13 The Environment: Our Challenges and Responsibilities

GUIDING QUESTIONS

Politics & Government

- How has the international community responded to ozone depletion?
- How has the international community responded to climate change?
- What are the principal international agreements concerning the environment?

Economy & Human Geography

- How are resources, the environment, and human populations interconnected?
- What is sustainable development?
- What are the environmental threats to water resources and how might they be addressed?
- Should Canada treat water as a resource to be traded?
- How is human activity affecting the atmosphere and the ozone layer?
- What is global warming?
- How can we offset environmental threats at the local, national, and international levels?

TIMELINE

1962
Rachel Carson's book *Silent Spring* is published

1970
First Earth Day

1971
Canadian government establishes the Department of the Environment

B.C. activists found Greenpeace

1972
UN Conference on the Human Environment is held in Stockholm, Sweden, and leads to creation of the United Nations Environment Programme (UNEP)

1974
Agricultural Land Reserve established in B.C.

1987
The UN report *Our Common Future* urges the developed world to limit the use of resources for a sustainable lifestyle

1988
The UN creates Intergovernmental Panel on Climate Change

CHAPTER FOCUS QUESTION

How is global development causing environmental issues and what challenges do they pose for Canada?

Earth's resources, environment, and human populations are interconnected. As the world's population increases, the scale of human impact on the planet grows. Oceans, fresh water, soil, forests, minerals, and energy resources have been used, and often abused. Our use of fossil fuels has caused the thinning of the ozone layer and the greenhouse effect. We have caused harmful changes in the **biosphere**, the zone of earth, water, and air in which we live. Our livelihoods come from this thin zone, and all things, including people, eventually return to it.

Canada has a unique perspective on the effects of changes to the environment caused by human activities. The impact of global warming is evident in the Arctic's melting ice and permafrost, and in the decreased water flows from retreating glaciers in the Rocky Mountains. Changes to the environment threaten Canada's boreal and temperate forests. The overuse of resources has depleted marine harvests and other food supplies, and our health is compromised by toxins in our rivers and soils. Changes to the environment also cause extreme weather, such as droughts, storms, and floods.

Canada, along with other industrialized countries, must take its share of responsibility for causing problems related to environmental changes. As a major consumer and exporter of resources and fossil fuels, we leave a larger environmental footprint than countries of comparable size. While major decisions are made by government and industry, many individuals and communities have become active in helping to protect the environment. Recycling, composting, and green energy initiatives are all examples of how Canadians can work to preserve a healthy environment.

In this chapter, you will examine some of the changes in our environment, including global warming, the depletion of the ozone layer, and the threats to our water resources. You will also look at some of the solutions proposed and initiatives launched to help address the problems created by environmental changes.

KEY TERMS

deforestation
global warming
acid precipitation
CO_2 emissions
groundwater
aquifer
greenhouse gases (GHG)
ultraviolet radiation (UV)
ozone layer
CFCs (chlorofluorocarbons)
Montréal Protocol
Kyoto Protocol

1992
Earth Summit in Rio de Janeiro, Brazil, calls for a sustainable world economy

1997
Countries signing the Kyoto Protocol commit to cut their CO_2 emissions

2000
Environmental Protection Act comes into force in Canada

2007
Fourth Assessment Report of Intergovernmental Panel on Climate Change

Bali conference held to agree on new treaty to replace Kyoto in 2012

2008
British Columbia government introduces a carbon tax on energy

2009
UN Climate Change Conference in Copenhagen, Denmark

2014
Fifth Assessment Report of Intergovernmental Panel on Climate Change

- How are resources, the environment, and human populations interconnected?

KEY TERMS

biosphere regions of Earth occupied by living organisms, made up of all the ecozones

stewardship careful management of resources to ensure that they are sustainable

permafrost subsoil that remains frozen all year long

carrying capacity the largest population that an environment can support

deforestation the process of destroying a forest and replacing it with something else

Why Care About the Environment?

People are changing Earth and the effects are seen all over the planet. The world's boreal forests are threatened with increased fire risk, water needs are outstripping supply, flooding and storms are more severe, and tropical diseases are affecting people farther north. For years, there have been warnings about how people's actions affect the environment. In 1992, 1700 concerned scientists from around the globe signed the World Scientists' Warning to Humanity:

> *Human beings and the natural world are on a collision course. Human activities inflict harsh and often irreversible damage on the environment and on critical resources.... A great change in our* ***stewardship*** *of the Earth and the life on it is required, if vast human misery is to be avoided and our global home on this planet is not to be irretrievably mutilated.*

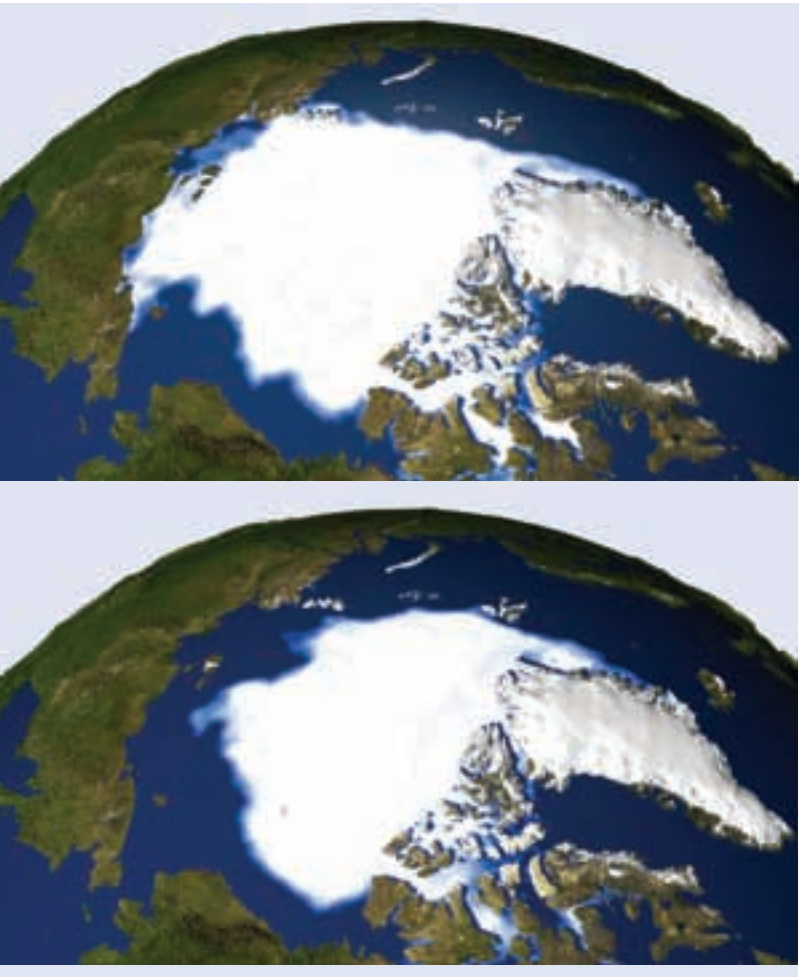

FIGURE 13–1 The top photograph shows Arctic ice in September, 1979. The bottom photograph shows the same view in September, 2005.

Interpreting a Photograph What differences do you see between the two photographs? What do the differences mean?

Despite these warnings, people continue to take Earth and its resources for granted. In 2009, the United Nations Environment Programme (UNEP) report on climate change again warned that "serious and irreversible changes in Earth's Ecosystems due to anthropogenic [human] activities are increasingly recognized...."

It can be difficult to convince Canadians that rising temperatures are a problem even though the changes are evident. Extreme weather conditions, such as the ice storm that hit eastern Ontario and Québec in January 1998, are happening more frequently. Warmer weather brings more droughts that make forest fires more likely.

Canada's Arctic regions show some of the most dramatic signs of change. Sea ice is shrinking and the seasonal melt is happening weeks earlier. Polar bears are in danger of extinction as they slowly starve because they cannot use the ice to hunt seals. Arctic communities face sinking shorelines and transport problems as a result of melting **permafrost**. The effects of these climate changes are also political. Some countries, including the United States, Russia, Denmark, and Norway, see the potential for economic wealth from oil and natural gas deposits in the Arctic seabed and shipping lanes through an ice-free Northwest Passage. These nations question Canada's claim to sovereignty over the Arctic, as you read in Chapter 7.

Population Growth and Sustainability

As you read in Chapter 11, Earth is getting more and more crowded every day. Each year, nearly 80 million people are added to the world's population, putting more pressure on Earth's natural systems. Because much of the population increase is in the developing world, the impact is not as great as if it had occurred in the developed world. About 80 percent of the goods and services produced from the world's resources are being consumed by 20 percent of the world's population, mainly in industrialized Western countries. As an increasing number of nations reach the development levels of the industrialized world, pollution and waste levels are rising and threaten to overwhelm Earth's **carrying capacity** and natural systems.

Feeding a Growing Population

The United Nations estimates that the world's population will be close to 8 billion by 2028 (see Chapter 11). Massive amounts of land and water are required to feed all these people. For example, 70 percent of the world's water is used for agriculture. It can take up to 1500 litres of water to produce 1 kilogram of wheat and 500 litres for 1 kilogram of potatoes. As standards of living improve, people are eating more meat and dairy products, which puts the greatest strain on resources. For example, it takes about 1000 litres of water to produce 1 litre of milk, and nearly 16 000 litres to produce 1 kilogram of beef. Added to this are the costs of **deforestation** to create grazing land, energy use to ship food, and depletion of resources. The problem may not only be how to feed the world's growing population, but how to ensure enough resources are available to keep up with the increase.

Agricultural Practices

Soil is one of our primary resources. It is the basis of plant life, which in turn gives us food and other resources. It can take hundreds of years for soil to form in some places. But it can be eroded by wind or water in a fraction of that time. In North America, the "dust bowl" of the 1930s (see Chapter 4) led to improved farming techniques, such as planting trees to form wind breaks, contour plowing, and using wheat stubble and straw to return nutrients to the soil and stop wind erosion.

FIGURE 13–2 The Tata Nano, produced in India, is a compact car aimed at the millions of motorcycle owners in the developing world. It features low emissions, excellent fuel economy, and a starting price of about $2500.

Thinking Critically What impact do you think the Tata Nano will have on the economy, people's lifestyles, and the environment if many people in the developing world drive them?

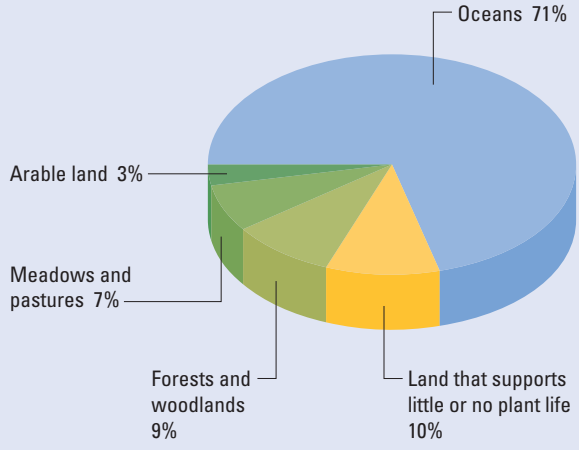

FIGURE 13–3 Only a small percentage of Earth's surface can be used for growing crops, yet soils are being lost and degraded around the world.

KEY TERMS

global warming the observed and projected increase in the earth's average temperature due to burning of fossil fuels and deforestation

ecology the science concerned with the relationship between living things and their environment

acid precipitation any form of precipitation that is high in sulfuric and nitric acids as a result of pollution in the air

Today, Canada's farmers face challenges, such as changes in weather patterns due to **global warming**, urban settlements encroaching on farmland, competition from giant farms operated by multinational corporations, and genetically modified crops mixing with regular crops. More than 100 genetically modified foods, such as soybeans, corn, and potatoes, have been approved by the Canadian government. Many of these crops rely on herbicides, which increase the risk of damage to the environment and possibly lead to long-term effects on people's health.

Making Room for People

Forests are a vital part of world **ecology** because they take in carbon dioxide and give off oxygen. Almost half of the forests that covered Earth before humans began to practise agriculture have been cleared or are in a degraded state. Every day, approximately 350 square kilometres of forest are lost worldwide. These forests are being turned into agricultural or grazing land, harvested for timber, or cleared to make room for human settlements. Many forests and natural areas are also suffering from the effects of industrial pollution, such as **acid precipitation**. When the environment can no longer neutralize the acidic content of the soil and water, plants and animals die, and entire ecosystems are ruined.

Without the protection of trees and their roots, wind and rain can erode the soil and leave barren landscapes. This damage is particularly severe on hillsides, where soil erosion and deadly mudslides can silt lakes and rivers, affecting water quality and marine ecosystems. Floods are more common when forests are no longer there to absorb and slowly release rainfall. In Canada, deforestation deprives wildlife of habitat, which may lead to more attacks by bears and cougars as urban settlements encroach on their territory.

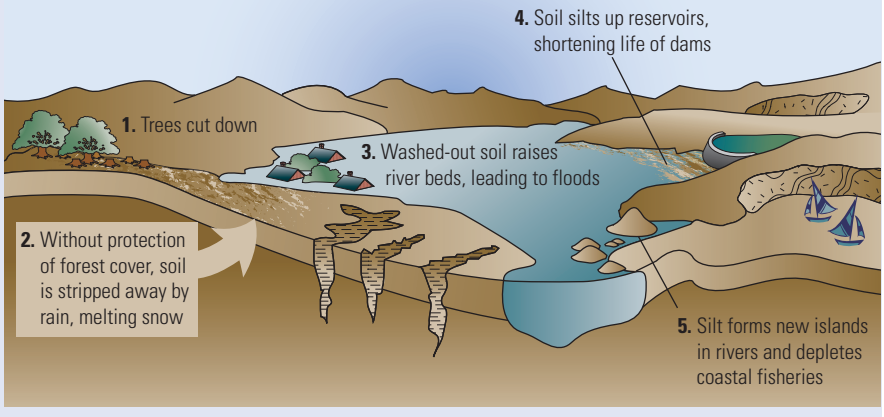

FIGURE 13–4 The immediate effects of deforestation are dramatic and wide ranging.

Thinking Critically Where in Canada are forests being cleared? What steps could be taken to slow the rate of clearing?

PRACTICE QUESTIONS

1. Write three different headlines, each one summarizing one of the concerns in the World Scientists' Warning to Humanity.
2. Provide specific examples of environmental changes in Canada's Arctic.
3. Explain the difficulties of feeding a growing world population.
4. Explain why soil is an important resource.
5. List three farming techniques used to protect soils.
6. Explain the challenges and concerns faced by farmers today.
7. Discuss the environmental impact of deforestation.

Problem Solving and Decision Making

CRITICAL INQUIRY Cause and Consequence

Problem solving is the process of figuring out how to reach a desired goal. Decision making is the process of selecting one of two or more possible solutions to a problem.

Steps to Problem Solving and Decision Making

1. **Identify the problem.** Analyze the components of the issue and any relationships among the parts. State the problem clearly and concisely.
2. **Gather all the information you can.** Research the issue. Take note of cause and effect when they apply.
3. **Brainstorm possible options or solutions.** Generate ideas on the subject. Include those you have read about as well as any ideas you come up with. Do not try to evaluate ideas at this stage.
4. **Consider the advantages and disadvantages of each option.** Use organizers or other aids to help you categorize the options and solutions.
5. **Rank the options.** Evaluate the options or solutions and select the top three choices.
6. **Decide on the option you think is the best.** Be able to support your decision with a number of reasons.
7. **Evaluate the effectiveness of your decision.** If you are dissatisfied with the results, return to step five and select from the remaining two choices.

FIGURE 13–5 Some experts estimate that more than 90 percent of waste from Canada's cities ends up in landfills.

Practising the Skill

Canadians are used to discarding their solid waste in landfills. In some large urban centres, landfills are full and there is nowhere for the garbage to go. Some people worry that if landfills are not managed properly, they can pollute groundwater and emit methane gas. What are some possible solutions to the problem of solid waste disposal?

- Many cities encourage people to decrease waste by using the three Rs—reduce, reuse, and recycle. Some cities also restrict the amount of waste they will accept. This approach can be expensive, as cities need to collect, sort, and recycle the materials they collect, as well as promote their programs and convince people to change their habits.
- Other cities incinerate some of their solid waste to keep it out of landfills. This approach has the advantage of producing heat, which in turn can be used to produce electricity. But some people argue that the smoke and ash released into the air contain hazardous chemicals.
- Another option is to ship solid waste to rural areas. While this might solve the problem for one city, it could cause problems where the new landfill is created. It also costs money and uses fuel to ship the waste, which increases the environmental footprint of the landfill.

Applying the Skill

1. Evaluate the solutions presented and look for other options. Decide which option you think is best and support your decision with reasons.
2. Use the steps to problem solving and decision making to examine the following issues.
   - **a)** The Alberta oil sands
   - **b)** Rising water levels in coastal areas
   - **c)** Alternative energy sources in British Columbia
   - **d)** Preserving sufficient natural habitat for wildlife

- What is sustainable development?

KEY TERMS

sustainable development a way to maintain economic growth without damaging the environment

Earth Summit a meeting of world leaders, held in Rio de Janeiro, Brazil, in 1992, to discuss environmental changes and sustainable development

Agenda 21 a statement of environmental action, produced at the 1992 Earth Summit, that outlines actions that should be taken to protect the planet and achieve sustainable development

herbicides substances used to kill plants

pesticides substances used to kill pests such as unwanted plants and animals

organic grown or produced without chemical fertilizers or pesticides

CO_2 emissions carbon dioxide emissions caused by burning of fossil fuels; largest contributor to global warming

biodiversity having a variety of life forms

ecotourism tourism to threatened areas that tries to be low-impact and small-scale

WEB LINK

Visit the Pearson Web site to learn more about the Earth Summit and Agenda 21.

Sustainable Development

Although scientists have warned of the harmful effects of environmental change for many years, developed nations have made only moderate progress toward **sustainable development**. Globalization and the emphasis on economic growth have encouraged wasteful consumption habits. One example of the devastating effects of abusing natural resources is the collapse of the cod fisheries off the coast of Newfoundland. Overfishing depleted cod stocks to the point that the Canadian government imposed a moratorium on cod fishing in 1992 and finally banned cod fishing altogether in 2003. This marked the end of an industry that thousands of Newfoundlanders depended on. Future generations depend on today's leaders and individuals to find sustainable ways to support economic growth.

International Efforts

Many international meetings have discussed how to maintain economic growth without damaging the environment so much that it compromises the future of life on Earth. In 1987, the United Nations World Commission on Environment and Development published its report, *Our Common Future*, asking people in the developed world to reduce resource consumption and develop a sustainable lifestyle. In 1992, 172 nations participated in the UN's **Earth Summit** in Rio de Janeiro, Brazil. International leaders looked at various environmental issues that affect people around the world, including toxic chemicals used in production (for example, lead in gasoline and radioactive waste), alternative energy sources to replace fossil fuels, and the scarcity of water. The conference produced a statement of action called **Agenda 21**. This document proposed several actions that should be taken globally, nationally, and locally to achieve sustainable development. Despite having this blueprint for action, there has been little progress in slowing the wasteful consumption that threatens the well-being of the planet.

The First Nations' Approach

Some approaches to sustainable development are modelled on Aboriginal peoples' practice of environmental stewardship and responsibility. On their Web site, the Squamish Lil'wat First Nation says, "Elders teach that we should keep in mind seven generations ahead of us in everything we do, to ensure that we care for future generations in our present decisions." This idea of responsibility has inspired many people to think about how their actions affect others and what they can do today to protect the environment for future generations.

FIGURE 13–6 The Gwa'ni Hatchery, near Alert Bay on Vancouver Island, is part of the Namgis First Nation Project, which helps to ensure that salmon stocks are managed and sustained for future generations.

Thinking Critically What elements of the First Nations' approach to decision making can you see in different environmental protection programs in your school or community?

Farming for the Future

The globalization of agriculture has led to unsustainable practices such as offshore farms (see Chapter 12) and large-scale farming operations (often referred to as "factory farms"). These approaches keep costs down by using large-scale, assembly-line methods to mass produce livestock and crops. Multinational corporations, such as Monsanto and DuPont, have tried to control markets for their seeds, fertilizers, and pesticides by aggressively promoting the genetically modified (GM) seeds they develop. These companies argue that new biotechnologies are necessary to feed the growing world population. Critics point to the environmental effects of using GM seeds. GM crops depend on **herbicides** and **pesticides**, rather than natural defences, and these chemicals can be dangerous as they seep into groundwater and streams.

FIGURE 13–7 The market for natural pest control is growing. One ladybug can eat up to 4000 harmful insects in its lifetime.

Thinking Critically What other activities might use chemicals that would harm the soil and affect the environment?

Becoming more aware of the impact food production has on the environment and their health has prompted many people to adopt a more sustainable diet. This change is reflected in the increase in certified **organic** farms in Canada to more than 3500 in 2006. But organic farms represent only 0.9 percent of Canada's agricultural land, and most of these farms grow cereal crops for export. At the same time, nearly 90 percent of organic food bought in Canada is imported. Concern over the environmental impact of shipping food great distances has led some people to become "locavores," eating foods that are grown or produced locally. Supporters of this diet say it is more sustainable because shorter shipping distances reduce **CO_2 emissions**. Despite this growing demand, many local farmers find it hard to compete with low-priced imported food and must produce crops in demand for export in order to make enough money to get by.

WEB LINK

Visit the Pearson Web site to learn more about foods produced in British Columbia.

Can We Preserve Our Forests?

Around the world, 1.6 billion people depend on forests for food, shelter, and employment. Forests also protect **biodiversity** and remove carbon dioxide from the atmosphere. To emphasize the importance of forests and support efforts to promote sustainable management and conservation, the UN declared 2011 the International Year of Forests.

Several measures have been introduced to preserve and manage the world's forests. Some programs focus on reforestation, replanting trees where they have been cut down for timber or paper. Other programs grow trees specifically for these purposes, thus preserving existing forests. Another approach is to show that there is economic value in preserving forests instead of cutting them down. **Ecotourism** programs allow people to explore threatened natural environments, while the tours raise money for conservation efforts. Individuals can also help to preserve forests by conserving paper. One fifth of wood harvested worldwide ends up in paper, and nearly half of that is used for packaging. In 2003, Canadians used more than 2 million tonnes of paper, which is about 20 000 pages per person.

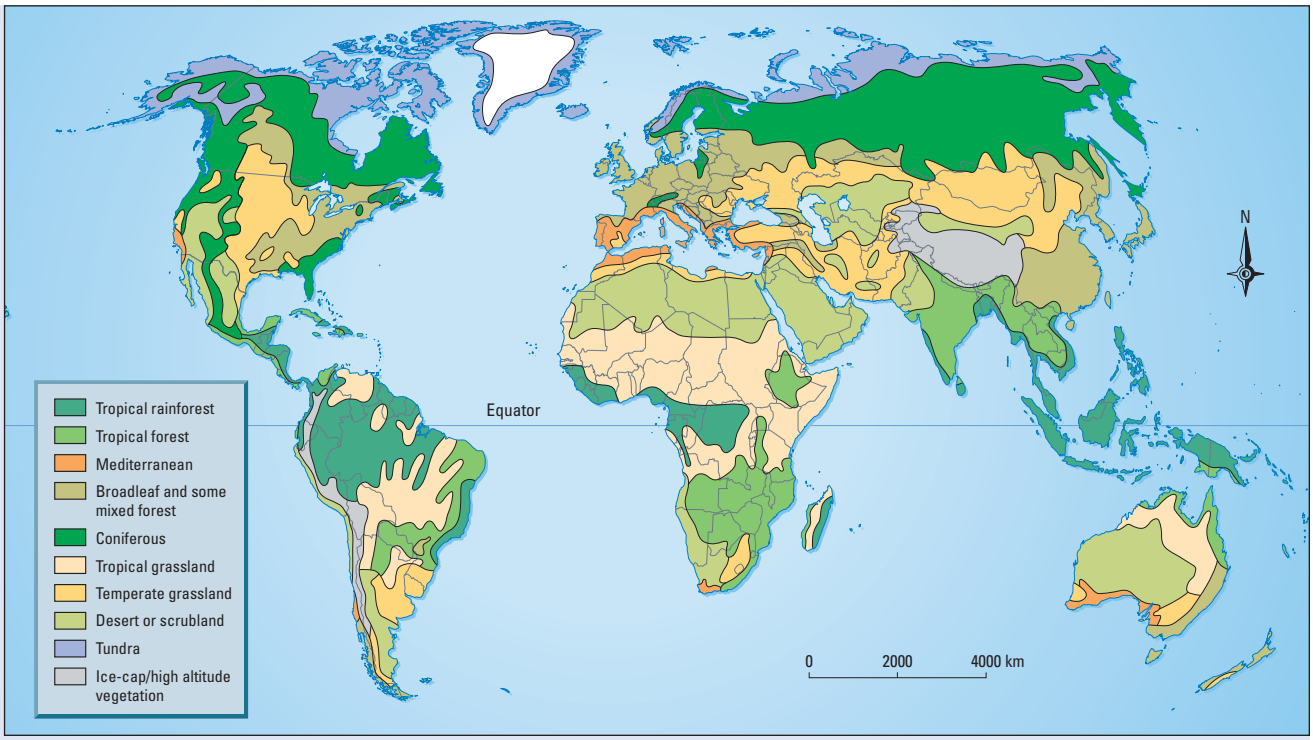

FIGURE 13–8 This map shows forested areas that existed under natural conditions. Much of the forested areas in India, China, Western Europe, and eastern North America have been cleared.

KEY TERMS

Protected Areas Strategy (PAS) a plan to preserve approximately 12 percent of B.C.'s provincial land for parks, recreation, and wilderness

watersheds river basins drained by a river and flowing into the same large body of water

Protecting British Columbia's Forests

In 1993, the government of British Columbia launched the **Protected Areas Strategy (PAS)** to preserve about 12 percent of provincial land for parks, recreation, and wilderness. However, the PAS only included a portion of B.C.'s coastal old-growth **watersheds**. Once considered only as a source of revenue, they are now seen as a resource for recreation, research, industry, and—in the case of First Nations peoples—culture. These diverse needs must be balanced with careful management and stewardship to ensure the sustainability of British Columbia's economic and heritage resources.

One example of the clash between these interests is the Great Bear Rainforest. This area is one of the last remaining tracts of unspoiled temperate rainforest left in the world. It is home to thousands of species, including the Kermode (or spirit) bear. These bears are rare, and logging and industrial development in the area threaten their habitat and existence. In a 2006 agreement, First Nations communities, environmentalists, and logging companies agreed to conserve part of the 6.4 million hectares of the Great Bear Rainforest. Two million hectares are protected from logging, with lighter-touch logging outside that area. The agreement supports conservation-based economies in coastal communities and strengthened First Nations involvement in deciding the future of the forest.

FIGURE 13–9 The Great Bear Rainforest is located on B.C.'s central coast between the northern tip of Vancouver Island and the southern tip of the Alaska Panhandle.

Thinking Critically In what other areas might an agreement to conserve land be used to promote sustainable use of resources? Explain.

up close and personal

Simon Jackson: Create the Change You Want to See

CRITICAL INQUIRY Perspectives

When Simon Jackson learned about the plight of the spirit bear, he wanted to do something to help. In 1995, when he was 13 years old, he founded the Spirit Bear Youth Coalition (SBYC) to unite young people to save British Columbia's endangered white bear. He wanted to give young people a voice as the future stewards of the rainforest and get them involved in protecting the environment.

Since it began, the SBYC has reached nearly 6 million young people in more than 70 countries, becoming one of the world's largest youth-run environmental organizations. Today, two thirds of the spirit bear's old-growth rainforest habitat is protected. But the SBYC still has work to do. As part of their efforts to protect the bears' remaining habitat, Simon and the SBYC have helped to produce an animated film called *The Spirit Bear*. This movie will spread the SBYC's message, and all proceeds from the film will go toward saving the rest of the bears' habitat.

Simon works hard to get his message to young people and decision makers alike. He learned from experts in the environmental movement, such as Dr. Jane Goodall, and from people in business, media, and politics. Simon and the SBYC have received various awards, and *Time* magazine named Simon one of its 60 "Heroes for the Planet." Through the SBYC,

WEB LINK

Find out more about the Spirit Bear Youth Coalition on the Pearson Web site.

FIGURE 13–10 Simon Jackson, shown in 2000 when he was 17 years old, advises young people to "Position yourself so you're ready to take advantage of success when opportunity knocks."

Simon encourages young people to become involved in environmental and social issues, and to use the experiences they gain as a way to make a difference in the world. He says, "I don't really think what I've done is unique or special. Anybody has the capacity to create change."

1. Make a list of environmental issues that concern you. Choose one and outline how you might begin a campaign to create change.
2. How important and necessary are organizations such as SBYC in protecting the environment?

PRACTICE QUESTIONS

1. Which countries or areas of the developed and developing worlds might be most affected by
   a) population growth?
   b) resource use?
2. If the First Nations' approach to decision making were used, do you think there would be so many endangered species? Keeping that approach in mind, how would you respond to the comments in the World Scientists' Warning to Humanity?
3. Explain the issues related to large-scale farming operations.
4. How have some people tried to make food production more sustainable?
5. What strategies are being used to better manage the world's forests?
6. Explain how the Great Bear Rainforest has become an example of environmental stewardship.

- What are the environmental threats to water resources and how might they be addressed?

Water: The Indispensable Resource

People cannot survive without water. Every person needs at least 1.8 litres of fresh water each day for good health. With water so readily available, Canadians seldom think of it as one of the planet's scarcest resources.

The State of the World's Water

Only 2.5 percent of the world's water is fresh water. About 70 percent of that is in the form of ice caps and glaciers, and most of the remaining amount is **groundwater**. Only 0.3 percent of the world's fresh water is in lakes and rivers. As Figure 13–11 shows, **surface water** is by far the most used source of water.

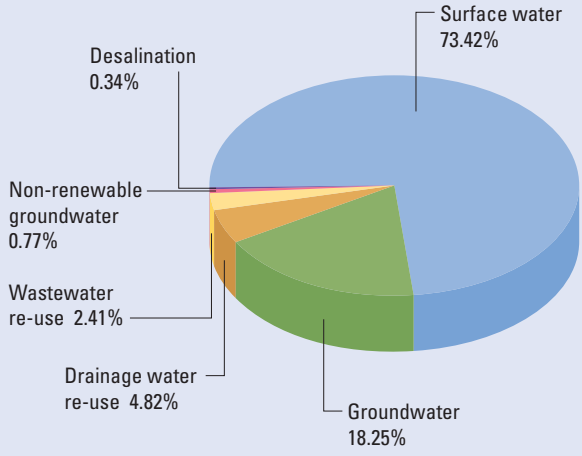

FIGURE 13–11 Global water withdrawals by supply source

In its World Water Development Report (2009), the United Nations World Water Assessment Programme (WWAP) noted that many people still lack adequate access to water. The UN's media release on the report states that freshwater withdrawals from surface and groundwater sources "have tripled over the last 50 years, while the area under irrigation doubled during the same period." The report links this increase to population growth, noting that "demand for freshwater is increasing by 64 billion cubic metres a year." Much of this demand comes from growing populations in the developing world, where water is already scarce.

But water scarcity does not only threaten developing countries. The UN's 2009 report revealed that many sources of fresh water are threatened. Industrialization and rising living standards are rapidly increasing the demand for water. Diets are changing to include more foods, such as meat, that require larger amounts of water to produce. The UN report predicts that if demands for water keep increasing, nearly half of the world's people will face severe water shortages by 2030.

Threats to Our Freshwater Supply

Canada's major water resources contain about 20 percent of the world's total fresh water and 7 percent of the world's renewable freshwater supply. Much of the fresh water is in northern regions, held in glaciers and the polar ice caps, inaccessible to fast-growing urban centres in the south. The Great Lakes contain 18 percent of all the surface fresh water on Earth, but we share them with the United States and they are becoming increasingly polluted. The average Canadian uses about 343 litres of water per day, compared to Germany's 193 and China's 86 litres per person per day (Figure 13–15).

Surface Water Pollution

People often build settlements and cities around sources of surface water, such as lakes, rivers, and coastal waters, but they sometimes neglect to take care of these resources. Surface water can be polluted from municipal, agricultural, and industrial sources. Municipal **wastewater** may contain human waste, detergents, and solvents. Agricultural chemicals like herbicides and pesticides can also make their way into surface water. Industries such as oil refineries, pulp mills, and chemical factories release wastes into rivers and oceans.

The effects of surface water pollution are apparent in Canada. For example, toxic wastes such as mercury have been found in whales and polar bears in the Arctic. Beluga whales in the St. Lawrence River are threatened by water pollution from industrial, agricultural, and human wastes. In British Columbia, sturgeon in the Fraser River are also at risk. Sewage is a major threat to the ecology of the Fraser River. An estimated 90 percent of the municipal waste in the river originates in the Fraser Valley and Vancouver areas. In lakes near populated areas, chemicals and wastes promote the growth of algae and weeds, which can deplete the lakes' oxygen supply, harming other living things, and affect recreational use. In the Okanagan, the spread of **watermilfoil weed** could threaten a multimillion-dollar tourist industry.

Abusing an Underground Resource

Increasing populations are the main threat to the world's freshwater supply. Falling groundwater tables and diversion of surface supplies for crop irrigation are the main causes of shortages. The Yellow River in China, the Ganges River in India, the Nile River in Africa, and the Colorado River in the United States are examples of rivers that run dry, or have little water left when they reach the sea. These shortages threaten world agricultural production. About 36 percent of the world's harvests comes from irrigated croplands. The United States, China, and India are all facing reduced groundwater supplies. These countries produce half of the world's food. In the latter half of the 20th century, the amount of irrigated land increased to more than 250 million hectares. Using new well-drilling technologies and techniques, farmers were able to tap the groundwater in **aquifers** beneath their land. The problem is that, unlike surface water supplies, aquifers are not rapidly replenished.

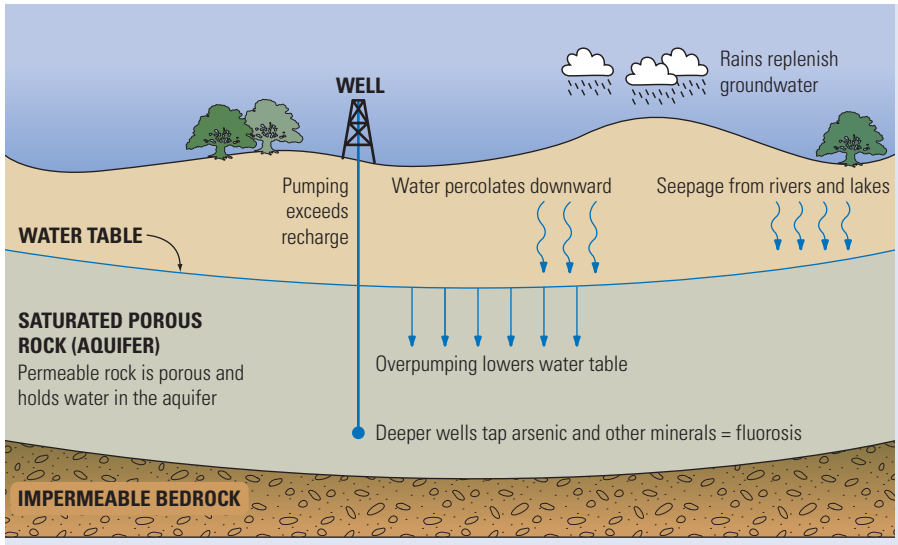

FIGURE 13–12 Groundwater depletion. Overpumping with diesel and electric pumps mines the water faster than it can be recharged by rain or seepage from surface sources. The falling water table means wells must be dug deeper.

KEY TERMS

groundwater water beneath Earth's surface in underground streams and other forms

surface water water that is readily available on Earth's surface in streams, rivers, lakes, wetlands, and oceans

wastewater water that has been used in homes or industries and, as a result, contains waste products

watermilfoil weed a plant that grows and spreads quickly, choking out native plants, affecting spawning areas for fish, and posing a safety problem if it grows around public beaches

aquifer an underground layer of rock, gravel, etc., from which water can be drawn for wells and which is a source of springs

Should Canada treat water as a resource to be traded?

As freshwater supplies diminish around the world, business people from Vancouver Island to Newfoundland have been quick to suggest ways to take advantage of Canada's abundant water supply. Although the federal government has officially opposed large-scale export of water since 1987, there have been conflicts over treating water as a sellable resource on the provincial level. In 1996, the government of British Columbia banned the export of bulk water and was sued by a California company under the North American Free Trade Agreement (NAFTA) for compensation for lost opportunity. Public outcry forced the government of Ontario to cancel a deal to export Lake Superior water to Asia. In Newfoundland, a plan to export lake water to the United States and the Middle East raised questions about Canada's water export policies.

Water Exports: Drinking Canada Dry

Some Canadians argue that Canada's fresh water should be treated like other resources exported for profit. They point out that this new industry would increase revenues and create jobs in areas of high unemployment, such as the Maritimes. Opponents claim that water is different from other natural resources. They argue that it is essential to human survival and Canada's supply should be treated as a public resource rather than a commodity sold to profit only a few. Maude Barlow of the Council of Canadians, a nationalist lobby group, strongly opposes exporting water. She believes that "Once you turn on the tap, you can't turn it off again." Nationalists claim that, under the terms of NAFTA, exporting any bulk water will mean that all water can be treated like any other trade good and Canada will lose control of its water.

Some water experts think that the whole issue of bulk water exports is overblown. They claim that transporting bulk water over long distances may not be profitable. A report to the government of Québec pointed out that desalination plants could turn salt water into fresh water for less than the cost of transporting it long distances by tanker. U.S. studies show that conservation

FIGURE 13–13 The southwestern U.S. is an arid region with scarce water resources. All of the surface water is regulated by legislation, and overreliance on groundwater has led to dramatic drops in the water table.

TIMELINE Water Export Decisions in Canada

1967
U.S. Supreme Court authorizes removal of bulk water from Lake Michigan into the Mississippi River system through the Chicago Diversion—the Chicago Shipping and Sanitary Canal. This is the only major diversion out of the Great Lakes Basin.

1970
Canada Water Act does not mention exports of bulk water.

1988
Canada Water Preservation Act introduced but not passed due to election. Would have banned the export of bulk water and large-scale diversions.

1998
A California company, Sun Belt Water Inc., files suit under NAFTA after B.C. government bans bulk water exports.

Public pressure forces Ontario government to cancel permit for bulk water exports from Great Lakes to Asian markets.

methods, such as low-flush toilets and drip irrigation, make far better economic sense than schemes to import large amounts of water. However, rich countries like the United States and Canada do not always adopt the most obvious or lowest-cost solutions to resource issues. The southwestern U.S. sunbelt states are looking for a quick solution to water shortages, and some see Canada's vast freshwater lakes as a resource they are willing to pay for.

Since 2002, the United States has linked a safe and reliable water supply to its national security. Global Water Futures, an American institute contracted by the U.S. government, has noted that "Water issues are critical to U.S. national security and integral to upholding American values of humanitarianism and democratic development. Moreover, engagement with international water issues guarantees business opportunity for the U.S. private sector, which is well positioned to contribute to development and reap economic reward." As a result of this new policy, the U.S. is putting pressure on Canada to give Americans access to Canadian freshwater supplies.

As the population grows and lifestyles put more pressure on water resources, sustainable water supplies may reach a crisis state in North America in the 21st century. In their 2008 report *Climate Change and Water*, the Intergovernmental Panel on Climate Change (IPCC) states, "Climate change will constrain North America's already over-allocated water resources, thereby increasing competition among agriculture, municipal industrial, and ecological uses." The integration of the North American economy and Canada's reliance on U.S. agriculture for much of our vegetables may force Canada to face difficult choices about our water resources.

FIGURE 13–14 While government regulations have prevented the export of bulk water, few Canadians pay attention to the fact that Canada exported about $38 million worth of bottled water in 2008.

Analyzing the Issue

1. Why might Québec be opposed to regulation of the export of water supplies?
2. With a partner, script and act out a short dialogue between a Canadian opponent of water exports and a Texas farmer whose wells are running dry.
3. Do you think Canada should allow the export of bottled water, bulk water, both bottled and bulk water, or no water? Give reasons for your answer.
4. Write a short opinion piece for a blog entitled "Three Good Reasons to (or Not to) Export Canada's Water." Include a suggestion for an appropriate picture to accompany your opinion piece.
5. Debate the pros and cons of bulk water exports.

2001

Canadian government amends the International Boundary Waters Treaty Act prohibiting bulk water removals from boundary water basins within Canada.

Government of Newfoundland and Labrador cancels plans to export water because it is unprofitable.

Government of Québec bans bulk water exports.

2005

Great Lakes Charter Annex Agreement signed by Ontario, Québec, and eight U.S. states that border the Great Lakes, banning the diversion of water other than to communities beside the Great Lakes.

2006

Businessman applies to the B.C. government to export 1 million gallons of water a day from a Kamloops Lake for export to the Middle East. Public opposition forces withdrawal of the proposal.

2007

Closed-door discussions in Calgary between Canada, Mexico, and U.S. on bulk water exports for North American Future 2025 Project.

KEY TERMS

carbon footprint the total amount of carbon dioxide (CO_2) and other greenhouse gases emitted over the full life cycle of a product or service

troposphere the lowest level of Earth's atmosphere

greenhouse gases (GHG) various gases in the atmosphere that absorb and emit radiation, including carbon dioxide, methane, nitrous oxide, and ozone

ultraviolet radiation (UV) invisible rays from the sun that can cause skin cancer

ozone layer a thin layer of ozone in the atmosphere 15 to 30 kilometres above Earth; the ozone layer filters the sun's ultraviolet (UV) rays

CFCs (chlorofluorocarbons) chemicals used in coolants, solvents, and aerosol cans that damage the ozone layer

Montréal Protocol an international agreement signed in 1987 to phase out the ozone-depleting chemicals CFCs

Conserving Our Water Resources

Experience has shown that conserving water by using it more efficiently makes sound economic and environmental sense. Infrastructure costs for water supply and wastewater treatment are reduced. The ecosystem is sustained and improved because less water is withdrawn.

Improving Supply

Water development programs are moving toward conservation and efficient small-scale supply systems. Some experts are optimistic that technology can help us manage our water supplies. Large-scale projects can be replaced by micro-dams, hydro systems that run with a river's natural flow, shallow wells, and more efficient rainwater harvesting. As technologies develop, experts believe we will use more reclaimed or recycled water and, to a lesser degree, desalinated sea water. Low-energy sprinkler systems and drip irrigation, which directs water to plant roots, are reducing agricultural water consumption in water-scarce Israel and could be used worldwide.

Reducing Water Consumption

In developed countries, industrial and domestic water use can be reduced using the same thinking. For example, high-efficiency and low-flow toilets reduce the amount of water needed to flush millions of toilets by 70 percent. Many Canadian municipalities are offering rebates to encourage people to switch to energy-efficient toilets. Taxes or user rates could also be introduced to encourage people to conserve water.

In 2009, the Federation of Canadian Municipalities called on cities to promote municipal drinking water to reduce the consumption of bottled water. Only 5 percent of these bottles are recycled and they leave a **carbon footprint** from processing and distribution. A total of 50 municipalities have voted to introduce restrictions on bottled water.

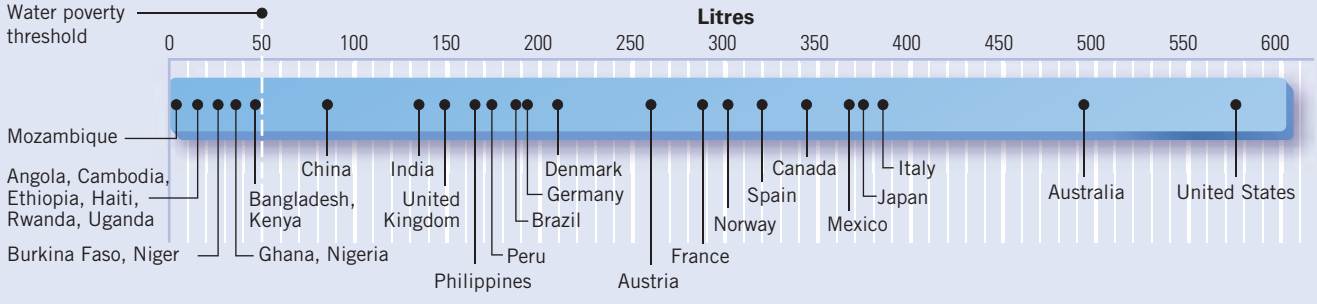

FIGURE 13–15 Average water use per person per day, 1998–2002

PRACTICE QUESTIONS

1. Do you agree that increasing populations are the main threat to the world's freshwater supply? Explain your answer.
2. What are the main threats to surface water in Canada?
3. In a two-column organizer, list the benefits and problems associated with groundwater use.
4. Which of the solutions to water management do you consider to be the most practical? Explain.

Change Is in the Air

● How is human activity affecting the atmosphere and the ozone layer?

The lowest layer of Earth's atmosphere, the **troposphere**, contains most of the atmospheric gases, including **"greenhouse" gases (GHG)**: water vapour, carbon dioxide, methane, nitrous oxide, and ozone. These gases occur naturally and play a vital role in regulating Earth's temperature, but human activities have upset the balance, causing ozone layer depletion and global warming.

The Hole in the Ozone Layer

Ozone, a special kind of oxygen (O_3), is the only gas in the atmosphere that blocks the sun's ultraviolet (UV) rays. **Ultraviolet radiation** can cause skin cancer in humans, and can damage other animal and plant species.

In 1978, satellite observation of the atmosphere revealed that the **ozone layer** was thinning. Ozone depletion is most evident over the polar regions, where seasonal thinning, or a "hole," appears in the ozone layer during winter and early spring each year. As much as 60 percent of the layer disappears over Antarctica in the spring, filling in again over the summer.

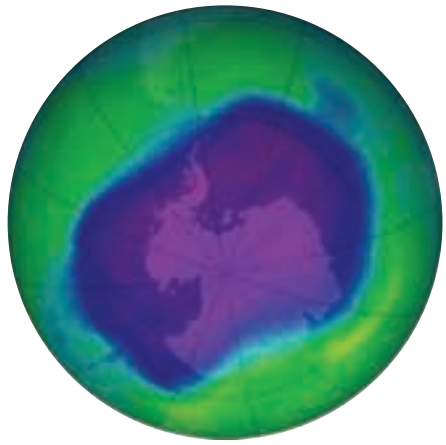

FIGURE 13–16 The hole in the ozone layer above Antarctica on September 24, 2006

The Montréal Protocol

● How has the international community responded to ozone depletion?

Chemicals, particularly **chlorofluorocarbons** (**CFCs**), destroy the ozone layer. CFCs have been widely used since the 1930s in coolants for refrigerators and air conditioners, and in foams, solvents, and aerosol cans. It is believed that the release of CFCs into the atmosphere has done 80 percent of the damage to the ozone layer.

The United Nations Environment Programme created the **Montréal Protocol** to phase out the use of ozone-depleting chemicals. In 1987, all industrial nations agreed to the protocol, which allowed countries of the developing world to use CFCs until 2000. The Montréal Protocol successfully united countries in the effort to reduce CFCs. In 2009, 97 percent of all the chemicals controlled by the protocol had been phased out.

In 2007, the countries involved in the protocol met again in Montréal to deal with hydrochlorofluorocarbons (HCFCs), the less-harmful replacement for CFCs. With new chemicals available that do not damage the atmosphere, the world agreed to phase out HCFCs in developed countries by 2030 and in developing countries by 2040. Only the complete elimination of HCFCs will begin to halt the damage to the ozone layer. The United States Environmental Protection Agency claims that even when all ozone-depleting chemicals are phased out, it could take a century before the annual thinning of the ozone over Antarctica does not reappear.

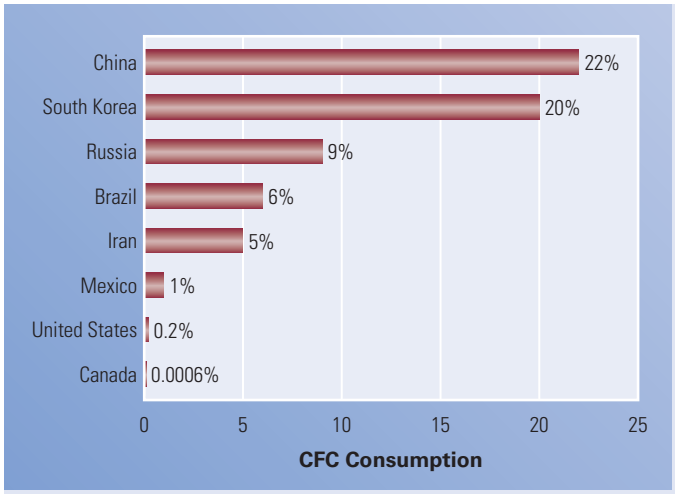

FIGURE 13–17 CFC consumption, 1999 (percentage of world totals)
Thinking Critically What reasons might account for the countries with the top and the bottom CFC emissions?

FAST FORWARD

A previously unforeseen source could increase Canada's GHG emissions dramatically. Arctic permafrost soils store staggering amounts of carbon, holding twice as much carbon as the atmosphere. Melting permafrost will release this carbon.

Greenhouse Gas Emissions

While natural emissions from volcanoes and other processes collect in the atmosphere, the results of human activities have the greatest effect. Since the Industrial Revolution in the 19th century, industrial and chemical contaminants have polluted the air. These pollutants cause smog, acid rain, and the widening hole in the ozone layer.

Fossil fuels—coal, oil, and natural gas—are at the centre of global warming. Coal is widely used outside Canada for heating and energy generation. China and other Asian countries are the world's greatest producers and consumers of coal. As Figure 13–18 shows, greenhouse gas (GHG) emissions in Canada have increased since 1990. Environment Canada reports that there was significant long-term growth in emissions between 1990 and 2007. These emissions came from increases in oil and gas production (much of it for export), motor vehicles, and coal electricity generation.

Canada ranked seventh in the world for carbon emissions from fossil fuels. It will move up on this list if it continues to produce greenhouse gas emissions at the same rate. One reason for increasing emissions is the development of the Alberta tar sands, where natural gas is used to process the tar sands. According to the oil industry, 29.5 megatonnes of greenhouse gases are emitted from the tar sands each year. This accounts for nearly 5 percent of Canada's total emissions. According to Sierra Club Canada, that figure will rise to more than 50 megatonnes by 2015. If that happens, the tar sands would be the single greatest contributor to GHG emissions growth in Canada. Carbon stored in **peatlands** disturbed by tar sands development will also add to the total GHG output.

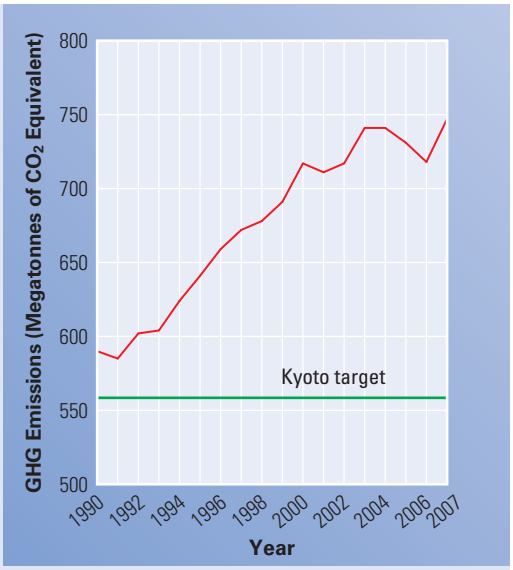

FIGURE 13–18 Canadian greenhouse gas (GHG) emissions, 1990–2007. The green line indicates Canada's GHG emission targets outlined in the Kyoto Protocol (see page 444).

Thinking Critically In 2009, the Conservative government set a target of reducing emissions by 20 percent from 2006 levels. Why do you think they picked 2006 as a baseline date? Do you agree or disagree with this target? Why or why not?

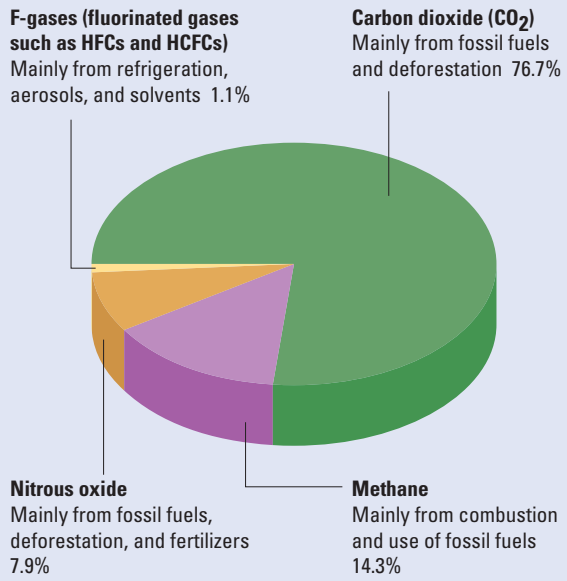

FIGURE 13–19 Greenhouse gases that contribute to global warming

Reading a Graph Which are the two main greenhouse gases? What percentage of greenhouse gases comes from burning fossil fuels and deforestation?

Things Are Warming Up

The gases in the atmosphere work like the glass in a greenhouse. They trap heat energy from the sun, creating our climate and making life on Earth possible. If these gases—especially carbon dioxide—are out of balance, they can cause major changes to our climate. Natural factors, such as volcanic explosions and meteor impacts, have caused dramatic climatic changes in the past. Scientists estimate that carbon dioxide (CO_2) in the atmosphere has increased by 30 percent since the Industrial Revolution and the subsequent burning of massive amounts of fossil fuels. By increasing the heat-trapping gases, we have increased the **greenhouse effect**. The global temperature has risen by about 0.74°C in the past 100 years. Scientists predict that it could rise by an additional 0.2°C every 10 years for the next two decades. Even minor increases in Earth's temperature can have profound effects on life on Earth.

In 2007, the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) summarized the state of global climate change:

(1) Warming of the world climate system is undeniable.
(2) The rise in global average temperature is very likely due to increases in greenhouse gases.
(3) Despite present policies, emissions will continue to grow over the next few decades.
(4) Present adaptation strategies do not adequately address the threat of climate change.

● What is global warming?

KEY TERMS

peatlands wetlands with soil formed mostly from decomposing plants

greenhouse effect greenhouse gases trap heat in the atmosphere, causing Earth's temperature to rise

WEB LINK

For more information about Earth's temperature increase and a summary of the Fourth Assessment Report of the IPCC, 2007, visit the Pearson Web site.

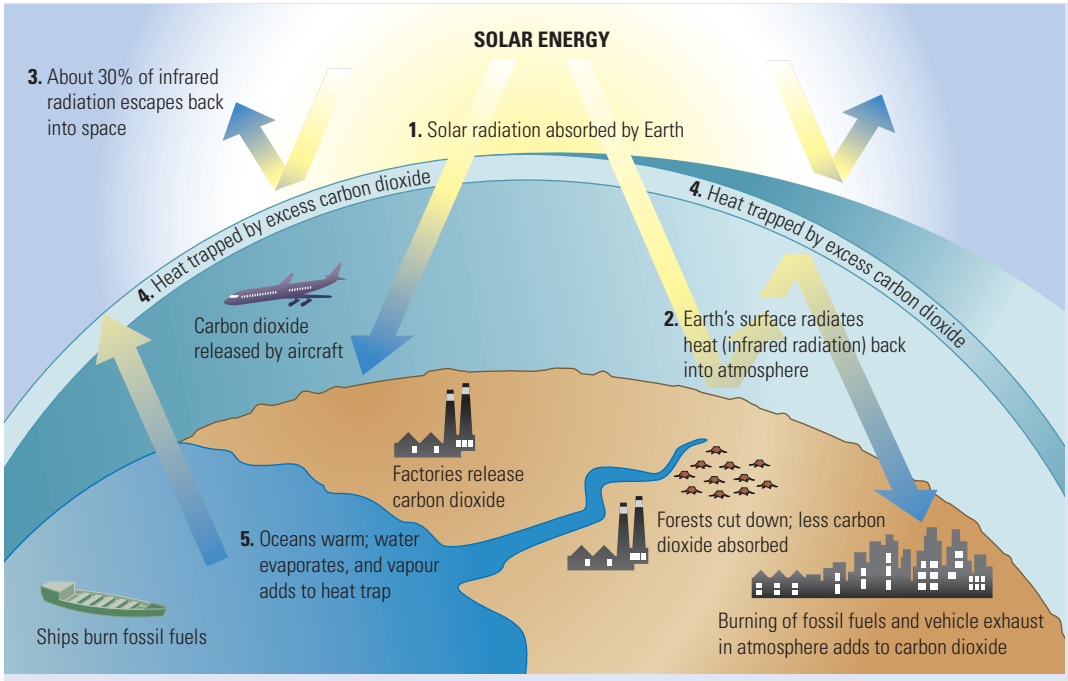

FIGURE 13–20
How the greenhouse effect works. Excess carbon dioxide accumulations trap heat that would otherwise be radiated back into space.

Consequences of Global Warming

Scientists agree that the increased number of heat waves and violent storms in recent years are linked to global warming. Above-average temperatures in polar regions are melting glaciers, and sea levels are rising as a result. Other effects are harder to link directly to global warming. These include diseases extending their ranges because of warmer temperatures, and the earlier arrival of spring in many parts of the world. Plant and animal ranges are shifting as species try to adapt to changing temperatures by moving to different habitats. Coral reefs in more than 30 countries are experiencing coral bleaching as the microscopic algae that give them their colours fail to adapt to warmer water temperatures and die.

WEB LINK
The full UNEP report on climate change is available on the Pearson Web site.

Geographic Area	Results of Climate Change
Arctic regions	Summer sea ice melts, exposing darker ocean, absorbing more heat accelerating melting and increasing sea levels
Greenland and Antarctic Ice Sheets	Ice sheet breakup exposes land accelerating warming and rise in sea levels
Boreal Forests	Dry spells and lengthier cultivation seasons result in a higher susceptibility to pests and fire
Tropical Rainforests	Loss of forest cover affects regional hydrological cycle and climate triggering further forest dieback
Atlantic and Pacific Oceans	Ocean circulation systems of winds and currents destabilized by temperature changes and addition of fresh water from ice sheets
Indian, Saharan, and West African Monsoons	Monsoons, seasonal winds and rain critical to agricultural economies disrupted

FIGURE 13–21 A 2009 UN Environment Programme (UNEP) report on climate change outlined the elements of Earth's system vulnerable to possible change.

up close and personal

David Suzuki: Can One Person Make a Difference?

CRITICAL INQUIRY Cause and Consequence

Scientist David Suzuki became internationally famous for his commitment to the environment. Suzuki was born in Vancouver in 1936. From an early age, Suzuki's father fostered a love and appreciation of nature in his son. During the Second World War, Suzuki and his family were interned with thousands of other Japanese Canadians. His internment camp was located in a deserted mining town in the Slocan Valley. Later, Suzuki trained as a geneticist, but he has also applied his scientific knowledge to many environmental issues. He has contributed to a growing awareness of environmental issues in Canada and around the world through his popular books and radio and television programs. Today, he continues his role as a warrior for the environment through his speaking engagements and the David Suzuki Foundation. Most recently, he has been focusing on the disastrous effects of climate change.

FIGURE 13–22 David Suzuki

Understanding Significance In what ways might David Suzuki's background have encouraged his commitment to the environment?

Forests and Climate Change

Even small changes in temperature and precipitation can affect forest growth. Although changes in forests will differ regionally, they will affect Canada's economy, society, and culture.

Warmer temperatures have already had damaging effects on British Columbia's pine forests. Warmer winters allowed the mountain pine beetle to survive in previously inhospitable areas and to extend its range. Westerly winds have allowed the insect to migrate over the Rockies and take root in the pine forests of northern Alberta. This has raised fears for the rest of Canada's pine forests. The spruce budworm is also a concern in the boreal forests of Western Canada. The effect of these insects goes beyond the loss of wood. Dead trees act as fuel for wildfires that threaten communities. Once a forest dies, it no longer acts as a **carbon sink**, but emits carbon dioxide into the atmosphere instead.

KEY TERM

carbon sink a reservoir that can absorb and store carbon dioxide from the atmosphere, including forests, peat, and oceans

WEB LINK

For more information about the mountain pine beetle, visit the Pearson Web site.

FASTFORWARD

A Walk in the Arctic Woods

In 2009, the International Union of Forest Research Organizations claimed that, as a result of global warming, trees might someday spread to Canada's Arctic where only tundra now exists. The report says that in areas of northern Canada, Sweden, Finland, and Russia, the evergreen trees of the boreal forests will start to shift northward. By 2070, forests may spread to Baffin Island, the coastline of Hudson Bay, northern Québec, and Labrador. This shift of forests will change the ecology in the new forested areas and in the old areas where different species of plants and animals will now thrive. The authors of the report caution that it will take a long time for new forests to establish themselves in warming areas.

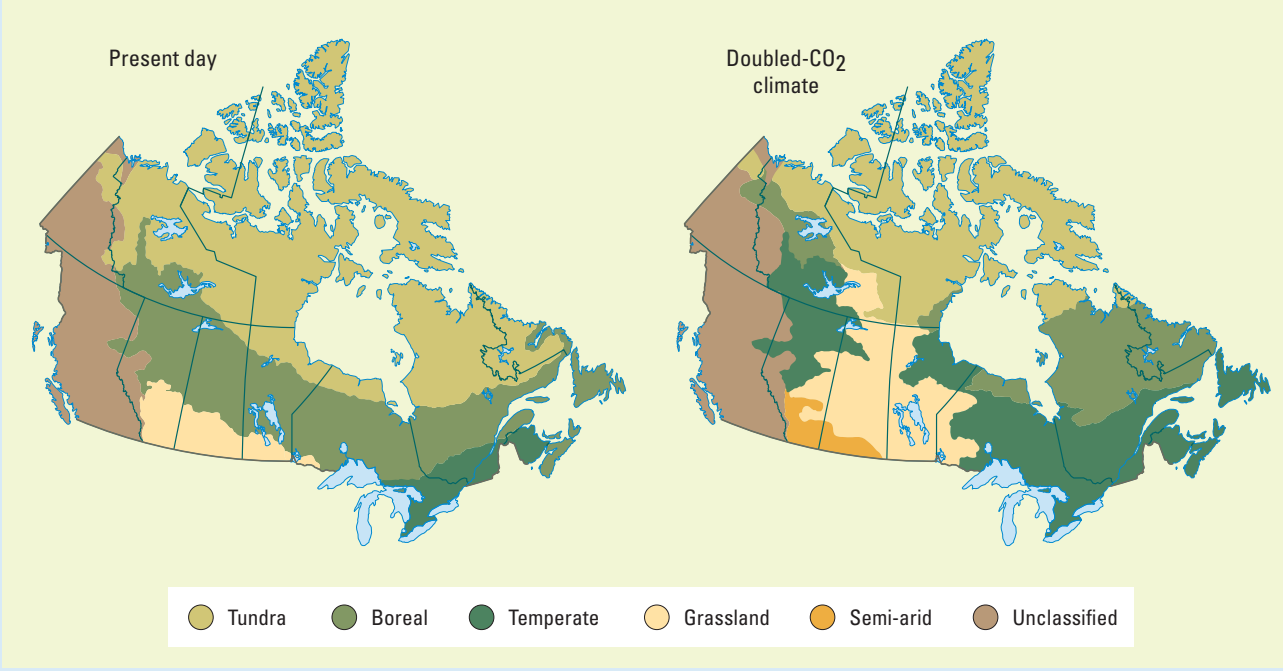

FIGURE 13–23 Projected changes to vegetation boundaries with doubled CO_2 levels

Using Evidence What changes do you see in the forest and grassland boundaries with the doubled CO_2 climate?

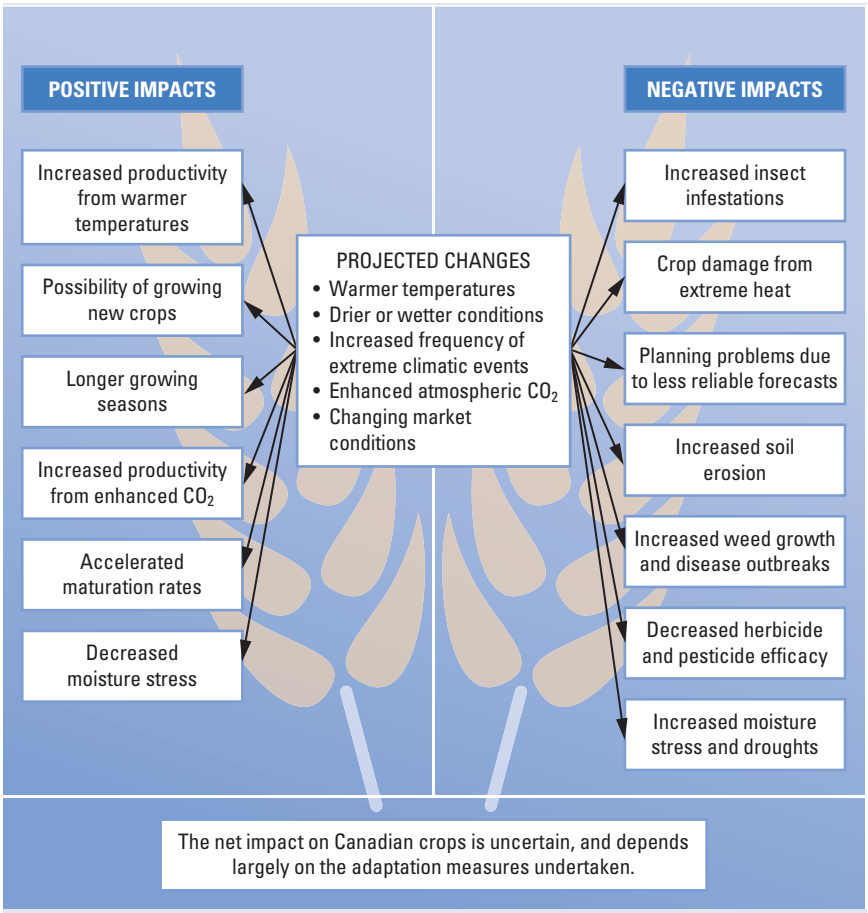

FIGURE 13–24 Potential impacts of climate change on agricultural crops in Canada

Thinking Critically Natural Resources Canada suggests that, as a result of climate change, extreme events such as floods, storms, and droughts present the greatest challenge to Canadian agriculture. Give examples of how these threats would affect agricultural production and what impact that would have on Canadian consumers.

Agriculture and Climate Change

Climate change is expected to impact Canada's agriculture in both positive and negative ways. For example, warmer temperatures would make the growing season longer, but they could also increase crop damage due to heat stress and pest problems. Warmer temperatures may make it possible to grow crops farther north, but the soils will not be as rich. Impacts would vary by region and crop.

Agriculture is extremely sensitive to any changes in climate, particularly the levels of moisture available. Global warming will likely affect water supply for agriculture. For example, less **meltwater** from receding glaciers in the Rocky Mountains will mean less available water for Alberta and British Columbia agriculture during the dry summer months. The benefits of a longer growing season may then be offset by water shortages. Warmer winters may mean less protective snow cover and could also bring thaws that damage crops. As Figure 13–24 shows, the impact of climate change on agriculture will vary widely and have significant impacts on the Canadian economy.

Water and Climate Change

The uneven distribution of water resources and yearly variations in precipitation have led to droughts, floods, and water quality problems around the world. Many areas face dire prospects as increased pressure is put on this limited resource. For example, as the Himalayan glaciers (Asia's "water towers") melt due to global warming, the reduced water supply will have devastating effects on the human, agricultural, and industrial needs of South and Southeast Asia. Subsistence farmers living in the valleys of the Indus River in Pakistan, the Irrawaddy River in Myanmar, or the Mekong River in Cambodia, Laos, Thailand, and Vietnam may be further threatened by changing weather patterns.

Changes in ocean temperatures could have an effect on the temperatures of ocean currents. In turn, these ocean currents may affect the regularity and moisture content of winds, such as the monsoons of Asia. In 2009, an Indian newspaper reported that "Farmers from Uttar Pradesh and Bihar said the precipitation and the number of rainy days had come down significantly and disrupted the entire agricultural cycle in the region during the last five

years." Changes in wind and precipitation patterns also bring damaging floods or droughts. The latter results in desertification as deserts expand into previously semi-arid areas. When rivers and lakes dry up in these areas, millions of people will be forced to leave their farms and livestock, becoming environmental refugees.

In Canada, changes in temperature and precipitation can affect **runoff**, evaporation, and the storage of water in lakes, soils, and glaciers. Arid regions, such as the Okanagan Valley and parts of the Prairies, will be particularly vulnerable due to present supply problems. Reduced flows from glaciers and less precipitation will decrease summer flows of rivers, which will in turn affect agriculture and salmon spawning. In winter, less ice cover, winter thaws, and snow-rain precipitation may increase the risk of flooding in many regions.

Despite its relative abundance of water on a per-capita basis, many regions of Canada have experienced water-related problems. Changes in water levels and warmer temperatures could increase bacteria and contamination in some areas. Elsewhere, increased flooding could flush urban and agricultural waste into rivers and municipal water systems. In coastal areas, rising sea levels may increase saltwater invasion into freshwater supplies. In the North, melting permafrost may make the ground unstable and affect the transmission of water supplies.

Melting glaciers and ice caps, and warming oceans, will result in rising sea levels. These changes will have a serious impact on Canada's coastline. Some effects might include cliff erosion, land destabilization, flooding of low-lying areas, and the disruption of infrastructure, such as roads and pipelines. Low-lying deltas, such as the Fraser River delta in British Columbia and the Mackenzie River delta in the Northwest Territories would be severely affected by a significant rise in sea levels.

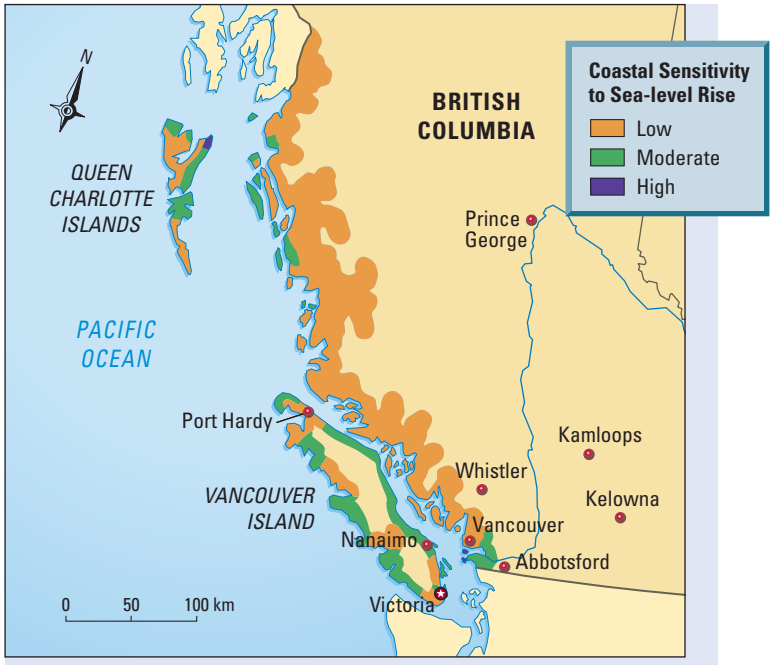

FIGURE 13–25 Coastlines of Canada likely to be affected by rising sea levels

KEY TERMS

meltwater melted snow or ice, including ice from glaciers

runoff water from rain and melting snow that cannot be held in the soil so makes its way into streams, rivers, lakes, and oceans

WEB LINK

Visit the Pearson Web site to explore the possible effects of rising sea levels on Canadian cities.

PRACTICE QUESTIONS

1. Create a two-column chart with the headings "Ozone Depletion" and "Global Warming." Under each heading, list the causes, effects, and possible solutions to these issues.
2. How successful was the Montréal Protocol? Explain.
3. What areas of Canada might be most affected by changes in agriculture due to global warming? Give examples to support your answer.
4. Use a two-column organizer to show the advantages and disadvantages of global warming for Canadian agriculture. Do the advantages outweigh the disadvantages? Explain.
5. What effects will rising sea levels have on coastal communities?
6. **Patterns and Change** Describe how global warming will affect economic activity, settlement, and transportation in the future.

- How has the international community responded to climate change?
- What are the principal international agreements concerning the environment?

KEY TERMS

United Nations Framework Convention on Climate Change (UNFCCC) the UN's plan to keep greenhouse gas concentrations from increasing, created at the 1992 Earth Summit in Rio de Janeiro, Brazil

Kyoto Protocol an international agreement that sets binding targets for reducing greenhouse gas emissions; the average target is 5 percent of 1990 levels by 2008–2012

carbon credit if an organization produces more greenhouse gases than it is allowed, it can purchase a credit from an organization that is below its target emission levels

Taking Action on Greenhouse Gas Emissions

In 2006, noted economist Nicholas Stern released a report for the British government presenting a compelling case for decisive action against global warming. The Stern Review stated:

> *Our actions now and over the coming decades could create risks of major disruption to economic and social activity, on a scale similar to those associated with the great wars and the economic depression of the first half of the 20th century. And it will be difficult or impossible to reverse these changes.*
>
> ***–Nicholas Stern***

Kyoto Protocol

The **United Nations Framework Convention on Climate Change (UNFCCC)** was created at the 1992 Earth Summit in Rio de Janeiro, Brazil. This treaty outlined a plan to stabilize greenhouse gas concentrations in the atmosphere to prevent dangerous interference with Earth's climate system. Several protocols that set emission limits came out of this convention, including the **Kyoto Protocol**. This document outlined target reductions for GHG emissions. It also introduced the system of **carbon credits**, which allow countries that do not meet their reduction targets to buy credits from countries that keep emissions below their allotted levels. In 1997, Canada signed the Kyoto Protocol, promising to reduce greenhouse gas emissions by 6 percent of its 1990 level by 2012. In 2007, the Canadian government announced it could not meet its Kyoto Protocol targets, and developed a separate plan to reduce pollution and GHG emissions (see Case Study).

Idea	Description
Carbon Tax	In 2008, British Columbia introduced a tax on fossil fuels to reduce use and meet the government's goal of reducing GHG emissions by 33 percent by 2020. The money raised is returned in reductions of other taxes.
Cap and Trade	A ceiling is put on emissions, and companies exceeding it must buy permits on the "carbon market" from companies under the allowable limit. If no permits are available, the rights to higher than targeted emissions could also be bought. These costs are meant to encourage companies to reduce emissions. The Western provinces and the U.S. favour this system.
Carbon Sequestration (locking away)	Carbon dioxide would be collected and shipped to a geologically suitable area below layers of impermeable rock. Storage areas might be depleted fossil fuel reservoirs. The technology is already in use with water and natural gas. Saskatchewan and Alberta are promoting this system.

FIGURE 13–26 Three approaches to limiting GHG emissions being discussed in Canada and the United States

Thinking Critically What might be the drawbacks of each of these approaches? How could governments be convinced to apply any of these approaches?

Bali Road Map

In 2007, delegates from 189 countries met in Bali, Indonesia, to prepare a new treaty to replace the Kyoto Protocol in 2012. Two groups emerged at the Bali conference. One group agreed with the European Union's support of the Kyoto model of absolute reduction in GHG emissions by 25 to 40 percent by 2020. The second group, which included Canada, Japan, Russia, and many Asia-Pacific Economic Cooperation members, supported the United States' call for flexible goals focused on reducing carbon intensity (the amount of carbon released per unit of energy produced). This idea was rejected by the EU group, who argued that it would not reduce overall emissions. The final agreement, called the Bali Road Map, encouraged countries to cooperate to fight climate change.

Moving to Sustainable Energy Sources

While political debates continue, Earth is still heating up. Most leaders agree that all nations need to move toward sustainable development and clean energy sources to slow down climate change. There are many sustainable sources of energy that could be used to lessen dependence on fossil fuels. These include wind turbines, solar power panels, tidal power, ground-source energy or geothermal power (which uses heat from underground sources where available), and biofuels derived from biomass (plant or animal material). The environmental group Greenpeace claims that by 2030 wind power could provide 15 percent of the world's electricity. Although all these alternative sources of energy have drawbacks, they are renewable without harmful emissions.

FIGURE 13–27 Wind turbines would be effective in windy locations such as along the coast of British Columbia or in the Alberta foothills.

Thinking Critically Why would some people oppose having wind turbines like these in their area?

Source	Advantages	Disadvantages
Hydroelectric power	Vast quantities of power. Dams and reservoirs control flooding and provide recreation.	Dams and reservoirs can cause environmental and social disruption. Transmission lines take land as right of way and emit waves.
Run-of-river hydropower	Emissions free. Minimum impact on river flow or fish.	Power plant, access roads, and transmission lines disrupt ecosystem. River levels may be affected.
Wind power	Emissions free. Easily installed for individual or large-scale use. Land can have other uses.	Need reliable, strong winds. Noisy and a visual pollutant. Threat to migrating birds.
Geothermal	No pollutants or emissions. Discharges are safe to recycle. No storage needed.	Expensive to build. Must be located in geologically active areas.
Tidal	Regular source. First turbines tested in Bay of Fundy in 2009.	Limited locations. Interferes with aquatic life and coastal transportation.
Biofuels	Biodegradable, readily available biomass; few pollutants when burned.	Not as efficient as fossil fuels. Some croplands used for ethanol, leading to higher food prices.

FIGURE 13–28 Advantages and disadvantages of various sustainable energy sources

case study

Politics, Conferences, and Climate Change

FIGURE 13–29 Low-lying island nations like the Maldives are facing extinction if climate change cannot be controlled and sea levels continue to rise.

The author of the British government's 2006 Stern Review, a report on the economics of climate change, remarked: "The first thing that struck me... was the magnitude of the risks and the potentially devastating effects on the lives of people across the world. We were gambling the planet." Despite this warning, meaningful action at the international level has been elusive.

There are few today who deny that global warming is changing our relationship to the biosphere. The difficulty in finding an effective and realistic solution lies in getting the 192 member countries of the United Nations to agree on and implement a program to reduce greenhouse gas (GHG) emissions. Each nation wants to protect its right to develop and use its industries as it sees fit.

The politics of climate change were first evident at the 1992 Earth Summit in Rio de Janeiro, Brazil. The leaders could not agree on how to best deal with greenhouse gas concentrations in a way that worked for all nations. This debate essentially led to a postponement of any action until the next conference in Kyoto, Japan, held five years later.

Kyoto, 1997

The Kyoto Protocol established GHG emission targets for industrialized nations. Countries that ratified the protocol agreed to meet their given targets by 2012. The United States, which was the largest producer of greenhouse gases when the Kyoto Protocol was established, did not ratify the treaty.

As Figure 13–30 shows, compliance with Kyoto GHG targets has varied across different nations. Domestic politics have played a significant role in the failure of Kyoto in all but a few countries. In Canada, the Liberal government ratified the treaty and proposed steps to meet its targets, but emissions continued to rise. One reason for Canada's inability to meet its targets was that the federal government signed the agreement, but provincial governments regulate polluting industries. After the Conservative government under Prime Minister Stephen Harper came to power, it announced that Canada could not meet its limits in the Kyoto Protocol and developed its own plans to address air pollution and climate change in 2007. Due to the lack of social or economic changes that would reduce greenhouse gases, Canada continues to lead G8 nations in the growth of emissions.

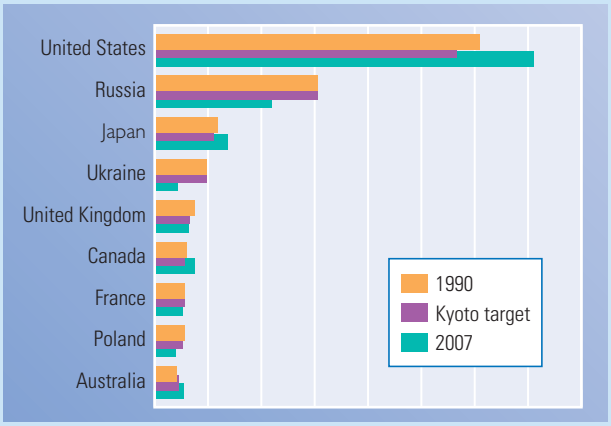

FIGURE 13–30 GHG emissions for selected countries who signed the Kyoto Protocol

Thinking Critically Why might some countries have signed but not ratified the protocol?

Bali, 2007

World leaders met again in Bali, Indonesia, to discuss climate change. The focus of this conference was on developing the next steps after the Kyoto Protocol and to come up with a timetable for meeting greenhouse gas emission targets. The final agreement, called the Bali Road Map, proposes long-term cooperation between nations to cut emissions and share technology that promotes clean, renewable energy. The road map was, by necessity, a compromise. It allows countries to determine how they can best address climate change by taking "nationally appropriate steps." While this clause is intended to make sure that developing countries are not handicapped by their targets, critics fear that industrialized nations may take advantage of this leeway.

Copenhagen, 2009

The UN held another meeting in Copenhagen, Denmark, to finalize the agreement outlined in the Bali Road Map. Once again, politics hampered efforts to come up with a plan that all nations could agree to. The dividing line fell between developed and developing nations. Both China and India, two of the world's greatest GHG emitters, take the position that global warming is caused by the accumulation of greenhouse gases from developed, industrialized countries and that poor, developing countries should not have their economic development restricted. The Prime Minister of India emphasized his country's position: "For us, the foremost priority is the removal of poverty, for which we need sustained rapid economic growth."

When President Obama entered office in 2009, the United States changed its position on climate change, which also influenced Canada. Prime Minister Harper noted that "The alignment of our climate change policies with those of the Obama Administration is a critical element of Canada's overall approach due to the close integration of our economies and our geographic proximity." This sentiment was reflected in Canada's support of the U.S. position at the Copenhagen Conference. When negotiations for a new treaty broke down, the U.S., China, India, Brazil, and South Africa worked together to draft a new Copenhagen Accord. This agreement did not include specific long-term targets for GHG emission cuts, but it did promise US$30 billion in aid over the next three years to help developing countries reduce their emissions. Canada supported the accord, but other countries felt that it was not a fair agreement because it was drafted by only a few powerful countries. The accord was not unanimously accepted, so it did not pass.

While developed and newly industrializing countries debate, nations facing the immediate consequences of global warming grow more frustrated. The president of the Maldives, an archipelago of 1200 islands that face steadily rising sea levels, expressed that frustration: "The Maldives has committed to becoming carbon neutral by 2020, using the wind and sun to power the entire nation. If that can happen in a relatively poor, developing country, it can happen anywhere. What we lack is not technology, but political will."

WEB LINK
Visit the Pearson Web site to find out more about climate conferences and agreements.

Looking Further

1. Why is it so difficult for countries to reach an agreement to reduce GHG emissions?
2. Do you agree or disagree with Canada's position on the environment? Explain.
3. Do you support the position of India, China, and some developing countries? Why or why not?
4. **Perspectives** How are the perspectives of the Maldives and India, although opposed, both based on perceived needs for survival?

What If…

What might be the impact on Canada's energy consumption if the rest of Canada follows the First Nations' example?

First Nations Lead the Way in Clean Energy

Many of Canada's First Nations communities are leading the way in adopting green energy solutions to meet their energy needs. Projects include small-scale hydro stations, wind generation, solar power, and new approaches to energy efficiency. These initiatives aim to provide reliable and sustainable energy sources while minimizing GHG emissions.

Many communities in remote locations are forced to use diesel generators that are expensive, environmentally damaging, and unreliable. Adopting alternative or green energy sources not only provides clean and sustainable energy supplies, but also economic development and jobs. The Taku River Tlingit First Nation in Atlin, B.C., is an example of a community that was able to replace diesel-generated power with a renewable energy project. A Tlingit-owned power company operates a run-of-river (meaning that it relies on the natural force of the river) two-megawatt power project. This will save 1.5 million litres of diesel and 4500 tonnes of greenhouse gases. The result is to reduce the community's carbon footprint by the same amount as removing 1600 cars from the road.

On Haida Gwaii (the Queen Charlotte Islands) the Haida Nation will partner with NaiKun Wind Energy to build a Hecate Strait wind-power project. The 110-turbine project will generate enough power to light 130 000 homes. This project will also create jobs and revenue for the Haida Nation.

At Sooke on Vancouver Island, the T'Sou-ke Nation has the largest system of solar panels operating in B.C. The band office has banks of solar panels that provide electricity and power batteries for emergencies or cloudy days. The fisheries building is powered entirely by solar power. With the solar panels and conservation initiatives, energy consumption on the reserve has dropped by 30 percent. Excess power is sold to B.C. Hydro. Another benefit has been training the band members as solar panel installers. The T'Sou-ke Nation has become an example for other remote communities.

There are many other First Nations communities adopting innovative green projects that set an example for the rest of Canada. As T'Sou-ke Chief Gordon Planes said: "We are going to change B.C. and we are going to change Canada."

FIGURE 13–31 The T'Sou-ke Nation is going solar powered as part of a community sustainability push. They have the largest solar-powered system in B.C. and will be selling power to B.C. Hydro. Here, T'Sou-ke Nation Elder Linda Bristol stands in front of some of the solar panels on the reserve. The residences in the background have small panels used for hot water heating only.

Doing Our Part for the Environment

- How can we offset environmental threats at the local, national, and international levels?

Since the 1992 Earth Summit, Canada has tried to make its economy more responsive to environmental concerns. In some areas, forest practices have improved significantly. Many communities have adopted waste recycling programs, and Canadian innovations have helped to turn sewage into fertilizer and develop more energy-efficient cars and buildings. Canadians have been less successful at reducing the use of pesticides and herbicides, or in cutting back paper and water consumption. Canada's boreal forests, groundwater supplies, and other resources are still being depleted at a concerning rate. Greenhouse gas emissions in Canada have increased, even after signing the Kyoto Protocol.

Individuals Can Make a Difference

WEB LINK

Find out more about what individuals can do to help fight climate change by visiting the Pearson Web site.

Canadians consume 15 times more energy than people in developing countries. Our small population can have as much impact on world energy and resources as a less developed country many times our size. But we can all do our part to help the environment by becoming active in the community and taking responsibility for our environmental footprint. Individuals can help fight climate change by recycling, composting, buying local, and using energy-efficient appliances, lights, and transportation. Each of us can conserve water by installing low-flush toilets and taking shorter showers. Drinking tap water rather than bottled water reduces water consumption and saves the energy needed to make and recycle plastic bottles. Reuseable shopping bags can help cut down on the billions of plastic bags used worldwide each year. These bags can make their way into oceans and rivers, where they can harm animals and their habitats.

As people like Simon Jackson demonstrate, individuals have the capacity to bring about change. Becoming aware of the state of the local environment is the first step. Find out about school-based groups or community organizations that are working to help protect the environment, and get involved. Our actions will help set the course for future generations, and as a report from the United Nations Environment Programme stated, our "present course is unsustainable and postponing action is no longer an option."

FIGURE 13–32 Volunteers help to recycle donated computers in Vancouver. Many cities have special programs for recycling electronics.

PRACTICE QUESTIONS

1. What was the purpose of the Kyoto Protocol? What was Canada's involvement in this agreement?
2. What two viewpoints emerged from the Bali conference on greenhouse gas emissions in 2007?
3. Why have international efforts to reduce GHG emissions been ineffective? What might account for Canada's poor record in reducing emissions?
4. Which forms of sustainable energy would be practical in your area? Support your choices.
5. For what reasons have many First Nations communities turned to alternative energy sources? How might the example of these First Nations help other Canadians reduce their carbon footprint?
6. Provide specific steps individual Canadians can take to reduce their environmental footprint.

CHAPTER FOCUS QUESTION

How is global development causing environmental issues and what challenges do they pose for Canada?

1. In this chapter you have read about the many ways that climate change is affecting Canada's environment. Use an organizer like the one below to categorize the challenges of climate change described in the chapter.
   - **a)** In the first column, list the primary global causes of climate change.
   - **b)** In the second column, list the secondary, or more localized, causes of climate change.
   - **c)** In the third column, list the effects of climate change that are evident or visible in Canada.
   - **d)** In the fourth column, list the long-term consequences for Canada and the world.
   - **e)** In the last column, list some of the solutions proposed to help meet the challenges of climate change.

Primary Causes	Secondary Causes	Effects in Canada	Long-Term Consequences	Possible Solutions

2. Use the information you gathered above to develop an outline for an essay discussing Canada's role in contributing to climate change and the effects and consequences for the environment.

Vocabulary Focus

3. For each term below, write a sentence showing its relationship to environmental issues in Canada.
   - **a)** ozone layer
   - **b)** deforestation
   - **c)** Montréal Protocol
   - **d)** Kyoto Protocol
   - **e)** groundwater
   - **f)** greenhouse effect
   - **g)** CO_2 emissions

Knowledge and Understanding

4. Explain how effective each of the following was in dealing with threats to the environment.
   - **a)** The UN report *Our Common Future*
   - **b)** United Nations creates the Intergovernmental Panel on Climate Change
   - **c)** British Columbia government introduces a carbon tax on energy
   - **d)** Agricultural Land Reserve established in British Columbia

5. Describe the effects of global warming on each of the following:
   a) Arctic regions
   b) forests
   c) agriculture
6. List an advantage and a disadvantage for each of the following alternative energy sources:
   a) wind
   b) run-of-river hydro
   c) tidal
7. Note and give reasons for the Canadian government's record in reducing GHG emissions.
8. **a)** Why is global warming an environmental problem?
   b) Why is international cooperation needed to deal with this problem?
9. Make a list of the types of information you would need if you were sent to determine the amount of Canada's forests that should be preserved.
10. Make a list of some of the sources of water pollution in your community. Find out what action is being taken to deal with the worst examples of pollution.
11. How many of the causes of global warming can be found in Canada? Suggest actions that could be taken to deal with the emissions in your area.

Critical Thinking

12. How successful has the world been at living up to the goals of Agenda 21 in the past decades? Give specific examples from this chapter.
13. In a short paragraph, summarize the steps Canadians need to take to ensure that freshwater supplies are used in a sustainable way.
14. Explain which approach to limiting GHG emissions you would be in favour of and why.
15. Send an e-mail or a letter to the federal Minister of the Environment explaining why that department should give the highest priority to addressing the problems of Canada's forests.
16. Research a First Nations community in British Columbia and discover how they share their traditional lands and culture with tourists.
17. In a group, develop a proposal for a film on one of the issues in this chapter. Submit a story outline, cast, setting, soundtrack, and working title.
18. In a small group, write and perform a TV spot called "Water Minutes" (in the style of "Heritage Minutes"), promoting the benefits of water conservation.
19. Does it surprise you that Canada has not been at the forefront of reducing GHG emissions? Explain why or why not.
20. Suggest ways that the Canadian government can take more of an international leadership role in environmental sustainability.

Document Analysis

21. This statement was issued by British and U.S. scientists in 1997:

    It has often been assumed that population growth is the dominant problem we face. But what matters is not only the... number of people... but also how... much natural resource they utilize, and how much pollution and waste they generate. We must tackle [the problems of] population and consumption together.

    a) What is the problem of consumption? How would you tackle this problem on a personal level?
    b) Why is it difficult to solve the problem of consumption?
    c) Do you agree with the scientists' statement? Explain your answer.
    d) Could sustainable development successfully deal with the environmental problems caused by growing populations and consumption? Explain.