initial switch to a carbon-free energy system would lower economic activity, eventually, new industrial and economic opportunities will arise. There will be new market opportunities and job creation in areas of clean energy technologies, energy efficiency, design and construction of resilient and green buildings, and more. Economics is on the side of a low-emissions future.

As individuals, our actions to help mitigate climate change can be accomplished without having to invest large sums of money. Shopping at thrift stores, eating a more plant-based diet, and putting on a sweater instead of tuning up the heat in the house will all come with cost savings for the family. Larger projects such as installing an electric heat pump in the home will come with an initial expense but can come with considerable yearly cost savings depending on factors such as how you currently heat your home; how energy efficient your home is; and the climate where you live.

Name:

Date:

Activity 1b–Student BLM: Our actions matter – Do all actions have the same impact?

1. Some actions in Mission Zero come with a 40,000 g footprint and others 0 g. Brainstorm some hypotheses to explain why the manufacture of a pair of jeans would have a relatively large footprint.

2. Some actions have a relatively small footprint even for the option with the highest impact (ex. shower / long bath). Does this mean that, for this action, we shouldn't choose the option with a smaller footprint? Why or why not?

3. What are some actions you, and your family, could take to help mitigate climate change? What are the costs/benefits associated with these actions?

4. Discuss some of the costs/benefits of mitigating climate change compared to the costs/benefits associated with no action being taken.

Activity 2: Climate change mind map

Summary

In this activity, students will draw a conceptual map showing 1) the physical impacts of climate change on the environment, and 2) their socio-economic consequences. Following the activity on Adaptation and Mitigation (p. 20), they will revisit the map to offer 3) adaptation strategies to address those consequences.

Duration: Two 60-minute sessions

Learning outcomes

After participating in the activity, students will be able to:

- Identify physical impacts of climate change on the environment, and
- Discuss the consequences of climate change on society and the economy.

Competency outcomes

During this activity, students will develop or improve these abilities:

- Critical thinking
- Collaboration
- Communication

Set-up and materials

- Computer and projector (for video capsules)
- **Climate Change and the Environment** infographic

- **Climate Change and the Economy** infographic
- **Climate Change: Health and Urban Living** infographic
- Copies of **Mind Map Rubric** for students
- Copies of the **Climate Change and Society Mind Map** student worksheet
- Chart paper (one sheet per group of two to three students)
- Coloured markers or pencils

Tip: Some students may find it easier to put their ideas on sticky notes so that they can move them around during the planning phase.

What to do

1. Brainstorm some impacts of climate change and their socio-economic consequences. If you like, show this helpful video to fuel the discussion: The Impacts of Climate Change (Climate Commission), found at www.youtube.com/watch?v=lhkgmKXOM1A .
2. Hand out a large sheet of chart paper to teams of two to three students and ask them to write "Climate change and society" at the centre of the sheet. From the centre of the map, ask students to creatively build three distinct concept levels as in the example below (see Figure 1).

   Tip: Tell students to use the **Climate Change and Society Mind Map** worksheet to sketch out their ideas.

   Level 1: Physical impacts of climate change, e.g., rising temperature or increased precipitation (two to three per map)
   Level 2: Consequences of these impacts on society and the economy, e.g., longer growing seasons, damaged roads (one to two per impact) The next level will be filled out later, following the **Adaptation and Mitigation** activity (p. 20), so ask students to leave some room for this:
   Level 3: Adaptation measures that could be taken to deal with these consequences, e.g., expand agriculture northward, reroute main transportation arteries (one to two per consequence)

3. Students should feel free to unleash their creativity and represent the concepts with shapes, text and drawings, using connecting lines between concepts to justify the link.

   Tip: Students can use **Climate Change and the Environment**, **Climate Change and the Economy**, and **Climate Change: Health and Urban Living** infographics as tools to help complete their mind maps.

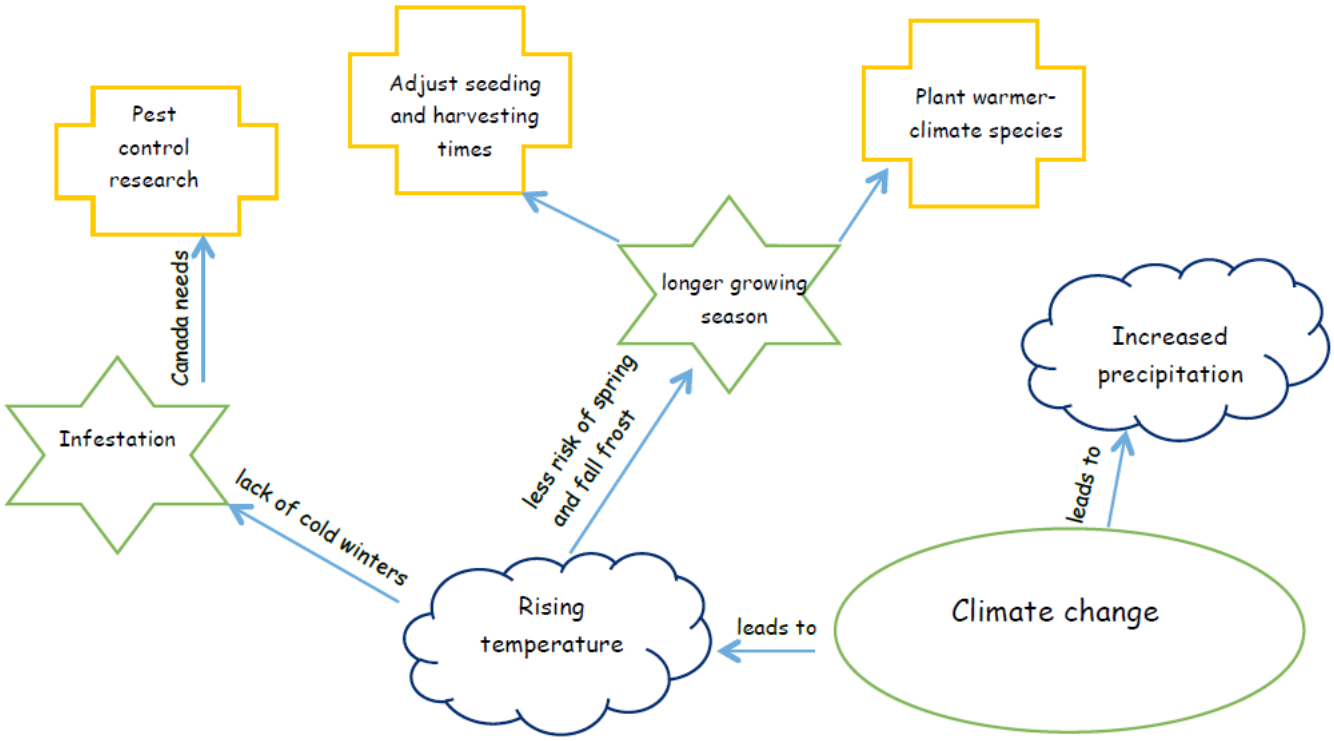
4. Ask students to present their conceptual maps to the class. Encourage dialogue by asking students with similar concepts to add their interpretations to the discussion.

Extension

- Ask students to cut out their concepts to make a large classroom concept wall. Use different cardboard backdrops (attached with glue) to identify the three levels — this will keep the hierarchy visible.

Mind map example

Figure 1. Example of a multi-level mind map



The image is a flowchart depicting relationships between various factors related to climate change and agriculture. At the center is a large oval labeled Climate change. To the left, a cloud-shaped outline with Rising temperature is connected with an arrow labeled leads to. Then a line labelled lack of cold winters go to Infestation. A line ftrom there labelled Canada needs, goesd to Pest Control Research.

The cloud shaped Rising Temperature also has a line that is labelled less risk of spring and fall frost, and it goes to longer growing season. At longer growing season there are two lines, one goes to adjust seeding and harvesting times and the other goes to plant warmer climate species. Finally, the large oval Cimate Change also has a line that is labelled lead to that goes to Increased Precipitation.

Names:

Date:

Activity 2–Student BLM: Climate change and society mind map

Draw a sketch of your mind map including 1) the impacts of climate change and 2) the consequences of these impacts on society and the economy.

What I learned from my classmates' presentations:

Names:

Date:

Activity 2–Teacher BLM: Mind map rubric

Area	**Highly effective**	**Effective**	**Satisfactory**	**Unsatisfactory**
Concepts and terminology	Shows an understanding of the topic's concepts and principles and uses appropriate scientific terminology.	Makes some mistakes in terminology or shows a few misunderstandings of concepts.	Makes mistakes in terminology and shows a lack of understanding of some concepts.	Shows no understanding of the topic's concepts and principles.
Relationships between concepts	Provides highly relevant and original links between concepts.	Provides adequate links between concepts.	Provides some links between concepts.	Provides no links between concepts.
Adaptation solutions	Provides highly relevant and realistic solutions.	Provides relevant solutions.	Provides a few relevant solutions.	Provides no solutions.
Work ethic	Plans the concept map in a highly effective manner.	Plans the concept map in an effective manner.	Plans the concept map in an adequate manner.	Does not plan the concept map.
Communication	Presents the concept map in a highly effective manner and provides examples to support the	Presents the concept map in an effective manner.	Presents the concept map in an adequate manner.	Does not present the concept map in an effective manner

Area	**Highly effective**	**Effective**	**Satisfactory**	**Unsatisfactory**
	analysis.			
Design and layout	The design and layout contribute greatly to the flow and clarity of the map in a highly effective manner. An original and effective design is used to denote level hierarchy.	The design and layout contribute to the clarity of the map in an effective manner. The level hierarchy is evident.	The design and layout contribute to the clarity of the map in an adequate manner. The level hierarchy is present.	The design and layout do not contribute to the clarity of the map. Attention has not been paid to the level hierarchy.
Collaboration skills	Consistently works towards group goals and encourages people to work well together.	Frequently works towards group goals and encourages people to work well together.	Adequately works towards group goals and encourages people to work well together.	Rarely works towards group goals.

Activity 3: Adaptation and mitigation

Summary

In this activity, students collaborate to define and identify the concepts of adaptation and mitigation as they pertain to climate change.

Duration: 60 to 75 minutes

Learning outcomes

After participating in the activity, students will be able to:

- Define and differentiate between the concepts of adaptation and mitigation as they pertain to climate change,
- Identify examples of adaptation and mitigation measures,
- Discuss the importance of using both adaptation and mitigation measures to fight against climate change.

Competency outcomes

During this activity, students will develop or improve these abilities:

- Collaboration
- Inference
- Research
- Critical thinking

Set-up and materials

- Computer, tablet, or dictionary (one per team)
- Colour printout of Adaptation and Mitigation Goals, cut into strips
- Copies of Adaptation or Mitigation? student worksheet
- Copies of the Climate Change: Adaptation and Mitigation infographic
- Adapting to Our Changing Climate in Canada poster

Tip: Check out Natural Resources Canada's new poster, Adapting to Our Changing Climate in Canada. It will help students learn more about our changing climate, the impacts it's having, and how Canadians are adapting. Request your copy using the online order form or by calling 1-800-387-2000 (Product # M174-13/2016). Alternatively, you can download the web-accessible version.

What to do

1. Following the **Conceptual Map** activity, launch the discussion on adaptation and mitigation by watching the video capsule called "Climate change adaptation: It's time for decisions now" (GIZ online) at www.youtube.com/watch?v=FO46sPwm4xk.
2. On the blackboard or Smart Board, write "Adaptation Measures" (on one side) and "Mitigation Measures" (on the other side).
   Brainstorming phase: Ask students if they know what these words mean (synonyms, resemblances) and write their ideas under each heading.
   Research phase: Ask students to find two or three words related to these concepts using the Internet or the dictionary.
   Validation phase: Synthesize the results and work with students to define the concepts.

3. Provide students with the following examples of adaptation measures and mitigation measures with respect to biodiversity and nature. Work with students to refine their definitions further.
   Adaptation measures:

- Revise building code to ensure flood-resistant basements.
- Protect, revegetate, and stabilize sand dunes to reduce erosion.
- Fly fuel in to mines (costing mining companies millions of dollars) to get around shortened winter road season.

Mitigation measures:

- Replace fossil-fuel-based energy with renewable energy sources like wind and solar.
- Plant millions of trees to absorb and trap carbon dioxide from the atmosphere.
- Feed cattle seaweed instead of traditional hay and grains to reduce the methane content of cow belching and flatulence.

4. As a whole-class activity, ask students to help you classify the **Adaptation and Mitigation Goals** as either “Adaptation” or “Mitigation.”
5. Hand out the **Adaptation or Mitigation?** student worksheet.
6. Assign two measures per pair of students and ask them to justify whether they fall under “Adaptation” or “Mitigation.”
7. Ask each pair to join another group to compare answers.
8. As a class, decide where each example should be classified and why. Hand out the **Climate Change: Adaptation and Mitigation** infographic to compare answers.

Tip: Your class answers may vary from the **Climate Change: Adaptation and Mitigation** infographic. The important part for assessment purposes is that students are able to justify their choice based on the goals of adaptation and mitigation.

Extension

- Return to the **Mind Map** activity (p. 16) and ask students to assign adaptations to their consequences.
- Some students may have experienced climate change impacts, large or small (e.g., recurrent flooding; earlier spring smelt runs). They may also have witnessed adaptation measures (e.g., their village may have been relocated; they may now go smelt fishing earlier in the season).

Tap into any first-hand knowledge and make connections to their lives outside the classroom by inviting students to share their stories.

- When it comes to adaptation or mitigation, discuss whether one is more important than the other. Are there some measures that address both at the same time?
- Discuss how the following might be barriers to climate change adaptation:
    - Short-term thinking
    - Using uncertainty as a reason to do nothing
    - Unrealistic optimism

      For a more detailed discussion on this topic, see the Natural Resources Canada report **Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation**, p. 273–74.
- Read the following article and justify whether this is an example of adaptation or mitigation:

  P.E.I. farmer assists in near-eradication of methane from cow farts

  www.cbc.ca/news/canada/prince-edward-island/pei-cow-farting-1.3856202

Activity 3–Teacher BLM: Adaptation and mitigation goals

Cut out the goals and work with students to assign each to either adaptation or mitigation.

Increase the capacity of species to adapt.

Cut down greenhouse gas emissions.

Improve the ability of animals and plants to thrive under different climate conditions.

Build resilience to extreme weather and climate changes.

Trap greenhouse gas emissions.

Name:

Date:

Activity 3—Student BLM: Adaptation or mitigation?

What type of measure does each example below represent: adaptation or mitigation? Justify your answers.

Concept	Adaptation	Mitigation
Designate more forests as protected areas.		
Improve roads, bridges and building design to resist weather damage.		
Protect homes and buildings from flooding.		
Invest in ways to absorb rainwater, like « green » roofs and porous driveways.		
Promote water and energy conservation.		
Invest in or provide rebates for energy-efficient fridges, furnaces, and appliances.		
Promote cycling, walking and taking transit as alternatives to driving.		
Increase sources of renewable energy like wind and solar.		
Improve industrial processes to use less energy and materials.		

Activity 4: Graphic encounters

Summary

In this activity, students travel around the classroom making observations about various maps and graphs related to climate change. Students are then asked to “translate” the information into an infographic, highlighting the information they found most compelling. They are also asked to provide suggestions of a target audience for this information.

Duration: two 60-75 minutes sessions

Learning outcomes

After participating in the activity, students will be able to:

- Explain how physical processes help to shape features and patterns on Earth’s surface,
- Compare and interpret maps and graphs to explain how climate change can affect physical processes on Earth, and
- Explain ways in which living things and natural systems are affected by climate change.

Competency outcomes

During this activity, students will develop or improve these abilities:

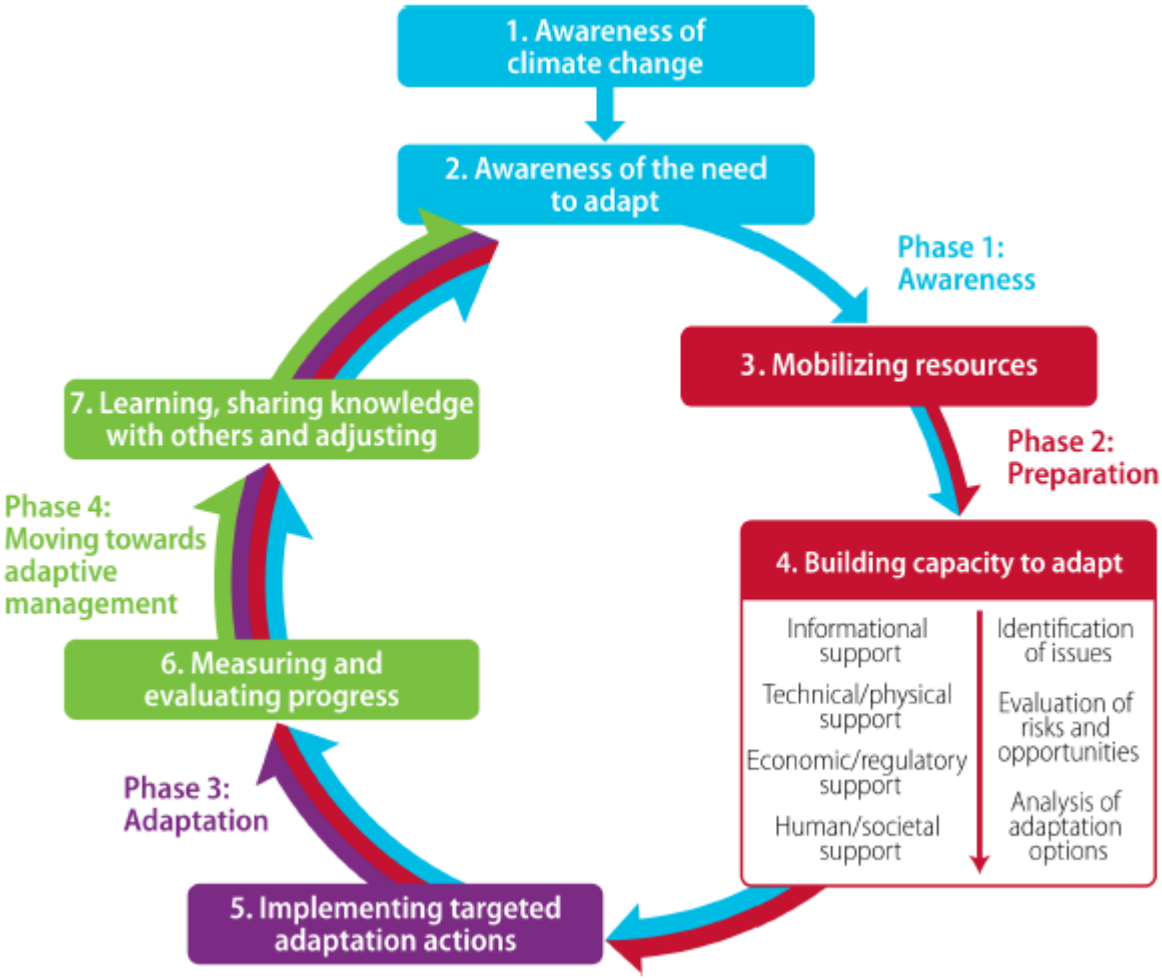
- Research
- Communication
- Creativity
- Critical thinking
- Collaboration

The Adaptation Process

Like any process involving changes in thinking and practice, adapting to a changing climate involves deepening levels of engagement (phases) and actions that can be taken in support of decision-making (steps). The figure below summarizes these phases and steps, which integrate observations on how adaptation is occurring in Canada with common elements of several adaptation planning frameworks. Although presented as a linear process, organizations may take different pathways as they transition and iterate through these phases and steps.

Phases in the adaptation process include awareness, preparation, implementation and iterative learning. The seven steps are:

1. Awareness of climate change: the adaptation process begins once an individual or organization becomes aware of a changing climate as a threat or opportunity.
2. Awareness of the need to adapt: an awareness of the magnitude of the problem helps to identify adaptation as a solution.
3. Mobilizing resources: awareness can lead individuals and organizations to dedicate human and/or financial resources to help clarify the nature of threats or opportunities.
4. Building capacity to adapt: involves applying scientific information, financial resources, and skills to focused activities such as issue screening, risk assessment and in-depth analysis to generate the understanding needed for informed decision making.
5. Implementing targeted adaptation actions: concrete actions are put in place to reduce vulnerability (risk or exposure) to climate change and/or to take advantage of opportunities.
6. Measuring and evaluating progress: measuring and evaluating the effectiveness of adaptation actions and related assumptions and uncertainties provides the feedback necessary for improved management.
7. Learning, sharing knowledge with others and adjusting: the last step leads to refinements in the adaptation actions implemented and transfer of lessons to future adaptation.



The image is a circular flowchart illustrating a four-phase adaptive management process related to climate change adaptation. In the center of the circle, there are four main phases, each represented with different-colored boxes and numbered steps.

Phase 1 is titled "Awareness" and includes:
1-A light blue box with the text "1. Awareness of climate change."
2-A dark blue box with the text "2. Awareness of the need to adapt."

Phase 2 is titled "Preparation" and includes:

3- A red box with the text "3. Mobilizing resources."

4-Another red box with the text "4. Building capacity to adapt," which contains a white square detailing components like Informational support, Technical/physical support, Economic/regulatory support, Human/societal support, Identification of issues, Evaluation of risks and opportunities, and Analysis of adaptation options.

Phase 3, labeled "Adaptation," has:
5- purple box stating "5. Implementing targeted adaptation actions."

Phase 4, titled "Moving towards adaptive management," consists of:
6- A green box with "6. Measuring and evaluating progress."
7-A light green box with "7. Learning, sharing knowledge with others and adjusting."

Each phase connects with colored arrows matching the relevant phase color, articulating a continuous flow from one step to the next.

This content is taken directly from Warren, F.J. and Lemmen, D.S., editors (2014) Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation; Government of Canada, Ottawa, ON. p. 260.

Set-up and materials

- 10 climate maps/graphs printed on legal or ledger size paper- If you have a small class, you may want to use fewer than 10 images. The ratio should be one image per team of three students.
- 10 sheets of chart paper
- 10 copies of Guiding Questions
- One marker per student
- One pack of sticky notes per student
- One double-sided copy per student of Graphic Encounters: Assignment and Rubric (Day 2)
- Laptops or access to computer room (optional) (Day 2)

Note: The climate maps and graphs used in this activity are taken from:

- 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; and
- 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.
- Both reports are available at: http://www.nrcan.gc.ca/environment

What to do

Day 1

- Hang the maps and graphs (p. 29) around the classroom, with a sheet of chart paper below each. Hang a copy of the **Guiding Questions** above each image.
- Explain to students that climate change adaptation and mitigation decisions are rooted in scientific evidence. When decision-makers and scientists interpret the data, they are trying to figure out what effect it will have on the world we live in.
- Ask students to form groups of three and place themselves under one map or graph. Give them **one minute** to silently contemplate the image before they start to talk to their group about it.
- Give them three minutes to write their ideas on the first two guiding questions on the chart paper; **any questions they have should go on the sticky notes**. They can discuss these with their group, but each student should be writing down his or her own ideas on the chart paper (whether or not the others find it interesting).
- Ask the students to rotate to the next map or graph and repeat steps 2 and 3. Before writing out their ideas, they should read what other students have written and put check marks next to the items they agree with rather than re-writing an idea.
- After several rounds (choose the number of rounds based on the time available), discuss the discoveries made by the students.

  Tip: Ask the last group of students to have analyzed the map or graph to lead the discussion.

- Before the end of class, ask each student to put his or her name under the map or graph they found most compelling and that they would like to continue exploring. **The students are free to form new groups based on their preferred image.**

Day 2

- Introduce the “create an infographic” assignment to the students. It is strongly recommended that you spend some time analyzing a few existing infographics with the students so that they know what is expected of them, starting with the six infographics that accompany this resource. **Tip:** To learn more about using infographics as a teaching and assessment tool, visit Kathy Schrock’s Infographics as a Creative Assessment at http://bit.ly/schrockinfographics.
- Download the two Natural Resources Canada reports that the maps and graphs in this assignment are taken from (Canada in a Changing Climate; and Canada’s Marine Coasts in a Changing Climate) so that they are readily available to students.

We’d love to see your students’ creations! Send photographs or short videos of your class’s infographics to:
jarmstrong@techno-science.ca

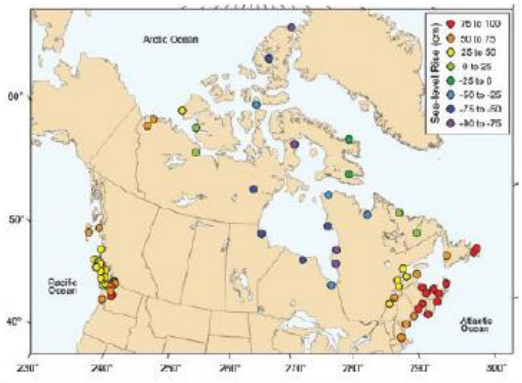


FIGURE 3: Projected relative sea-level change (cm) at 2100 for the median of a high-emissions scenario (RCP8.5) for coastal locations in Canada and the northern United States. See Chapter 2 for information on methodology and the climate change scenarios used in this report. Graphs showing projected change in sea level through this century for each of the Canadian sites shown in this figure are found in the relevant regional chapter (Chapter 4, 5 or 6).

Canada's Marine Coasts in a Changing Climate, p.11

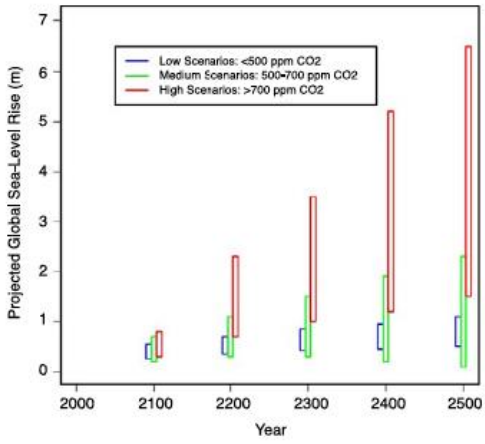


FIGURE 26: Projected global sea-level change from 2100 to 2500, based on carbon dioxide concentrations at 2100 (*based on* Figure 13.13 of Church et al., 2013a; *see* footnote 2).

Canada's Marine Coasts in a Changing Climate, p. 54

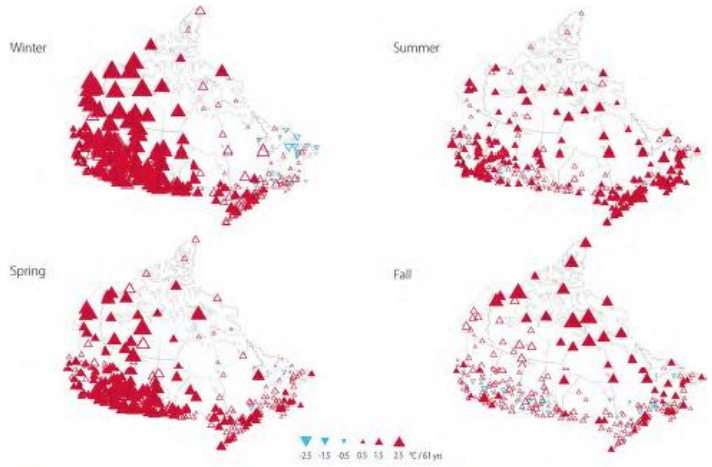


FIGURE 5: Trends in seasonal mean temperature for 1950-2010. Upward- (red) and downward- (blue) pointing triangles indicate positive and negative trends, respectively. Filled triangles correspond to trends significant at the 5% level. The size of the triangle is proportional to the magnitude of the trend. The legend may not include all sizes shown in the figure *(Source: Vincent et al., 2012.)*.

Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation, p. 28

Figure 3:

Projected relative sea-level change (cm) at 2100 for the median of a high-emission scenario (RCP8.5) for coastal locations in Canada and the northern United States. See Chapter 2 for information on methodology and the climate change scenarios used in this report. Graphs showing projected change in sea level through this century for each of the Canadian cities shown in this figure are found in the relevant regional chapter (Chapter 4, 5 or 6). Canada's Marine Coasts in a Changing Climate, p.11. Note: Teacher will have to provide more description.

Figure 26:

Projected global sea-level change from 2100 to 2500, based on carbon dioxide concentrations at 2100 (based on Figure 13.13 of Church et al., 2013a; see footnote 2). Canada's Marine Coasts in a Changing Climate, p. 54. Note: Teacher will have to provide more description.

Figure 5:

Trends in seasonal mean temperature for 1950–2010. Upward (red) and downward (blue) pointing triangles indicate positive and negative trends, respectively. Filled triangles correspond to trends significant at the 5% level. The size of the triangle is proportional to the magnitude of the trend. The legend may not include all sizes shown in the figure (Source: Vincent et al., 2012). Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation, p. 28. Note: Teacher will have to provide more description.

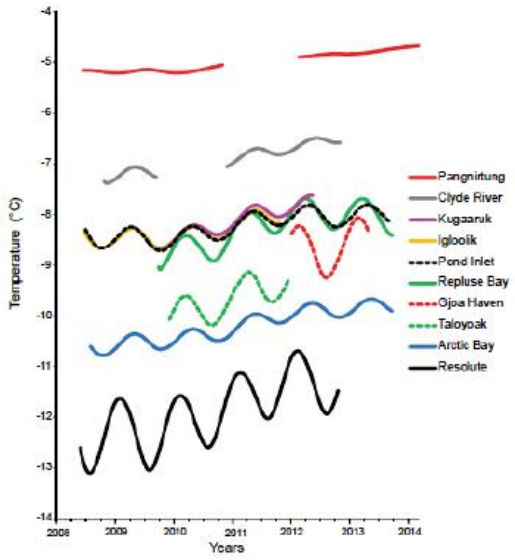


FIGURE 16: Permafrost temperatures at 15 m depth for 10 communities in Nunavut (*from* Ednie and Smith, 2015). Steady increases are seen at all sites during the period of observation, ranging from 0.04°C/year in Igloolik to 0.29°C/year in Resolute. The average increase is 0.15°C/year for all sites.

Canada's Marine Coasts in a Changing Climate, p. 171

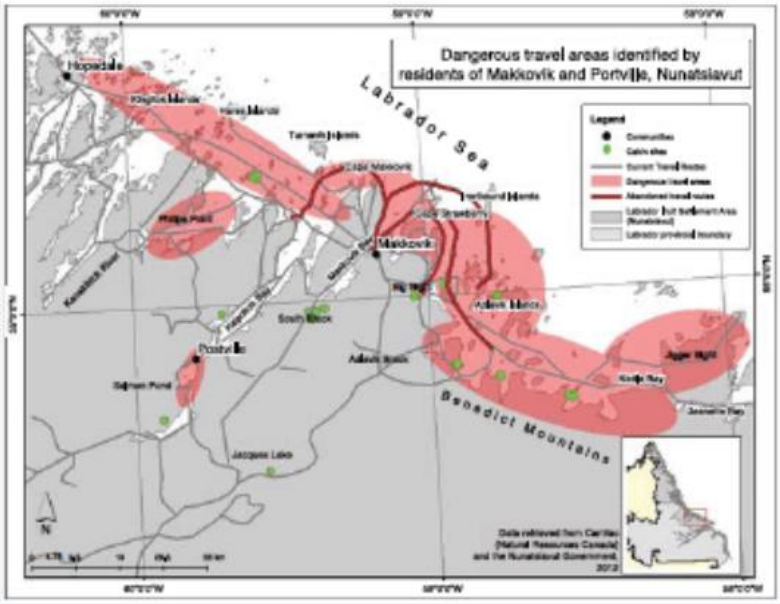


FIGURE 18: Dangerous travel areas (red) identified by residents of Makkovik and Postville, Nunatsiavut, NL (*from* Riedlsperger, 2013). Abandoned sea-ice travel routes are depicted as dark red lines. Inland trails (grey lines) now provide safer and more dependable travel routes.

Canada's Marine Coasts in a Changing Climate, p. 177

Figure 16:

Permafrost temperatures at 15 m depth for 10 communities in Nunavut (from Ednie and Smith, 2015). Steady increases are seen at all sites during the period of observation, ranging from 0.04°C/year in Igloolik to 0.29°C/year in Resolute. The average increase is 0.15°C/year for all sites. Canada's Marine Coasts in a Changing Climate, p. 171. Note: Teacher will have to provide more description.

Figure 18:

Dangerous travel areas (red) identified by residents of Makkovik and Postville, Nunatsiavut, NL (from Riedlsperger, 2013). Abandoned sea-ice travel routes are depicted as dark red lines. Inland trails (grey lines) now provide safer and more dependable travel routes. Canada's Marine Coasts in a Changing Climate, p. 177. Note: Teacher will have to provide more description.

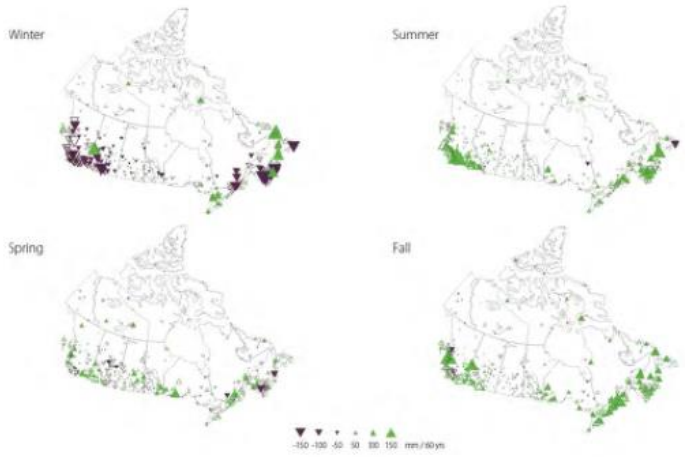


FIGURE 8: Seasonal total precipitation trends for 1950-2009. Upward- and downward-pointing triangles indicate positive and negative trends, respectively. Filled triangles correspond to trends significant at the 5% level. The size of the triangle is proportional to the magnitude of the trend. The legend may not include all sizes shown in the figure *(Source: Mekis and Vincent, 2011a).*

Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation, p. 8

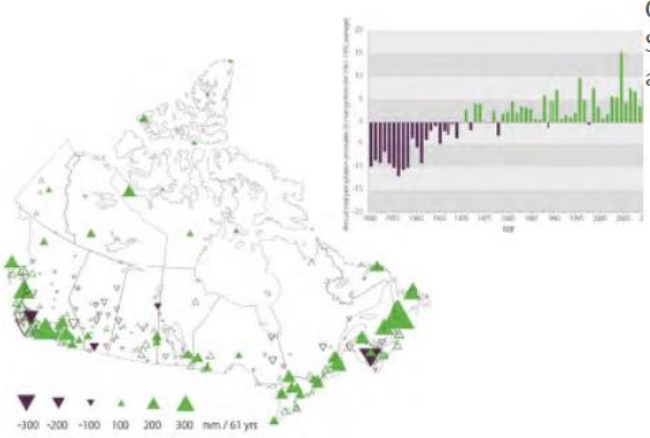


FIGURE 2: Patterns of change in annual total precipitation over the period 1950–2010. Upward (green) and downward (p pointing triangles indicate positive and negative trends, respectively. Filled triangles correspond to trends signi the 5% level *(Source: Mekis and Vincent, 2011b).* ***Inset:*** Annual total precipitation anomalies (expressed in % cha the 1961–1990 average) for Canada, 1950–2010 *(Source: Mekis and Vincent, 2011a; Environment Canada, 2011).*

Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation, p. 30

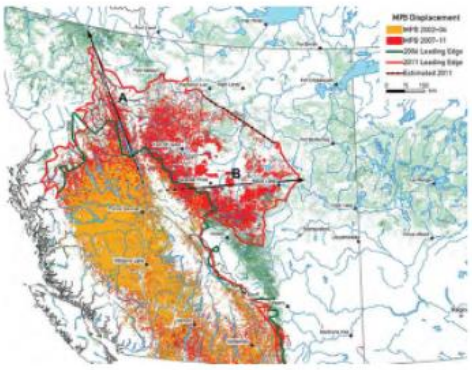


FIGURE 4: Map of Mountain Pine Beetle distribution, showing change for the 2002–2006 and 2007–2011 time periods and direction of change *(Source: Natural Resources Canada, 2012c).*

Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation, p. 10

Figure 8:

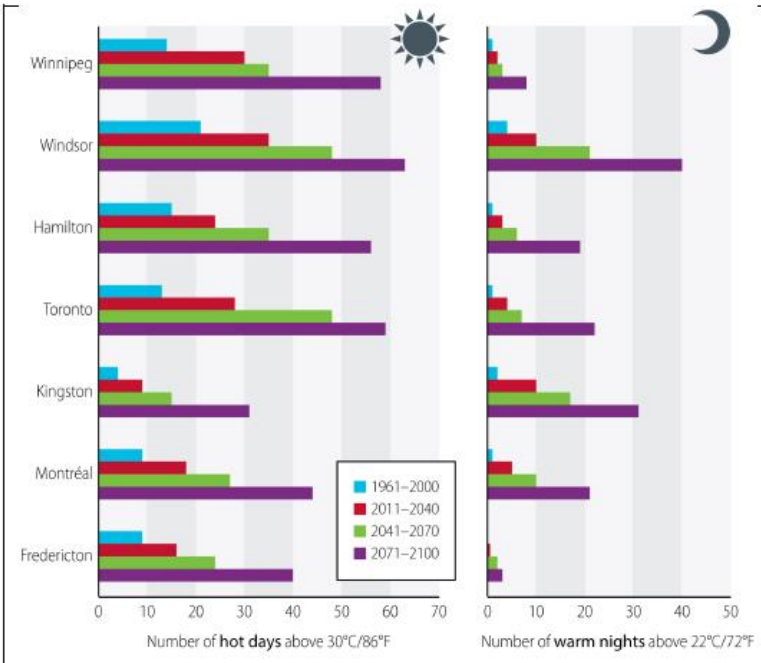
Seasonal total precipitation trends for 1950-2009. Upward- and downward-pointing triangles indicate positive and negative trends, respectively. Filled triangles correspond to trends significant at the 5% level. The size of the triangle is proportional to the magnitude of the trend. The legend may not include all sizes shown in the figure (Source: Mekis and Vincent, 2011a). Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation, p. 8. Note: Teacher will have to provide more description.

Figure 2:

Patterns of change in annual total precipitation over the period 1950–2010. Upward (green) and downward (purple) pointing triangles indicate positive and negative trends, respectively. Filled triangles correspond to trends significant at the 5% level (Source: Mekis and Vincent, 2011b). Inset: Annual total precipitation anomalies (expressed in % change the 1961–1990 average) for Canada, 1950–2010 (Source: Mekis and Vincent, 2011a; Environment Canada, 2011). Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation, p. 30. Note: Teacher will have to provide more description.

Figure 4:

Map of Mountain Pine Beetle distribution, showing change for the 2002–2006 and 2007–2011 time periods and direction of change (Source: Natural Resources Canada, 2012a). Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation, p. 10. Note: Teacher will have to provide more description.



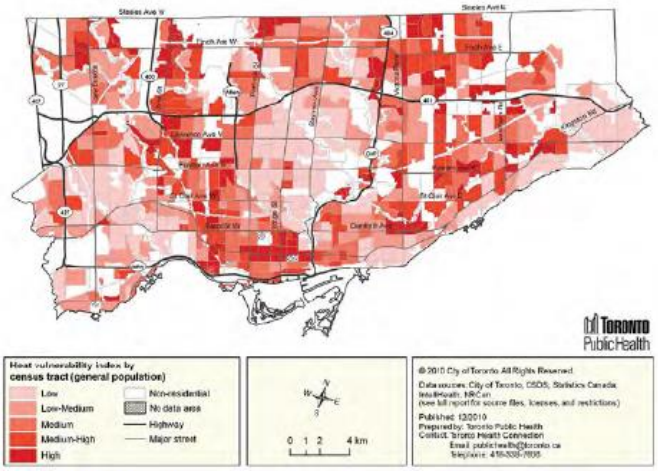


FIGURE 9: Vulnerability to heat in Toronto *(Source: Toronto Public Health, 2011a).*

Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation, p. 12

Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation, p. 213

No figure number

Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation, p. 12.

Note: Teacher will have to provide more description.

Figure 9:

Vulnerability to heat in Toronto (Source: Toronto Public Health, 2011a).

Heat vulnerability, index, by census tract (parental population), Low Vulnerability, Moderate Vulnerability, Adults 65+, Adults with Less High School, Living Alone, Aged 5-14. Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation, p. 213.

Note: Teacher will have to provide more description.

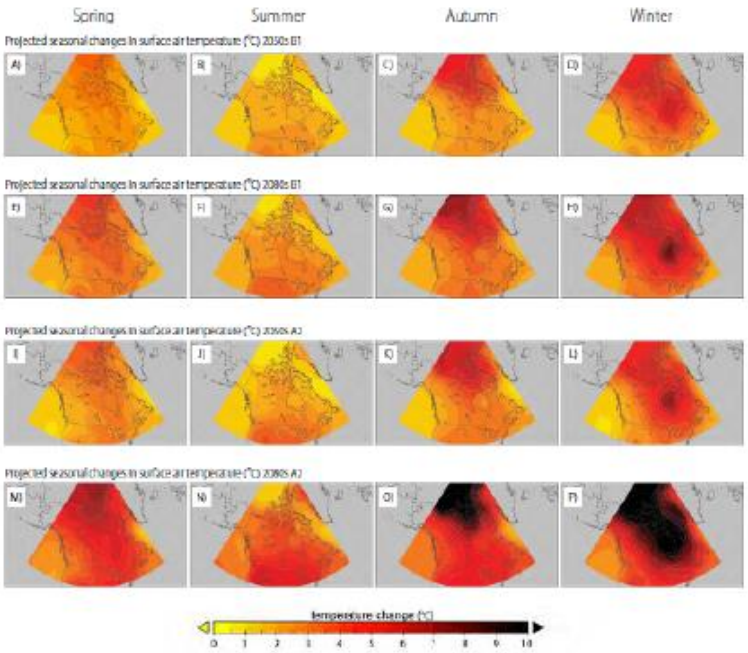


FIGURE 11: Projected seasonal changes in temperature across Canada for the middle and end of the 21st century under various SRES scenarios. Changes are expressed relative to average values between 1961–1990. Row 1 (A–D) is scenario B1 mid-century, row 2 (E–H) is B1 towards the end of the century, row 3 (I–L) is A2 mid-century, and row 4 (M–P) is A2 towards the end of the century. Column 1 (A, E, I, M) is Spring, Column 2 (B, F, J, N) is Summer, Column 3 (C, G, K, O) is Autumn, Column 4 (D,H, L, P) is Winter (*Source: Canadian Centre for Climate Modeling and Analysis*).

Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation, p. 34

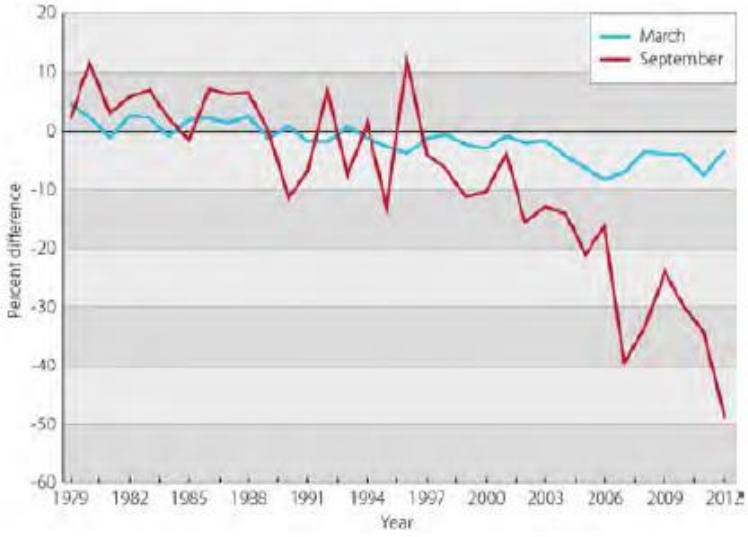


FIGURE 19: Trends in Arctic sea ice extent over the period 1979-2012 shown as time series of the percentage difference in ice extent in March and September relative to the mean values for the period 1979-2000. The rate of decrease for the March and September ice extents is -2.6% and -13% per decade, respectively (as determined by least squares linear regression). Both trends are statistically significant *(Source: Perovich et al., 2012)*.

Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation, p. 8 and 41.

Figure 11:

Projected seasonal changes in temperature across Canada for the middle and end of the 21st century under various SRES scenarios. Changes are expressed relative to average values between 1981-2000 mean. Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation, p. 34. Note: Teacher will have to provide more description.

Figure 19:

Trends in Arctic sea ice extent over the period 1979-2012 shown as time series of the percentage difference in ice extent in March and September relative to the mean values for the period 1979-2000. The rate of decrease for the March and September ice extents is -2.6% and -13% per decade, respectively (as determined by least squares linear regression). Both trends are statistically significant (Source: Perovich et al., 2012). Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation, p. 8 and 41. Note: Teacher will have to provide more description.

FIGURE 8: Map of Western Canada showing projected significant improvement and decline in land suitability for spring seeded small grain crops (Source: AAFC, 2012a).

Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation, p. 109.

FIGURE 1: Climatic and phenological changes can bring about ecological mismatch of migratory birds. Curves represent the progress of spring in two years, as the increase of degree-days (heat accumulation) over time. The curve for the recent year (red line) lies above that for the past (blue line) because of winter and spring warming, which means that degree-days increase more rapidly. Migratory birds show no change, advancement or delay in arrival date. Species that now arrive at the same or later date face higher degree-days and relatively advanced ecological processes such as insect emergence, and are thus 'thermally delayed. Even species that have advanced their arrival may experience a thermal delay, if advancement does not fully compensate for increasing temperatures. Only a large advancement in arrival can fully compensate for climate change *(modified from Saino et al., 2010).*

Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation, p. 165.

Figure 8:

Map of Western Canada showing projected significant improvement and decline in land suitability for spring-seeded small grain crops (source: AAFC, 2014a). Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation, p. 109. Note: Teacher will have to provide more description.

Figure 1:

Climatic and phenological changes can bring about ecological mismatch of migratory birds. Curves represent the progress of spring in two years, as the increase of degree-days (heat accumulation) over time. The curve for the recent year (red line) lies above that for the past (blue line) because of winter and spring warming, which means that degree-days increase more rapidly. Migratory birds show no change, advancement or delay in arrival date. Species that now arrive at the same or later date face higher degree-days and relatively advanced ecological processes such as insect emergence, and are thus thermally delayed. Even species that have advanced their arrival may experience a thermal delay, if advancement does not fully compensate for increasing temperatures. Only a large advancement in arrival can fully compensate for climate change (modified from Saino et al., 2010). Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation, p. 165. Note: Teacher will have to provide more description.

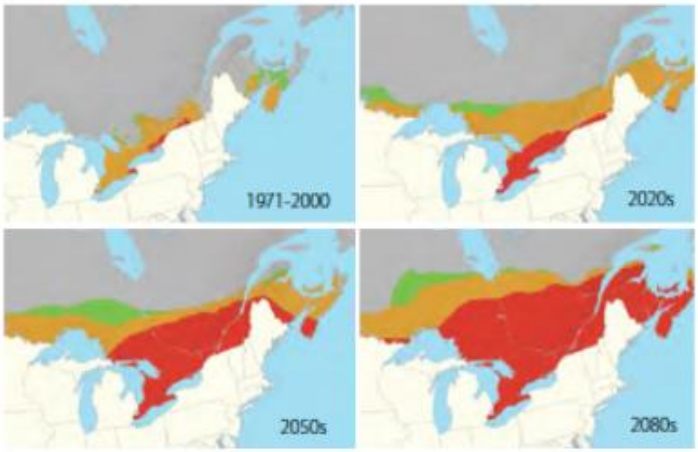


FIGURE 3: Risk maps for establishment and spread of the Lyme disease vector Ixodes scapularis under (1971-2000) and projected future climate (2020s to 2080s) after Ogden et al., 2008a. The green zone indicates the main extent of locations where *I. scapularis* may become established. The orange and red zones indicate areas with increasingly high risk for *I. scapularis* population emergence. The grey zone indicates areas where the risk of *I. scapularis* population emergence is very low *(Source: Ogden et al., 2008a).*

Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation, p. 201.

TABLE 4: Community observations of environmental change in the northern coastal region, compiled from the various sources cited in Section 3.5.

WEATHER

Observations based on traditional knowledge (TK)	Northwest Territories (Inuvialuit Settlement Region)	Nunavut	Quebec (Nunavik)	Labrador (Nunatsiavut)	Quebec (northern Hudson Bay (Cree))	Implications (generalized across communities)
Increasing variability and decreased ability to predict weather	Yes	Yes	Yes	Yes	Yes	Increased danger when travelling on land or ice
Changes in wind velocity, direction and frequency	Yes	Yes	Yes	Yes	Yes	Increased danger when travelling on land or ice; decreased reliability of TK
Increased frequency of thunderstorms and extreme weather events	Yes	Yes	Yes	Yes	No	Increased danger when travelling on land or ice; increased damage to infrastructure; constrained access to resource harvesting; accelerated coastal erosion
Differences in snow: less snow in winter, but more snow in some cases; arriving later in the fall/ winter; lighter and wetter in texture	Yes	Yes	Yes	Yes	Yes	Increased danger/difficulty when travelling on land or ice; constrained access to hunting grounds; changes in hunting routes; decreased reliability of TK; implications for sea ice freeze-up and break-up, and ice consistency and reliability
Increased storm surges and coastal erosion	Yes	Yes	No	No	No	Increased danger when travelling on land or ice; increased damage to infrastructure; constrained access to resource harvesting; accelerated coastal erosion
Increased rain (usually in fall and/ or spring, summer)	Yes	Yes	No	No	No	Implications for infrastructure; implications for sea ice freeze-up and break-up, and ice consistency and reliability

TEMPERATURE

Observations based on traditional knowledge (TK)	Northwest Territories (Inuvialuit Settlement Region)	Nunavut	Quebec (Nunavik)	Labrador (Nunatsiavut)	Quebec (northern Hudson Bay (Cree))	Implications (generalized across communities)
Warmer summer (in some communities)	Yes	Yes	Yes	Yes	No	Implications for aging processes of traditional foods; changing flora/fauna; implications for sea ice
Cooler summer (in some communities)	Yes	Yes	No	Yes	No	Implications for aging processes of traditional foods
Warmer winter; fewer cold days; winter starting later	Yes	Yes	Yes	Yes	Yes	Implications for aging processes of traditional foods; changing flora/fauna; implications for sea ice and travel on ice

Canada's Marine Coasts in a Changing Climate, p. 172.

Figure 3:

Risk maps for establishment and spread of the Lyme disease vector Ixodes scapularis under (1971-2000) and projected future climate (2020s to 2080s) after Ogden et al., 2008a. The green zone indicates the main extent of locations where I. scapularis may become established. The orange and red zones indicate areas with increasingly high risk for I. scapularis population emergence. The grey zone indicates areas where the risk of I. scapularis population emergence is very low (Source: Ogden et al., 2008a). Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation, p. 201. Note: Teacher will have to provide more description.

Table 4:

Community observations of environmental change in the northern coastal region, compiled from the various sources cited in Section 2.3. Canada's Marine Coasts in a Changing Climate, p. 172. Note: Teacher will have to provide more description.

Activity 4–Teacher BLM: Guiding questions

Guiding questions

- In your own words, what is this image trying to convey?
- What do you notice? Is there anything strange or surprising? Do you see trends?
- Can you think of any environmental, economic, or social consequences of this data?
- On sticky notes, write down any questions you have about this image.

Name:

Date:

Activity 4–Student BLM: Assignment and rubric

The first step towards adaptation implementation is awareness of climate change, potential impacts, and the need to adapt. Increased awareness of climate change can occur spontaneously (e.g. through the experience of extreme events) or through planned activities (e.g. workshops, awareness-raising campaigns, learning modules or publications). Note: From Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation, p. 274.

In this assignment, your team will "translate" the map or graph you chose into an infographic that clearly communicates its message and importance to an audience. The infographic must convey both the information contained in the image as well as a summary of further research your team will conduct to support your ideas. Start with the two reports produced by Natural Resources Canada (Canada in a Changing Climate; and Canada's Marine Coasts in a Changing Climate) that your teacher has downloaded for you.

Graphic encounters rubric

Area	Exemplary	Proficient	Satisfactory	Unsatisfactory
Main idea Infographic conveys the main idea in a clear and compelling manner				
Research Infographic reflects research into the environmental and/or social significance of the data				
Graphics Graphics are relevant, chosen to enhance and support the data				

Area	Exemplary	Proficient	Satisfactory	Unsatisfactory
Layout and design The layout of the graphics and text purposely enhances the communication of the main ideas. The flow of information is uncluttered and well organized.				
Language Language is used in a precise and concise manner with no errors in spelling, grammar or punctuation.				
Audience Infographic clearly identifies and supports the relevance of the information for at least two socio-economic sectors.				
Infographic elements Contains a title that reflects the main idea of the infographic				
Infographic elements Contains at least 5 images				
Infographic elements Each image contains a concise statement to help audience understand it				

Area	Exemplary	Proficient	Satisfactory	Unsatisfactory
Infographic elements Contains (on the back) a reference list for research and images, with references cited properly				

Names:

Image chosen:

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

OR

Canada's Marine Coasts in a Changing Climate, p.

Further research notes (environmental and/or social relevance of the data):

Information to include:

On the back of the infographic, please answer the following:

In your opinion, which of the following sectors should be concerned by this information? (Choose at least two.) Why?

1. Energy (oil and gas, wind, solar)
2. Food production
3. Mining
4. Forestry
5. Tourism
6. Housing/construction
7. Insurance

8. Manufacturing
9. Biodiversity
10. Infrastructure and transportation
11. Health and social well-being

Activity 5: Funding frenzy

Adaptation involves making adjustments in our decisions, activities and ways of thinking in response to observed or expected changes in climate, with the goals of (a) reducing harm and (b) taking advantage of potential opportunities. Adaptation can include behavioural changes, operational modifications, technological interventions, planning changes and revised investment practices, regulations and legislation.

While adaptation in the natural environment occurs spontaneously, adaptation in human systems often benefits from careful planning that is guided by both scientific research and detailed understanding of the systems involved. Note: Excerpted from 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, p. 20.

One of the most commonly cited barriers to adaptation is deficiencies in information for decision making. Decision makers are looking for the right type of information, at an appropriate scale and level of detail that is accessible and understandable. Note: Excerpted from 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, p. 276.

Summary

In this role-play activity, students will act as stakeholders in a working group session. They will try to build consensus on how best to use federal funding to address their climate change adaptation needs.

Duration: Two 60-75 minute sessions

Learning outcomes

After participating in the activity, students will be able to:

- Describe socio-economic impacts of climate change from a variety of stakeholder perspectives
- Recognize and analyze differing priorities for climate change research
- Demonstrate an understanding and appreciation of the consensus process

Competency outcomes

During this activity, students will develop or improve these abilities:

- Communication
- Critical thinking
- Collaboration
- Creativity and innovation

Set-up and materials

- **Stakeholder Profiles** (each student should get his/her own copy)
- **Stakeholder Note-Taking Sheet** (one per student)
- **Alliance-Building Sheet** (one per student)
- Laptop or iPad (one per group) with access to one common Google Slides document

Tip: One Google Slides document saves document loading time; and allows groups to access each other's slides. As another time-saver, consider creating slides for each stakeholder group ahead of time with the following headings: socio-economic importance; impacts of climate change; research needs (social and/or scientific).

What to do

Day 1

1. Introduce the activity with the following scenario:

   The federal government has just announced the creation of the Climate Adaptation Research Fund to be administered by the National Research Council (NRC) of Canada. The National Research Council is the Government of Canada's premier organization for research and development. Working with clients and partners, the NRC provides innovation support, strategic research, and scientific and technical services to develop and deploy solutions to meet Canada's current and future industrial and societal needs. This $1 million fund is to be used for research-based projects that will enable Canada to adapt to climate change impacts

across a variety of sectors like forestry, agriculture, mining, etc. This research can be used for scientific study (science and technology focus), for social science research (focus on people and societal issues), or a mixture of both. Your interest group has been asked to make a pitch to the federal government on how best to use these funds for your sector.
Your group will have two to three minutes to present your case, highlighting your socio-economic importance and the relevance of your research needs.

2. Divide class into teams of two to three students. Each team receives copies of a specific stakeholder profile.

   Tip: For classroom management purposes, ensure that each member of the group receives his or her own copy of the profile. Use page protectors so that the profiles can be used again next year.

3. Tell students that they will be preparing three to four slides in Google Slides for their “pitch.” The pitch should include the socio-economic importance of their sector and the impacts on it of climate change, as well as their research needs (social and/or scientific).

   Tip: Consider assigning each student a sub-topic so that everyone is accountable and each student has a part to present.

4. Ask students to silently read their profile, highlighting words or expressions they don’t understand. Give them time to discuss their understanding of the profile with their team to ensure they are on the same page.
5. Explain that there is not much time to prepare for this presentation: they will have another 10 minutes to re-read the profile, plus 15 to 20 minutes to figure out what to put on the slides and decide who says what. Emphasize that they should focus on content first and only work on making their slides attractive if they have time.
6. Place the desks in a U-shape facing the projection screen.
7. Just before the first group presents, tell the class that you have just received news from the people at the NRC.

The NRC has decided that they will only be funding four studies to deepen the significance of each study. This means that after the initial pitches are made, the groups are going to have to build alliances with each other in order to find common ground for a study. The NRC has prepared note-taking sheets to facilitate the job of trying to find issues and research needs in common. You should ask questions to find out more about the other groups' positions. It is very important to listen to each presentation and jot down your initial thoughts.

8. Hand out the Stakeholder Note-Taking Sheet to each student. Ask them to take notes during the presentations.
9. For homework, ask students to fill out their Alliance-Building Sheet to prepare for their group meeting next class. The sheet indicates who you would like to merge with around a specific issue, and your reasons to support this decision.

Day 2

10. Ask the students to get into their original stakeholder groups to discuss their notes. As a team, they should decide on which strategic alliances could be formed with the other sectors.
11. Give students 10 minutes to approach potential allies to discuss their common interests based on their Alliance-Building Sheets.

    Tip: More than two teams may want to build alliances together. If this is the case, split them into sub-groups for intensive brainstorming; they can then come back together to merge their discussions.

12. Ask students, as an alliance, to come up with a joint pitch for the funding, using a similar format to their original presentation (common socio-economic importance/impacts; common research needs). They should also highlight the win-win aspect of this alliance.

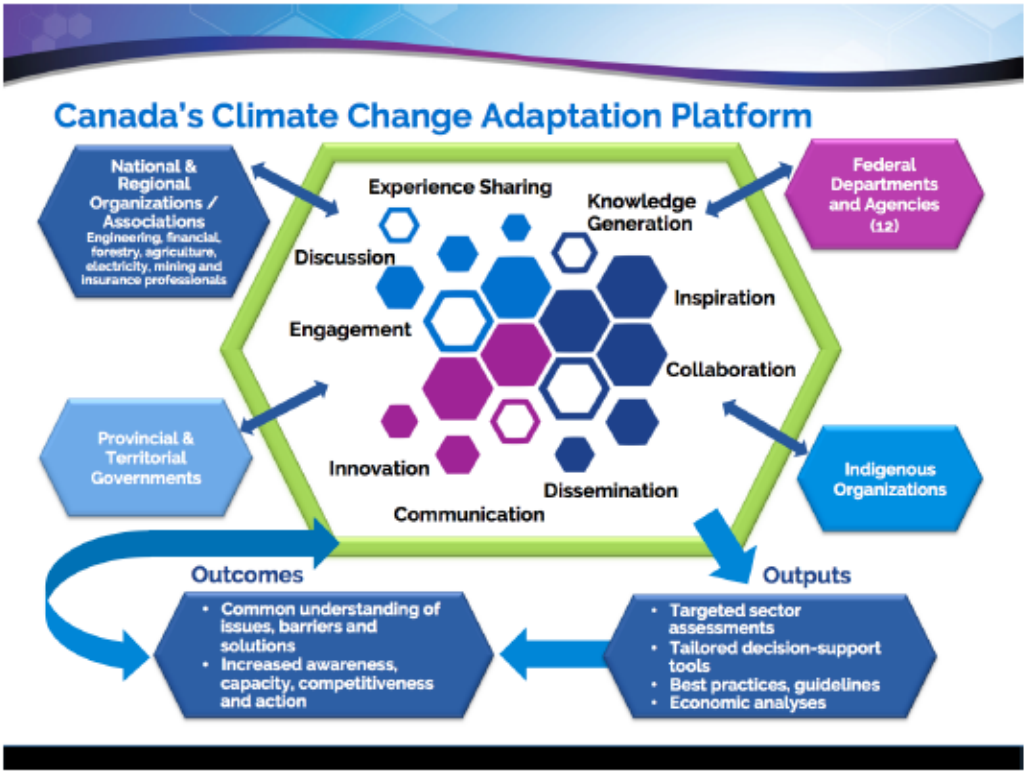
    Tip: Consider assigning each student (or pairs) a sub-topic so that everyone is accountable and each student has a part to present.

13. Ask each alliance to prepare three to four slides in Google Slides for their presentation.
14. As a class, decide who gets funding and how much (optional).
15. Generate a whole-class discussion of the consensus-building activity. How did it feel to shift from competitor to collaborator? What skills did you have to use in these different roles? Which did you prefer and why? What were the advantages or disadvantages?

Activity 5–Teacher backgrounder

The adaptation platform

The Adaptation Platform, a unique mechanism in Canada, brings together representatives from industry, professional and not-for-profit organizations, federal, provincial and territorial governments, and researchers to tackle shared climate change adaptation priorities (See Figure 1). Collaboration between the public and private sectors, and across jurisdictions and disciplines, is essential to address the complex and cross-cutting issue of climate change adaptation.



The image portrays an infographic titled "Canada's Climate Change Adaptation Platform." At the center is a large green hexagon labeled with six interconnected themes: Experience Sharing, Knowledge Generation, Inspiration, Collaboration, Dissemination, and Communication. These themes encircle a cluster of hexagons in varying shades of blue and purple, suggesting a dynamic and interconnected network.

Surrounding the central hexagon are four labeled boxes:

- "National & Regional Organizations / Associations,"- (sectors such as engineering, forestry, agriculture, infrastructure, electricity, mining, tourism and insurance professionals)
- "Federal Departments and Agencies (12),"
- "Provincial & Territorial Governments"
- "Indigenous Organizations."

Arrows connect these boxes to the central hexagon, illustrating their contribution to the adaptation platform.

Below the main graphic are two blue boxes labeled "Outcomes" and "Outputs," each with bullet points listing specific objectives.

Outputs

- Common understanding of issues, barriers and solutions
- Increased awareness, capacity, competitiveness and action

Outputs

- Targeted sector assessments
- Tailored decision-support tools
- Best practices, guidelines
- Economic analyses

Figure 1 Canada's Climate Change Adaptation Platform. Source: Natural Resources Canada, http://www.nrcan.gc.ca/environment/impacts-adaptation/adaptation-platform/10027.

Platform participants are both the users and producers of adaptation knowledge and tools. As a result, the Platform's work is demand-driven, facilitating the analysis and implementation of adaptation action, and directly responding to the needs of decision- makers in Canada's public and private sectors. By providing the structure to pool financial resources, knowledge, and people, the

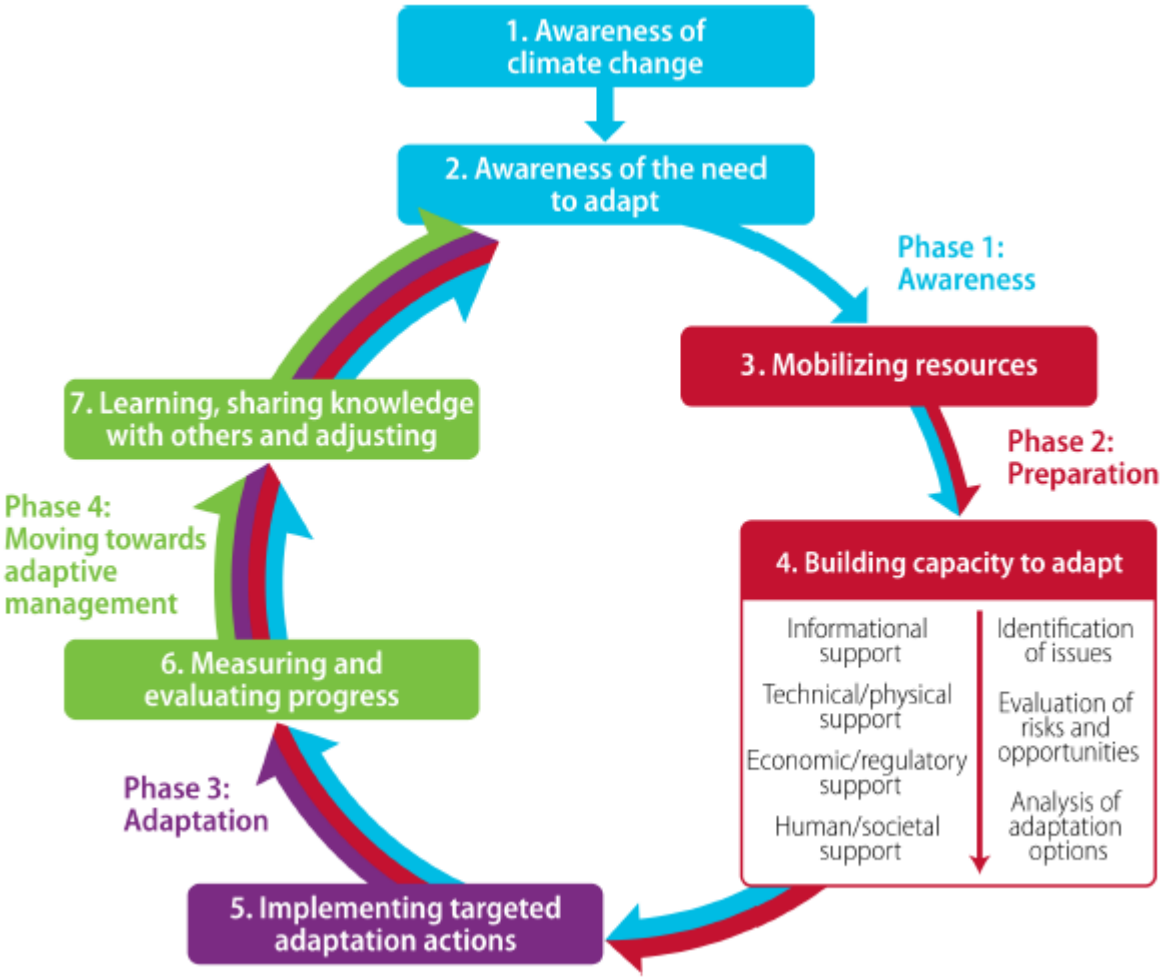
Adaptation Platform works to create new information and tools for adaptation and get these products to the appropriate users.

Canada's Adaptation Platform is structured around several components: a plenary body, a series of subject-matter specific working groups, a secretariat and a broad network of individuals engaged in delivering adaptation actions. Additionally, Regional Adaptation Collaboratives (including the Pan-Territorial Adaptation Partnership) are active across the country performing outreach and enhancing regional dissemination of Platform results.

Natural Resources Canada, chair of the Adaptation Platform, has committed ongoing resources to support the overall Platform, selected Working Group activities, and to provide the secretariat function.

Subject-matter specific Working Groups focus efforts on shared adaptation priorities within their particular subject matter area. Plenary members, comprised of senior-level representatives of governments and national organizations, identify critical and emerging adaptation priorities in Canada and to support collaborative efforts in focused areas of work. Plenary members also generate support for adaptation action and disseminate adaptation knowledge within their organizations and extended networks (Excerpt from The Adaptation Platform: Equipping Canadians for a Changing Climate (4th Annual Report) (2016); Natural Resources Canada. http://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/earthsciences/pdf/adaptation/AP-Annual-Report-2015-16_EN.pdf)

These consensus-building activities are an integral part of the adaptation planning process (see Figure 2).



The image is a circular flowchart illustrating a four-phase adaptive management process related to climate change adaptation. In the center of the circle, there are four main phases, each represented with different-colored boxes and numbered steps.

Phase 1 is titled "Awareness" and includes:
1-A light blue box with the text "1. Awareness of climate change."
2-A dark blue box with the text "2. Awareness of the need to adapt."

Phase 2 is titled "Preparation" and includes:

3- A red box with the text "3. Mobilizing resources."

4-Another red box with the text "4. Building capacity to adapt," which contains a white square detailing components like Informational support, Technical/physical support, Economic/regulatory support, Human/societal support, Identification of issues, Evaluation of risks and opportunities, and Analysis of adaptation options.

Phase 3, labeled "Adaptation," has:
5- purple box stating "5. Implementing targeted adaptation actions."

Phase 4, titled "Moving towards adaptive management," consists of:
6- A green box with "6. Measuring and evaluating progress."
7-A light green box with "7. Learning, sharing knowledge with others and adjusting."

Each phase connects with colored arrows matching the relevant phase color, articulating a continuous flow from one step to the next.

Figure 2. Steps in the adaptation planning process (Eyzaguirre and Warren, 2014). Source: Canada's Marine Coasts in a Changing Climate, p. 83.

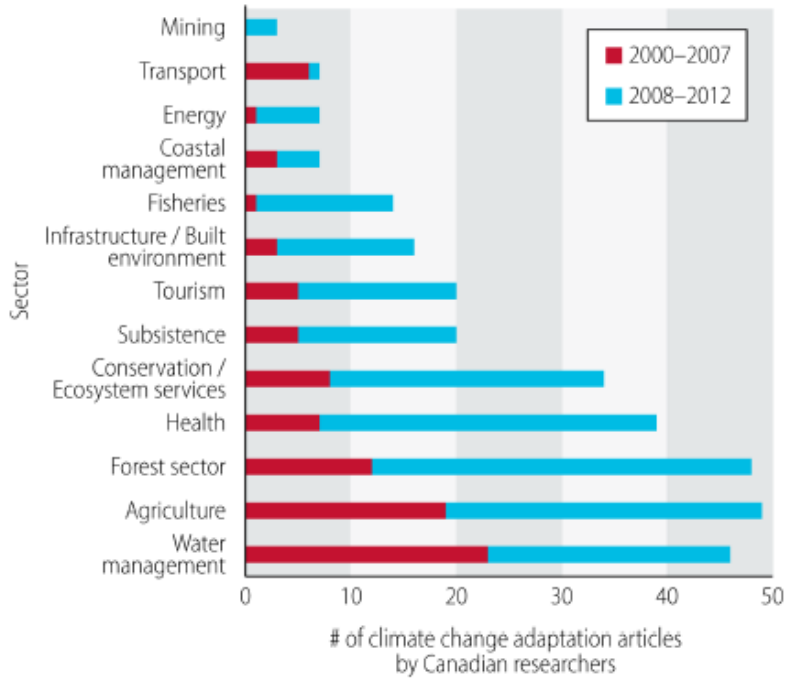


Figure 3: Number of climate change adaptation articles by Canadian researchers by sector (2000–2013). Source: Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation, p. 12.

# of climate change adaptation articles by Canadian researchers

The image is a horizontal bar chart illustrating the number of climate change adaptation articles by Canadian researchers, divided by sector and time period. The x-axis represents the number of articles, ranging from 0 to 50. The y-axis lists sectors, including Mining, Transport, Energy, Coastal management, Fisheries, Infrastructure/Built environment, Tourism, Subsistence, Conservation/Ecosystem services, Health, Forest sector, Agriculture, and Water management. Each sector has two corresponding bars: a red bar for the period 2000-2007, and a blue bar for 2008-2012. Notably, Water management and Agriculture have the longest bars, indicating they have the most articles. The chart uses a gradient background with alternating shades of light gray and white for better visual separation of the bars.

More information

For more information on climate change impacts and adaption, see Natural Resources Canada's website: www.nrcan.gc.ca/environment/impacts-adaptation.

For a list of additional resources, including regional initiatives, please consult Canada's Marine Coasts in a Changing Climate, p. 273.

Activity 5–Student BLM: Stakeholder glossary

- **Building code**: code used by the construction industry to ensure that safety conditions are met
- **Commodity**: trade goods, articles of commerce
- **Consumption**: the use of goods to satisfy needs (e.g. water or energy consumption)
- **Cost-benefit analysis**: evaluate the potential costs and benefits of a decision **Crop**: a cultivated plant that is grown commercially on a large scale **Drainage basin**: an area where water collects from rivers and streams
- **Ecosystem services**: The variety of resources and processes that are supplied by ecosystems and benefit human societies. These include products like clean drinking water and processes such as the decomposition of wastes
- **Erosion**: condition in which the earth's surface is worn away by the action of water and wind
- **GDP**: the measure of a country's economy. It is the total market values of goods and services produced by a country.
- **Hydroelectricity**: electricity produced by water power
- **Hydrological**: refers to water
- **Infrastructure**: the combination of facilities and equipment needed for the functioning of a country or area (e.g. water infrastructure or transportation infrastructure)
- **Resilience**: ability to "bounce back" after an event
- **Retrofit**: to substitute or add parts to an existing structure to adapt it to new conditions
- **Smelting**: extract metals by heating
- **Stakeholder**: a person or organization that has an interest (or stakes) in a specific issue
- **Supply chain**: the network of companies involved in producing, handling and/or distributing a specific product (e.g. seed producer > farmer > processing plant > distributor > grocery store)
- **Threshold**: a state or level marking a boundary (tipping point)
- **Vulnerability**: the state of being vulnerable or exposed to a threat, such as hazards associated with changing weather and climate patterns, the sensitivity of specific populations, and the ability of individuals and communities to take protective measures.

Name:

Date:

Activity 5–Student BLM: Stakeholder note-taking sheet

Stakeholder	Socio-economic relevance/importance	Impacts of climate change (positive/negative)	Research needs — societal issues	Research needs — science and technology issues
Name				
Name				
Name				
Name				
Name				
Name				
Name				
Name				
Name				
Name				

Activity 5–Student BLM: Alliance-building sheet

Stakeholder:

Team member names:

Stakeholder 1

Socio-economic similarities:

Socio-economic differences:

Research needs similarities:

Research needs differences:

Potential win-win solutions:

Stakeholder 2

Socio-economic similarities:

Socio-economic differences:

Research needs similarities:

Research needs differences:

Potential win-win solutions:

Rubric

The Alliance-Building Sheet includes an analysis of at least two stakeholder groups. Each analysis:

Area	Exemplary	Proficient	Satisfactory	Unsatisfactory
Clearly compares similarities and differences in socio-economic impacts between their profile and the other stakeholders.				
Clearly compares similarities and differences in research needs between their profile and the other stakeholders.				
Provides creative potential win-win solutions, i.e., solutions that would benefit both parties.				

Activity 5–Teacher BLM: Presentation rubric

Criteria	Exemplary	Proficient	Satisfactory	Unsatisfactory
Understanding of content: Socio-economic profile of the stakeholder	The slides communicate the socio-economic profile of the stakeholder with a high degree of effectiveness.	The slides communicate the socio-economic profile of the stakeholder with considerable effectiveness.	The slides communicate the socio-economic profile of the stakeholder with some effectiveness.	The slides communicate the socio-economic profile of the stakeholder with limited effectiveness.
Understanding of content: Research needs of the stakeholder and their importance.	The slides communicate the research needs of the stakeholder and their importance with a high degree of effectiveness.	The slides communicate the research needs of the stakeholder and their importance with considerable effectiveness.	The slides communicate the research needs of the stakeholder and their importance with some effectiveness.	The slides communicate the research needs of the stakeholder and their importance with limited effectiveness.
Viewpoint	Consistently answers questions from the viewpoint of the stakeholder.	Frequently answers questions from the viewpoint of the stakeholder.	Sometimes answers questions from the viewpoint of the stakeholder.	Rarely answers questions from the viewpoint of the stakeholder.

Criteria	Exemplary	Proficient	Satisfactory	Unsatisfactory
Oral communication	Consistently gives information with appropriate use of notes, eye contact, clarity, and volume.	Frequently gives information with appropriate use of notes, eye contact, clarity and volume.	Sometimes gives information with appropriate use of notes, eye contact, clarity and volume.	Rarely gives information with appropriate use of notes, eye contact, clarity and volume.
Active listening	Consistently demonstrates active listening skills.	Frequently demonstrates active listening skills.	Sometimes demonstrates active listening skills.	Rarely demonstrates active listening skills
Contribution to group: Contributes knowledge, opinions and skills.	Consistently contributes knowledge, opinions and skills.	Frequently contributes knowledge, opinions and skills.	Adequately contributes knowledge, opinions and skills.	Rarely contributes knowledge, opinions or skills.
Problem-solving: Looks for and suggests solutions; and/or refines solutions suggested by others.	Consistently looks for and suggests solutions; and/or refines solutions suggested by others.	Frequently looks for and suggests solutions; and/or refines solutions suggested by others.	Adequately looks for and suggests solutions; and/or refines solutions suggested by others.	Rarely looks for and suggests solutions or refines solutions suggested by others.

Criteria	Exemplary	Proficient	Satisfactory	Unsatisfactory
Consensus-building skills: Values the knowledge, opinion and skills of all group members and encourages their contributions.	Consistently values the knowledge, opinion and skills of all group members and encourages their contributions.	Frequently values the knowledge, opinion and skills of all group members and encourages their contributions.	Adequately values the knowledge, opinion and skills of all group members and encourages their contributions.	Rarely values the knowledge, opinion and skills of all group members or encourages their contributions.
Time Management: Stays focused on task.	Consistently stays focused on task.	Frequently stays focused on task.	Adequately stays focused on task.	Rarely stays focused on task.
Collaboration skills: Works towards group goals. Encourages people to work well together.	Consistently works towards group goals and encourages people to work well together.	Frequently works towards group goals and encourages people to work well together.	Adequately works towards group goals and encourages people to work well together.	Rarely works towards group goals.

This lesson plan was produced by the Canada Science and Technology Museum.

[View all of Ingenium's learning resources on our website.]