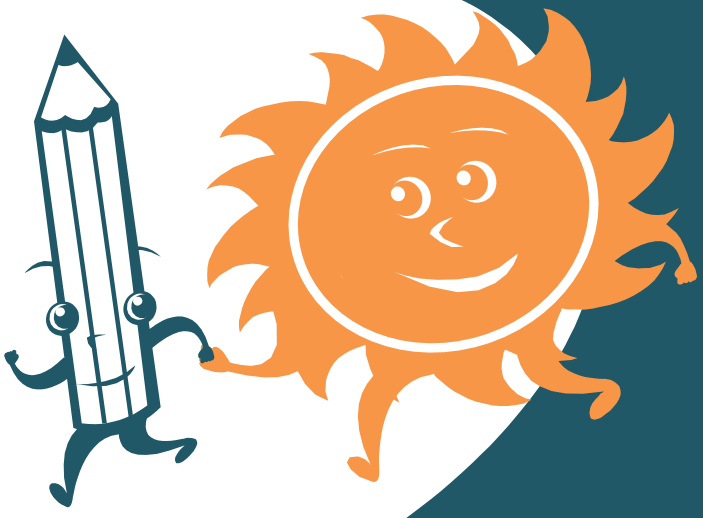
Taking on CLIMATE CHANGE

A teaching companion for educators in Nova Scotia



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ABOUT THE TEACHING COMPANION

This teaching companion is meant to encourage and support the inclusion of climate change education in Nova Scotia schools. It includes the following:

- A brief explanation of why teaching climate change is important
- Suggestions for dealing with possible barriers to integrating climate change into classroom teaching
- Climate change basics and an introduction to the essential principles of climate science
- Clarification of common climate change misconceptions
- Links to climate change-specific teaching materials and background information for teachers

This last point is particularly important. Created to complement existing resources, this teaching companion has been designed to help Nova Scotia teachers access existing high-quality information on climate change prepared for educators, as well as lesson plans, curriculum units, and other classroom resources.

This teaching companion is one of the products of a research study conducted in Nova Scotia. The study, as well as the development of this teaching companion, was funded by Nova Scotia Environment's Climate Change Adaptation Fund.

As part of the study, a large sample of pre-service and in-service teachers completed an online questionnaire. The questionnaire included questions on climate change science and impacts, barriers to integrating climate change into classroom teaching, and what resources and other support teachers would like to see to help improve climate change education in the province. The content of this teaching companion is informed by the study results.

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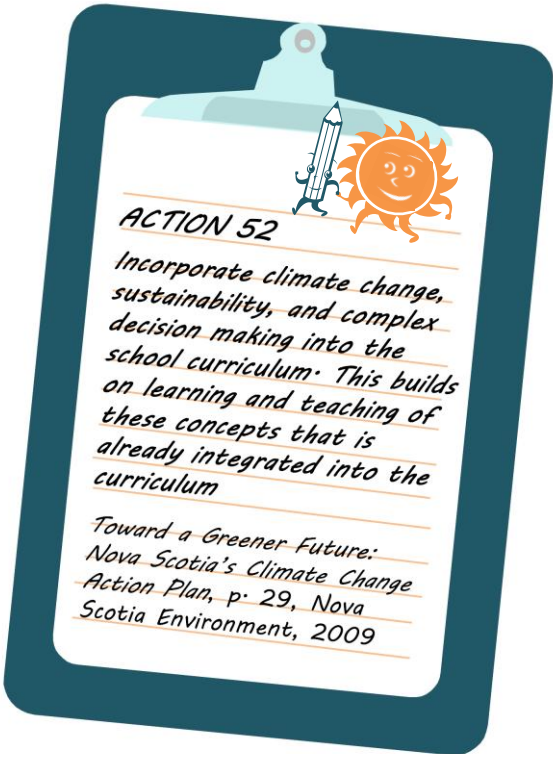
NOVA SCOTIA
Environment

WHY TEACH ABOUT CLIMATE CHANGE?

Climate change is one of the most important environmental issues facing the world in the 21st century. Increasing education about climate change, including projected impacts, causes, and options for mitigation and adaptation, is (and will continue to be) a necessary part of responding to this complex global phenomenon.

Nova Scotia Environment has acknowledged the importance of education as part of the province's response to climate change. In its Climate Change Action Plan, *Toward a Greener Future*, Nova Scotia Environment describes education as a major focus and calls for climate change to be included in school curriculum (see inset). Until provincial curriculum outcomes are updated to reflect this priority, Nova Scotia teachers are encouraged to take advantage of opportunities to integrate climate change into their current teaching practice (see *Recommended Resources* section for sample lesson plans and other ideas of ways to do this).



There are many reasons why teaching students about climate change makes sense. For example, studies show that information taught to students can be transferred to their families and wider communities[1]. Students stand to benefit the most, however. Below are just some of the ways that climate change education can help students.

Benefits for students[2]:

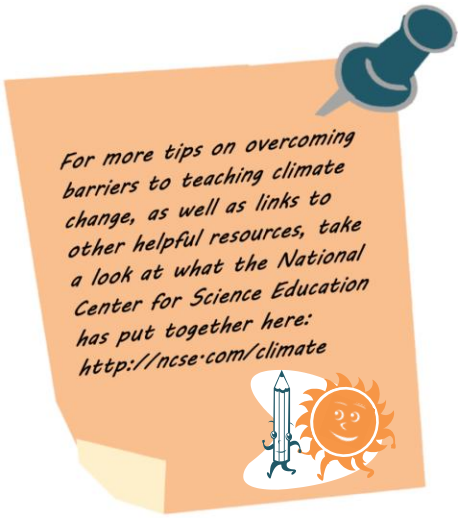
- Useful for learning about complexity and complex systems, and may help prepare students for dealing with other complex issues
- Covering important real-world issues can capture students' attention and make learning feel more relevant
- Knowledge about climate change can help empower students to take action, including adopting more sustainable behaviours
- Can help alleviate worries about climate change-related risks

Teaching about climate change in schools is also important as students are already exposed to the issue elsewhere (e.g., the Internet and other media). Many studies have shown that climate change confusion, misunderstandings, and knowledge gaps are common amongst students of all ages (elementary through college and university)[3]. Including climate change in classroom lessons and discussions creates opportunities for students to be exposed to information on climate change that is scientifically-informed and age-appropriate. Students have also been shown to respond well to direct climate change instruction[4].

[1]See, for example, Vaughan, C., Gack, J., Solorazano, H. & Ray, R. (2003). The effect of environmental education on schoolchildren, their Parents, and community members: A study of intergenerational and intercommunity learning. *The Journal of Environmental Education, 34*(3), 12-21.
[2]For a more detailed discussion of these benefits see Dalhberg, S. (2001). Using climate change as a teaching tool. *Canadian Journal of Environmental Education, 6*, 9-17 and Taber, F. & Taylor, N. (2009). Climate of concern - A search for effective strategies for teaching children about global warming. *International Journal of Environmental & Science Education, 3*(3), 97-116.
[3]See, for example, Pruneau, D., Liboiron, L., Vrain, E., Bourque, W. & Langis, J. (2001). People's ideas about climate change: A source of inspiration for the creation of educational programs. *Canadian Journal of Environmental Education, 6,* 121-138 and Shepardson, D. P., Niyogi, D., Choi, S. & Charusombat, U. (2009). Seventh grade students' conceptions of global warming and climate change. *Environmental Education Research, 15*(5), 549–570.
[4]See, for example, Baker, J., & Sherren, K. (2011). Bringing climate change into the classroom: Introducing teaching modules for use with Nova Scotia's public school curricula. Retrieved from http://climatechange.gov.ns.ca/files/04/24/ClimateChange_TeachingModules_NSSchools_Mar2012.pdf and Lee, O., Lester, B. T., Ma, L., Lambert, J., & Jean-Baptiste, M. (2007). Conceptions of the greenhouse effect and global warming among elementary students from diverse languages and cultures. *Journal of Geoscience Education, 55*(2), 117-125.

LIMITS & BARRIERS

Although students are likely to benefit from high-quality climate change education, teachers may be reluctant, or feel unable, to cover the topic. Below are some of the challenges that either Nova Scotia teachers reported facing in their classrooms or that have been identified elsewhere[5]. A few tips or suggestions are included for each.



1 TEACHERS FEEL UNPREPARED AND/OR LACK RESOURCES

Teaching climate change is challenging as it is an issue that transcends discipline boundaries. Understanding climate change also requires keeping up with rapidly changing science, and being able to make sense of what can be conflicting and misleading media coverage. Not surprisingly, teachers tend to deemphasize or avoid issues that they are less knowledgeable about or comfortable with. The fact that climate change has not been explicitly included in NS' provincial curricula also creates additional work for those interested in climate change education.

- Invite expert guest speakers to visit the classroom and make presentations
- Make use of existing resources for teaching climate change and background information designed for educators (e.g., see *Recommended Resources*)
- Explore opportunities for collaboration with colleagues, e.g., joint interdisciplinary approach

2 CLIMATE CHANGE IS VIEWED AS BEING CONTROVERSIAL

Climate change critics exist (they're small in numbers, but vocal with their arguments) who doubt the evidence for anthropogenic climate change and attempt to delay action on climate change. Yet, nearly all climate scientists agree that the Earth's climate is changing and that human activities are causing global warming[6].

- Teach consensus science, but be prepared to deal with public controversy; if counter arguments are introduced, use them as lessons in critical thinking
- Do not ask students to engage in mock debates or other activities that are likely to confuse students by giving equal weight to critics' arguments
- Avoid using teaching resources that contradict the scientific consensus on climate change, or that focus on teaching manufactured controversy

3 STUDENTS MAY BECOME SCARED AND/OR OVERWHELMED

Climate change is a complex global phenomenon that will likely result in more negative impacts than benefits. As such, it may seem to be an inappropriate topic to address in classrooms. In reality, however, there is strong support for climate change education, and the experience can be positive for students.

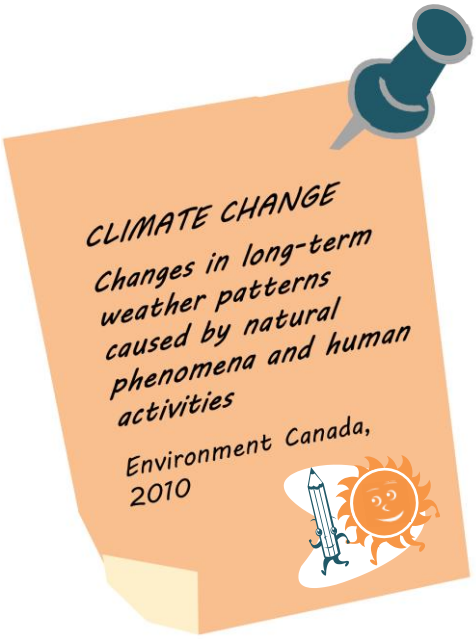
- Ensure that students are exposed to age-appropriate material, e.g., focus on issues like the differences between climate and weather for younger students and save conceptually difficult issues, such as the relationship between the carbon cycle and other components of Earth's system, for older students
- Avoid the use of scare tactics, i.e., do not focus on tragedies and natural disasters or apocalyptic future scenarios. Instead, emphasize concrete actions that can be done to mitigate or adapt to a changing climate
- Take advantage of opportunities to contextualize information and make the material relevant to students, e.g., by discussing local impacts
- Create opportunities for hands-on problem solving, e.g., analyzing actual data or holding mock summits

[5] The first barrier, in particular, was commonly identified by the sample of pre- and in-service teachers who participated in an anonymous online questionnaire in 2013, funded by NS Environment's Climate Change Adaptation Fund. The others were reported by fewer NS teachers, but are raised elsewhere, e.g., see: http://www.pbs.org/newshour/rundown/2012/05/teaching-climate-change.html

[6] A 2010 study published in the *Proceedings of the National Academy of Sciences of the United States* found that 97-98% of a sample of 1372 of the most actively published climate scientists agree that anthropogenic climate change is happening, as described by the IPCC

CLIMATE CHANGE BASICS

The global climate has changed many times during Earth's history. Tiny bubbles preserved in deep sea ice cores act as snapshots of earlier climates, providing scientists with important information about the chemical composition of the atmosphere. By measuring the ratios of different water isotopes, scientists can also use ice cores to reconstruct historical temperature records. Additional clues about ancient climates come from studying other natural records such as tree rings, ocean sediment, and fossils. Not only do scientists have an understanding of what past climates were like, they also know that natural factors, such as changes in solar activity, volcanic eruptions, levels of greenhouse gases, and the Earth's orbit around the sun, caused past climate changes[7].



Fast forward to present day: the Earth's climate is changing again. However, current climate change is not due to natural causes alone. The vast majority of climate scientists agree that humans are contributing to contemporary climate change, largely as a result of activities – e.g., burning fossil fuels and deforestation – that release carbon dioxide and other greenhouse gases (such as methane) into the atmosphere. The result is an intensified (or amplified) greenhouse effect and a planet that is gradually warming. Increasing global average air and ocean temperatures are also accompanied by many related changes, including changes to precipitation (rain and snow) patterns, rising sea-levels, and more extreme weather events.

An understanding of the Earth's climate system and the greenhouse effect is important in order to move beyond the simplified introduction to climate change provided above. The following seven essential principles of climate science are taken from *Climate Literacy: The Essential Principles of Climate Sciences*. These essential principles, as well as a modified summary of key concepts for each, are included here in order to help establish a basic framework of understanding of climate science. For more information on these principles, and for additional resources on climate change that may be useful for teachers, please see *Climate Literacy*[8] or any of the other materials listed in the *Recommended Resources* section of this guide.

1 THE SUN IS THE PRIMARY SOURCE OF ENERGY FOR EARTH'S CLIMATE SYSTEM

- *The sun warms the Earth (sunlight is absorbed by the land, oceans, and atmosphere) and is the driving force behind weather and climate*
- *Over the past million years, gradual changes in the Earth's orbit and rotation around the sun, as well as changes in solar output, caused climate changes (e.g., warmer periods and ice ages)*
- *Changes in solar output over the past few decades have been too small to cause recent global warming*
- *The 'greenhouse effect' is the term used for the natural insulating effect of the atmosphere. Incoming sunlight heats the Earth and is then re-emitted as heat energy. Greenhouse gases (GHGs), such as water vapour and CO_2, occur naturally in the atmosphere. They absorb and trap some of the heat energy re-emitted from the Earth, warming the planet*

2 CLIMATE IS REGULATED BY COMPLEX INTERACTIONS AMONG COMPONENTS OF THE EARTH

- *Earth's climate is influenced not only by the sun, but also by interactions between the various components of Earth's system – atmosphere, oceans, biosphere (plants and animals), etc.- and regional differences in these components and their interactions result in variations in climate*

[7] Le Treut, H. et al. (2007). Historical overview of climate change, in Climate change 2007: The physical science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (Eds.)]. Cambridge University Press, Cambridge & New York

[8] The U.S. Global Change Research Program's *Climate Literacy: The Essential Principles of Climate Sciences* is available for free download at http://www.climatescience.gov/Library/Literacy/

- *Oceans play a major role in regulating climate, absorbing, storing and transporting heat and CO_2*
- *Changes to the composition of the atmosphere affect the amount of solar energy that is absorbed or reflected – changing global climate*
- *The concentration of greenhouse gases in the atmosphere is controlled both by natural processes and human activities – e.g., atmospheric $C0_2$ concentrations increase as a result of deforestation and burning fossil fuels and decrease due to absorption of $C0_2$ by oceans and photosynthesizing plants*
- *Aerosols – tiny airborne particles – have both cooling (by reflecting incoming sunlight back into space) and warming (by absorbing and re-emitting heat energy into the atmosphere) effects on climate*

3 LIFE ON EARTH DEPENDS ON, IS SHAPED BY, AND AFFECTS CLIMATE

- *Complex life could not exist on Earth without warming from the natural greenhouse effect*
- *Individual species have specific climatic requirements and so climate change (warming or cooling) can negatively affect species and entire ecosystems (Note: the fossil record provides evidence of both gradual and abrupt extinctions as a result of past climate changes)*
- *Natural records indicate that Earth's climate has been especially stable for the last 10,000 years*
- *Life - from microbes to humans - influences the global carbon cycle in important ways*

4 CLIMATE VARIES OVER SPACE AND TIME BY BOTH NATURAL AND MAN-MADE PROCESSES

- *Climate and weather mean different things. Climate refers to long-term averages in weather patterns*
- *Scientific evidence tells us that climate change has occurred in the past, is happening now, and will happen in the future*
- *Unlike earlier climate changes, contemporary climate change may occur at a faster rate and cannot be explained by natural factors alone (Earth's average temperature is warmer now than at any time during the last 900 years - and possibly as long as 4,000 years - and the rate of warming has increased significantly in the last 50 years)*
- *Carbon dioxide (largely as a result of human activities) is being released into the atmosphere more quickly than it is being removed from the atmosphere by natural processes – the result: $C0_2$ released into the atmosphere now could remain in the atmosphere for a century or longer*

5 OUR UNDERSTANDING OF THE CLIMATE SYSTEM IS IMPROVED THROUGH OBSERVATIONS, THEORETICAL STUDIES, AND MODELLING

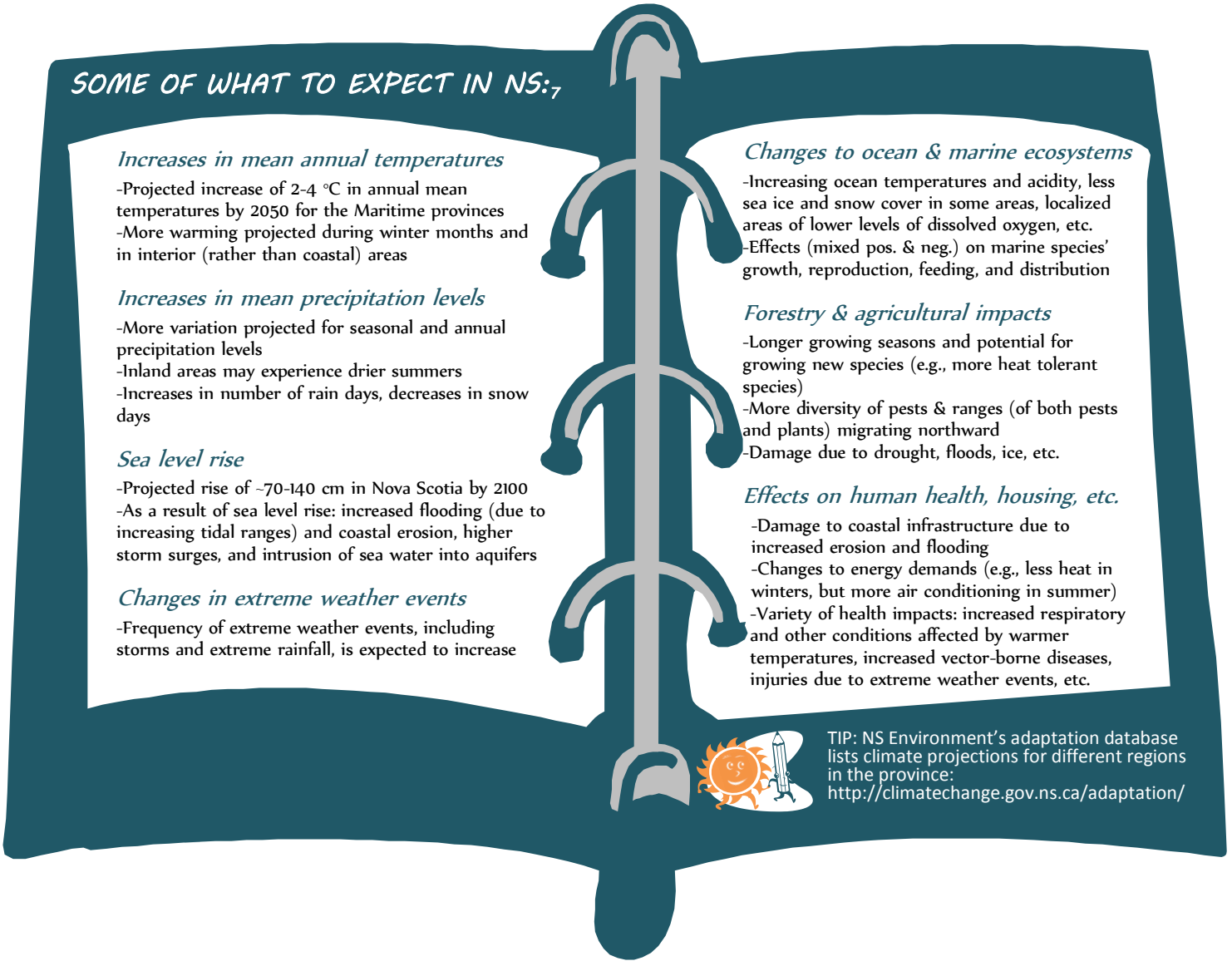
- *Studying the Earth's climate system leads to a better understanding of how it behaves and can lead to improved predictions for the future*
- *Scientists' understanding of the climate system is improved through extensive research, including observing the natural environment and recording a wide variety of data (Note: natural records such as tree rings and ice cores provide insight into past climates)*
- *Increasingly sophisticated computer models are used to represent Earth's climate and make future predictions*
- *Scientists have enough confidence in their climate change projections to use them to guide and evaluate decision-making about responses to climate change*

6 HUMAN ACTIVITIES ARE IMPACTING THE CLIMATE SYSTEM

- *Human activities that release GHGs (burning fossil fuels, deforestation, expansion of farming, etc.) are increasing the concentration of these gases in the atmosphere and, as a result, are amplifying the natural greenhouse effect and increasing Earth's average temperature*
- *There is mounting evidence that climate change due to human activities is resulting in changes to both physical and biological systems*
- *Scientists expect that climate change will result in positive and negative impacts, but that negative impacts will outweigh the positives if global average temps. increase by 2-3 °C over the next century*

7 CLIMATE CHANGE WILL HAVE CONSEQUENCES FOR THE EARTH SYSTEM AND HUMAN LIVES

- *Sea level is rising due to the melting of land ice (ice sheets and glaciers) and the expansion of seawater as the oceans warm up*
- *The chemistry of ocean water is changing (becoming more acidic), in addition to getting warmer*
- *The availability and quality of freshwater resources is expected to change*
- *More frequent extreme weather events (e.g., heat waves, major storms, and droughts) are likely*
- *Ecosystem changes are already occurring: species' ranges are shifting and non-native species are spreading*
- *Human cold-related health issues and deaths are projected to decrease, but respiratory and heat-related injury and deaths, spread of infectious diseases, crop shortages due to droughts and flooding, and extreme weather events are projected to increase*



SOME OF WHAT TO EXPECT IN NS:[7]

Increases in mean annual temperatures

-Projected increase of 2-4 °C in annual mean temperatures by 2050 for the Maritime provinces
-More warming projected during winter months and in interior (rather than coastal) areas

Increases in mean precipitation levels

-More variation projected for seasonal and annual precipitation levels
-Inland areas may experience drier summers
-Increases in number of rain days, decreases in snow days

Sea level rise

-Projected rise of ~70-140 cm in Nova Scotia by 2100
-As a result of sea level rise: increased flooding (due to increasing tidal ranges) and coastal erosion, higher storm surges, and intrusion of sea water into aquifers

Changes in extreme weather events

-Frequency of extreme weather events, including storms and extreme rainfall, is expected to increase

Changes to ocean & marine ecosystems

-Increasing ocean temperatures and acidity, less sea ice and snow cover in some areas, localized areas of lower levels of dissolved oxygen, etc.
-Effects (mixed pos. & neg.) on marine species' growth, reproduction, feeding, and distribution

Forestry & agricultural impacts

-Longer growing seasons and potential for growing new species (e.g., more heat tolerant species)
-More diversity of pests & ranges (of both pests and plants) migrating northward
-Damage due to drought, floods, ice, etc.

Effects on human health, housing, etc.

-Damage to coastal infrastructure due to increased erosion and flooding
-Changes to energy demands (e.g., less heat in winters, but more air conditioning in summer)
-Variety of health impacts: increased respiratory and other conditions affected by warmer temperatures, increased vector-borne diseases, injuries due to extreme weather events, etc.

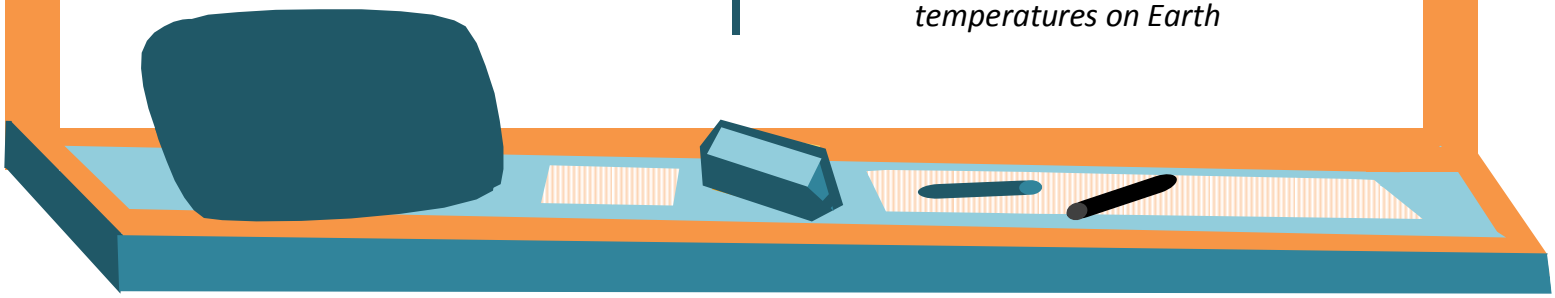
TIP: NS Environment's adaptation database lists climate projections for different regions in the province: http://climatechange.gov.ns.ca/adaptation/

[9]Natural Resources Canada (2007*). From impacts to adaptation: Canada in a changing climate*. Retrieved from http://www.nrcan.gc.ca/sites/www.nrcan.gc.ca.earth-sciences/files/pdf/assess/2007/pdf/full-complete.pdf; Richards, W. & Daigle, R. (2011). *Scenarios and guidance for adapting to climate change and sea level rise: NS and PEI municipalities*. Retrieved from http://atlanticadaptation.ca/sites/discoveryspace.upei.ca.acasa/files/ACASA%20Scenarios%20and%20Guidance%20for%20Adaptation%20NS%20and%20PEI_1.pdf; Shackell, N. & Loder, J. (2012). *Climate change and its effects on ecosystems, habitats and biota. State of the Scotian Shelf report.* Fisheries and Oceans Canada. Retrieved from http://coinatlantic.ca/docs/climate-change-and-its-effects-on-ecosystems-habitats-and-biota.pdf.

CLARIFYING COMMON MISCONCEPTIONS

Both teachers and students commonly hold misconceptions related to climate change. To improve the quality of climate change education, it is important that teachers become aware of their own misconceptions and also attempt to determine those held by their students. The list below identifies and corrects some of the misconceptions commonly held by teachers in Nova Scotia[10], with more detailed explanations on the following page.

	MISCONCEPTION	REALITY
1.	*The greenhouse effect is caused by humans, and therefore it wouldn't exist if there were no humans*	*The greenhouse effect is a natural phenomenon and would exist whether or not humans lived on Earth*
2.	*Ozone layer depletion (including ozone holes) contributes significantly to the greenhouse effect*	*Thinning of the ozone layer results in higher levels of ultraviolet radiation reaching Earth's surface, but does not significantly strengthen the greenhouse effect*
3.	*Sea level rise is due to melting of sea ice at the poles*	*The major causes of sea level rise are the melting of land-based ice (i.e., mountain glaciers, polar ice caps, and ice sheets), and thermal expansion (i.e., water expanding as it heats up)*
4.	*Radioactive waste from nuclear power generation contributes considerably to climate change*	*Radioactive waste does not contribute to climate change; however, there are costs and benefits that come with nuclear power generation*
5.	*Contemporary climate change is caused by the sun getting hotter and/or more sun spots*	*Solar activity follows natural cycles of activity. Over the past 30 years, the sun has shown a slight cooling trend[11]- the opposite of temperatures on Earth*



[10] As identified in the 2013 questionnaire funded by NS Environment's Climate Change Adaptation Fund.

[11] Lockwood, M. & Fröhlich, C. (2008). Recent oppositely directed trends in solar climate forcings and the global mean surface air temperature. Different reconstructions of the total solar irradiance variation and dependence on response time scale. *Proceedings of the Royal Society A, 464*(2094), 1367-1385.

MORE ABOUT THESE COMMON MISCONCEPTIONS:

1. Although there are synthetic greenhouse gases (e.g., chlorofluorocarbons (CFCs)), most of the greenhouse gases exist naturally in the atmosphere, including carbon dioxide, water vapour, methane, ozone, and nitrous oxide. Greenhouse gases are gases that are able to retain (or trap) heat, and their presence in the atmosphere keeps the Earth warm enough to support life. When the greenhouse effect is described in negative terms, it is actually the *enhanced* greenhouse effect that is being referred to, i.e., the amplification of the natural greenhouse effect as a result of human emissions of greenhouse gases. Between 1990 and 2011, the warming effect from greenhouse gases increased 30%, mainly due to CO_2[12].

2. A layer of ozone (the ozone layer!) in the stratosphere acts as a protective shield to incoming ultraviolet B (UVB) radiation from the sun. Ozone-depleting substances – chlorofluorocarbons (CFCs), halons, and other synthetic chemicals that contain either chlorine or bromine – break down in the stratosphere and release either chlorine or bromine, gases that deteriorate the ozone layer. Ozone depletion does not cause the sun's UVB output to increase, but a thinner ozone layer means more UVB reaches Earth's surface. While a thinner ozone layer does not contribute significantly to global warming, ozone-depleting substances are important greenhouse gases[13].

3. Rising global temperatures cause oceans to warm and expand (thermal expansion), and land-based ice (i.e., mountain glaciers, polar ice caps, and ice sheets) to melt. The result: sea-level rise. Although warmer temperatures also cause sea ice to melt, loss of sea ice does little to directly contribute to sea-level rise. This is due to the fact that sea ice is already floating in the ocean, and so its melting has a negligible effect on the total volume of the ocean. Sea ice melt, however, can indirectly contribute to sea level rise. As sea ice (which reflects sunlight back into space) shrinks and disappears, more sunlight is absorbed by the ocean, increasing warming and accelerating the melting of glaciers and ice sheets[14].

4. Nuclear power generation results in no direct CO_2 emissions making it one of a number of low-carbon options for energy production (others include hydro, wind, solar, and biofuels). (Note: GHG emissions occur at various stages in the lifecycle of nuclear power, including as a result of uranium mining and the construction of nuclear plants; however, the total lifecycle GHG emissions are far below those from fossil fuel-based energy production, but higher than at least some renewables.[15]) Yet, social and environmental concerns undermine its potential as an alternative to fossil fuel-based production. For example, while radioactive waste does not contribute to climate change, it is hazardous to humans and the environment.

5. Although the sun follows an 11-year cycle in which small (approx. 0.1%) fluctuations in the intensity of solar radiation occur (due to changes in sunspot activity), these minute ups and downs have little effect on Earth's climate. Changes in solar activity can also occur on much shorter (e.g., eruptions of solar flares that can take place within minutes) and longer (e.g., changes in the solar magnetic field that occur over decades or much longer) timeframes. While satellite measurements rule out changes in solar output and variability as the cause of recent (i.e., within the last 50 years) global warming, changes in solar activity may have been important drivers of some historical climate changes.[16]

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[12] World Meteorological Organization. (2012). WMO Greenhouse Gas Bulletin #8. Retrieved from http://www.wmo.int/pages/prog/arep/gaw/ghg/GHGbulletin.html

[13] If you want to know more about ozone layer depletion, including more about ozone depleting substances and myths about ozone layer depletion, see the US EPA's page on *The Science of Ozone Layer Depletion*: http://www.epa.gov/ozone/science/

[14] NASA's short video *Shrinking ice, Rising seas* does a nice job of explaining sea level rise in a way that could be helpful to both students and adults: http://climate.nasa.gov/climate_reel/MeltingIceRisingSeas640360

[15] See Kurt Kleiner's report Nuclear energy: Assessing the emissions, for more information: http://www.nature.com/climate/2008/0810/full/climate.2008.99.html

[16] National Academy of Sciences. (2012). The effects of solar variability on Earth's climate: A workshop report. Retrieved from https://download.nap.edu/catalog.php?record_id=13519

RECOMMENDED RESOURCES

The final pages of this teaching guide identify a variety of climate change resources that may be useful to Nova Scotia teachers. Although all the resources listed here are considered high-quality, a rating (on a five-star scale) is provided to help communicate such things as readability, use of reputable sources of scientific information, and teacher-friendliness.

CLIMATE CHANGE BACKGROUNDERS, PROFESSIONAL DEVELOPMENT, ETC.

TITLE	BRIEF DESCRIPTION/FEATURES	ACCESS
Climate Literacy: The Essential Principles of Climate Sciences ★★★★★	▪ Bulk of the resource is spent explaining seven essential principles of climate science (also includes a discussion of climate literacy, including why it is important, and key definitions) ▪ After identifying each principle, key concepts are listed in easy-to-understand language ▪ Nice layout and well organized – a good starting place for learning about the Earth's climate and causes and impacts of climate change	http://www.climatescience.gov/Library/Literacy/
Global Climate Change Modules ★★★★★	▪ A variety of free, high-quality teacher professional development modules (completion time 3-5 hours each, self-paced) ▪ Geared to junior-high school teachers ▪ Prepared and funded jointly by NASA and PBS	http://www.pbs.org/teachers/stem/professionaldevelopment
Inspiring Climate Change Excellence (ICEE) ★★★★	▪ Overview of an ICEE professional development course that took place in Boulder, CO in 2010 ▪ Material is organized into eight sections (e.g., How Scientists Know, Human Impacts, and Mitigation and Adaptation) and includes learning objectives, videos, and activities	http://cires.colorado.edu/education/outreach/ICEE/workshop/
Cool It! **Teacher's Guide** ★★★	▪ Basic, short introduction to climate change prepared for teachers by the Union of Concerned Scientists ▪ Includes a sample climate change lesson plan, modifiable to different grade levels	http://www.ucsusa.org/assets/documents/ucs/cool-it-global-warming-card.pdf
Climate Change Learning Resources - Impact, Mitigation and Adaptation ★★★	▪ Resource, from Europe's Earthwatch Institute, organized thematically into 6 booklets (e.g., climate change basics, impacts on biodiversity, and mitigation) ▪ Includes suggestions for class discussions and links to additional resources for student research - nice layout and clearly written information (could be used with students)	http://www.earthwatch.org/europe/get_involved/involved_learning/learning_resources/resources_climatechange/
The Ultimate Climate Change FAQ ★★★★½	▪ List of frequently asked questions and answers about the science and impacts of climate change complied by UK's *The Guardian* newspaper ▪ Answers are either directly from university experts or extracted from recent reference works on climate change	http://www.guardian.co.uk/environment/2011/may/05/ultimate-climate-faq-topics

Skeptical Science: Getting Skeptical about Global Warming Skepticism ★★★★★	▪ Website and App (iPhone and Android) that index common objections to climate change, and provide rebuttals using peer-reviewed scientific literature at various levels (basic, intermediate, and advanced) ▪ Private initiative, but one that has been very well-received by climate change scientists and educators ▪ Could be of use to both teachers and students, and could form the basis of classroom or take-home activities for students, in particular, assignments designed to teach the use of evidence in scientific reasoning and argument	http://www.skepticalscience.com/
Frequently Asked Questions About Global Warming & Climate Change: Back to Basics ★★★	▪ Short (7 pg.) brochure with brief answers to common questions about climate change ▪ Resource produced by the US Environmental Protection Agency, using the Intergovernmental Panel on Climate Change's (IPCC) Fourth Assessment Report (2007) as the key reference	http://www.epa.gov/climatechange/Downloads/ghgemissions/Climate_Basics.pdf
YouthXchange: Climate Change and Lifestyles Guidebook ★★★	▪ Guidebook developed by UNESCO & UNEP for use by educators and/or youth (high school +) with a focus on the relationship between climate change and lifestyles ▪ Includes some introductory background information on climate change causes and effects, but majority of the guide is organized into sections (e.g., food, leisure and entertainment) that take readers through connections between actions and climate change- includes questions that could be used as starting points for discussions	http://unesdoc.unesco.org/images/0021/002128/212876E.pdf

DATABASES OF TEACHING RESOURCES

TITLE	BRIEF DESCRIPTION/FEATURES	ACCESS
Resources for Rethinking ★★★★★	▪ A large searchable database of lesson plans, curriculum units, and other teaching materials focused on themes related to sustainable development ▪ All resources have been reviewed by teachers and are connected to provincial curriculum outcomes ▪ Database is searchable by jurisdiction, grade level, subject area, and theme (including climate change) ▪ Project by Learning for a Sustainable Future	www.r4r.ca
Climate Energy & Energy Awareness Network (CLEAN) ★★★★★	▪ Website is organized into 7 essential principles of climate literacy, a guiding principle for informed climate discussions, and a principle for energy awareness ▪ Supporting concepts are provided for each principle, as well as information on teaching the principle (e.g., why it is important to teach, ways it can be challenging to teach, and ideas for integrating it into classroom teaching at different levels) ▪ For each principle, there is also a collection of downloadable teaching activities available (organized by middle school, high school, and college level) that have been reviewed by educators and scientists ▪ Part of the US' National Science Digital Library	http://cleanet.org/clean/literacy/index.html

LESSON PLANS, TEACHING UNITS, & OTHER CLASSROOM ACTIVITIES

TITLE	LEVEL	SUBJECT(S)	BRIEF DESCRIPTION/FEATURES	SOURCE	ACCESS
Climate Change ★★★★★	K-12	Interdisciplinary	▪ Stand-alone activities focused on science of climate change, as well as impacts, adaptations, and other actions ▪ Includes recommended grade levels for each activity (but no identified curriculum connections), step-by-step instructions, and student handouts (when required) ▪ Focus on critical thinking & active learning ▪ Most activities available in English and French	WildBC: 2008	http://wildbc.org/index.php/programs/climate-change-education/
Climate Change: Creating Solutions for our Future ★★★★★	4-6	Science	▪ Education kit containing 6 lessons (each made up of between 1-7 activities, with 2 suggestions for post-lesson activities) ▪ Very teacher-friendly resource: includes student materials, answers, short explanations, links to more information, etc. ▪ Variety of opportunities for interactive and hands-on learning experiences: e.g., students conduct surveys, participate in game shows, and carry out experiments ▪ Designed to meet science outcomes recommended by the Pan-Canadian Science Framework for Canadian Science Education	Alberta Government and USC Canada: 2004	http://environment.gov.ab.ca/info/library/5883.pdf
The Climate Change Action Pack ★★★★½	4-6	Interdisciplinary (science, social studies, math, etc.)	▪ Teaching supplement organized into 3 sections: Earth Sciences (10 lessons), Energy (5 lessons), & Habitat (7 lessons) ▪ Includes background checks for teachers, student materials, hands-on activities, and suggestions for additional activities ▪ NS curriculum links provided for lessons, NS-focused content (lessons are designed to be adaptable for Grade 4-6 students)	Scientists and Innovators in the Schools: 2002	http://atlanticsciencelinks.dal.ca/CCAP.pdf
Bringing Climate Change into the Classroom ★★★★★	4 7 10	Interdisciplinary (science focus) for Grade 4 & 7; Grade 10 science	▪ 3 separate teaching modules, each consisting of 7 lesson plans covering some basics of climate change science and projected impacts ▪ Teacher friendly: includes student materials, background info, step-by-step instructions for teachers ▪ NS curriculum outcomes are listed, and content is NS specific	Dalhousie University and Nova Scotia Education: 2011	http://climatechange.gov.ns.ca/files/04/21/ClimateChangeLessonPlans_Grade4_FINAL_July.pdf http://climatechange.gov.ns.ca/files/04/22/ClimateChangeLessonPlans_Grade7_FINAL_July.pdf http://climatechange.gov.ns.ca/files/04/23/ClimateChangeLessonPlans_Grade10_FINAL_July.pdf

Climate Change in Canada 	4-6 10-12	Science	▪ 7 exercises for junior students (Gr. 4-6) and 8 exercises for senior students (Gr. 10-12) ▪ Exercises are designed to be completed with the help of posters prepared by as part of the DNR's Climate Change in Canada poster series ▪ Exercises are fill-in-the-blank activities, in which students are required to locate information from the appropriate posters ▪ Answer keys are provided for download online ▪ Not particularly student-friendly	Natural Resources (DNR) Canada: 2010	http://www.nrcan.gc.ca/earth-sciences/climate-change/community-adaptation/poster/623 Note: The posters must be ordered from the DNR website
Earth Math 	4-12	Math	▪ Collection of 46 short activities (intended as supplements to lessons, i.e., extra challenges or enrichment activities) focused on climate change math problems ▪ Starts with table identifying topics and recommended grade levels for activities, also includes teacher's guide and answer key for each activity ▪ Activities involve real-world problems and often use real data	NASA: 2009	http://www.nasa.gov/pdf/470042main_Earth_Math.pdf
Canada's Forests: A Breath of Fresh Air – Vol. 2: Climate Change 	4-12	Interdisciplinary (language arts, math, science, geography, visual arts, etc.)	▪ Teaching kit consisting of 9 lessons and 2 pre-lesson activities ▪ Teacher friendly: includes background reading and material, student materials/handouts ▪ Focus on experiential learning – experiments, group art project, board game activity, debate, etc. ▪ Aimed at a national audience, so only includes broad grade level and subject categories	Canadian Forestry Association: 2001	http://www.canadianforestry.com/kits/english/Vol2_e.pdf/Vol2_e.pdf
Sustainable Schools 	6-8	Science and social studies	▪ Teacher's guide to school sustainability consisting of 5 modules, one on steps to sustainability and the others on waste generation, water usage, energy consumption, and schoolyard biodiversity ▪ Includes background info, student readings, and worksheets ▪ Specific curriculum outcomes (for New Brunswick) are identified for each student activity. Variety of types of activities, including calculating food miles, tracking home energy and water use, and constructing toilet dams and composters ▪ Specific NB curriculum outcomes are identified for each student activity, but can be adapted for NS	Falls Brook Centre (Community education and training centre):	http://www.fallsbrookcentre.ca/fbc/wp-content/uploads/2010/09/Sustainable-Schools-manual-FINAL.pdf

Climate Change: Connections and Solutions ★★★★★	6-8 9-12	Science and social studies	▪ Designed as 2-week units, but can be taught as stand-alone activities or units ▪ First week focuses on the science of climate change (including greenhouse effect and carbon cycle) and second week looks at connections between climate change and social, economic, and environmental factors ▪ Includes student materials and interactive and experiential activities ▪ Lists the National Science Education Standards addressed by each activity, but can be adapted for NS	Facing the Future: 2007	https://www.facingthefuture.org/Curriculum/PreviewandBuyCurriculum/tabid/550/List/1/CategoryID/16/Level/a/Default.aspx#.URvdnKWABpJ
Make the Link: Climate Change Learning Resources ★★★★	6-12	Interdisciplinary	▪ Learning resource pack consisting of 7 units; each unit contains activities that can be incorporated into 1-3 lesson plans ▪ International content and perspectives in some lessons (UK, Bulgaria, Senegal, Netherlands, Kenya, Malawi) ▪ UK curriculum connections, but with opportunities for focusing on local impacts and response ▪ High quality student materials, clear instructions, ideas for differentiation, intro with info for teachers, etc.	Plan UK: 2012	http://www.mtl-cec.org/fr/educators/uk-learning-resources.html
Thinking About Climate Change: A Guide for Teachers and Students ★★★	7-10	Interdisciplinary (humanities, science, math, IT)	▪ Based on Tim Flannery's *We Are the Weather Makers* (teachers will want at least one copy of the book, but do not require class sets, as some lessons are organized around readings) ▪ Resource organized according to disciplines: humanities (8 lessons), science (8 lessons), math (5 lessons), IT (2 lessons) ▪ Australian resource: links to Australian curriculum and some Australian content in lessons and student worksheets, but adaptable to NS	Purves Environmental Fund: 2007	http://www.theweathermakers.org/pdf/tacc.pdf