Science at Work

Sheila Watt-Cloutier is an Officer of the Order of Canada. She was nominated for the Nobel Peace Prize in 2007 for her work in bringing heightened attention to climate change and global warming.

Canadians in Science

SheilaWatt-Cloutier wants the world to understand the drastic impact that climate change is having on her people, the Inuit of Canada's North. For Sheila, climate change is a human rights issue because it threatens to destroy the Inuit way of life. She is urging nations to decrease their greenhouse gas emissions. She served as president and chair of the Inuit Circumpolar Conference (ICC), an organization representing Inuit in Canada, Alaska, Greenland, and Russia. The ICC persuaded governments to sign a global ban on persistent organic pollutants, which contaminate the Arctic food chain and accumulate in the fat of animals that are important sources of food for Inuit people. Sheila hopes students interested in the environment will look for connections among the many diverse topics related to the environment. She also hopes they will recognize the human stories underlying environmental issues.

In Sheila Watt-Cloutier's Words

Almost every facet of Inuit life has been affected by climate change. Hunting especially has been disturbed. We remain a hunting people of the land, ice, and snow. The process of the hunt teaches our young people to be patient, courageous, bold under pressure, and reflective. They learn to control their impulses, withstand stress, and develop sound judgement and wisdom.

For Inuit people, climate change is an issue related to our right and ability to exist as an Indigenous people. That right is now being challenged and minimized by the unpredictability of our climate. Climate change means that less of our culture in terms of traditional knowledge is being passed down to our young people.

Climate change has been discussed mainly as a scientific, economic, and technological issue, not as a human issue. People have failed to make connections to the human face of the problem. That is all changing now. People everywhere are awakening to the important role of these connections in the web of existence that connects us all through our shared atmosphere.

Inuit hunters use a blend of modern technology and traditional practices to survive in their northern environment.

Earth Science at Work

The study of climate change contributes to these careers, as well as many more.

Meteorologist

Meteorologists study the weather. They collect data from satellites, computer models, radar, and observation stations in order to forecast future weather. Many meteorologists in Canada work for the federal government with Environment Canada.

Ecologist

Ecologists study the relationships among living things and the environment. They might investigate how factors such as temperature, precipitation, or urban development are affecting certain species. They work for governments, research institutions, conservation authorities, environmental consulting firms, and major corporations.

Greenhouse Gas Practitioner

Greenhouse gas practitioners measure, evaluate, and report on emissions from industry and vehicles. They also report on decreases in emissions that occur as a result of new projects launched by companies and other organizations. In addition, they develop plans for monitoring and accounting for emissions.

Go to **scienceontario** to find out more

Over to You

1. Why are ice and snow important to the Inuit way of life?
2. Explain why Sheila Watt-Cloutier believes climate change is a human rights issue.
3. Identify three effects that greenhouse gas emissions have on the Inuit way of life and three effects greenhouse gas emissions have on your life. What changes to your lifestyle can you make to help reduce your contribution to greenhouse gas emissions?
4. Research a career involving climate change that interests you. If you wish, you may choose a career from the list above. **What essential skills would you need for this career?**

Unit 3 Projects

Inquiry Project

Reflecting on Land Use

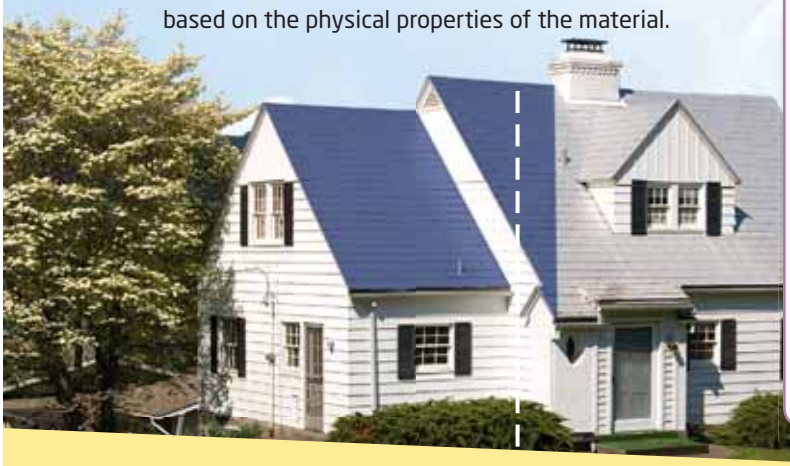
Over the last few decades that scientists have been making climate predictions, the focus has shifted from avoiding climate change to minimizing it, as well as adapting to it. One suggestion is to change the albedo of Earth's surface by rethinking how we use the land. Since the atmosphere is mostly transparent to visible light, increasing the amount of light that is reflected from the land, and thus reducing the amount that is absorbed by the land, is one way to help reduce the temperature near Earth's surface.

Inquiry Question

How does ground cover affect the amount of solar energy that is absorbed by the land?

Initiate and Plan

1. Identify one specific land use. List three or more materials that the surface of the land could be covered with and still be suitable for the use you identified.
2. Design a process you can follow to expose a small sample of each material to sunlight and measure any change in temperature. List the equipment you will need and the steps you will take to carry out your process. Have your teacher approve your investigation, including any safety precautions.
3. Set up your investigation to test the ability of each material to reflect solar energy and therefore warm the air above it.
4. For each material you test, write a hypothesis describing the results you expect, in absolute terms or relative to the other materials. Explain your hypothesis, based on the physical properties of the material.



Perform and Record

5. Perform your investigation, and record your results.

Analyze and Interpret

1. Compare how effectively each material prevented the surface from warming.
2. What applications might there be for the material that worked most effectively? Keep in mind that the use of the material needs to solve more problems than it creates. For example, replacing black road surfaces with white or reflective surfaces would make it nearly impossible for people to drive on the roads in daylight. On the other hand, planting trees to shade roads and parking lots might be successful.
3. Assess the accuracy of your results. If one of your classmates tried to reproduce your results, how successful would your classmate be? Explain your reasoning.
4. If you had to carry out your investigation again, what would you do differently?

Communicate Your Findings

5. Present your results using both a visual component and a written component.

Assessment Criteria

Once you complete your project, ask yourself these questions. Did you...

- K/U provide an accurate description of each ground-cover material, and explain why it would not interfere with the land use?
- T/I formulate an appropriate hypothesis about possible changes in temperature for each material?
- T/I control appropriate variables and use equipment and materials safely, accurately, and effectively?
- T/I analyze and interpret the data for each material you tested to determine whether the evidence supports or contradicts your hypothesis?
- T/I identify sources of error that may have limited the accuracy of your process, and suggest improvements to your original design?
- C organize and record data accurately, using appropriate visual and written components?

An Issue to Analyze

Dealing with Climate Change

Scientific studies have resulted in some worrying predictions about future climate change. Scientists can only provide probabilities for their predictions, however, and preventing the possible effects of climate change could be very expensive. As a result, there are different opinions about the wisest course of action. A cost-benefit analysis can help you decide what should be done about climate change

Issue

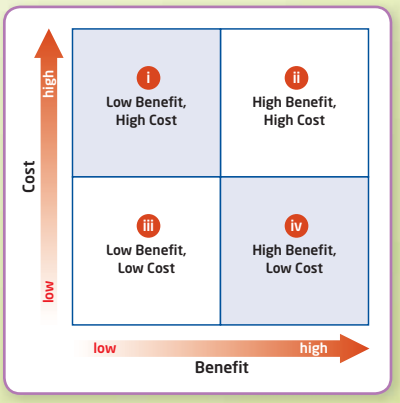
What actions could be taken to deal with the possible effects of climate change?

Initiate and Plan

1. Make a list of actions and initiatives related to climate change that you have read about in this unit.
2. Research the projected costs and benefits of eight of these actions and initiatives.

Perform and Record

3. Draw a cost-benefit matrix like the one shown below.
4. Choose one action or initiative that would help to reduce the severity of predicted climate change. Place the name of the action or initiative in one of the cells of the cost-benefit matrix, based on the cost of the action or initiative and its perceived benefit. For example, an initiative that would cost a lot but would yield greatly beneficial results would be placed in the "High Benefit, High Cost" quadrant. Any action or initiative requiring technology that is not yet perfected or invented would have a very high cost.
5. Repeat step 4 for each of the other actions and initiatives.



Analyze and Interpret

1. Which actions or initiatives would you recommend, based on their relative costs and benefits? Explain your reasoning.
2. For each action or initiative you recommend, identify two ways that you could contribute to its implementation.
3. Collaborate with your classmates to reach a consensus on the most highly recommended action or initiative. Summarize the reasons for your choice.
4. For your choice, identify the costs and strategies for implementing and enforcing it. Prepare a brief summary that describes the recommendations of your class.

Communicate Your Findings

5. Take what you have learned and decided in this project, and write a persuasive letter to your representative in Parliament (federal or provincial) to express your opinion about Ontario's course of action or inaction regarding climate change.

Assessment Criteria

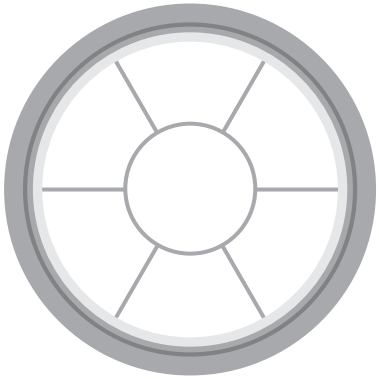
Once you complete your project, ask yourself these questions. Did you...

- K/U make a list of actions and initiatives related to climate change?
- A consider the evidence from your cost-benefit analysis when recommending actions or initiatives?
- A identify two personal contributions you could make to help implement your recommended actions or initiatives?
- A survey the personal opinions of your classmates before choosing one action or initiative?
- A summarize multiple perspectives on the action or initiative, related to cost, implementation, and enforcement?
- C collect information from a variety of sources?
- C organize and communicate the information accurately for the intended audience and purpose?

Unit 3 Review

Connect to the BIG IDEAS

Use this bicycle wheel graphic organizer to connect what you have learned in this unit to the Big Ideas, found on page 263. Draw one bicycle wheel for each Big Idea and write the Big Idea in the centre. Between the spokes of the wheel, briefly describe six examples of that Big Idea.



Knowledge and Understanding K/U

1. Which of the following factors affects Earth's climate by changing the albedo of the planet?

a. the acidity of the oceans

b. the amount of energy emitted by the Sun

c. the tilt of Earth's axis

d. the size of the polar icecaps

2. Which of the following biomes is found in Ontario?

a. boreal forest

b. desert

c. permanent ice

d. temperate rainforest

3. Which greenhouse gas has the highest global warming potential?

a. carbon dioxide

b. chlorofluorocarbons (CFCs)

c. methane

d. nitrous oxide

4. Which of the following activities will reduce your carbon footprint?

a. eating large amounts of meat and dairy products

b. leaving appliances plugged in when not in use

c. using compact fluorescent light bulbs

d. using single-use plastic shopping bags

5. Which of the following tools do scientists use to predict future climate change?

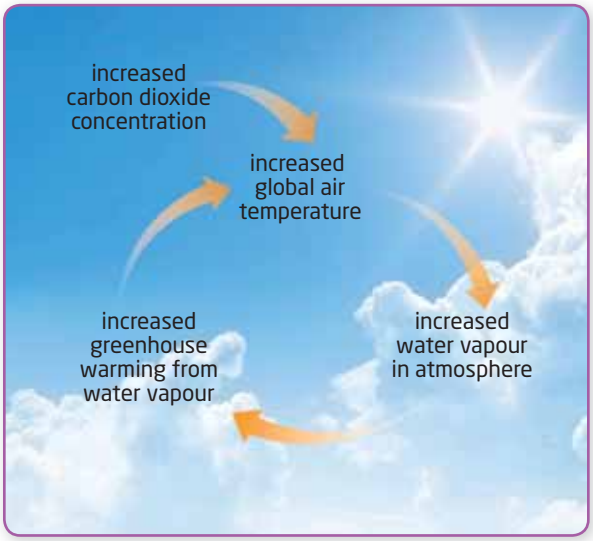
a. radar

b. weather satellites

c. general circulation models

d. ice cores

6. The diagram below shows a feedback loop in Earth's climate system. Write a short paragraph that describes this feedback loop. Identify it as a positive feedback loop or a negative feedback loop.



7. How might global warming affect Canadian agriculture by 2050?

8. Compare the end result of a positive feedback loop with the end result of a negative feedback loop.

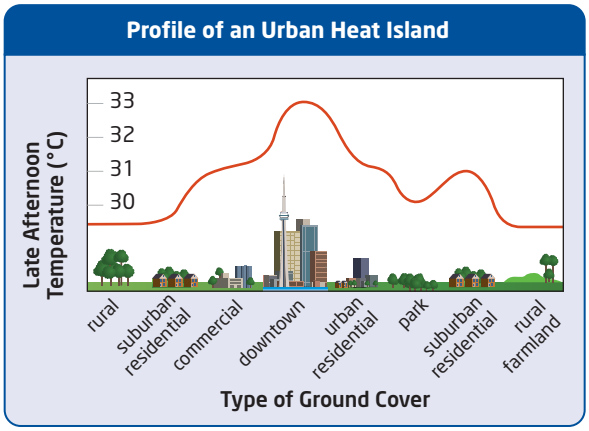
9. What is the relationship between the concentration of carbon dioxide in the atmosphere and the acidity of the oceans?

10. Explorers have found fossils of ferns, trees, and alligators on islands in the high Arctic. Geologists say that these islands were at the same latitude on the globe when those organisms lived as they are now. What conclusions about climate can scientists draw from the fossils?

11. How do bodies of water affect local temperatures?

12. Global and local climates have changed many times in Earth's history. Name three reasons why people are concerned about the changing climate today.

13. The diagram below shows the temperature profile around an urban area. How do roads and buildings affect local climate?



14. How do scientists test the accuracy of general circulation models?

15. Explain whether you think a cap-and-trade system is a better way of dealing with increased carbon dioxide emissions than introducing carbon taxes.

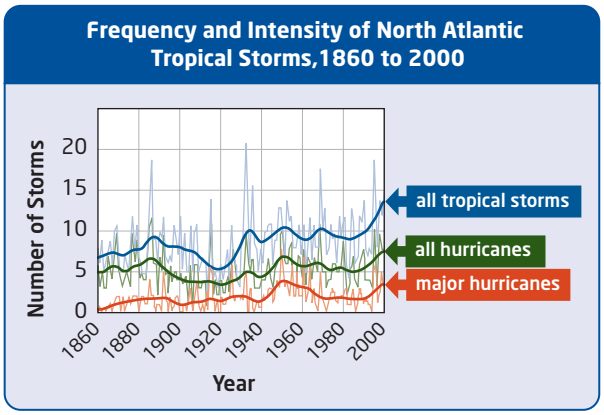
Thinking and Investigation T/I

16. One argument against taking action on climate change is that we do not know what changes would have taken place without human intervention, so we cannot know what effect our actions will have on the environment. How can scientists tell which changes are the result of human activities?

17. Research myths and facts about climate change. Which of the myths sound plausible to you? Write a short essay that describes how a specific myth became widespread and explains why this myth is incorrect. Remember to cite all of your references.

18. Some skeptics who claim that anthropogenic climate change is a myth state that carbon dioxide is only a few parts per million in the atmosphere and that it has changed by only a few parts per million in 200 years. They claim that this change is too small to affect the climate. Based on what you have learned in Unit 3, explain why you agree or disagree with the sceptics' claim.

19. The graph below shows the frequency of tropical storms and hurricanes in the North Atlantic Ocean. How does this graph support the idea that Earth's oceans are warming?



20. Given that the weather is unpredictable within any single week, why do scientists think they can predict climate?

21. Research any new initiatives to monitor Earth's climate that have been developed since the publication of this book. Write a paragraph that outlines these initiatives and their objectives.

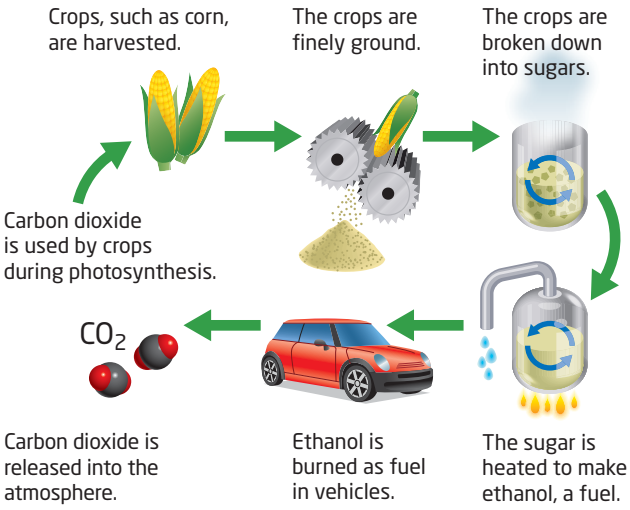
22. Imagine that your grandparents lived in the same town in Ontario for the past 80 years. They comment that winters are not like they used to be. Is this statement evidence of a change in weather or in climate? Explain your answer.

23. Identify three sources of bias in weather records. What steps have scientists taken to counteract these biases?

Unit 3 Review

Communication C

24. The following diagram shows how ethanol (a biofuel) is made and used. Analyze the illustration for bias by using the list of questions you learned in Chapter 9. Then create a list of questions you have about the topic described in the diagram. Write a short paragraph that describes any changes you suggest be made to the diagram to clarify the information or to eliminate bias.



25. Create an image that you think is effective for promoting your point of view about climate change. You may use photography, drawing, painting, collage, sculpture, fashion, or any other visual method to convey your ideas.

26. Write a letter to the editor of your local newspaper outlining five actions that every person can take to lower greenhouse gas emissions in your area. Be sure to include information about how much carbon emissions can be reduced by each action.

27. Summarize the sources and sinks of greenhouse gases by using a graphic organizer of your choice.

28. Think back to the opinion you had when you began this unit about whether humans are responsible for climate change on Earth. Write a paragraph that answers the following questions.

- **a.** What have you learned that you did not expect?
- **b.** What have you learned that has supported your opinion?
- **c.** What have you learned that has challenged your opinion?
- **d.** What questions have not yet been addressed?
- **e.** What questions do you have now that you did not have before?
- **f.** What evidence would cause you to change your opinion?

Application A

29. If an error were discovered in the way paleoclimatologists have evaluated ice cores, would all of their assumptions about past climates have to be discarded? Explain your answer.

30. Why are the Arctic and Antarctic regions the most likely regions of the planet to show warming if increased greenhouse gas concentrations are causing a stronger greenhouse effect?

31. Global warming is expected to make Earth's climate warmer in the winter, hotter in the summer, and drier all year round. What are some adaptations that humans will have to make if these predictions are true?

32. Why would a forestry company be more concerned about the possibility of climate change than a farmer?

33. Hundreds of millions of years ago, carbon dioxide levels were much higher than they are today, but Earth's average temperature was not significantly higher. What factors may have caused these conditions?

34. The winters of 2007 and 2008 were the snowiest in Toronto's history. Explain why these snowfall records do not constitute evidence of climate change.

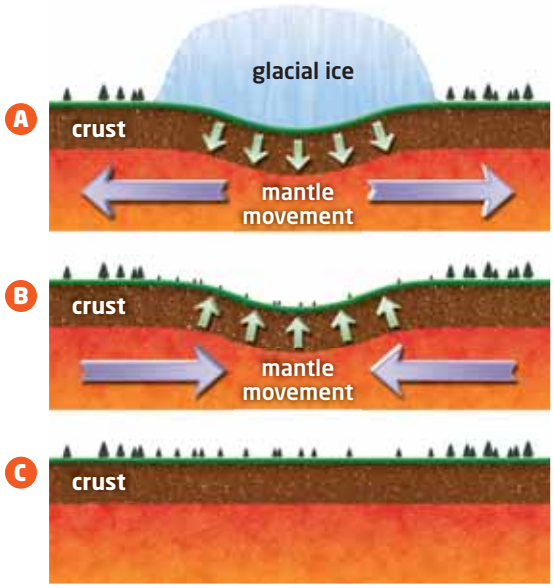
Literacy Test Prep

Read the selection below and answer the questions that follow it.

Continental Rebound and Sea Level

Some scientists think that global sea level is rising so fast because Antarctic ice is melting faster than they previously thought. Measurements of ice loss in Antarctica may be incorrect due to a factor called rebound, which is illustrated below. During the last ice age, the huge masses of ice that covered parts of the continents pushed down on the land. After the ice melted, the land began to rise again, and it is still rising slowly today. Because measurements of sea level are taken relative to the land, a rise in the land can distort calculations of actual increases in ocean volume.

To determine the impact of continental rebound on sea level, Dr. Richard Peltier of the University of Toronto developed a complex computer model that describes where on Earth land is being uplifted or is subsiding, and by how much. To confirm the predictions of his model, two gravity-measuring satellites were launched into Earth orbit in 2002. They are part of the Gravity Recovery and Climate Experiment (GRACE). The two satellites work together to detect very small variations in gravitational attraction around the planet that indicate where land is growing thicker or thinner. Data collected by the GRACE program have so far confirmed most of the predictions of Dr. Peltier's model.



Multiple Choice

In your notebook, record the best or most correct answer.

35. Which of the following statements best summarizes the main point of the first paragraph of the selection?

- **a.** The movement of the continental crust is causing ice in the Antarctic to melt faster than scientists predicted.
- **b.** Ocean volume is greater than scientists thought it was because there is so much ice on the continents.
- **c.** Continental rebound may have caused scientists to incorrectly measure the rate at which Antarctic ice is melting.
- **d.** The weight of glacial ice is pushing down on the continents and causing sea level to rise.

36. The purpose of the information in the second paragraph is to

- **a.** encourage the reader to construct a computer model to study sea-level rise
- **b.** organize information about gravity-measuring satellites
- **c.** inform the reader about a scientific study on continental rebound
- **d.** recommend that the reader find additional information about GRACE

37. According to the diagram, what causes the land to uplift?

- **a.** the weight of the ice
- **b.** the movement of the mantle
- **c.** the thickness of the crust
- **d.** the amount of water in the ocean

Written Answer

38. Write a short essay that explains how important you think the movement of tectonic plates is to the climate change that has been measured in the last 200 years. Use specific details and examples from the selection and from the material you learned in this unit to support your opinion.