


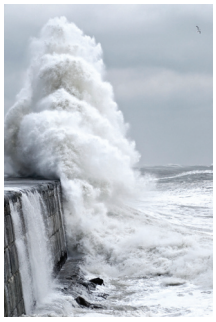
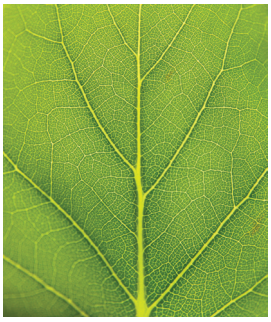

climate change for planning students

four-lecture module

CANADIAN INSTITUTE OF PLANNERS
INSTITUT CANADIEN DES URBANISTES

Foreward

This workbook and accompanying materials are a product of a collaborative process among the Canadian Institute of Planners, CitySpaces Consulting, Dr. Wayne Caldwell and several advisors. As principal authors, CitySpaces and Dr. Caldwell wish to acknowledge their sincere appreciation for the ongoing support and insightful feedback of their colleagues:

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Introduction

These four lecture components are directed to university-level planning students. Intended for insertion into an existing planning course, over a two- to four- week period, the lectures have been designed as four 90-minute sessions. For longer class periods, the proposed exercises may be integrated into class time, with more time allocated to the Discussion Q&A activities. For shorter classes (60 minutes), the instructor may choose to eliminate a section in each of the lectures.

Lecture titles and accompanying exercises are:

Lecture 1 | Introducing Climate Change: Causes, Indications, Key Voices, Impacts
Exercise: Walking Tour Field Trip and Report

Lecture 2 | Understanding How Climate Will Change, Potential Impacts & Vulnerabilities
Exercise: Assessing Impacts and Vulnerabilities

Lecture 3 | Responding to Climate Change
Exercise: Identifying Adaptation Strategies

Lecture 4 | Planners' Roles in Implementing Responses to Climate Change
Exercise: Climate Change Action Strategies

Each lecture will include most of the following sections:

- Learning Objectives
- Notes to Instructors
- Suggested Reading (intended preparation for the lecture. The instructor may choose among the recommended resources).
- Lecture Notes (for the instructor)
- Discussion Q&A (for discussion during class)
- Exercises (suited for completion out of class, or as an in-class facilitated exercise)
- In-depth Exploration (describes areas for optional further study, including resources)

Internet access is helpful to support the lecture material. Lecture 2, in particular, uses Google™ Earth interactively to stimulate discussion about the possible impacts of climate change.

This guide has been produced in grey-scale to maximize quality when printed or copied in black and white. A PowerPoint® presentation accompanies this guide, and includes all the images in full colour. There are no images for Lecture 4.

1

Introducing Climate Change: Causes, Indications, Key Voices, Impacts

Lecture 1 is an overview to get students thinking about how their own communities could be impacted by climate change. The learning objectives of this lecture are familiarization with:

- What climate change is;
- Causes and evidence for climate change;
- Potential impacts of climate change on the students' communities; and
- Key voices of climate change.

LECTURE 1 NOTES TO INSTRUCTOR

Lecture 1 consists of four sections, each addressing one of the learning objectives listed above. This lecture relies on a series of images to illustrate evidence of climate change and to stimulate discussion about potential impacts, so please ensure you have a projector available.

Lecture 1 includes two Discussion Q&A activities and an exercise (a walking tour). The notes can be presented relatively quickly, leaving time for the exercise. Alternatively, you may want to organize a longer field trip outside of class time.

We suggest drawing on local climate change experts to assist with this lecture and/or to accompany the class on the walking tour. You can find suggestions for finding a local expert at the end of the lecture notes.

LECTURE 1 SUGGESTED READING

What is climate change? and Climate Change Versus Weather:

- http://www.adaptation.nrcan.gc.ca/posters/cc_e.php
- http://www.nasa.gov/mission_pages/noaa-n/climate/climate_weather.html

IPCC Fourth Assessment Report: Synthesis Report: Summary for Policy Makers

- http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf

From Impacts to Adaptation: Canada in a Changing Climate 2007 Synthesis Chapter

- http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf

1.1 What is Climate Change?

Climate change means change in average weather conditions. These include temperature, wind patterns and precipitation. Statistics about increasing temperature and rising sea level are often presented as global averages. These changes will have an impact on natural and human systems, but the kinds of future climate changes we can expect in our communities will not only be felt as gradual increases; we are likely to experience more extremes in weather and more variability in the climate, including wider ranges of temperature or precipitation. We may even see rapid flips in climate.

The National Aeronautics and Space Administration (NASA) website does a good job of explaining the difference between "climate" and "weather". The link is included as a reading list resource for students. Some excerpts from the website are included below for easy reference.

> "The difference between weather and climate is a measure of time. Weather is what conditions of the atmosphere are over a short period of time, and climate is how the atmosphere behaves over relatively long periods of time.
>
> In most places, weather can change from minute-to-minute, hour-to-hour, day-to-day, and season-to-season. Climate, however, is the average of weather over time and space. An easy way to remember the difference is that climate is what you expect, like a very hot summer, and weather is what you get, like a hot day with pop-up thunderstorms.
>
> In addition to long-term climate change, there are shorter term climate variations. This so-called climate variability can be represented by periodic or intermittent changes related to El Niño, La Niña, volcanic eruptions, or other changes in the earth system".
>
> Source: NASA, "Climate and Global Change, Features: *What is the Difference Between Weather and Climate?*". Available at http://www.nasa.gov/mission_pages/noaa-n/climate/climate_weather.html

1.2 Causes and Indications of Climate Change?

This section examines some of the evidence that accelerated and unprecedented rates of warming are occurring, and the causes of these relatively rapid increases.

1.2.1 The earth's atmosphere is warming.

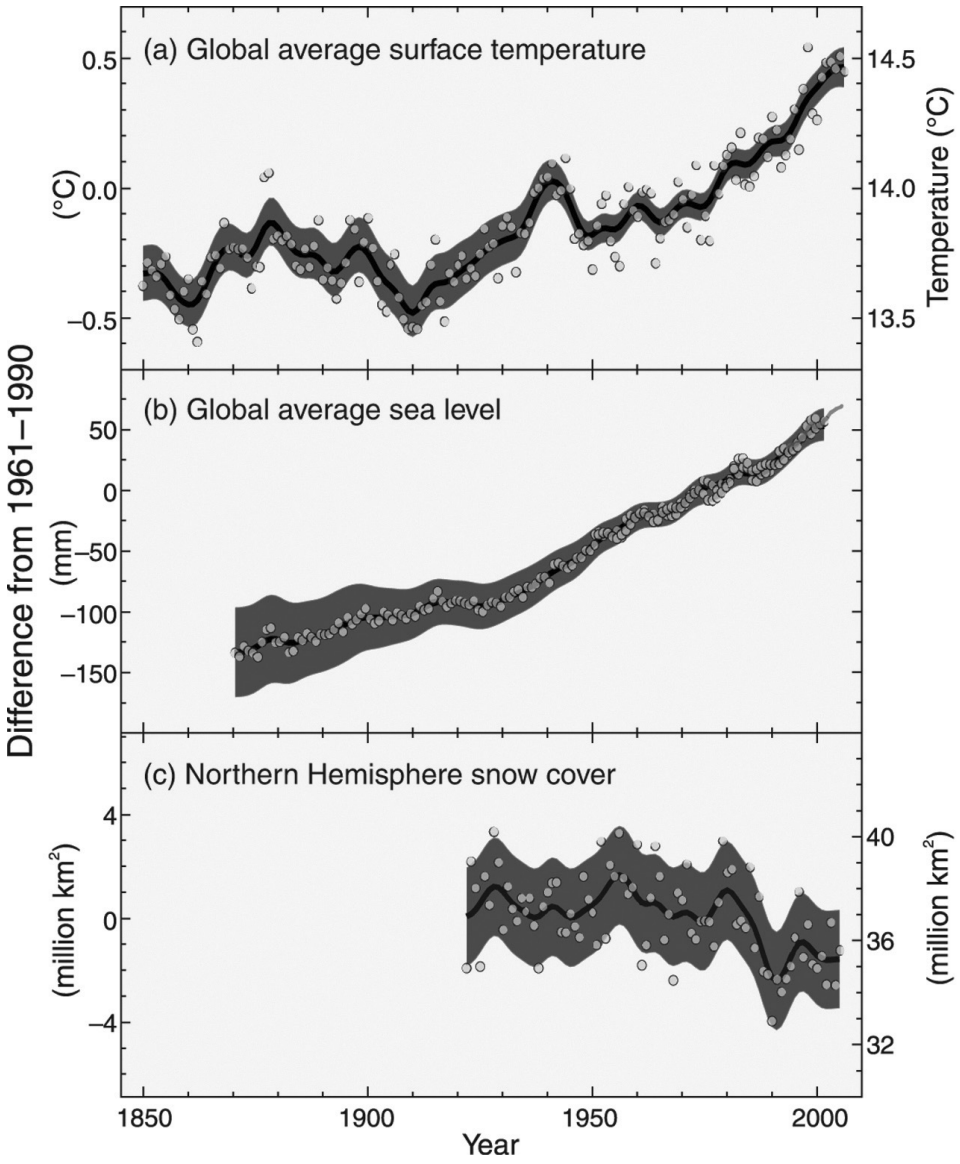
The earth's climate has always changed over its entire history; a result of such factors as changing energy output from the sun, volcanic eruptions, or movement of tectonic plates. However, the recent rates of warming are larger than can be explained by natural climate variability.

The following image illustrates the relatively rapid recent increase in global average temperature, as well as observed increases in sea level and decreases in snow cover. The Intergovernmental Panel on Climate Change uses this figure to provide evidence for its statement that "warming of the climate system is unequivocal"(IPCC 2007. Climate Change 2007: Synthesis Report. Summary for Policy Makers, p.2). The cited report provides further detail; excerpts from page 2 are included here:

- Eleven of the last twelve years (1995-2006) rank among the twelve warmest years in the instrumental record of global surface temperature (since 1850).
- Rising sea level is consistent with warming.

- Observed decreases in snow and ice extent are also consistent with warming.
- During the past 50 years, it is very likely that cold days, cold nights and frosts have become less frequent over most land areas, and hot nights have become more frequent.

Figure 1.1 Observed Changes in Temperature, Sea Level and Snow Cover



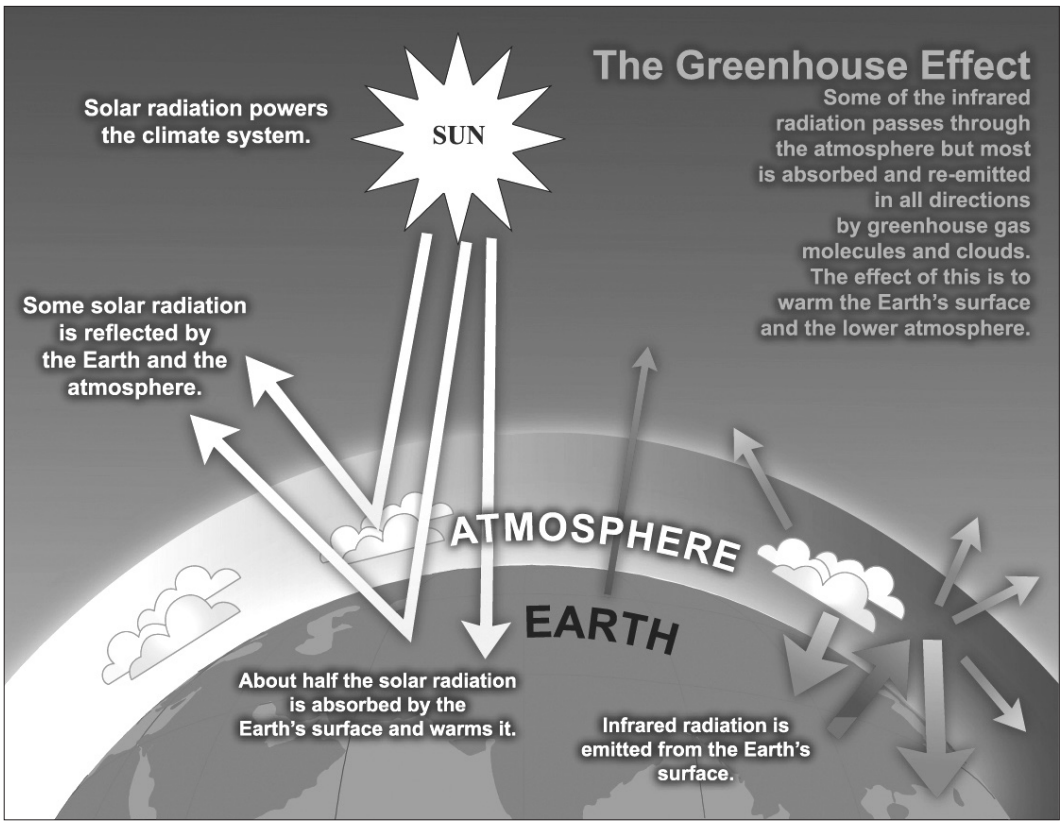
Source: IPCC, AR4 Synthesis Report Figure SPM1 is available at http://www.ipcc.ch/graphics/gr-ar4-syr.htm

Figure 1.1. shows observed changes in (a) global average surface temperature, (b) global average sea level from tide gauge (blue) and satellite (red) data, and (c) Northern Hemisphere snow cover for March-April. All changes are relative to corresponding averages for the period 1961–1990. Smoothed curves represent decadal average values, while circles show yearly values. The shaded areas are the uncertainty intervals.

1.2.2 Greenhouse Gas Build-Up Contributes to Global Warming

As greenhouse gases (such as carbon dioxide and methane), build up in the atmosphere, they act as a blanket, trapping reflected energy from the sun. This is a good thing, and is necessary to keep the earth warm enough for us to live. However, more and more greenhouse gases are being released into the atmosphere, causing the earth's temperature to increase at unprecedented rates. Measurements over the past century show the earth's temperature has risen by 0.7°C. Using computer-based climate models, scientists have determined that the earth could warm by 1.1 to 6.4°C over the next century.

Figure 1.2 Greenhouse Effect



Source: IPCC 2007. "Climate Change 2007. Assessment Report 4, Working Group 1, Historical Overview of Climate Change Science", FAQ 1.3, Figure 1.1. Figures are available at http://www.ipcc.ch/graphics/gr-ar4-wg1.htm

1.2.3 Global Averages and Varying Regional Impacts

These figures of projected temperature increase are global averages and, in reality, the effects of these changes will be felt differently, and more or less intensely, in different regions of the world. All parts of the earth are expected to warm, but those closer to the North Pole are expected to warm more intensely. Similarly, those regions close to the pole are expected to receive more precipitation, while those adjacent to the tropics are expected to see decreases. However, the tropics will experience more precipitation during the rainy seasons, in particular the tropical Pacific.

Geography also influences climate patterns. Interiors of continents are projected to warm more than the coastal areas. Precipitation is particularly sensitive to geographical influences, such as the

shape of nearby mountain ranges and wind flow direction. Scientific research on regional climate projections models is progressing so that increasingly the influence of regional features can be taken into account (IPCC, 2007. "Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the IPCC" [Solomon, S. et al (eds.)] Cambridge University Press, New York, NY, USA.)

In addition, changes will not always manifest themselves gradually, but often in intense weather events like more frequent severe storms.

1.2.4 Most of the current warming is due to human activities that release greenhouse gases into the atmosphere.

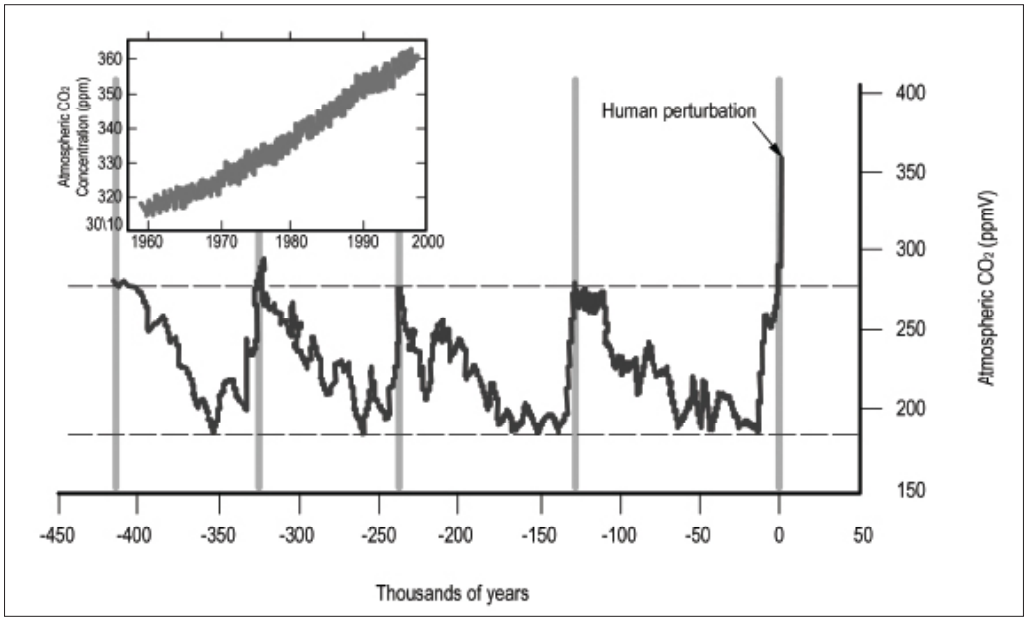
Scientists constructed a history of the amount of greenhouse gases in the atmosphere over the past 420,000 years. They measured the concentrations of gases, such as CO_2, in deep cores of ice taken from the Antarctic ice sheet.

The ice core records showed four climate cycles; four glacial-interglacial periods with lower CO_2 concentrations during the periods of glaciation.

Over the past 150 years, human perturbation, e.g., industrial development and intensification of agriculture, has produced significantly higher concentrations of CO_2 in the atmosphere than at any other time. (Source: http://www.in-cites.com/papers/Jean-RobertPetit.html)

The IPCC states that "most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic Greenhouse Gas (GHG) concentrations". (IPCC 2007. Climate Change 2007: Synthesis Report. Summary for Policy Makers, p.5).

Figure 1.3 Recent Human Influence on the Carbon Cycle

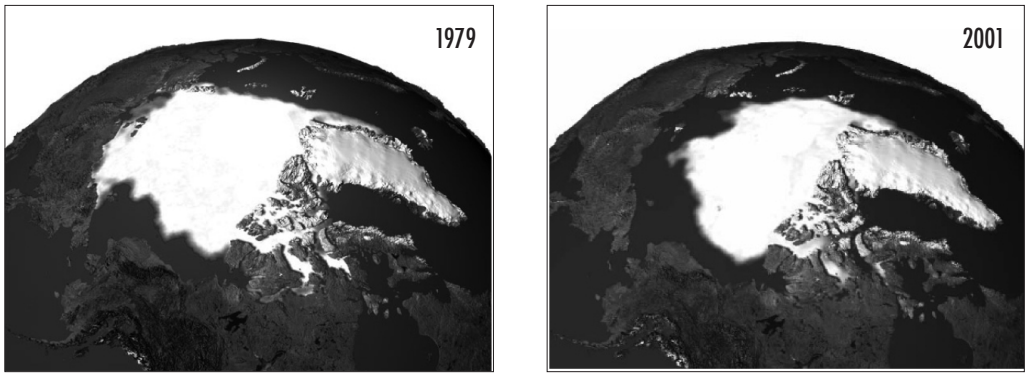


The diagram above shows the atmospheric CO_2 concentration from the Vostock ice core record, with the recent human perturbation superimposed. The inset shows the observed contemporary increase in atmospheric CO_2 concentration from the Mauna Loa (Hawaii) Observatory. Sources: Petit et al. (1999) Nature 399, 429-436 and National Oceanic and Atmospheric Administration (NOAA), USA.

1.2.5 Indications of Climate Change

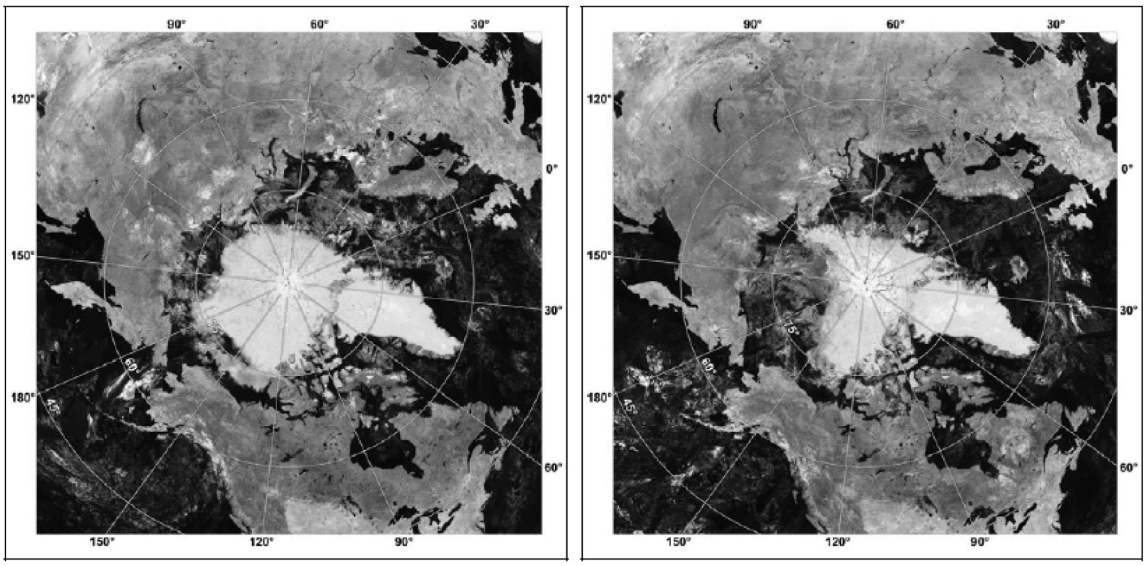
Until now, the Wilkins ice shelf (one of the largest in Antarctica) has been unthreatened by warming climate. It is now breaking apart. The loss of Wilkens is alarming given that its location is further south than previously lost ice shelves. It was considered to be better protected by colder temperatures (Source: guardian.co.uk, Wednesday, March 26th, 2008).

Figure 1.4 A 20% Reduction in September Sea Ice Cover Between 1979 and 2001.



Source: NASA/Goddard Space Flight Centre.

Figure 1.5. More recent, and dramatic, decrease in Arctic sea ice between 2006 and 2007.

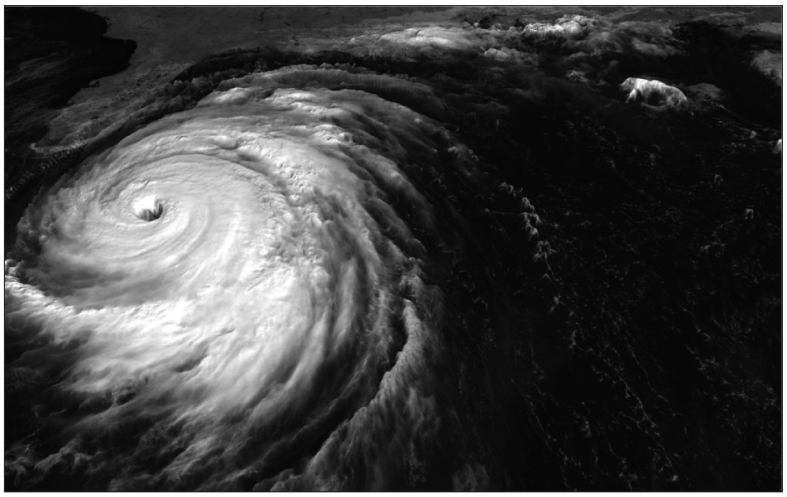


Source: MODIS satellite image composites, courtesy: A. Trichtchenko, NRCan.

Other indications of climate change have been observed in Greenland and the Western North Pacific. Between 1996 and 2005, Greenland experienced double the amount of historic ice loss (Fig. 1.6). Hurricane power has intensified, doubling over the past thirty years in the Western North Pacific. This is attributed to greater intensity and longer storms (Fig. 1.7).

Figure 1.6

Figure 1.7



1.3 The Impacts of Climate Change

Just as the climate will change dissimilarly throughout the country, these changes will impact different regions and communitues in disparate ways. Recent events, as illustrated in the accompanying images, give an idea of what we can expect to see more often.

Discussion Q&A – 1

Show the accompanying Powerpoint® presentation images, and engage students in discussion about how their communities could be impacted.

This is intended as an introductory exercise to get students thinking about how climate could affect their communities. Some students may not know how climate is expected to change in their regions, and may not be in a position to say how they will be impacted. Nevertheless, the images should spur initial thoughts that can be confirmed as their knowledge emerges. Depending on the success of this discussion, you may be able to use the outcome to organize the walking tour field trip exercise described below.

Some Key Voices of Climate Change

1. *Intergovernmental Panel on Climate Change (IPCC)*

A body of the United Nations, the IPCC provides decision-makers with an objective source of the latest scientific, technical and socio-economic information about climate change, and is generally considered the authority on the subject. The IPCC does not do research of its own, but bases its reports on the peer-reviewed work of hundreds of climate scientists around the world.

The IPCC and Albert Arnold (Al) Gore Jr. were awarded the Nobel Peace Prize in December 2007. Several scientists from Canadian universities and government departments contributed to the IPCC's award-winning work.

The IPCC has recently completed its Fourth Assessment Report entitled "Climate Change 2007", commonly referred to as *AR4*. The report, including a *Summary for Policy Makers*, is available at http://www.ipcc.ch/press/index.htm. Some of the key findings include:

- Given current mitigation policies and sustainable development practices, GHG (green house gas) emissions are expected to continue to grow over the next few decades;
- Continued GHG emissions, at current rates or higher, would induce changes during the 21st century that are very likely to be larger than those experienced during the 20th century;
- Global warming and sea level rise are projected to increase, even if GHG emissions were to be stabilized;
- Global average temperature is projected to rise anywhere from 1.1 to 6.4 degrees Celcius over the next century; and
- Sea level is projected to rise from 0.18 metres to 0.59 metres over the next century.

2. *Natural Resources Canada's (NRCan) Climate Change Impacts and Adaptation Directorate*

NRCan coordinated a nation-wide scientific assessment of climate change impacts and adaptation. This report, entitled "From Impacts to Adaptation: Canada in a Changing Climate 2007", is complementary to the IPCC's *AR4* Report, and discusses current and future risks, and opportunities that climate change presents to Canada. The report's national co-ordinator emphasized three important points:

- Warming of the climate is unequivocal;
- Adaptation is necessary, not an option; and
- Even those regions characterized by high incomes will be impacted.

The report highlights key issues facing each region of the country, and is intended to inform adaptation decision-making and policy development. It also provides examples of recent and ongoing adaptation initiatives. It can be found at http://adaptation.nrcan.gc.ca:80/assess/2007/index_e.php.

3. *Health Canada*

Health Canada will soon be releasing a health vulnerability assessment, a parallel study to NRCan's national climate change assessment.

4. *Stern Review on the Economics of Climate Change*

Sir Nicholas Stern wrote "The Stern Review on the Economics of Climate Change for the British Prime Minister and Chancellor" in 2006. The report assesses the impacts and risks arising from uncontrolled climate change, and the costs and opportunities associated with tackling it. Indicating that there is still time to avoid the worst impacts of climate change if we take strong action now, Stern estimates the costs of stabilizing the climate as roughly equal to 1% of world GDP, but warns that if we do not act now, climate change will cost the world the equivalent of 5%-20% of GDP every year, in perpetuity. The report can be found at:

http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/sternreview_index.cfm

5. *UK Climate Impacts Programme*

UK Climate Impacts Programme, commonly known as UKCIP, is a valuable and current source of information about climate projections and impacts, and strategies for local governments to respond to them. UKCIP is funded by the UK Department for Environment, Food & Rural Affairs (Defra) and is based at the University of Oxford. A rich array of information and resources are available at http://www.ukcip.org.uk, including:

- An "Adaptation Wizard" that guides users through the process from simple understanding of climate change to integration of climate change into decision-making;
- Maps showing projected climate changes in the UK; and
- A database of adaptation case studies, and presentations made by local governments, at a January 2008 workshop on local climate impacts, profiles and adaptation strategies.

6. *ICLEI (International Council for Local Environmental Initiatives) – Local Governments for Sustainability*

ICLEI – Local Governments for Sustainability is an international organization of more than 470 member cities, towns, and countries that have made a commitment to sustainable development. ICLEI – Canada has partnered with NRCan to pilot test an adaptation planning guide, entitled "Preparing for Climate Change: A Guidebook for Local, Regional and State Governments" that was produced in conjunction with University of Washington and King County, Washington. They will be working with Canadian municipalities to develop a supplement to the guide that addresses Canadian-specific issues. For more information go to http://www.iclei.org/index.php?id=7289&tx_ttnews[backPid]=7286&tx_ttnews[tt_news]=2415&cHash=27f5f79fb3.

7. *The Partners for Climate Protection (PCP) Program*

The Federation of Canadian Municipalities (FCM) has partnered with ICLEI to develop "The Partners for Climate Protection" (PCP) program. The program is a network of 155 Canadian municipal governments that have committed to reducing greenhouse gases and acting on climate change, with an emphasis on mitigation responses that reduce greenhouse gas emissions. PCP is the Canadian component of ICLEI's Cities for Climate Protection (CCP) network, comprising more then 800 communities world-wide. For more information go to http://www.sustainablecommunities.fcm.ca/Partners-for-Climate-Protection/.

Discussion Q&A - 2

Engage students in discussion of these key voices, by asking, for example:

- Are you familiar with these organizations?
- Are there any others that you would add to the list?

LECTURE 1 EXERCISE

Walking Tour Field Trip

The notes for Lecture 1 can be presented relatively quickly, leaving time for a walking field trip. Alternatively, you may want to organize a longer field trip outside of class time.

Organize a walking tour in your community. If possible identify a climate scientist in your area to help identify areas of vulnerability, and to possibly accompany the class on the walking tour. Check with university departments, local Natural Resources Canada (NRCan) offices, regional climate centres, or provincial government departments for scientists working in the areas of climate change projections, impacts and adaptation. Also refer to the recent NRCan assessment report, "From Impacts to Adaptation: Canada in a Changing Climate 2007". There are many authors for each of the regional chapters. Contact these authors to ask about a climate researcher in your area.

Aim to identify ten impacts likely to be brought about by climate change. Have the students identify these and write about how the community might be impacted, including some thoughts about which social, environmental and economic systems could be affected and how. Have them also begin to think about how planners' roles and activities could be affected, if they have acquired enough knowledge about this to date in their studies.

Alternatively, create teams of three to four students to do the walking tour outside of class time. Have the students prepare a report that can be graded.

2

Understanding How Climate Will Change: Potential Impacts and Vulnerabilities

Climate change planning is a new area for most Canadian planners. It involves familiar processes, but introduces a whole new gamut of information. Planners will be faced with accessing relevant, credible information on which they can base decisions and develop action strategies. Right now, there is no single, one-stop shop where local governments can find information to support their mitigation or adaptation planning activities. Local governments must rely on a range of resources from different sources.

This lecture discusses how climate will change, and the potential impacts and vulnerabilities of these changes, emphasizing the resources needed to understand climate change in a particular community. The learning objectives of this lecture are familiarization with:

- Climate change projections, including models and science, that describe how climate will change in a community or region;
- Possible climate change impacts and relevant sources of information;
- Potential vulnerabilities of Canadian communities and relevant sources of information.

LECTURE 2 NOTES TO INSTRUCTOR

This lecture consists of three sections, each addressing one of the learning objectives above.The exercise is intended for outside of class time, but it will be helpful to review during class.

As an addendum to this lecture, one subject area related to global climate models is treated in more detail – "Understanding Emissions Scenarios". This area is optional and would require a class longer than 90 minutes to include as part of the lecture. Alternatively, it may be used to introduce an exercise that students complete outside of class time.

Ideally, use a venue with internet access; exploring the links is a good way to investigate the resources with the students. In addition, it is helpful to have hard copies of the assessment reports on hand, and/or use a live link to illustrate the content of the document.

LECTURE 2 SUGGESTED READING

From Impacts to Adaptation: Canada in a Changing Climate 2007. Choose the regional chapter that covers your geographic location. Available at http://adaptation.nrcan.gc.ca/assess/2007/index_e.php

Climate Change 2007: Special Report Emissions Scenarios: Summary for Policy Makers. Available at http://www.ipcc.ch/pdf/special-reports/spm/sres-en.pdf and http://www.ipcc.ch/ipccreports/special-reports.htm

Field, C.B. et al. 2007. *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Chapters 7 and 14, which explore the impacts on industry, settlement and society and on North America. Available at http://www.ipcc.ch/ipccreports/ar4-wg2.htm

2.1 How Will Climate Change? — Climate Change Projections & GCMs

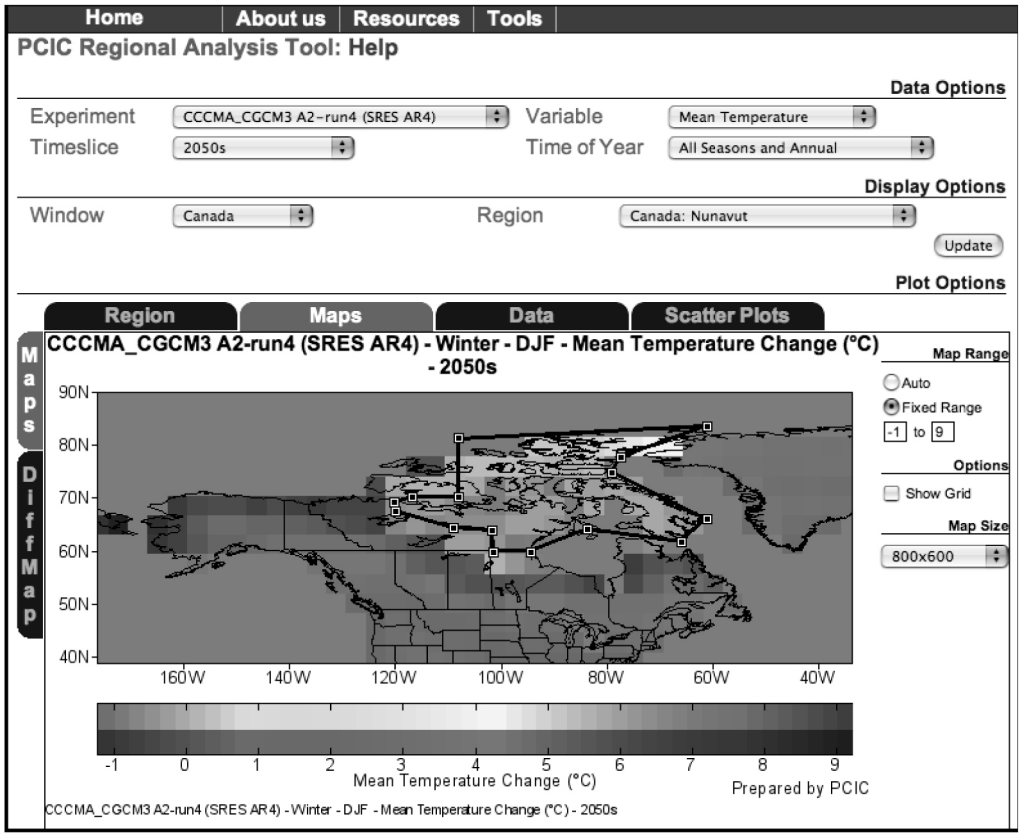
To understand how climate will change in your region, it is important to obtain future climate change projections. Climate scientists use sophisticated computer models called Global Climate Models or GCMS to project future climate changes.

2.1.1 Global Climate Models (GCMs)

Global Climate Models are complex computer representations of the earth's climate systems that project change over the next century. The models take into account atmosphere, land surface and oceanic physical processes to provide information about future climate impacts, including changes in temperature, sea level rise and precipitation.

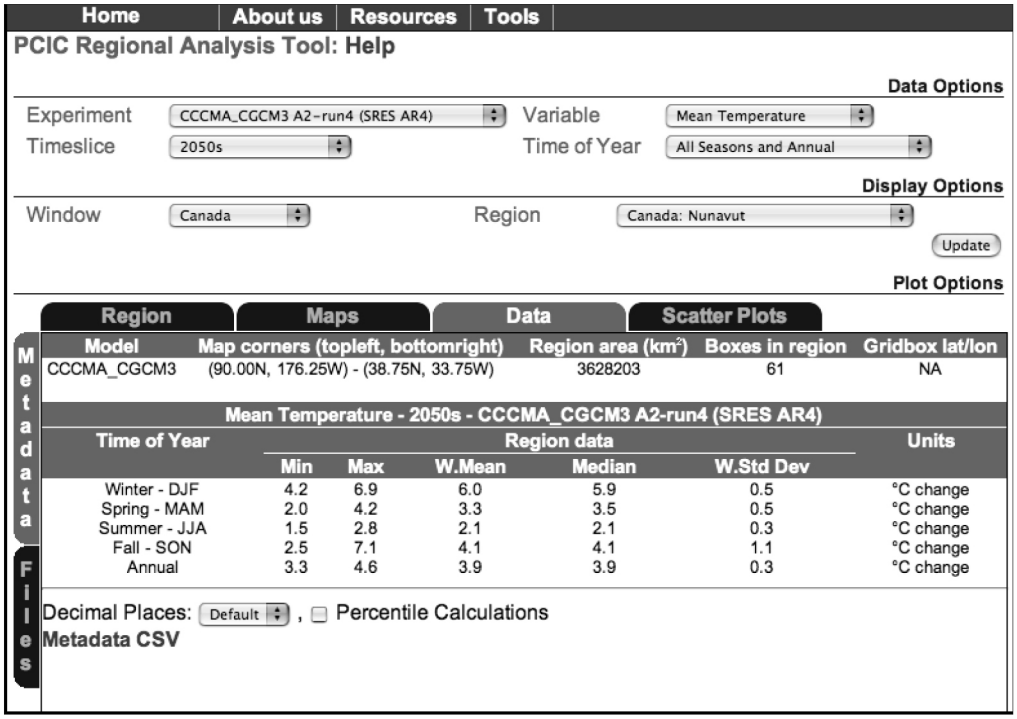
GCMs generate projections using different emissions' scenarios, incorporating information about the future composition of the atmosphere, which depends on population growth, economic activity and the use of energy and technology — ultimately, how much greenhouse gas we are likely to emit. For example, one scenario recommended by the IPCC is characterized by very rapid economic growth, global population peaking around 2050 and rapid introduction of new technologies[1]. See "In-Depth Exploration 2A" at the end of the lecture notes for more information about emissions' scenarios. Figures 2.1 and 2.2 show sample outputs from global climate models, including a map a data table.

Figure 2.1 Global Climate Model Output – Map of Change In Winter Temperature Projected For Nunavut From 2035-2065



[1] Warren, F.J. and Egginton, P.A. (2008): Background Information; in "From Impacts to Adaptation: Canada in a Changing Climate 2007", edited by D.S. Lemmen, F.J.Warren, J. Lacroix and E. Bush; Government of Canada, Ottawa, ON, p. 27-56

Figure 2.2 Global Climate Model Output – Data Table Describing Change In Temperature Projected For Nunavut From 2035-2065, Annually and All Seasons



Home | About us | Resources | Tools

PCIC Regional Analysis Tool: Help

Data Options

Experiment: CCCMA_CGCM3 A2-run4 (SRES AR4) | Variable: Mean Temperature

Timeslice: 2050s | Time of Year: All Seasons and Annual

Display Options

Window: Canada | Region: Canada: Nunavut

Update

Plot Options

Region | Maps | Data | Scatter Plots

Metadata | Files

Model	Map corners (topleft, bottomright)	Region area (km²)	Boxes in region	Gridbox lat/lon
CCCMA_CGCM3	(90.00N, 176.25W) - (38.75N, 33.75W)	3628203	61	NA

Mean Temperature - 2050s - CCCMA_CGCM3 A2-run4 (SRES AR4)

Time of Year	Region data					Units
	Min	Max	W.Mean	Median	W.Std Dev	
Winter - DJF	4.2	6.9	6.0	5.9	0.5	°C change
Spring - MAM	2.0	4.2	3.3	3.5	0.5	°C change
Summer - JJA	1.5	2.8	2.1	2.1	0.3	°C change
Fall - SON	2.5	7.1	4.1	4.1	1.1	°C change
Annual	3.3	4.6	3.9	3.9	0.3	°C change

Decimal Places: Default , Percentile Calculations

Metadata CSV

2.1.2 Regional Climate Models (RCMs)

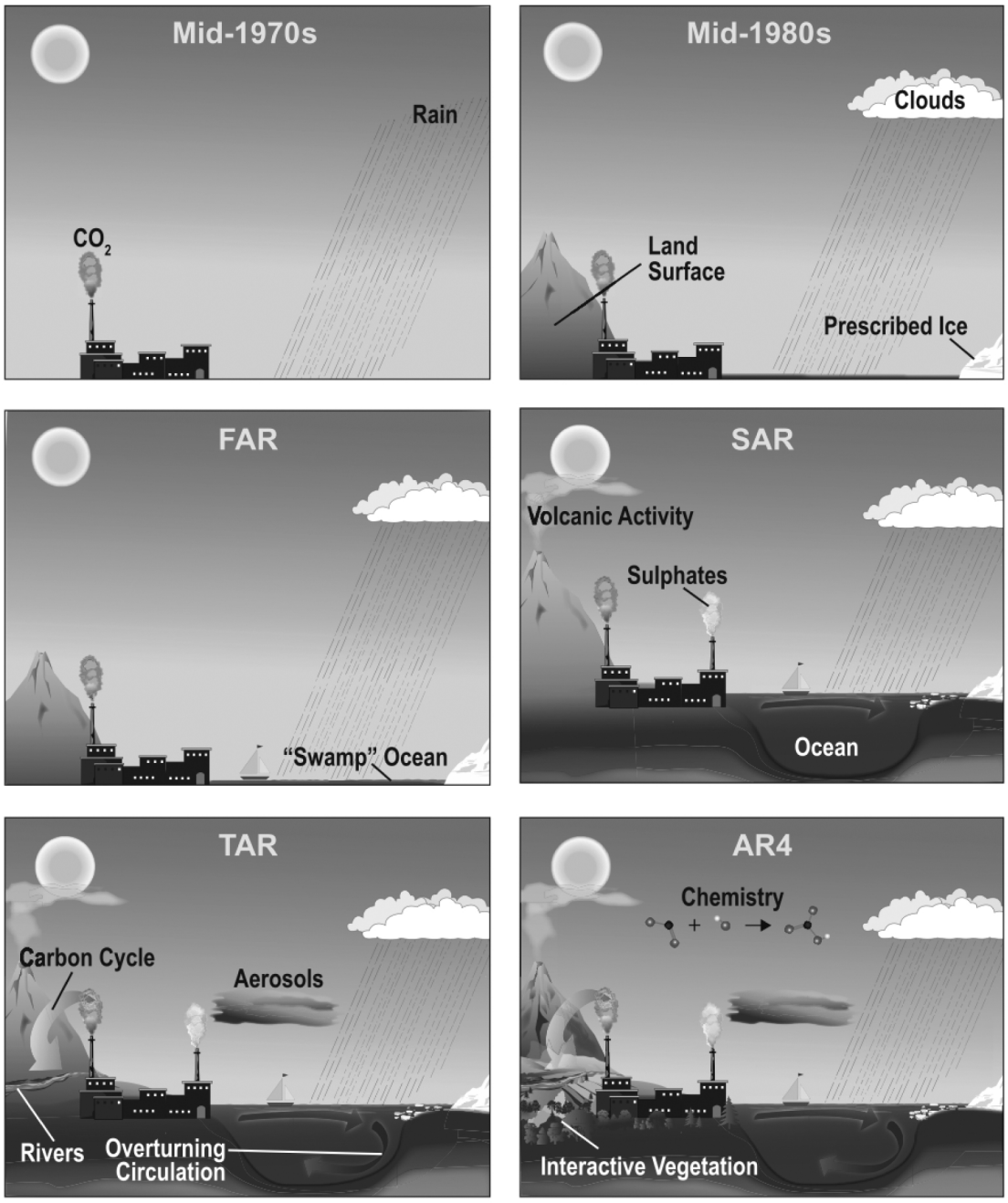
Regional Climate Models take into account geographic features, such as mountains, and provide climate projections at a finer scale – typically 50 km. This more detailed analysis – compared to 300 km for GCMs – makes these models better for assessing how climate change projections may be distributed within a region. However, they do have some limitations. Fewer regional models have been developed and are currently only available for a limited number of emissions' scenarios. They do not provide as wide a range of possible projection scenarios as the global models[2].

2.1.3 Evolving Climate Models

Global climate models have become more sophisticated over the last few decades, factoring a greater number of elements into climate projections. As the IPCC assessment reports have evolved, they have reviewed increasingly complex climate models. Figure 2.3 graphically illustrates the evolution of the models from the 1970s and 1980s to the First Assessment Report (FAR) in 1990, the Second Assessment Report (SAR) in 1995, the Third Assessment Report (TAR) in 2001 and the most recent report (AR4) released in 2007. Note that the more recent effects include ocean circulation, the effects of aerosols and the effects of interactive vegetation.

[2] Warren, F.J. and Egginton, P.A. (2008): Background Information; in "From Impacts to Adaptation: Canada in a Changing Climate 2007", edited by D.S. Lemmen, F.J.Warren, J. Lacroix and E. Bush; Government of Canada, Ottawa, ON, p. 27-56

Figure 2.3 The World in Global Climate Models



Source: IPCC 2007. "Climate Change 2007 - The Physical Science Basis, Contribution of Working Group I to the Fourth Assessment Report of the IPCC", Chapter 1 Final Figures.

2.1.4 Obtaining Local Climate Change Projections – Online Tools

Climate models are available online, but are generally not presented for easy consumption. The University of Victoria's Pacific Climate Impacts Consortium (PCIC) hosts a Regional Analysis Tool that provides temperature, precipitation, snow depth change and other projections. It has been designed for use by climate scientists rather than a public audience, but with a few guidelines you can find out about future climate in your area. This link connects you with a help page to guide you through the process: http://pacificclimate.org/tools/regionalanalysis/.

2.2 Climate Change Impacts and Related Information Sources

Some projections data is difficult to obtain. For example, there is currently no one-stop shop for sea level change data in Canadian communities. Also, there is a need to add meaning to the climate change projections numbers; we need to know what these numbers mean for our own communities and how projected climate changes will impact on them. There are good sources of projections that also provide descriptive information about the context and potential impacts related to the projected climate changes. Assessment reports, case studies and checklists are some of the additional resources worth exploring.

Begin by considering the potential impacts in your community using this checklist.

SAMPLE OF SECTORS AND POTENTIAL CLIMATE CHANGE IMPACTS Adapted from "Preparing for Climate Change: A Guidebook for Local, Regional and State Governments".
ENVIRONMENTAL IMPACTS
Biodiversity
• Shift in the distribution and range of species • Loss of species not able to adapt to changes • Increased competition from invasive species • Loss of habitat
Aquatic Ecosystems
• Shifts in species range and distribution • Increased competition from invasive species • Loss of near-shore habitat and coastal wetlands to sea level rise • Increased stress on coldwater species in lakes and rivers
Forests (including parks and urban forests)
• Increase in growth & productivity in the near-term where soil moisture is adequate and fire risk is low • Shift in the distribution and range of species; increased competition from invasive species • Increased risk of insect outbreaks • Increased risk of forest fire

ECONOMIC IMPACTS
Business
• Price volatility in energy and raw product markets due to more extreme weather events • Increased insurance premiums due to more extreme weather events • Fewer shipping disruptions associated with snow and ice • Impacts on business infrastructure located in floodplains or coastal areas
Recreation
• Increased opportunities for warm season activities in milder regions • Decreased opportunities for warm season activities during the hottest part of the year, (e.g., heat, forest fires, low water levels, reduced urban air quality) • Reduced opportunities for cold season recreation – decreased snow pack, reduced snow or ice quality • Shifts in tourism dollars from one recreation sector to another, or from community to community
Agriculture
• Changes in crop yields (varies by crop)and potential ability to "double crop" • Increased risk of heat stress • Increased demand for irrigation water due to longer and warmer growing season • Increased risk of pest outbreaks and weeds • Potential ability to grow new warmer weather crops
Forests (including parks and urban forests)
• Increase in growth & productivity in the near-term where soil moisture is adequate and fire risk is low • Shift in the distribution and range of species • Increased risk of insect outbreaks • Increased risk of forest fire • Increased competition from invasive species
SOCIAL IMPACTS
Health
• More heat-related stress, particularly among the elderly, the poor and other vulnerable populations • Fewer extreme cold-related health risks • Increase in vector-born illnesses (e.g., West Nile) • Reduced summer air quality in urban areas due to increased production of ground-level ozone • Compromised water quality

PHYSICAL INFRASTRUCTURE IMPACTS – with implications for financial and social disruption
Energy
• Reduced heating demand during winter months • Increased cooling demand during summer months • Increased or decreased hydroelectric generating capacity due to potential for higher or lower stream flows
Transportation
• Fewer travel disruptions, and lower maintenance and infrastructure costs associated with snow and ice • More travel disruptions associated with landslides, road washouts and flooding • Increased road surface damage from higher temperatures • Potential reductions in water-based navigation due to lower summer streamflows • Increased maintenance requirements for roadside and median strip vegetation • Increased brush fires in roadside and median strip vegetation
Infrastructure
• Need for new or upgraded flood and erosion control structures • More frequent landslides, road washouts and flooding • Increased demands on storm water management systems, with the potential for more combined storm water and sewer overflows • Reduced effectiveness of sea walls with sea level rise
Emergency Response
• Increased demands on emergency response services related to extreme weather events (e.g., heat, flooding, storms)
OTHER IMPACTS?

Discussion Q&A – 1: Fun with Google™ Earth

If you have an internet connection, ask students to suggest a location and find it using Google™ Earth. Ask the class how climate will change in this location and what the impacts might be. Change the scale – zoom in – and ask the same question. By seeing more detail at a bigger scale, the discussion may reveal new answers.

Assessment Reports

Two widely-respected resources by the Intergovernmental Panel on Climate Change (IPCC) and Natural Resources Canada (NRCan) are described below. The reports review scientific research from years prior to their publication, creating a lag time and information that soon becomes out of date. The most recent data indicates that the actual trends for temperature change, CO_2 concentration and sea level rise are at the high end of the range that is projected by IPCC's Fourth Assessment Report (AR4). Recent observations suggest that AR4 underestimates the rate at which change is actually happening.

1. *The Intergovernmental Panel on Climate Change (IPCC)* is considered to be the leading authority on climate change, producing four reports that assess the state of climate change science, based upon peer-reviewed published work. The fourth and most recent IPCC Assessment Report entitled "Climate Change 2007" (AR4), indicates that:

   "Warming is unequivocal, and most of the warming of the past 50 years is very likely (90%) due to increases in greenhouse gases".

   Chapters 7 and 14 of this report explore the impacts on industry, settlement and society, and on North America. The chapters are available at http://www.ipcc.ch/ipccreports/ar4-wg2.htm

2. *Natural Resources Canada (NRCan)* has completed its own assessment report entitled "From Impacts to Adaptation: Canada in a Changing Climate 2007". It is a national study that discusses current and future risks and opportunities that climate change presents to Canada, with a focus on human and managed systems. There are regional chapters that describe the anticipated climate changes and related impacts in six regions of Canada, including Northern Canada, Atlantic Canada, Quebec, Ontario, the Prairies and British Columbia. The report is available at http://adaptation.nrcan.gc.ca/assess/2007/index_e.php. Individual regional chapters can be downloaded, as well as the synthesis chapter.

Case Studies

Case studies give insights into how municipalities may be impacted by climate change, and how they have developed adaptation strategies. Two sources of case study information are described below, including NRCan's work on five Canadian municipal case studies, and the UKCIP's database – the Base for Research, Adaptation, Impacts and News (BRAIN).

1. *NRCan Municipal Case Studies*

NRCan has funded research on municipalities and their adaptations to climate change. In conjunction with the Canadian Institute of Planners (CIP), NRCan has produced plain language summaries of these case studies. The case studies include research and its relevance to planners, and specifically describe the effects of climate change on five Canadian communities, including:

- Calgary – Warmer weather and changing precipitation patterns are affecting the city's sole water supply;
- Salluit, a northern Quebec coastal community – Rapidly melting permafrost is threatening to undermine existing infrastructure;

- Delta, Graham Island (BC), and the New Brunswick coast in the Gulf of St. Lawrence – Rising sea levels, and increased storm frequency and severity are impacting habitats, property and infrastructure.

The case studies can be accessed at http://www.cip-icu.ca/web/la/en/pa/FDD921FC64CB4439A096528BFD59E779/template.asp.

2. *UK Climate Impacts Programme Database of Case Studies*

The UKCIP website is an excellent source for climate change resources geared to local governments. Its searchable databases now include the Base for Research, Adaptation, Impacts and News, referred to as the BRAIN. It is an extensive collection of research activities, adaptation actions, impacts of climate/weather and news of general climate change activities, divided into four categories:

- Adaptation Actions
- Impacts of Climate Change/Weather-related Events
- Research Activities
- Climate Digest

The BRAIN is located at http://www.ukcip.org.uk/index.php?option=com_content&task=view&id=226&Itemid=324

Discussion Q&A – 2

Talk about these resources with the group. The following questions are provided as a guide:

- Are you familiar with any of the resources mentioned above?
- Do you know of other resources you would like to share with the group?

2.3 Understanding Vulnerability

The information described above will help you do a preliminary scoping of climate change impacts. Once you have done this, delve a bit deeper – Who will be impacted? Which impacts present the greatest vulnerabilities in the face of climate change?

2.3.1 Who and What Will Be Impacted?

Consider who and what will be directly affected by the impacts. These might include:

- Individuals and groups of people, e.g., waterfront homeowners, farmers, or seniors living in their own homes;
- Infrastructure;
- Ecosystems;
- Land; or
- Businesses.

2.3.2 Vulnerability

Describe the vulnerability associated with particular climate impacts, using the following questions as guides:

- How difficult will it be for vulnerable groups and systems to respond or adapt to the change(s)?
- Are disadvantaged groups likely to be more adversely affected?
- Are fragile natural systems likely to be irreparably damaged?
- Does the community have resources and capacity to respond?

LECTURE 2 EXERCISE:
Assessing Impacts and Vulnerability

This would work well as a small group exercise. The goal is to develop an impact assessment of a community that includes climate change projection information, as well as analysis of the risk and vulnerability of the community involved. Students could choose to examine the community where they are studying (following up on the walking tour exercise done as part of Lecture 1). Alternatively, they may choose to study another community.

To help identify projected climate changes, review the relevant chapters from the national assessment, "From Impacts to Adaptation: Canada in a Changing climate 2007". Another option to help determine projected changes for a particular region is the PCIC Regional Analysis Tool described in Section 2.1.4. Explanatory notes for using the PCIC tool are included at the end of this exercise.

The worksheets at the end of this lecture can be used to document the exercise. Prepare a brief report on the findings, using the tasks below as a guide.

Scenario

You are a planner in a local government. You have been asked to prepare a report on the key climate change-related issues affecting, or likely to affect, your community and require action. Consider that you may have to convince nonbelievers that climate change is an issue, and that information is likely targeted to a generalist audience, needing relevant and compelling examples to make the science and numbers meaningful.

Tasks

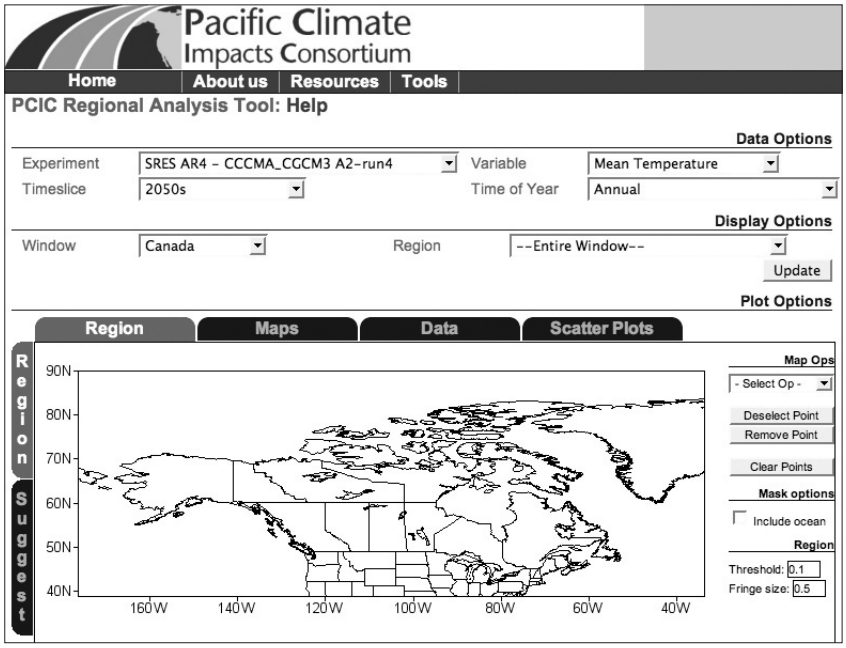
1. Paint a picture of the two or three most pressing climate impacts and issues in your community, using the following framework to describe the information:
    - Your community, including geographic location, approximate size, rural/urban setting;
    - Relevant climate variables, the projected changes for the variables (increase/decrease and by how much), and any information about the projections you can find (e.g. seasonal differences, ranges of projections, source of projections information);
    - The story of how these climate changes can potentially impact your community, including who and what systems will be impacted, and new opportunities that may arise;
2. Describe how the community could be vulnerable in the face of climate change by describing:
    - Areas of planning that are impacted;
    - How vulnerable impacted systems would be in the face of these climate changes.
3. Discuss any challenges you had in accessing information about projections and impacts.

Explanatory Notes for PCIC Regional Analysis Tool

The following notes provide guidelines to using PCIC's Regional Analysis Tool for identifying climate change projections for your region.

Opening Page

This is the opening page of PCIC's Regional Analysis Tool. Note that there are a number of options to help customize the search for information. The user chooses these in the Data Options section. Note also, that the Region tab is selected in the output display towards the bottom of the page.



Experiment

The first choice for the user is Experiment. The drop down menu contains a list of all the climate models that have been run to generate projections. In general, the naming convention is:

- First part of name = the modelling centre that created the model
- Second part of the name = the name of the model
- Third part of the name = the IPCC scenario (the particular run of the model)

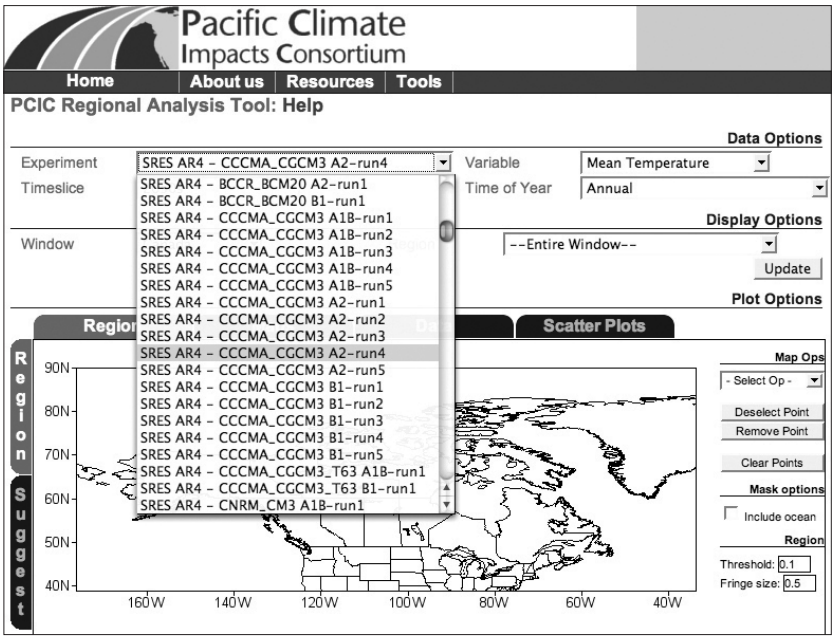
The page shows one experiment highlighted, the CCCMA_CGCM3 A2-run4.

This choice will generate a single projection using the Canadian Centre for Climate Modelling and Analysis' model called the "Canadian Global Climate Model 3", the fourth run of the model. It is projection based upon a high emissions scenario.

This Canadian model will reflect more closely Canadian features than other models in the list, such as the UK or Germany. The UK's models are identified by HADCM3 or UKMO_HADCM3, and the German models by ECHAM. American models include the NCAR and GFDL series.

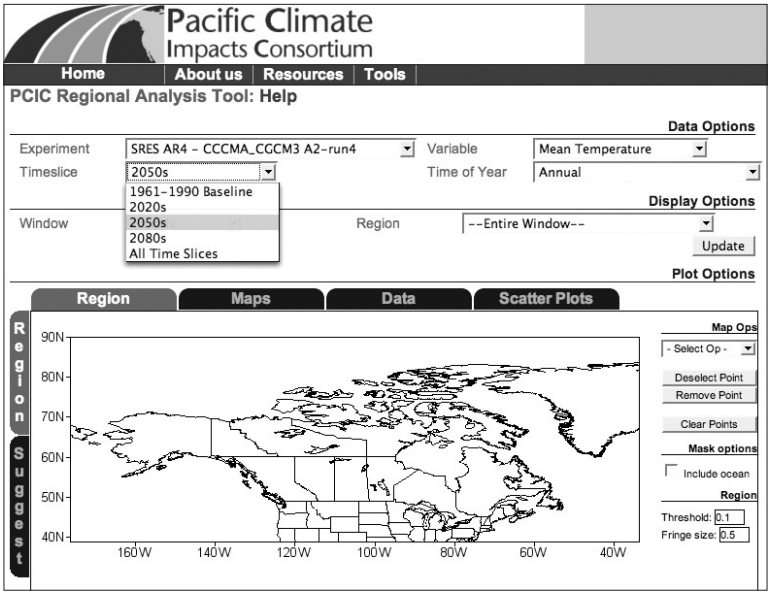
Also in the Experiment list is a choice called "PCIC A2 + B1". This choice will deliver 30 projections, 15 based on an A2 high emissions scenario, and 15 based on a B1 low emissions scenario. By looking at the output of all model runs, you will have a range of possible climate

change projections that reflect a low to high emissions scenario, and roughly suggest a worst/best case projection picture.



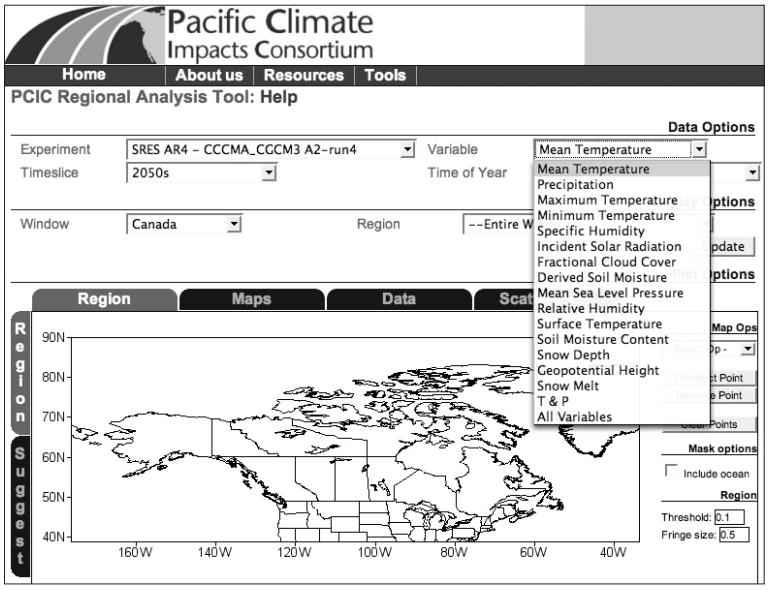
Choosing the Timeslice

The 1961-1990 selection gives you historical climate data. The other time choices are for future projections. These "time slices" are just that – a 30-year slice of time with the named decade in the middle. For example, the 2050s timeslice includes a time period from 2035 to 2065.



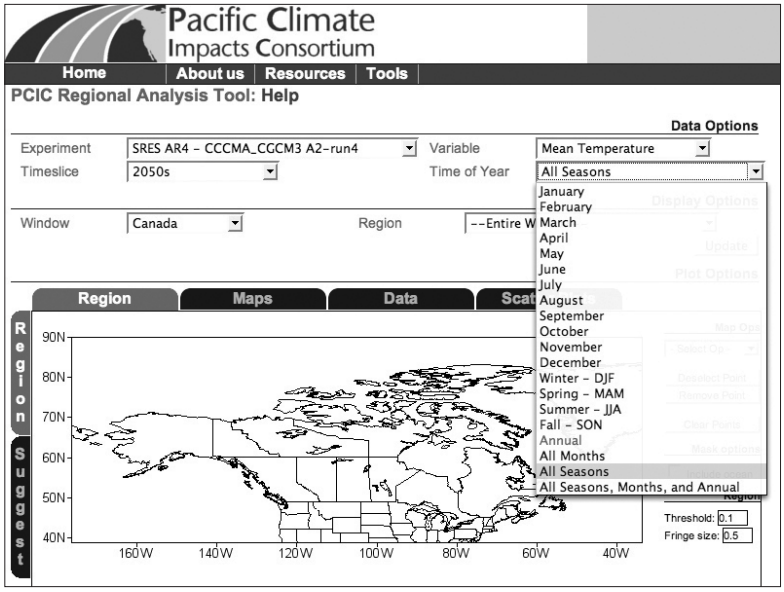
Choosing the Climate Variable

A range of climate variables is possible. Those most commonly used are temperature, precipitation, snow depth and snow melt. Note that sea level rise is not currently available.



Choosing Time of Year

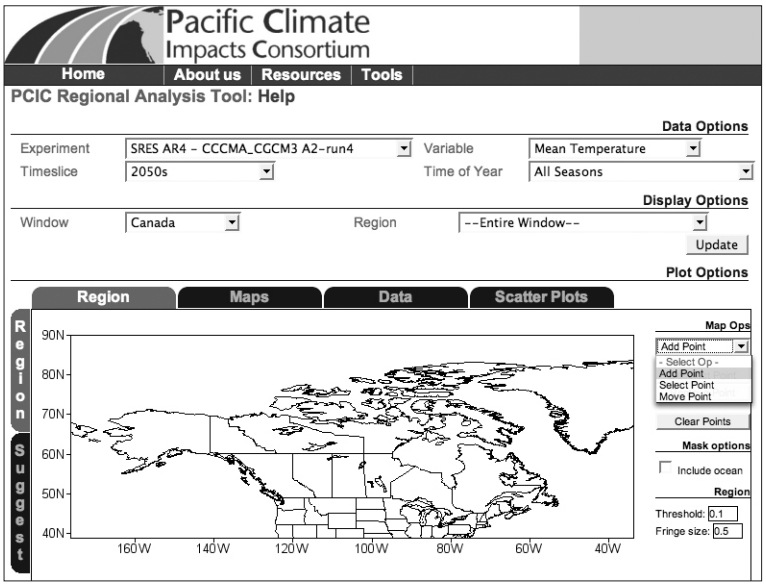
It is important to know about the seasonal changes in climate variables. Precipitation may be projected to increase in winter and decrease in summer, requiring different adaptation responses. The screen shot shows all seasons selected.



Choosing the Display Options

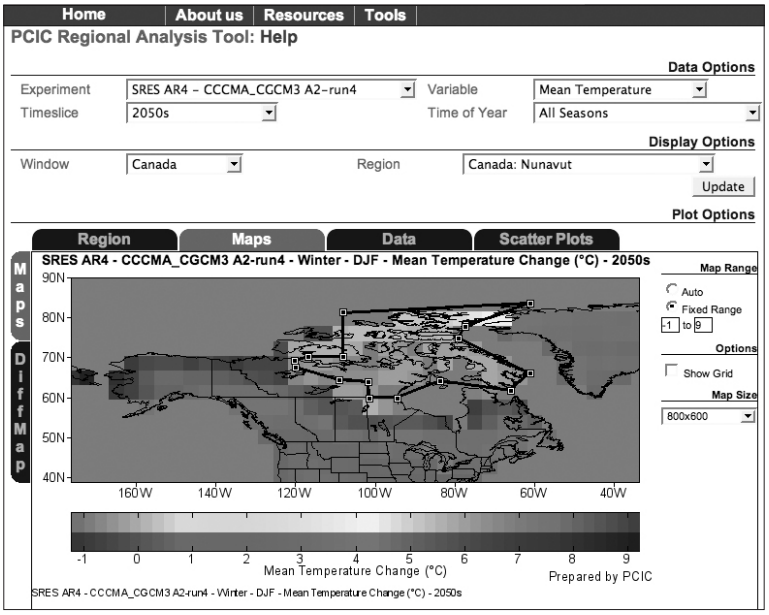
- Window – Allows you to choose the area displayed in the Map window.
- Region – The region for which the projections are generated.

Note that the user can define a custom region, by using the Select Op drop-down menu to the left of the screen and choosing Add Point to define the desired area.



Choosing the Plot Options

There are several options for displaying, or plotting, the projections data, including maps, line graphs, box plots and data tables. One of the data output, or "plot" options (as named in the PCIC tool), includes coloured maps. In this screenshot, the map shows projected temperature change for Nunavut for the 2050s timeslice.

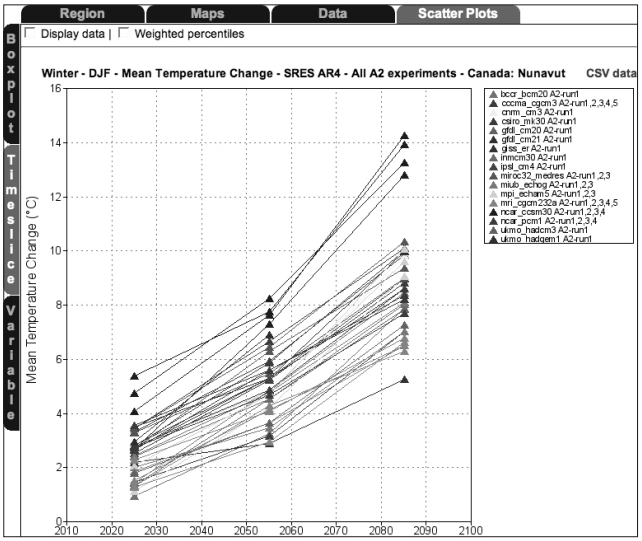


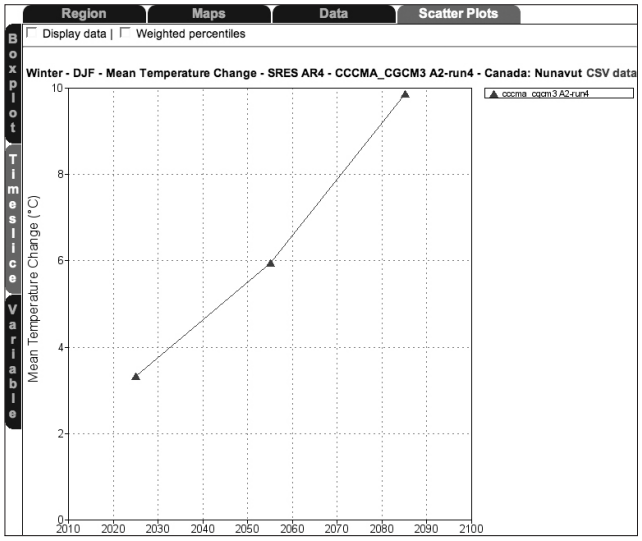
Line Graphs

Select the line graph option by choosing the Scatter Plot tab across the top of the output display, and the Timeslice tab along the left hand side. Note that the line graphs give projected temperature change for three timeslices – 2020s, 2050s and 2080s.

The figure to the left plots the projected mean temperature changes for Nunavut in winter, and is generated by all A2 scenario model runs.

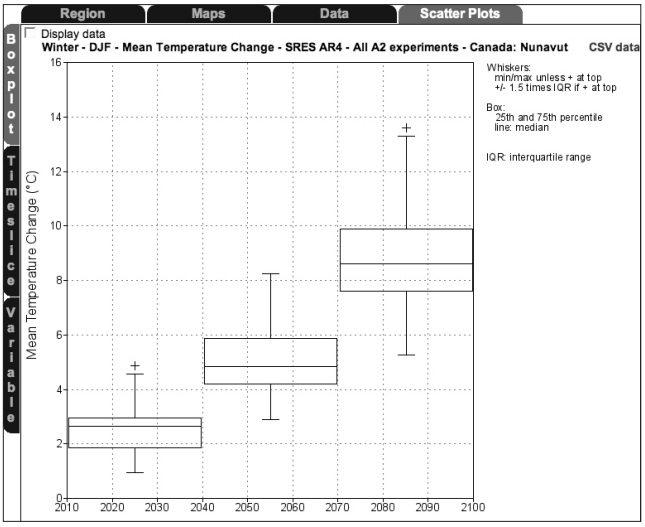
The figure to the right plots the same information, but is generated by one model run: CCCMA_ CGCM3 A2 run-4.

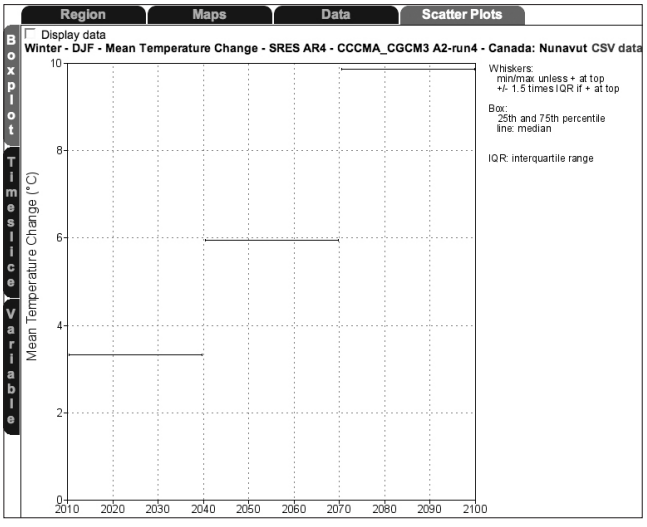




Box Plots

Box plots are useful for showing the range of possible projections for many different models and runs. However, they are not helpful in illustrating the projected temperature change for one model run, as shown in the right hand figure.





In the left hand diagram, all A2 scenario model runs (all A2x experiments) are used to generate the box plots. Three timeslices are represented here – 2020s, 2050s, 2080s.

The horizontal lines record the median value of the mean temperature change projections.

The area in the boxes above the median line represents the 25% of the projections that fall above the median (also called the 25th percentile), while those below the median line represent 25% of the projections that fall below (also called the 75th percentile). These box plots, therefore, show 50% of all the projections.

The vertical lines, or "whiskers", show the range of all 100% of the projections (50% above the median and 50% below), with the exception of some outlying points, represented by the plus signs.

Data Tables

Plotting options include a data table. This table illustrates mean temperature change in degrees Celsius for Nunavut, in all seasons, months and annually, in the 2050s timeslice, for one run of the CCCMA_CGCM3 model. Data includes the minimum and maximum, the weighted mean (W. Mean) and the median temperature change.

Region | Maps | Data | Scatter Plots

Metadata Files

Model	Map corners (topleft, bottomright)	Region area (km²)	Boxes in region	Gridbox lat/lon
CCCMA_CGCM3	(72.00N, 170W) - (30.00N, 100W)	1271400	19	NA

Mean Temperature - 2050s - SRES AR4 - CCCMA_CGCM3 A2-run4

Time of Year	Region data					Units
	Min	Max	W.Mean	Median	W.Std Dev	
January	4.8	6.8	6.2	6.3	0.5	°C change
February	4.1	6.5	5.5	5.7	0.8	°C change
March	3.5	5.4	4.5	4.6	0.6	°C change
April	1.6	4.1	3.2	3.4	0.7	°C change
May	1.0	3.1	2.3	2.6	0.7	°C change
June	1.2	2.5	1.9	1.8	0.3	°C change
July	1.8	2.9	2.3	2.2	0.3	°C change
August	1.5	3.0	2.2	1.9	0.5	°C change
September	0.8	2.8	1.7	1.7	0.5	°C change
October	2.7	6.7	4.5	4.7	1.1	°C change
November	3.0	5.8	4.4	4.6	0.8	°C change
December	5.7	7.9	6.4	6.4	0.5	°C change
Winter - DJF	5.5	6.6	6.1	6.2	0.4	°C change
Spring - MAM	2.0	4.1	3.3	3.7	0.6	°C change
Summer - JJA	1.6	2.8	2.1	2.0	0.3	°C change
Fall - SON	2.5	4.6	3.6	3.6	0.6	°C change
Annual	3.3	4.1	3.8	3.8	0.2	°C change

Decimal Places: Default , Percentile Calculations

Metadata CSV

IN-DEPTH EXPLORATION 2A: UNDERSTANDING EMISSIONS SCENARIOS (OPTIONAL)

If you would like to delve further into the different emissions' scenarios, refer to the IPCC's "Special Report Emissions Scenarios: Summary for Policy Makers". The document provides a readable description of the different emissions' scenarios, and explains how demographic, socioeconomic and technological development plays into the story lines. In particular, page three to the middle of page six are recommended as additional reading; pages six through twelve become more technical, and it is left to the instructor's discretion whether to include them as part of the recommended additional reading.

In summary, the report defines four story lines that characterize possible future states that will influence climate change, taking into account various patterns of demographic development, socioeconomic development and technological change. For example, story line A1 represents a future world of rapid economic growth, global population peaking mid-century followed by decline, and rapid introduction of new and efficient technologies. Story line A2 reflects continuous population growth, and slower economic growth and technological change.

Each story line yields a set of scenarios for a total of 40. Scientists develop computer models of projected climate change using some or all of these scenarios. Taken together, all of the different models generate many projections, from high to low, and represent the uncertainty that exists about how climate may change in the future.

Available at http://www.ipcc.ch/pdf/special-reports/spm/sres-en.pdf and http://www.ipcc.ch/ipccreports/special-reports.htm

Lecture 2 | Worksheets

CLIMATE CHANGE WORKSHEET FOR YOUR COMMUNITY
CLIMATE IMPACT ISSUE #___

Your Community (geographic location, approximate size, rural/urban setting):

Climate Impact Issue ___ :

Data

Climate variables	Projected change	More information needed?

The Impacts Story

How will the climate changes impact your community?

SOCIAL:

ENVIRONMENTAL:

ECONOMIC:

PHYSICAL INFRASTRUCTURE:

CLIMATE CHANGE WORKSHEET FOR YOUR COMMUNITY
CLIMATE IMPACT ISSUE #___

Who/what will be affected (home owners, farmers, infrastructure, eco-systems, land, businesses)?

Area of planning and other departments involved?

Any new opportunities?

Vulnerability

Factors contributing to vulnerability = disadvantaged groups, fragile natural systems. What about your community's capacity to respond: financial, skills, knowledge/awareness?

3

Responding to Climate Change

The third lecture in this series focuses on how communities and their planners can respond to climate change. The learning objectives are familiarization with:

- Current issues and potential responses that "real-life" planners, and other local government staff and decision-makers, are facing;
- An approach to planning for adaptation; and
- A range of responses, including:
  A. Mitigation and adaptation – distinction and overlaps
  B. Specific adaptation strategies for different impacts and sectors.

LECTURE 3 NOTES TO INSTRUCTOR

This lecture consists of three sections; the first part focuses on climate change impacts facing local governments now; the second on a planning-for-adaptation framework; and the third on mitigation and adaptation responses. There are four suggested Discussion Q&A activities, as well as an exercise, that with time permitting, could be done as an in-class facilitated session, or as a small out-of-class group activity.

As an addendum, one subject area about how mitigation and adaptation responses are linked is proposed for more detailed exploration. For example, the topic could form the basis of a special project, or thesis. Some references are identified.

SUGGESTED READING

Natural Resources Canada. "Municipal Case Studies: Climate Change and The Planning Process". The following plain language summaries are available at:

http://www.cip-icu.ca/web/la/en/pa/FDD921FC64CB4439A096528BFD59E779/template.asp

- Calgary: Municipal Water Supply;
- Corporation of Delta Case Study: Sensitivity of the Roberts Bank Tidal Flats to Accelerated Sea Level Rise and Intensified Storminess;

- Southeastern New Brunswick Coastal Communities Case Study: Impacts of Sea Level Rise;
- Salluit Case Study: Impacts of Degrading Permafrost; and
- Graham Island, Haida Gwaii, BC: Storms and Coastal Erosion

Adaptation – Mitigation Integration

- http://www.amica-climate.net/484.html
- http://www.amica-climate.net/online_tool0.html

LECTURE 3 NOTES

3.1 Climate Change Impacts Facing Local Governments Now

As an introduction to this lecture, show one of the two 12-minute videos that have been designed to stimulate dialogue among local government representatives, scientists and engineers on how to adapt water-related infrastructure. The videos, created by EKOS Communications Inc., apply peer-to-peer learning by having mainly mayors, councillors and senior policy advisers deliver the messages about the urgent need to address climate change, supported by clips from three highly respected climate research scientists from the University of British Columbia (UBC). While both videos are set in British Columbia, they illustrate the range of potential climate impacts related to water in urban and rural settings, and highlight lessons that apply generally.

Video 1: Adapting to Climate Change in the Lower Mainland of British Columbia

The first video has an urban focus and is set in the Lower Mainland area of British Columbia. It features Lois Jackson, Mayor of Delta and Chair of Metro Vancouver; Darrell Mussatto, Mayor of City of North Vancouver; David Cadman, Councillor of City of Vancouver; and Johnny Carline, CAO of Metro Vancouver. Drs. Stephen Sheppard, Stewart Cohen and Robin Sydneysmith from UBC provide the scientific background.

Video 2: Adapting to Climate Change in the Fraser Basin of British Columbia

The second video has a rural focus and is set in the Fraser Basin of British Columbia. It features David Laird, Mayor of Merritt; Sean Boven, Manager of Public Utilities for Merritt; Terry Lake, Mayor of Kamloops; David Duckworth, Manager of Public Works for Kamloops; David Trawin, Director of Planning and Development for Kamloops; and Scott Nelson, Mayor of Williams Lake. Drs. Stephen Sheppard, Stewart Cohen and Robin Sydneysmith from UBC provide the scientific background. The principal challenge faced in the interior region of BC is the mountain pine beetle salvage, and its potential impacts on groundwater recharge of aquifers. Additionally, there are growing concerns about long-term supply to meet ever-increasing demands for more water.

Discussion Q&A – 1

After presenting the video(s), engage students in a discussion, using the following suggested questions as a guide:

- What are some of the challenges these decision-makers face in addressing climate change? (The answers could range anywhere from a lack of information to support decisions to a council that does not buy-in to the urgency of climate change.)
- What role does/should local government have with respect to preparing for, and responding to, climate change? What about the role of planners in particular? (This can be kept brief as a primer for the fourth lecture that explores planners' roles and tools in greater detail).

3.2 Planning for Adaptation – A Framework

The planning-for-adaptation framework is simply a series of questions that outlines a process to identify responses to climate change. It addresses how communities can best prepare for, or adapt to, climate change. Like any planning process, things will not always occur in a sequential fashion. The steps in the five-stage process are described below, and are followed by a diagram that conceptually illustrates the planning sequence, identifying resources to help explore the questions.

Note to Instructor: You may want to present the information in lecture format using the descriptions below, or alternatively have students take a few minutes to review the diagram, and then have a discussion about the framework (See Discussion Q&A – 2).

1. How will climate change in my region?

   This will require an understanding of which climate variables are relevant to your region (temperature, sea level, precipitation, snow depth, etc.), and how they are expected to change. There will be uncertainty associated with this information, and you will likely be dealing with ranges of possible changes that could occur.

2. How will my community be impacted?

   This step requires an understanding of which sectors are key to the community, and how they might be impacted, as well as knowledge of its vulnerable elements (people, wildlife, habitat, businesses, etc.). This information can come from speaking with local people, experts, stakeholders, staff across departments and from learning gained in other areas – for example, case studies, and checklists of possible impacts by sector. Also, there may be positive benefits, equalling opportunities, which should not be overlooked.

3. How can my community respond?

   The process of developing possible adaptation actions can benefit from considering principles of good adaptation, some of which are common sense planning principles (A list of these principles is included as an addendum to this lecture).

   It may also be helpful to think about adaptation strategies in two ways:

   A. As building the capacity of an organization to respond; and/or
   B. Implementing actions that prepare the community for changes.

   Researching the experiences of similar communities is helpful in identifying workable strategies. Local and expert knowledge will also play a key role in the process of recognizing effective adaptation actions.

4. How can we implement actions? — Working with Decision-makers

   This step involves thinking about the organizational challenges a planner may face in developing adaptation strategies, including how to engage the community, as well as doubting decision-makers. This work will be supported by a range of tools, such as community plans and/or climate action plans. The recent CIP Policy on Climate Change outlines the roles and responsibilities of planners in responding to climate change. This is described in more detail in Lecture 4.

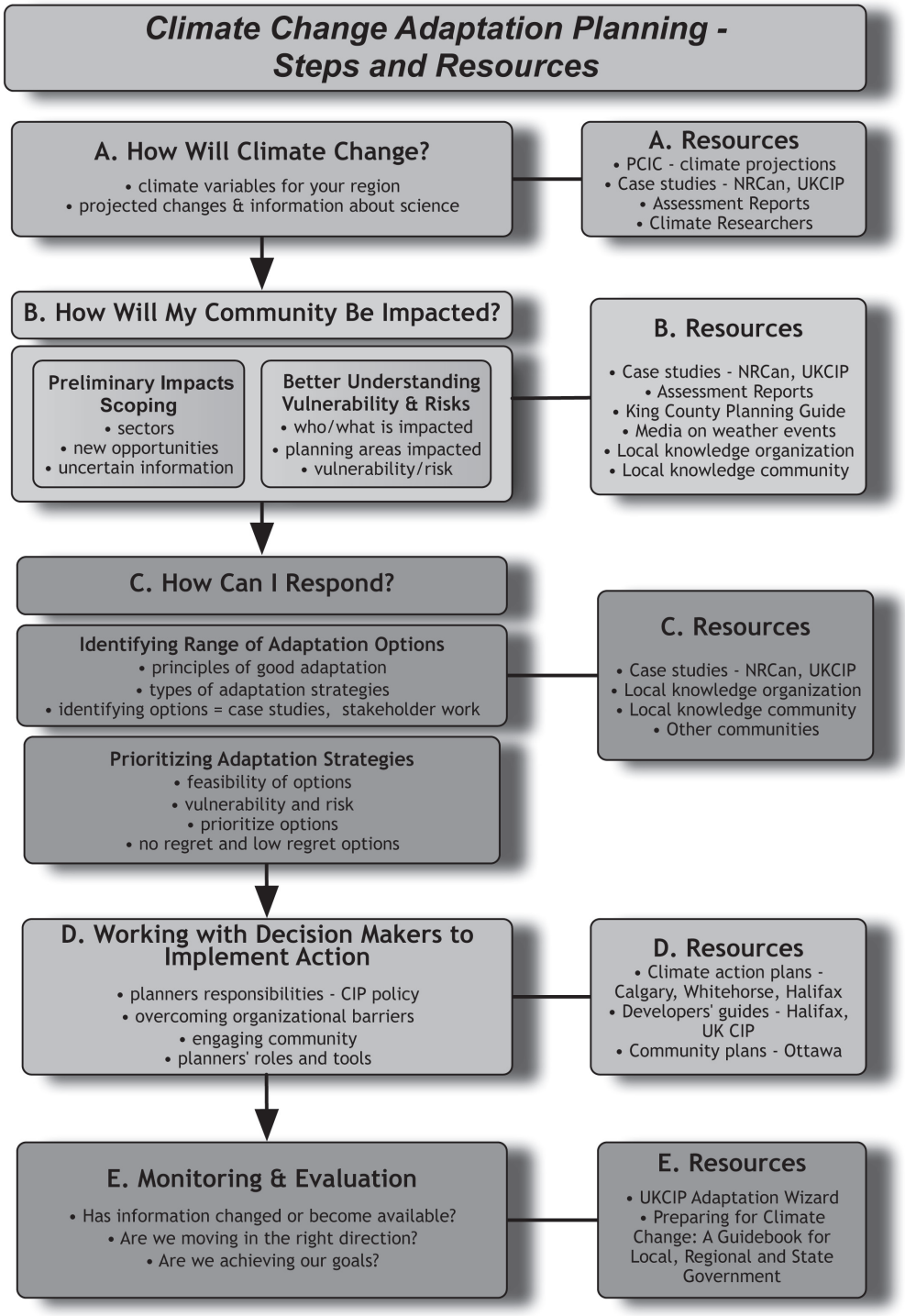
5. Monitoring and Evaluation

   It is important to be aware of the latest climate change information, since new data/research can impact strategy decisions. Monitoring and evaluation will indicate if the actions taken are working as intended, or if modifications are required. This is an important part of any planning process.

Discussion Q&A – 2

Suggested questions relating to the framework include:

- What might some of the challenges be in developing a climate change strategy?
- Where does stakeholder/public engagement fit into the climate change planning process?
- Do you have any comments about the framework and/or related resources?



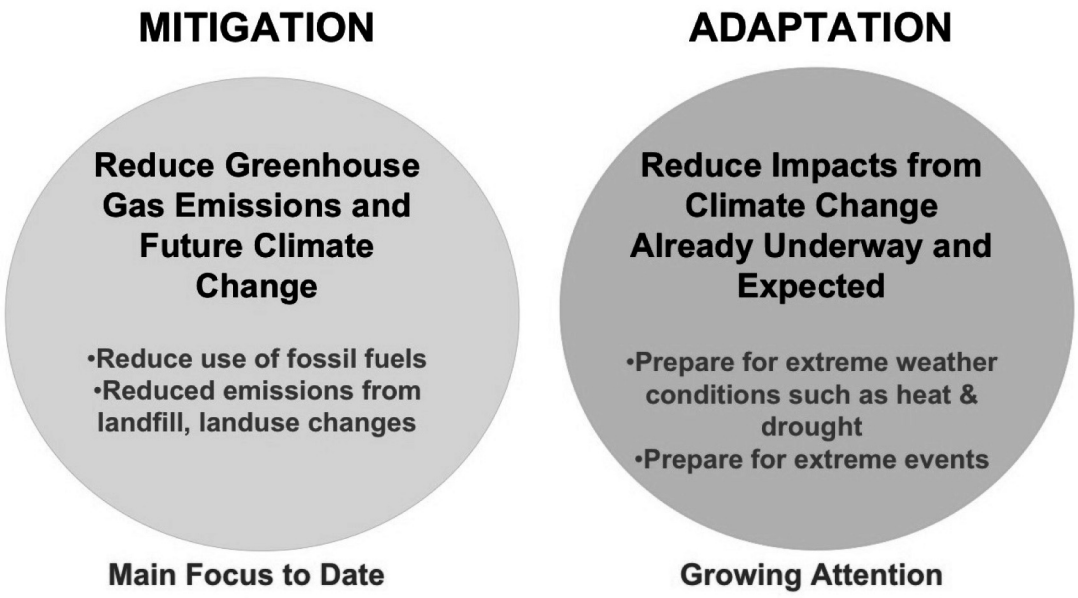
3.3 Responding to Climate Change - Mitigation and Adaptation

Possible responses to climate change are typically described as "mitigation" or "adaptation" responses.

Discussion Q&A – 3

Engage students in a discussion about "mitigation" and "adaptation" responses to climate change using the following suggested questions as a guide, and before using the slide below:

- Are the terms "mitigation" and "adaptation" familiar to you?
- Can you share some examples of "mitigation" and "adaptation" strategies?



Source: Jennifer Penney, Clean Air Partnership, Presentation to Upwind Downwind Conference, Hamilton Ontario, Feb 26 2008.

3.3.1 Mitigation Responses to Climate Change

Communities and governments can work to slow further climate change impacts by reducing the amount of greenhouse gas being emitted into the atmosphere. These types of actions are called "mitigating actions".

In a climate change context:

Mitigation = reducing greenhouse gas emissions to slow the rate of climate change.

The Kyoto Protocol is a global effort that promotes the reduction of greenhouse gas emissions; 174 parties have signed and ratified the protocol. At a local level, Canadian communities are actively responding to climate change; 155 municipal governments have committed to reducing greenhouse gases and acting on climate change through FCM/ICLEI's Partners for Climate Protection.

3.3.2. *Adaptation Responses to Climate Change*

Scientific research indicates that past emissions of greenhouse gases have created climate impacts that will continue for centuries. We WILL undergo climate change, despite efforts to mitigate future impacts. Therefore, communities also need to plan and implement adaptation strategies to minimize impacts and maximize opportunities.

In a climate change context:

Adaptation = preparing for climate changes in order to minimize negative impacts and maximize opportunities.

Relatively few communities are actively working on adaptive responses to climate change. In many cases it will be more cost–effective to prepare rather than react. Adaptation will increase our ability to cope with climate changes, and moderate the impacts on our daily quality of life. Adaptive measures can include new technologies, new legislation, policies and regulations, and new behaviours. Examples of adaptation measures include:

- Implementing or enhancing weather watch/warning systems;
- Improving housing and public buildings (e.g. insulation, shading, natural ventilation) ;
- Delivering educational programs (e.g. appropriate clothing, potential shelters); and
- Developing programs where staff visit people at-risk.

Discussion Q&A – 4

Mitigation and adaptation strategies can overlap or work against each other. Can you think of examples of overlap? Can you think of examples where a mitigation strategy would work against an adaptation strategy or vice versa?

Example 1 – A program to provide all seniors living in apartment units with an air conditioner to keep them cool and safe during heat waves. This well-intentioned strategy would increase energy use and greenhouse gas emissions and, in theory, contribute to increasing the effect the adaptation solution is trying to combat.

Example 2 – Green roofs: Planting the roofs of existing/new buildings with grass/vegetation to improve insulation, and to reduce the urban heat island effect in summer time. This action addresses the climate change problem of increased temperature. At the same time, a green roof plays a role in mitigating greenhouse gas emissions by reducing the need to use energy to cool the building.

Example 3 – Water Conservation: The systems that supply water use less energy because of the lower demand, and the behaviour change to reduced water usage is an adaptive strategy that prepares communities for a possible smaller water supply in times of drought.

For examples of adaptation and mitigation strategies working together see http://www.amica-climate.net/online_tool0.html

LECTURE 3 EXERCISE:
Identifying Adaptation Strategies

Time permitting, this could be done in class as a facilitated exercise. Ask students to review the following case studies. Focus on the two or three most relevant, or interesting, to the group. For each case study, identify possible adaptation strategies for the communities. Discuss the implications of the strategies:

- Which are easily implemented in the short term?
- Which would require a longer time frame?
- Which would be costly and require considerable resources to implement?
- Which strategies are related to building knowledge and awareness, and building support for taking action?
- Which strategies involve actions that more directly support adaptation, e.g. changing land use designations, or disconnecting stormwater run-off from the sanitary sewer?

Alternatively, have small groups of students do this as an exercise out of class and prepare a brief report on their findings. Ask each group to choose two case studies and carry out the steps described above, writing up their findings in a brief report.

LECTURE 3 EXERCISE Five Case Studies: How will They Adapt?			
	Climate Changes	Impacts/Issue	Adaptive Actions
1. Threatened Water Supply – (based on information from Calgary, Alberta)			
Population of one million; further growth projected	• Temperature increasing; • Precipitation patterns changing; more wet days, but with less precipitation each day	• Water shortage: lowering water levels in city's sole water source; • Competing uses for same water supply	

LECTURE 3 EXERCISE Five Case Studies: How will They Adapt?			
	Climate Changes	Impacts/Issue	Adaptive Actions
2. Storms & Sea Level Rise Eroding Coast – (based on information from NE New Brunswick)			
Population of 730,000, but 438,000 (60%) live within 50 kms of coast	• Sea level rise; • Increased intensity and severity of storm activity, including storm surges	• Flooding; • Erosion – loss of beaches, dunes; • Infrastructure damage to bridges, wharves, roads; • Salt water intrusion into fresh water aquifers; • Damaged bird and whildlife habitat; • Stress on coastal economy – business, tourism, property	
3. Land Slides & Failing Permafrost – (based on information from Salluit, Quebec)			
Population of 1,100 that is projected to increase	• Temperature increase of at least one to two degrees Celsius over the next 25 years	• Permafrost degradation leading to soil failure and land slides; • Unstable soil is safety and financial risk to community that needs immediate development of housing, amenities and infrastructure	
4. Farms Facing Dual Impact of Severe Drought & Intense Precipitation (based on information from the Prairie provinces)			
The Prairies (Alberta, Manitoba & Saskatchewan) are home to over five million people and 125,000+ farms	• Increasing temperature; • Increasing precipitation, but also more dry years; • Lower summer stream flows and falling lake levels	• More frequent drought, but also severe flooding; • Warmer growing conditions, but accompanied by drier soil that is susceptible to degradation	

LECTURE 3 EXERCISE Five Case Studies: How will They Adapt?			
	Climate Changes	Impacts/Issue	Adaptive Actions
5. Tourism: Winter Resorts & Declining Snow Levels (based on information from British Columbia and Alberta)			
Tourism, recreation, ski resorts	• Warmer winter temperatures; • Retreating glaciers	• Declining snow levels and snow at higher altitudes; • More frequent avalanches; • Trees growing further up groomed mountainsides; • Shorter winter sport seasons, reduced reliability of ski conditions	

IN DEPTH EXPLORATION 3-A

As knowledge of climate change evolves, there is more exploration of how mitigation and adaptation responses are linked. Adaptation responses are generally directed at, and benefit, the local scale while mitigation actions have potential impact globally.

This subject area is new, and could be an interesting topic for a graduate planning thesis. To explore the subject area in more detail see the following journal: "Mitigation and Adaptation Strategies for Global Change", Volume 12, Number 5/June 2007. It is a summary of several articles that explore the connections between mitigation and adaptation. Also explore the AMICA (Adaptation and Mitigation - an Integrated Climate Policy Approach) website at http://www.amica-climate.net/home1.html

4

Planners' Roles in Implementing Responses to Climate Change

The fourth and final lecture in this series examines the obligations of professional planners with respect to climate change, as well as the statutory tools and non-statutory activities available for implementing climate change responses. The learning objectives are familiarization with:

- The Canadian Institute of Planning's Policy on Climate Change, and the obligations of planners prescribed in the policy;
- Challenges to implementing climate change initiatives, which include:
  A. Scepticism and negativism on the part of decision-makers; and
  B. Building and maintaining community support for initiatives and actions; and
- Planning tools for implementing climate change responses, which include:
  A. Statutory tools; and
  B. Non-statutory tools (education, skills and experience of planners) that are well-suited to community-oriented initiatives.

NOTES TO INSTRUCTOR

Lecture Four consists of three sections, with the first focusing on CIP's Policy on Climate Change; the second discusses challenges to implementing climate change actions; and the third highlights the tools available to planners. Included in this lecture are four Discussion Q&A activities, as well as a 30-minute, in-class exercise, proposed as a way to pull together prior learning. Given the number of Discussion Q&A activities, it is recommended that the instructor select two or three, leaving enough time for the wrap-up exercise.

SUGGESTED READING

CIP's Policy on Climate Change:

http://www.cip-icu.ca/web/la/en/pa/638522902E284697B34CA539537CA5FC/template.asp

LECTURE 4 NOTES

4.1 CIP's Policy on Climate Change

Since 2005, CIP has partnered with Natural Resources Canada (NRCan) on a number of high-profile initiatives that have reinforced the Institute's concerns about the impacts of climate change, and spurred the organization to take a leadership role on this critical issue.

In February 2008, CIP Council adopted a Climate Change Policy, including this declaration:

"The Canadian Institute of Planners believes climate change is real and immediate. The impacts of climate change affect, and will continue to affect, all aspects of our mission to ensure a sustainable future and to shape better communities."

The policy statement represents a paradigm shift for all Canadian planners. The work of planners in local government will be directly impacted by a number of its directives.

The policy statement outlines a rationale, provides goals and objectives, and sets out ten policy directives. All 7,000 members of CIP are expected to abide the policy. As professional planners working in a local government setting, four of the directives are directly relevant to our day-to-day activities. These will help shape and guide all of our advice and recommendations, and should be conveyed to elected and administrative decision-makers".

1. **Consider Climate Change in Planning Activities**. CIP expects its members to consider climate change in their actions and recommendations within the broad scope of planning activities (e.g., long-range plan preparation, development approval, infrastructure planning, resource management), in order to:

   A. Minimize risks associated with extreme events and the cumulative effects of climate change;
   B. Protect natural resources and habitats;
   C. Ensure no adverse public health effects;
   D. Build resilience into communities; and
   E. Take advantage of mitigation and adaptation techniques, wherever possible.

2. **Plan Development and Infrastructure to Mitigate Climate Change**. CIP expects its members to plan development and infrastructure in ways that mitigate the effects of climate change in the long-term, such as energy-efficient and transit-oriented development.

3. **Develop Adaptation Strategies to Minimize the Impacts of Climate Change**. Given that mitigation efforts alone cannot avoid further impacts of climate change, CIP expects its members to develop suitable adaptation strategies to enable communities to manage the effects of climate change and minimize adverse impacts.

4. **Make Written Declarations About How Planning Activities Affect Climate Change**. In carrying out their responsibilities, CIP members shall make written declarations stating how their recommendations and actions contribute to mitigating, adapting to, or worsening climate change or have no effect at all.

Discussion Q&A – 1

- How do you think these policy directives will impact a planner's work?
- How do you think these policy directives will affect a planner's communications with:
  A. Councils;
  B. Developers;
  C. Stakeholders; or
  D. The community?

4.2 Challenges to Implementing Climate Change Initiatives and Actions

4.2.1 Scepticism and Negativism

In every local government there will be individuals – elected officials and staff – who are doubtful that climate change will have significant and substantial local impacts. They are reluctant to spend scarce resources on something they think may never happen, or will happen in a way that is simply too difficult to predict. There are others who feel that local government has very little scope to actually affect changing climate, because it is either "too big to solve", or is "outside their jurisdiction".

Discussion Q&A – 2

Note to Instructor: Ask what kinds of comments people have heard from climate change skeptics. Then ask how a planner might overcome these views and comments. Below are some views on how this might happen.

Overcoming This Challenge

You probably will not overcome this entirely – some individuals will remain unconvinced. For others, the "show me" rule prevails. Planners must be at the forefront of preparing and communicating reliable, locally relevant information. Try to find opportunities to meet with key decision-makers outside formal settings. Keep information flowing to elected officials about climate change. In some municipalities, the elected officials are "out in front" of the administration.

Consider when and how you might include "climate experts" in your presentations and meetings, making sure your "expert" can translate scientific findings into lay person's language and present them in a way that is compelling, relevant and credible. Look for these people in other university departments, provincial government departments (environment, sustainability, natural resources), local offices of federal government departments – especially Natural Resources Canada (NRCan) and Environment Canada – or in respected non-governmental organizations.

4.2.2 Building and Maintaining Community Support for Climate Change Initiatives

Elected decision-makers are accountable to their electorates. They rely on their staff to ensure that measures have been used to inform and, where appropriate, engage the community prior to making many decisions.

Almost every local government planner has, or soon will have, experience in community engagement. Many have attended, or given, workshops solely on best practices associated with communications and consultation. Some local governments have their own code of principles or protocols that must be used.

Planners understand that effective outreach will play a significant role in building and maintaining support for climate change initiatives and actions.

There is no such thing as a perfect community engagement process, but there are general principles and practices that can contribute to your success. A climate change strategy is the same as any other local government activity that involves community engagement.

Three Principles of Engagement

For each of the three principles discussed below, we have identified good practices and comments that are specific to climate change.

General Principle 1: The process must be open, inclusive and transparent.

Good Practice:

- A consultation plan should be presented to decision-makers before the process begins. This includes scope, time frame, budget, milestones and decision-points.

Comments Specific to Climate Change:

- Climate change science is technical, as are some measures of mitigation and adaptation. There should be recognition in designing the process that there is a legitimate role for experts in developing and recommending policy options. The knowledge and advice of these experts should be provided in a public setting, so it is clear how they have influenced outcomes.

General Principle 2: Information must be reliable, widely shared and easy to understand.

Good Practice:

- All available conventional and new media should be used.
- Use plain language and avoid jargon.

Comments Specific to Climate Change:

- Climate change science uses an abundance of terms that are unfamiliar to the majority of people. It is essential to express information about climate change as simply and as visually as possible. (See Lecture 1.)
- Describe and illustrate changes that have already been observed regionally and locally. Draw on the observations and experience of people who have lived in the area for a long time. Quote them in your communications' materials. Reference weather events where the consequences were widely experienced (e.g., ice storm in Central Canada, wind storm in Stanley Park).
- Describe and illustrate changes that are expected regionally and locally.
- Describe potential local consequences of climate change. Avoid overstating risks or likely impacts. Remember to consider new opportunities.
- Draw on learning and experience from the community.
- Work with natural allies to help distribute and communicate climate change information. These include environmental organizations, horticultural groups and educators.

General Principle 3: Affected and interested parties should be provided with a variety of opportunities to participate.

Good Practice:

- Identify the different types of community interests and stakeholders, and their preferred ways of engagement, at each phase of the process.
- Organize events at a scale where people can talk with each other.
- Use facilitators and enablers, particularly if large numbers of people are involved.
- Use experts appropriately. The more complex the subject, the more technical, professional or academic expertise may be needed.
- Summarize the key findings and themes after each event. Ensure these are publicly available.
- Properly record and document engagement activities so it is clearly evident who has been involved and how.

Comments Specific to Climate Change:

- Effective engagement processes take time and resources, regardless of the subject matter. Because climate change is a relatively new and complex subject for many people, the process should incorporate as many opportunities for learning as possible.
- Make a deliberate effort to personally contact people who already are committed to environmental and sustainability issues.
- Engage others in local government to act as resources in the community engagement process – staff who work in environmental protection, wastewater management, water supply, emergency management, fire and police, arborists. This "hands on" experience and perspective always enriches a planning process.
- Do not overlook former elected officials, or former senior administrators, who have a passion or particular knowledge of the subject.
- Make and maintain personal contact with opinion leaders within key stakeholder groups. In Aboriginal communities, seek out elders for conversations.
- Draw on local and regional resources, including educators, researchers and professionals who specialize in climate science. They are knowledgeable about regional impacts, the confidence with which projections of future change are made, and sources of additional information. Invite their participation and presentation at some events. Collaborate with these individuals ahead of meetings and events to make sure they understand the make-up of the audience, and how their technical knowledge can best be conveyed.
- Locate activities physically in the areas of potential impacts. (e.g., walking tour of a dyke threatened by sea level rise, a tour of areas devastated by infestations resulting from warming winters, an open house in a parking lot on a summer day).

Discussion Q&A – 3

Note to Instructor: If the group is smaller than ten participants, have this discussion in plenary. If larger, form smaller groups and, if limited by time, have two of the groups report to the whole group, each representing a different community.

TASK: Your Council has identified climate change as a corporate priority, and has allocated a significant amount of the next year's budget to producing a climate change strategy. Council expects a high level of community engagement. The Planning Department is tasked with coordination of this process. In what ways would a climate change consultation process differ from a consultation associated with a different topic?

4.3 Planning Tools For Implementing Climate Change Responses

4.3.1 Statutory Tools

A statutory tool is one that is required by law, or statute. Across Canada, local governments derive their land use planning authority through provincial statutes and regulations. While the specifics vary from province to province, local governments have the authority to prepare community plans and regulate certain aspects of development and building through bylaws (e.g., zoning, building and structures). These are the tools that planners typically use to:

- Minimize risks associated with extreme weather events and with the cumulative effects of climate change;
- Protect natural resources and habitats;
- Ensure no adverse public health effects;
- Build resilience into communities; and
- Take advantage of mitigation and adaptation techniques.

Community Plans

While some community plans reference climate change within the broader context of sustainability, most plans lack specific goals, policy statements or implementing actions. This is rapidly changing. Many local governments currently reviewing and updating their community plans are incorporating specific directives related to climate change mitigation and adaptation. Three examples are provided here:

Example 1: City of Ottawa. The City of Ottawa is updating its Official Plan, as part of the "Beyond Ottawa 20/20" initiative. With this work, the City issued a "white paper" entitled "Climate Change and the Official Plan Review".

The paper provides a local context and identifies opportunities presented through the Official Plan to "lessen the City's contribution to climate change (mitigation) and to prepare for the changes in the environment that are inevitable (adaptation)". The specific issues discussed are:

- Transportation – measures to reduce greenhouse gas emissions;
- Protection of resource areas and natural systems;
- Development – sustainable design and green building measures; and
- Renewable energy.

Available (as of September 2008) at http://www.ottawa.ca/residents/public_consult/beyond_2020/papers/white/climate_en.html

Example 2: Halifax Regional Municipality (HRM). HRM's Planning Strategy, adopted in 2006, includes elements that respond to the anticipated effects of climate change. The plan addresses coastal inundation — resulting from sea level rise and more frequent and intense storms — emissions reduction, hazards to development, including climate change impacts, and community energy. It directs HRM to prohibit all residential development on the coast within a 2.5 metre elevation above the ordinary high water mark, and to develop three climate change-related functional plans, including:

- Emissions Reduction Functional Plan;
- Potential Hazards to Development Functional Plan; and
- Community Energy Functional Plan.

The plan is available (as of September 2008) at http://www.halifax.ca/regionalplanning/FinalRegPlan.html

Example 3: The District of Central Saanich. The District of Central Saanich, located on Vancouver Island, BC, has incorporated climate change throughout its draft Official Community Plan, from its fundamental principles, goals and objectives, through to specific policies. One of nineteen fundamental principles is:

"Address the Causes and Impacts of Climate Change. The energy use of industrial, residential and commercial buildings and motor vehicles is responsible for the majority of greenhouse gas emissions, the leading cause of climate change. Central Saanich is committed to reducing green house gas emissions in the community by ensuring greater energy efficiency in new and retrofit buildings, including municipal facilities and infrastructure, and by fostering a reduction in private automobile usage in favour of less polluting forms of transportation. Adaptation to new conditions caused by climate change, such as sea level rise, increased storm surge, changing hydrological cycles and increase in major weather events is also key to addressing climate change."

The plan is available (as of September 2008) at http://www.centralsaanich.ca/__shared/assets/OCP_Bylaw_No1852.pdf?method=1

Province of BC Initiative. On April 15, 2008 the Government of BC introduced Bill 27 – Local Government (Green Communities) Statutes Amendment Act to help local governments create more compact, sustainable and greener communities. Once the legislation comes into force, local governments will be required to include greenhouse gas emission targets, policies and actions into their Official Community Plans.

Zoning Bylaws

Provincial statutes vary across Canada, but local governments generally have the authority to regulate land use and buildings/structures on privately-owned land. The primary regulatory tool is the "zoning bylaw". What can be regulated (or prohibited) varies considerably among provinces, and it is important to understand the authority of the enabling legislation. For example, in Ontario, the Planning Act is more prescriptive about what can be prohibited than in British Columbia, where specific zoning powers are fewer. Another tool, called a Development Permit, provides an alternative approach to preventing inappropriate development.

Generally, at a minimum, a zoning bylaw sets out:

- The density of the use of land, buildings and other structures;
- The siting, size and dimension of buildings and other structures;
- The shape, dimension and areas of parcels of land; and
- Requirements related to loading and parking.

Zoning bylaws are an effective tool to direct development away from current or anticipated hazardous conditions, and sensitive ecosystems. Many local governments have required building setbacks from watercourses/wetlands in the interest of environmental protection. But, building setbacks can also be used in situations where climate-related change is anticipated (e.g., rising sea level, higher flood levels). And, as in the case of the Halifax Regional Municipality, building bylaws, can be used to require habitable spaces to be a certain elevation in reference to sea level.

Other Statutory Tools

As previously noted, it is advisable to consult the enabling legislation of each provincial government. Some provinces have given local governments other statutory tools to help better manage the quality and impact of development.

Example 1: Site Plan Control Area, Ontario's Planning Act. In Ontario, the Planning Act provides for a "Site Plan Control Area" that, when established through the Official Plan, gives the municipality the authority to require detailed plans related to such matters as massing, exterior design, relationship of the building to adjacent areas, and sustainable design elements.

Example 2: Development Permit Area, British Columbia's Local Government Act. In BC, the Local Government Act provides for a similar measure – a Development Permit Area. Development Permit Areas allow for much more detailed review of specific plans and can require compliance with objectives and conditions for certain situations. They must be established within the Official Community Plan for one or more specific purposes, including, for example:

- Protection of the natural environment, its ecosystems and biological diversity;
- Protection of development from hazardous conditions;
- Establishment of objectives to promote energy conservation;
- Establishment of objectives to promote water conservation; and
- Establishment of objectives to promote the reduction of greenhouse gas emissions.

Example 3: Direct Control District, Alberta's Municipal Government Act. In Alberta, a municipality that has adopted a Municipal Development Plan, and wishes to exercise particular control of the use and development of land and buildings within a defined area, may designate the area as a "direct control district" in the land use bylaw. Once designated, Council may regulate and control the use and development in that district "in any manner it considers necessary".

In the context of climate change, these tools should be considered as potential vehicles to assist planners in minimizing potential hazardous situations associated with development and, where legislated, to work towards sustainable measures, including energy and water conservation, and reduction of greenhouse gas emissions.

4.3.2 Non-statutory Tools: Planners' Education, Skills And Experience

Planners are often called on to undertake projects that are far-removed from statutory tools. Their education, skills and experience are well-suited to community-oriented initiatives. Within the gamut of climate change mitigation and adaptation, their work could involve working with community groups on stewardship actions such as:

- Tree planting; urban forestry;
- Wetlands and creek restoration;
- Vehicle anti-idling programs;
- Car-sharing cooperatives; and
- Community education about climate change.

Discussion Q&A – 4

If there were no requirement for a community engagement process, and if you did not have to convince senior administrators and elected officials, what planning tool has the greatest role to play in climate change? Why?

LECTURE 4 EXERCISE:
Climate Change Action Strategies

Do this exercise in-class with small groups of four to five students, using the community in which the students currently live. Ask students to develop a ten-point strategy for responding to climate change, deciding on a balance between:

- Mitigation and adaptation measures; and
- Regulatory and non-regulatory tools.

Have students report back briefly to the class.

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