When Vancouver prepared its bid to host the 2010 Winter Olympic Games, it paid close attention to the all-important downhill ski events. Vancouver plans to host these at the nearby Whistler–Blackcomb ski area. When the International Olympic Committee considered Vancouver's bid, they had to think about geography, considering factors such as landforms, climate, and transportation.

What other ways can you think of in which landforms and climate would influence human activities?

Unit Expectations

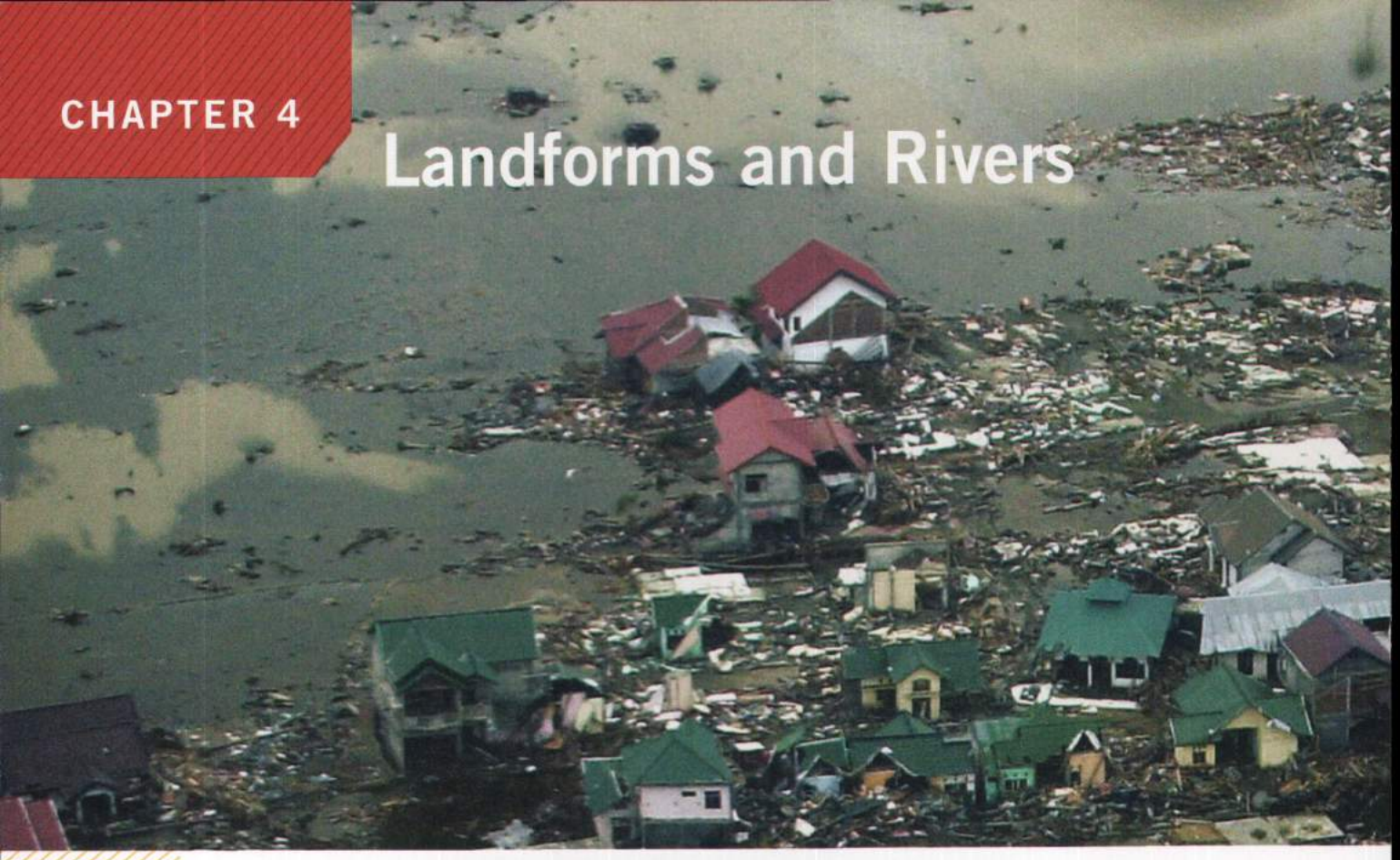
This unit will explore the question, **How does the environment affect human decisions?**

What You Will Learn in This Unit

- What are the patterns in physical geography around the world?
- What forces produce geographic patterns?
- How do patterns in physical geography affect people around the world?
- What geographic skills and information do I need to interpret physical patterns?
- How can I apply my learning to investigating geographic problems?

CHAPTER 4

Landforms and Rivers



Destruction left by the December 2004 tsunami.

Before READING

Making Connections

What do you see in the photo above? What kinds of help would the survivors need? With a partner, brainstorm things you could do from where you live to help the situation.

The people of the tropical island of Sumatra, Indonesia, were going about their morning activities. Tourists from around the world were enjoying a holiday on the beach. Little fishing boats bobbed gently on the turquoise water. Then, two unusual things took place. First, the ocean shrank back, exposing a wide area of ocean floor. Then within minutes, a long ridge appeared on the horizon, moving quickly toward the beach. As it approached, it grew larger, the top white with foam. Suddenly, the boats were tossed into the air like toys. People ran for their lives, but for most it was too late.

The first wave struck the beach seconds later. It drove through the line of palm trees and surged against homes and hotels. Two larger waves surged forward, 30 minutes apart, pushing into seaside towns, destroying everything. In a few hours it was all over—one of the worst such disasters ever known. The waves, called **tsunamis**, were caused by an undersea earthquake. More than 230 000 people died in the Southeast Asian tsunamis of December 26, 2004. It was an awesome display of nature's power.

WORDS MATTER

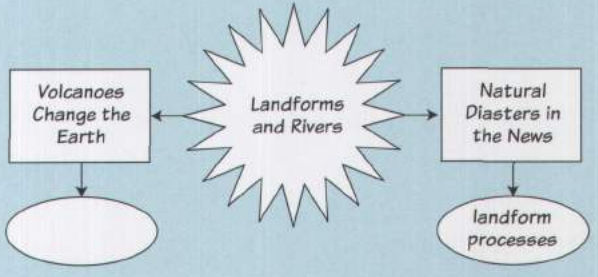
tsunami a long high wave caused by an undersea earthquake; a Japanese term meaning "harbour wave"

What You Will Learn in This Chapter

- What are the effects of earthquakes and volcanoes?
- What are landforms and world landform patterns?
- What are the major river systems of the world?
- How can I interpret landform features using contour lines on a topographic map?
- How can I draw a cross-section diagram to show landform features?

Thinking About LITERACY

In this chapter, you will take notes using a graphic organizer. Start with the chapter title in the centre. Put the section headings in boxes around the centre. When you finish a section, write *Main Ideas* and *Important Details* next to the section box.



Natural Disasters in the News

WORDS MATTER

landform processes changes that occur in landforms

Often you hear and see striking information about natural disasters. The tsunamis of 2004 are one such example, caused by an earthquake under the Indian Ocean. Volcanoes and landslides are other **landform processes** that have dramatic effects.

In 1903, part of the town of Frank, Alberta, was buried when 74 million tonnes of rock slid down the side of nearby Turtle Mountain in the middle of the night. At least 70 people died. Tornadoes, hurricanes, blizzards, and snow avalanches can all take lives and cause damage and disruption.

Part of the town of Frank, Alberta, remains buried under this landslide.

During READING

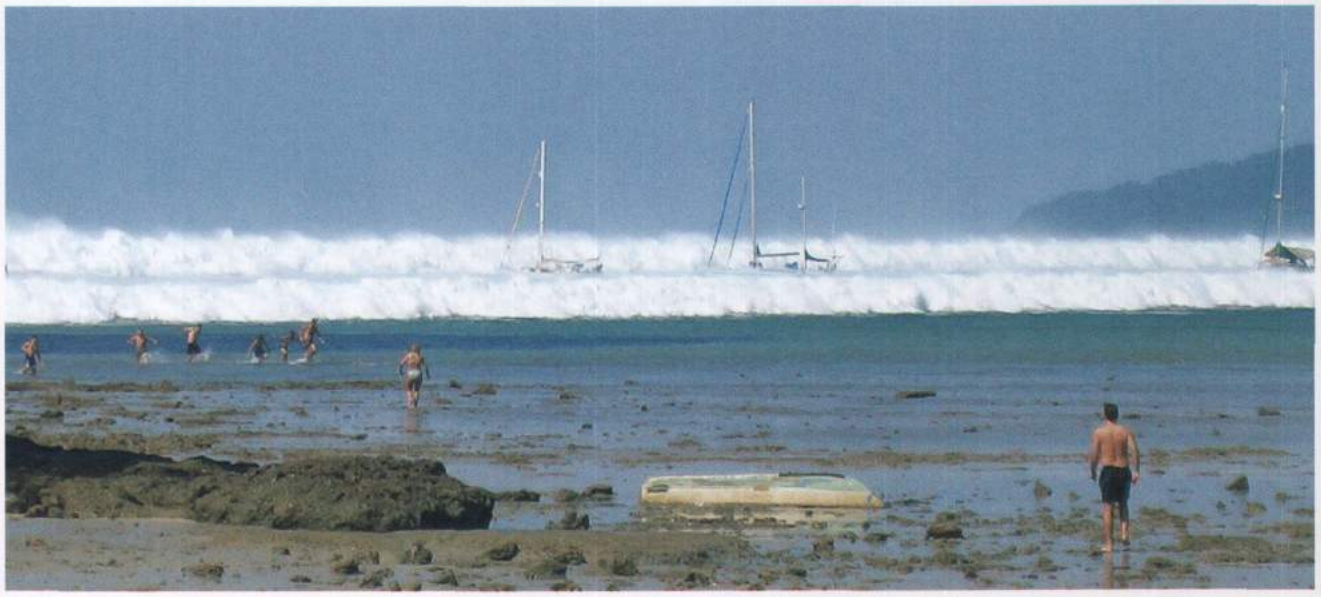
Checkpoint

A main idea is anything that can be defined or explained. To check, go back to the "What You Will Learn in This Chapter" points, and see if your main idea and notes for this section help you answer any of the questions.

What Causes a Tsunami?

True story: One summer, Danny and his friends started bobbing up and down together in the family's above-ground pool. They soon got a wave going back and forth. As it grew higher, it knocked over the end wall of the pool close to the house and smashed through a low window. The basement was quickly flooded with 30 centimetres of water!

Danny's home-made "tsunami" shows how destructive the force of water can be. A pailful is heavy, and a pool-full weighs many tonnes. A 30-metre ocean tsunami crashes against the shore with great force. The Southeast Asian tsunami knocked over an entire train and ripped up the tracks! In low-lying areas, it left a trail of destruction that reached several kilometres inland. Millions of people were homeless as communities were reduced to rubble.



In December 2004, the ocean receded just before the tsunami wave rushed toward the shore.

A tsunami is a special type of wave. It is sometimes (mistakenly) referred to as a **tidal wave**, but it is not related to the pull of the moon's gravity on the world's oceans. Nor is it like a **storm surge**, a sudden rise in sea level caused by high winds generated by storms and hurricanes that whip up the water. Other such ocean surges can occur when a massive landslide or a huge ice block breaking away from Greenland or Antarctica displaces water suddenly. A tsunami is different because it is caused when an earthquake shakes the ocean floor itself. When this happens, shock tremors race through the water outward in a circular pattern. You could see the same effect by dropping a large stone into a pond.

Scientists know that the tremors travel about ten times faster than the crest of water (the tsunami) that the motion creates. By measuring the speed of the tremor, they can estimate how long the tsunami will take to reach any part of the ocean basin.

WORDS MATTER

tidal wave the "bulge" in the ocean's surface caused by the pull of the moon's gravity, which becomes high tide at each place it travels to

storm surge the sudden rise in sea level caused by high winds pushing water toward coastlines

WEB LINK

For more information on tsunamis, visit www.pearsoned.ca/on7geography.

Why Do Earthquakes Occur?

The thin skin of the earth is constantly twitching and trembling. An earthquake shakes the planet about every three minutes, or 180 000 times a year. Most earthquakes are not strong enough to do any damage, but bigger ones have enormous destructive power. Loss of life is especially extensive when earthquakes occur in heavily populated regions without earthquake-proof buildings.

Five Deadliest Earthquakes Since 1995

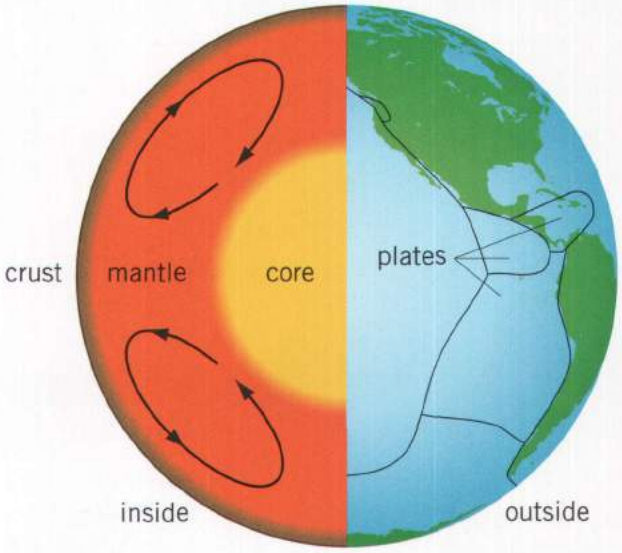
Location	Deaths	Magnitude*	Location
Sumatra, Indonesia (Asia)	230 000	9.2	December 26, 2004
Kashmir, Pakistan (Asia)	82 000	7.6	October 8, 2005
Gujarat, India (Asia)	20 085	7.7	January 26, 2001
NW Turkey (Asia)	12 000	7.4	August 17, 1999
Java, Indonesia (Asia)	6 234	6.3	May 27, 2006

* The strength of an earthquake measured by the Richter Scale, described on page G 69.

Zones of the Earth

Earthquakes occur because the planet's skin, the crust, is in motion. The planet is like a round egg. Scientists use the speed of earthquake tremors passing through the earth to identify three layers:

- *Core* (the yolk): a very hot, dense zone under intense pressure from the weight of overlying rock material
- *Mantle* (the egg white): a zone of thick molten rock called magma, slowly moving in broad currents
- *Crust* (the eggshell): a thin, brittle shell broken into several pieces called plates, and floating on the mantle



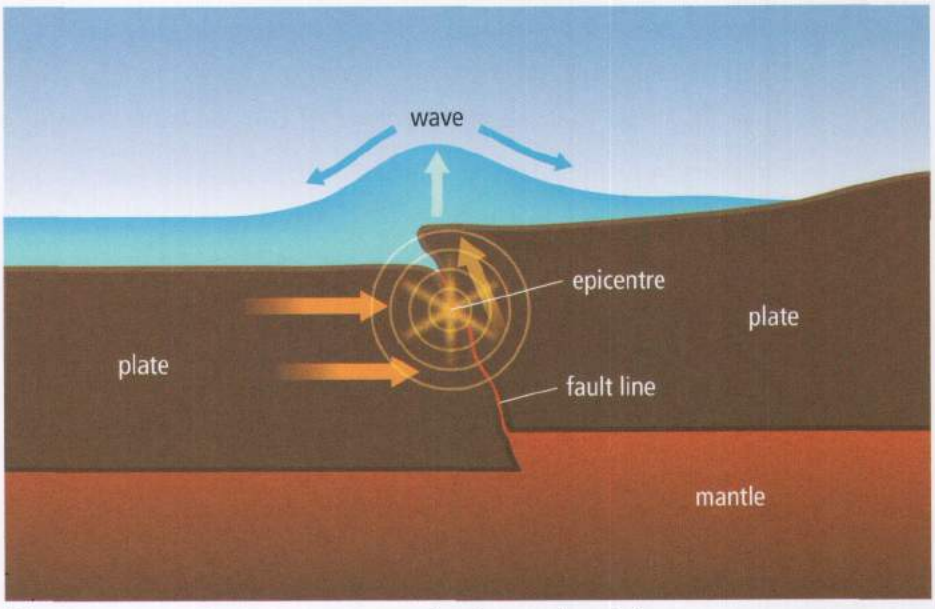
Scientists believe that the currents beneath the crust slowly move the plates around. Earthquakes occur as plates are ripped apart, hauled together, or dragged alongside one another. Rock under tension can bend a bit, until it snaps and moves several centimetres all at once. Tremendous energy is released at the break point, called the **epicentre**. The Richter Scale is a 10-point scale used to measure the strength of an earthquake. The Sumatra Earthquake of December 2004 (the cause of the tsunamis) reached 9.2, a very high reading, and lasted for about 10 minutes, the longest ever recorded. Scientists estimate that it released as much energy as Canadians would use in four months!

WEB LINK

For more information about earthquakes, visit www.pearsoned.ca/on7geography.

WORDS MATTER

epicentre the break point where earth's plates move suddenly, causing an earthquake



What is the connection between a tsunami and an earthquake?

THINKING It Over

1. How is a tsunami different from a tidal wave and a storm surge? K
2. Locate the sites of the five deadliest earthquakes on a world map. Just use the country if you can't find the exact location. What pattern do you observe? Would you expect to find plate boundaries here or not? Explain. T
3. Imagine that the Indian Ocean Tsunami Warning System has detected an ocean-floor earthquake near the point of the 2004 earthquake. Use what you have learned about earthquakes and tsunamis to write a concise 75- to 100-word warning for people around the Indian Ocean. C

Volcanoes Change the Earth

During READING

Checkpoint
Go back to your notes and review the meanings of *magma* and *mantle*.

Active Hawaiian volcanoes feature liquid flows of molten lava.

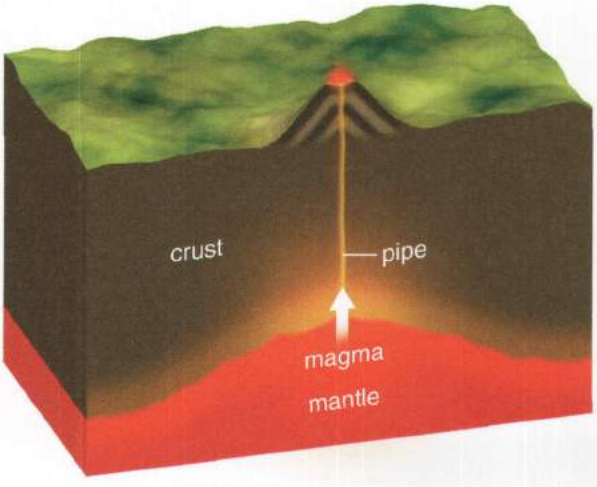
WORDS MATTER

composite cone a volcano made up of alternating layers of cinders and magma

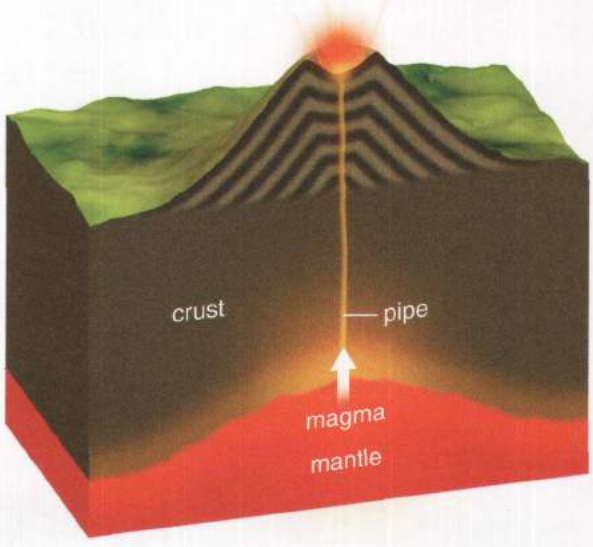
shield cone a volcano built entirely of magma

A volcano is one of the most spectacular natural shows on earth. The fiery blasts of molten rock are brighter than fireworks and much louder. The heat is intense, and massive clouds of choking gas and ash are often spewed out. This material all comes from the mantle, the molten zone beneath the earth's crust. Volcanoes are actively changing the face of the earth, either by building up new mountain peaks or blasting them away. Volcanoes occur where molten magma is able to break through the thin crust. The Hawaiian Islands formed where magma from the mantle forced its way to the surface.

Most of the time, the magma finds its way to the surface along cracks or faults in the crust. As you can see in the diagrams below, pressure from below pushes the magma upward, causing the volcano to mount higher and higher. The volcano shown is a **composite cone**, made up of layers of cinders and magma (called lava when it reaches the surface). Other volcanoes may be built entirely of cinders (cinder cone) or of magma (**shield cone**). Hawaii has shield cones. Extreme volcanic blasts happen when the "pipe" connecting the mantle to the surface becomes blocked with hardened material. The intense pressure of rising magma and gases can actually rip away the top of the mountain.



A composite cone forms from alternating layers of cinders and magma.



The cone grows higher with each period of volcanic activity.

Where Are Volcanoes Found?

Volcanoes usually occur along the edges of the plates. You know that some plates are being dragged toward one another by currents in the mantle below. When two plates collide, the ocean plate is dragged underneath the bigger continental plate. The end of the plate melts as it is pulled into the hot mantle, then the melted material finds its way back to the surface through cracks. This happens around the outer edge of the Pacific Ocean, across the bottom parts of Asia and Europe, and in a loop through the Caribbean region, just above South America. These are the most dangerous places on earth.

The Pacific Ring of Fire

The map on the next page shows the location of major active or recently active volcanoes. Notice how close most of them are to plate boundaries, locations where magma can most easily find its way through the earth's crust. The Pacific Ring of Fire is the name geographers give to the circular pattern of active volcanoes surrounding the Pacific. Some island nations around the Pacific, such as Japan, Indonesia, and the Philippines, are almost entirely of volcanic origin.

The Mid-Atlantic Ridge

You can also see the line of volcanic islands in the middle of the Atlantic Ocean. The Mid-Atlantic Ridge occurs where major plates are moving apart. The Atlantic Ocean floor is spreading and allowing magma to seep through this break in the earth's crust. The ridge slices right through Iceland, and new volcanic islands have formed there in recent years. A similar mid-ocean ridge also slices across the Indian Ocean.

A new volcano has been growing out of the crater of Krakatoa since 1930.

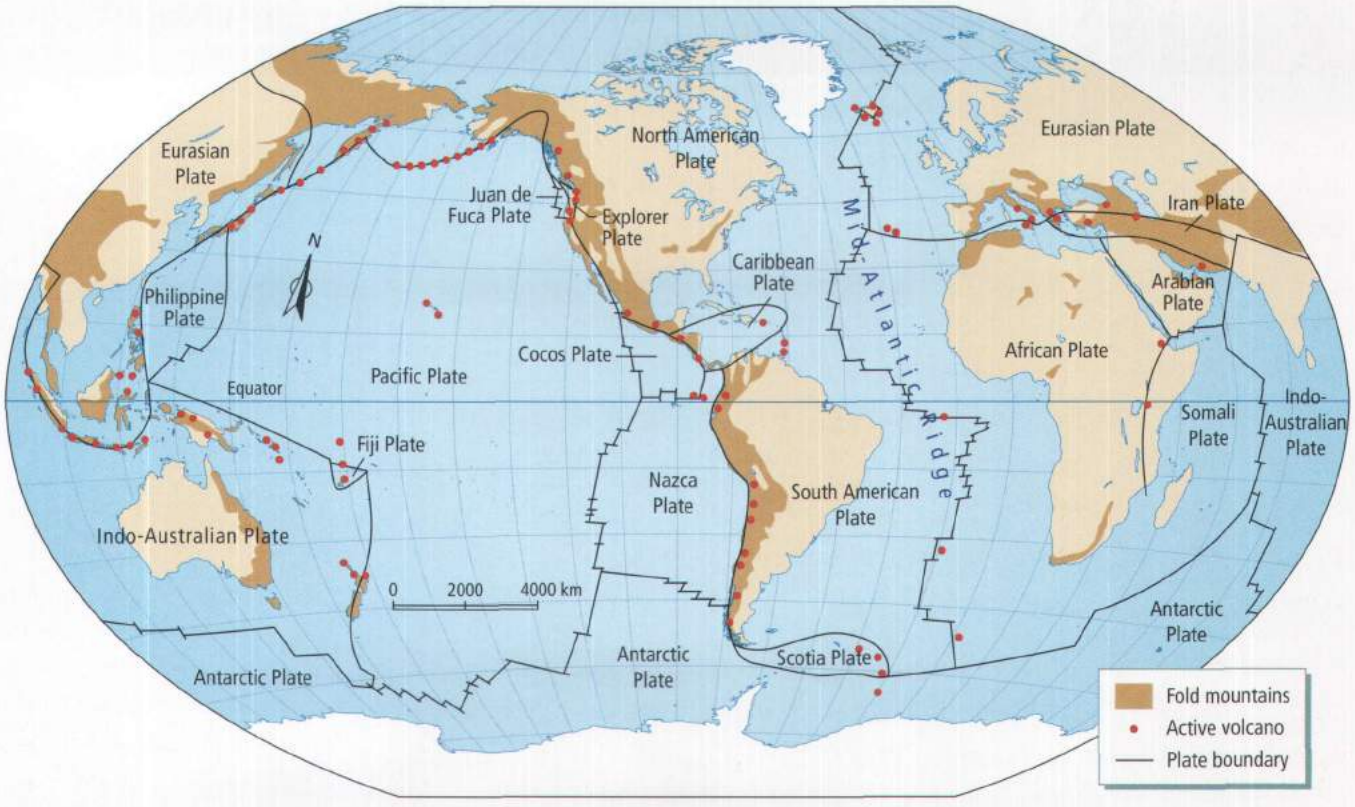
WEB LINK

For more information on volcanoes, visit www.pearsoned.ca/on7geography.

WORLD RECORDS

Krakatoa: The Biggest Known Blast

Imagine a chain of explosions so powerful that they broke windows and cracked walls 160 kilometres away. People 4800 kilometres across the Indian Ocean thought they were hearing cannon fire! That's what happened when the volcanic island of Krakatoa, Indonesia, was shattered by four massive blasts on August 27, 1883. Krakatoa is remembered for its volume, the loudest known noise in history.



The world's volcanoes and plates. What is their relationship?

THINKING It Over

1. The map shows 95 volcanoes. Count to find what percentage of them are found in a) the mid-Atlantic Ridge and b) the Pacific Ring of Fire. Give separate explanations why so many volcanoes are found in each location. *k*
2. Apply your knowledge. Why did the Krakatoa volcano explode? Why did tsunamis occur afterward? Why is a new volcano growing out of the Krakatoa crater? *k*
3. Use this section to write five good multiple-choice questions about volcanoes. Include three possible answers for each question. Afterward, see how many of the questions another student can correctly answer. *t*

Understanding Landform Patterns

Geographers are interested in patterns on the earth. They use the arrangement of cities, landforms, or river systems to help them identify unique regions. A few pages back, you learned that most active volcanoes are located at plate boundaries, especially around the Pacific Ring of Fire. In this section, you will focus on more landform patterns found on many of the continents. These include shield regions of ancient rocks, plains, and lowlands, and fold mountain chains. You will also learn that both rock age and rock type have been important in creating different landform patterns. Most of the examples in this section will highlight major North American landform regions.


An active volcano.


An ancient shield region.


Fold mountains.


Plains and lowlands.

Shields, Plains, and Lowlands

During the earth's 4.6-billion-year history, land masses have been built up and then worn away many times. Scottish geologist James Hutton first advanced this idea in 1785, but most scholars rejected it. At the time, scientists thought the earth was only 6000 years old, but this was too little time for so much change to have happened. German geographer Alfred Wegener was another landform pioneer. In 1912, he proposed that all of the continents were once joined together in one huge land mass named Pangaea. His theory was also criticized, but is now considered a key to understanding landform patterns. The modern theory of **plate tectonics** is built upon Wegener's pioneering work.

During READING

Checkpoint

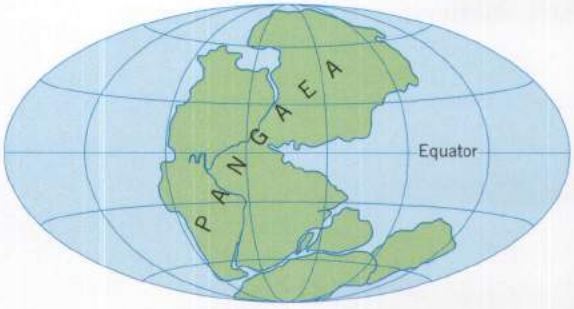
Why would the author want us to know about shields, plains, and lowlands? Write this question in your organizer. Add the answer after reading the whole section.

WORDS MATTER

plate tectonics the theory that all the continents were once joined together and are gradually drifting apart

Shield Regions

Pangaea was built around old shield regions. These regions were created by widespread volcanic activity billions of years before. They are largely composed of **igneous rock**; that is, solidified magma. Later, heat and pressure altered some parts of these old shield regions. This formed **metamorphic rock**, or changed rock. As Pangaea broke apart, the shield regions were scattered across the earth as the core of the continents. Today, they are heavily worn and carved by the relentless forces of erosion—water, ice, and wind. Ancient shields, such as the Canadian Shield, often have widespread areas of bare rock.



Which continents can you recognize in ancient Pangaea?

Metamorphic rock shows the effects of heat and pressure from within the earth.

WORDS MATTER

igneous rock solidified magma from inside the earth

metamorphic rock changed rock

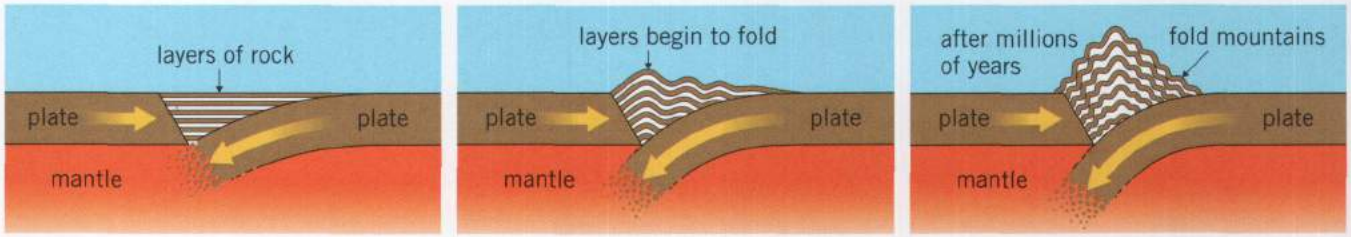
sedimentary rock thick beds of sediment that have slowly solidified into rock

Plains and Lowland Regions

The erosion of the shield regions created the rest of each continent. Rivers and glaciers carried eroded material, called sediment, into ancient seas. There, it accumulated into thick beds that slowly solidified into **sedimentary rock**. New land emerged around the ancient shields as the seas filled in. These plains and lowlands are underlaid by horizontal layers of sedimentary rock. Plains are broad areas of level land, such as the Great Plains region of central North America. Lowlands are plains located along coastlines, for example, the Great Lakes–St. Lawrence Lowlands.

Fold Mountain Regions

Look at a relief map of the world and you will see an amazing landform pattern. Great mountain chains cross the continents in bands. One chain runs the entire length of North America and South America, continuing into Antarctica. Another crosses Europe and Asia from west to east. These are the fold mountain systems of the world, huge crumpled ridges where plates collide.



Fold mountains form slowly as two plates move together, bending up sedimentary rock layers.

Fold mountains have been built from thick layers of sedimentary rock deposited in ocean basins. As currents in the mantle drag plates together, these layers are arched up in parallel ridges, like a wrinkled carpet. Of course, rock cannot bend much. Frequently the folds snap, causing earthquakes and movement along cracks called faults. As a result, the sedimentary layers have sometimes been heaved up and stand on end. The pressure of extreme folding has created areas of metamorphic rock in some fold mountain regions.

These great mountain systems form distinctive regions. They divide the flow of rivers. Their elevation causes clearly identified climate regions, which in turn create conditions for unique communities of plants and animals. In short, fold mountain patterns form ecozones.

IN MY WORLD

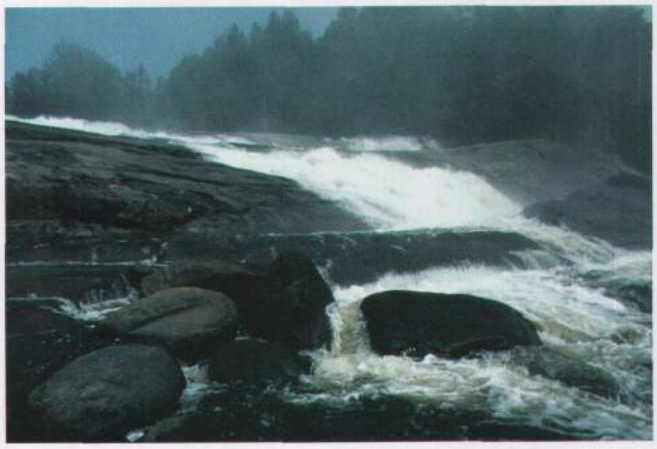
Identifying Local Physical Features

There are landform features, lakes, and streams in your region. You can locate them by using maps at different scales. Begin with the map of North America on page G 76 and identify the approximate location of your community. You can find the general elevation of your region on this map, and identify any major lakes, bays, or rivers nearby. For greater accuracy, look for the same information using an atlas map that shows elevation, waters, and the basic human features of the province.

Landform Regions of North America

1 The Rocky Mountains are formed from sedimentary rock folded and thrust up by the collision of plates.

2 Coastal mountain ranges, such as the Sierra Madre, have igneous and metamorphic rock from volcanic activity.



3 The Canadian Shield is the core of the continent, an ancient region of igneous and metamorphic rock.

4 The undisturbed sedimentary rocks of the Great Plains region were deposited in ancient seas.

5 The Appalachian Mountains are made of sedimentary rock, folded by plate collision and heavily eroded.

THINKING It Over

1. In your notebook, draw lines to match the information in these two columns: K

A. Landform Features	**B.** Types of Rock
* volcanoes	* igneous
* shields	* metamorphic
* plains and lowlands	* sedimentary
* fold mountains	

2. **a)** Why were James Hutton and Alfred Wegener considered foolish in their time? T

   b) Why are ocean fossils found on top of the Rocky Mountains? K

3. Use the map and photos of North America to make an observation chart comparing five major landform regions, as follows: C

Landform Region	General Elevation (map)	Description of Region (photos)
Rocky Mountains		

GEO SKILL

Reading Contour Lines on Topographic Maps

WORDS MATTER

contour lines lines on a map that connect points with the same elevation

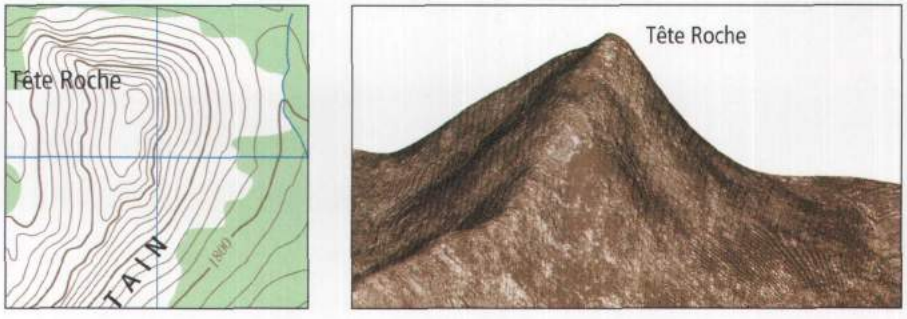
topographic map a very detailed map of physical and human features

elevation the height above sea level

A precise method for showing landforms is **contour lines**. Contours are lines on a **topographic map**, a very detailed map showing the physical and human features of an area. The lines connect points with the same **elevation.** The sample below is a small area along the Alberta–British Columbia border. It shows landform patterns and their effects on human activity.

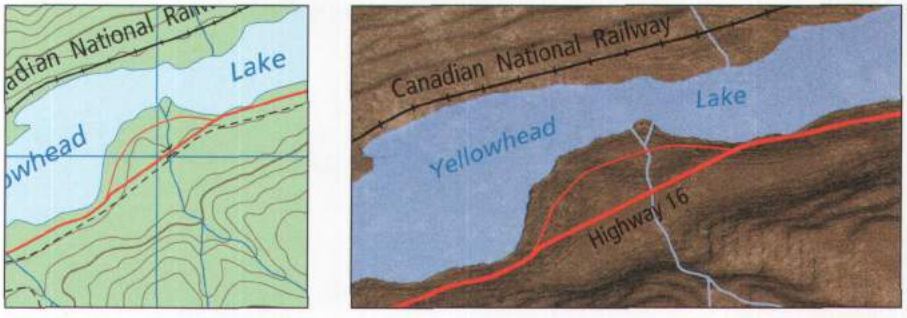
Step 1: Identify Hill and Mountain Patterns

Look for hills or mountains on the map by using the contour lines. These features are shown by contours that form closed loops. The higher the feature, the more contour lines you will find.



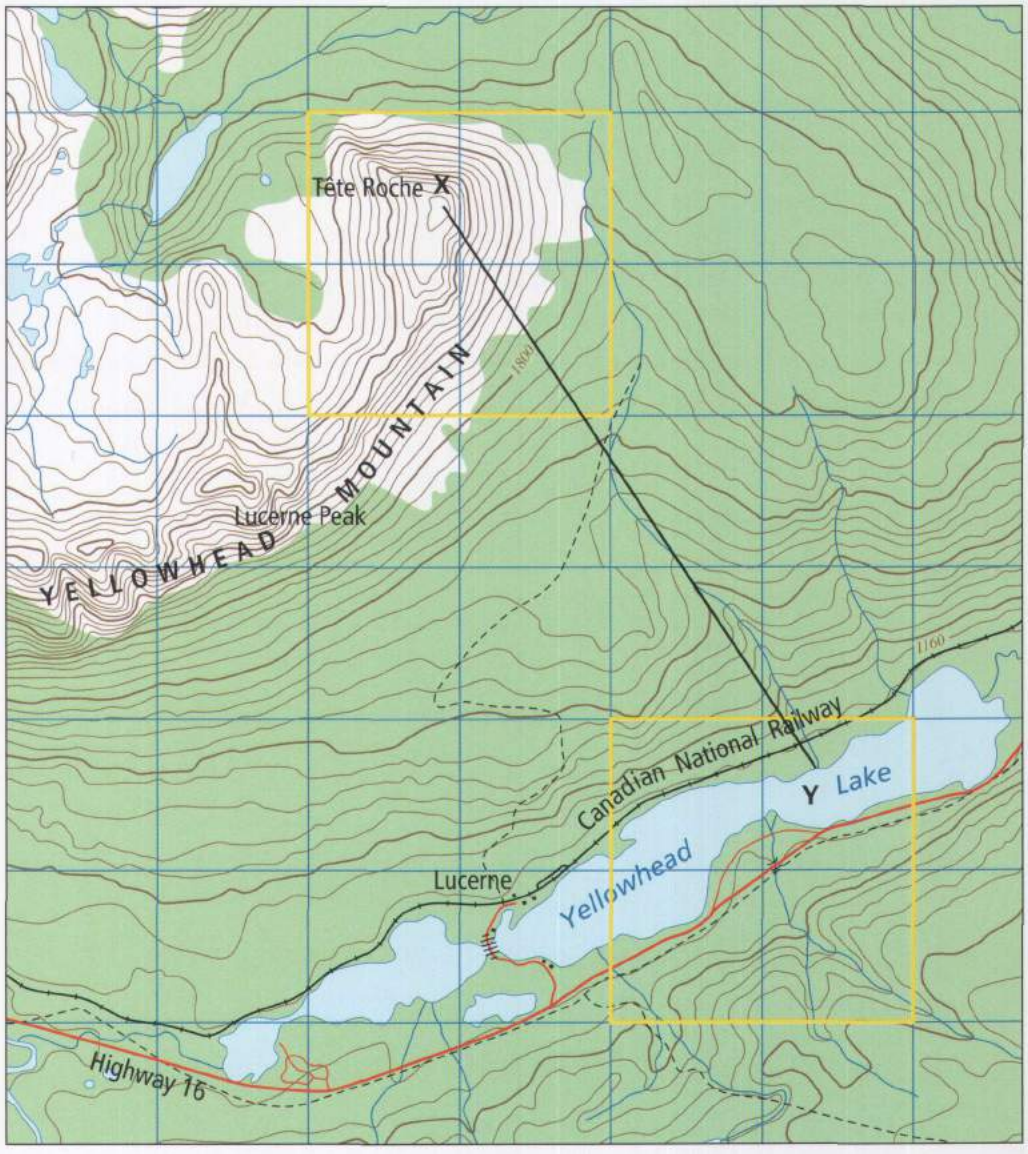
Step 2: Identify Valley Patterns

Look for water symbols as a guide to valleys. Streams will cut across contour lines, as they flow downhill to collect as lakes in lower places.



Step 3: Identify Human Symbols and Patterns

Look for symbols that show human activity on the topographic map. Examples used below include roads, railroads, trails (a dashed line), and buildings (small black squares) in a tiny community (Lucerne).



APPLY It

1. Locate the mountain diagram box on the map. Find and name two similar examples.
2. Find the valley diagram box on the map. How many streams flow into Yellowhead Lake?
3. Identify symbols of human activity in the map area. Where are these symbols located? How have landforms affected human activity in the Rocky Mountains?

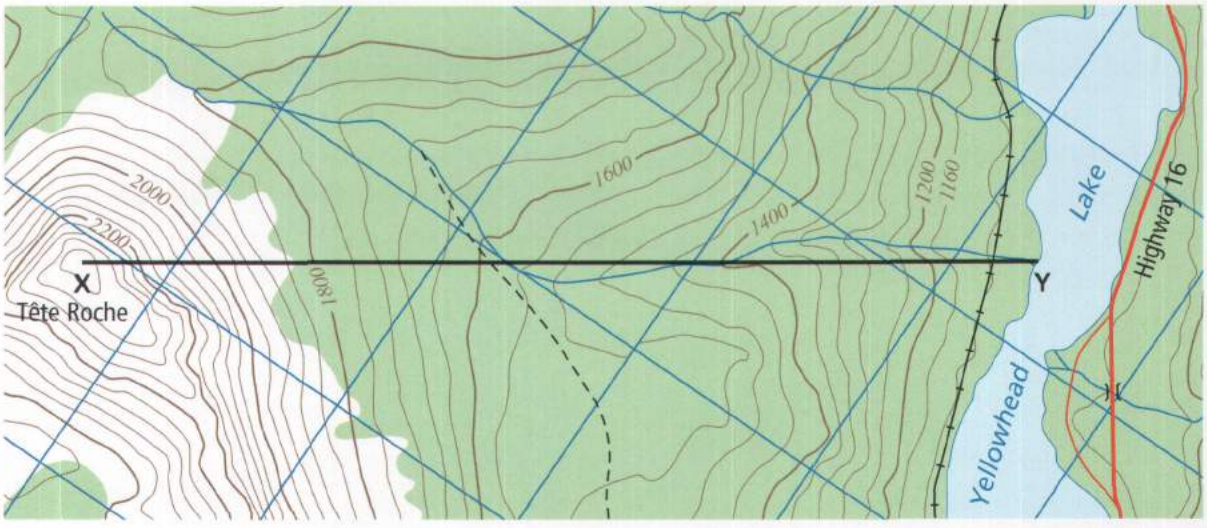
GEO SKILL

Using Contours to Draw a Cross-Section Diagram

Imagine that an injured climber is stranded on top of Tête Roche, a rugged mountain peak in the area covered by the Lucerne topographic map. The weather is too rough for a helicopter, so rescuers will need to climb the mountain from Yellowhead Lake to the peak. They are deciding between using an old trail, shown as a dashed line on the map, or following the stream valley that flows just east of Tête Roche down into Yellowhead Lake. Here's how to use the enlarged contour map to make a side view of their planned route close to the stream valley. It is called a **cross-section diagram**. Refer to the diagram on the next page as you follow these steps.

WORDS MATTER

cross-section diagram a diagram that shows the inside of an object, as though you had cut across it



Looking along the cross-section line from Yellowhead Lake to Tête Roche.

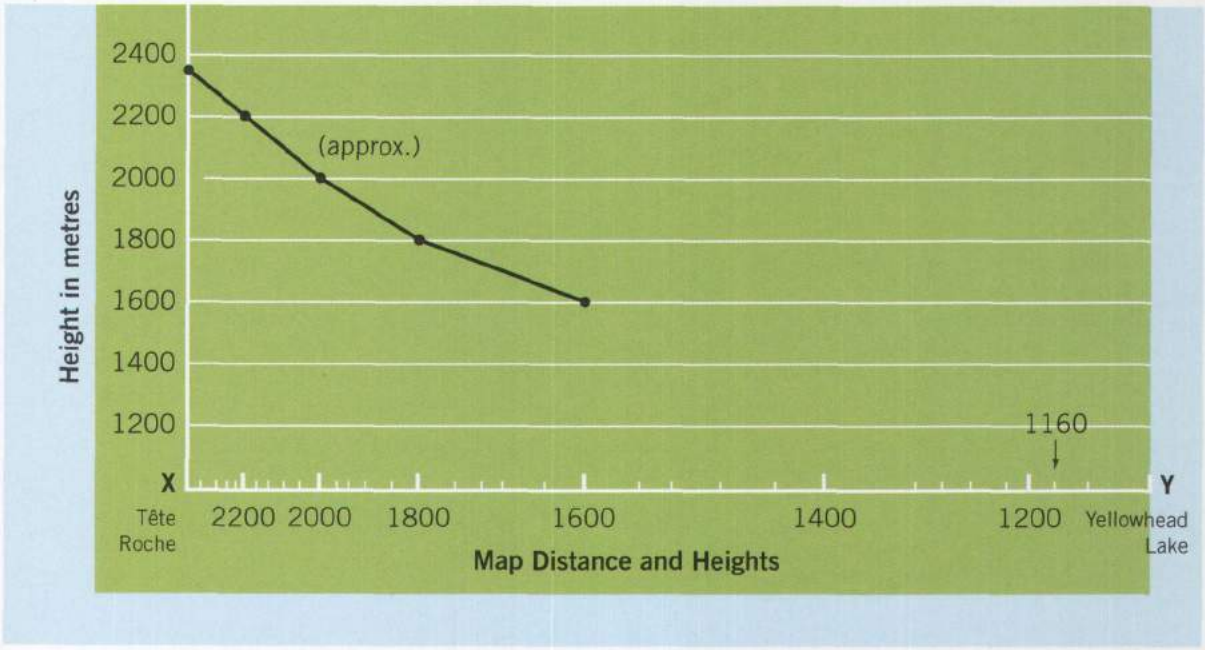
Step 1: Transfer Elevation to Paper Edge

Lay a strip of paper along the X–Y line on the enlarged map of contours. Carefully mark each point where there is a new contour line onto the paper edge. Record the elevation at each of these points on the strip of paper. Mark the shorelines of any lakes or rivers, too.

Step 2: Set Up the Cross-Section Graph

Draw the X–Y line on a piece of graph paper. Make a vertical scale in metres on the left side to show the range of elevations that you recorded on the strip of paper.

X–Y Cross-Section: Tête Roche to Yellowhead Lake



Step 3: Transfer Elevation Points onto the Graph

Lay the strip of paper along the bottom of the graph. Carefully transfer the contour points from the strip of paper to the bottom of the graph. Then, use the information along the strip of paper to position the points correctly on the graph itself.

Step 4: Finish the Cross-Section

Connect the points on the graph with a smooth line, showing any lakes as a flat surface. Then, complete the cross-section by adding a title and labels for important features along the cross-section. In this case, include the mountain, the lake, and transportation lines.

APPLY It

1. Draw and label the X–Y cross-section on graph paper. It has already been started for you in the diagram above. m
2. Compare your cross-section to the old trail up Tête Roche shown on the map. Which route should the rescuers follow? Explain the advantages and problems of each choice. m

Investigating River Systems

During READING

Checkpoint
Take notes on the characteristics, importance, and issues of the world's major river systems.

WORDS MATTER

river system the whole network of streams and lakes that come together to form one river

Sediments carried by the Ganges River are shown flowing into the Bay of Bengal in this satellite image.

Water is the most common agent of erosion. Water erosion is most evident in valleys that rivers have carved into the landscape. These valleys are among the most heavily populated regions of the planet, for many reasons. Valleys often have fertile soils because rivers carry loads of sediment down to the ocean. Streams are also a convenient means of transportation. For example, Canada's great rivers were the highways of the historic fur trade. In this section, you will investigate the characteristics, the importance, and the issues of some of the world's major river systems.

Great Rivers of the World

River system is the term given to the network of streams and lakes that eventually form one river; for example, the St. Lawrence or the Amazon. World and regional relief maps always show a fine blue web of rivers. As they cross continents, these systems flow from high places (the source, or headwaters) to low places (the mouth, or outflow). Some river mouths are long tapering inlets, such as the St. Lawrence River. This is a drowned river mouth, indicating either that ocean levels have risen or that the land has sunk. Other rivers, such as the Ganges River of India, have deposited low-lying deltas of fine sediments at their mouths. This material has been eroded from the land upstream.

The World's Longest River Systems

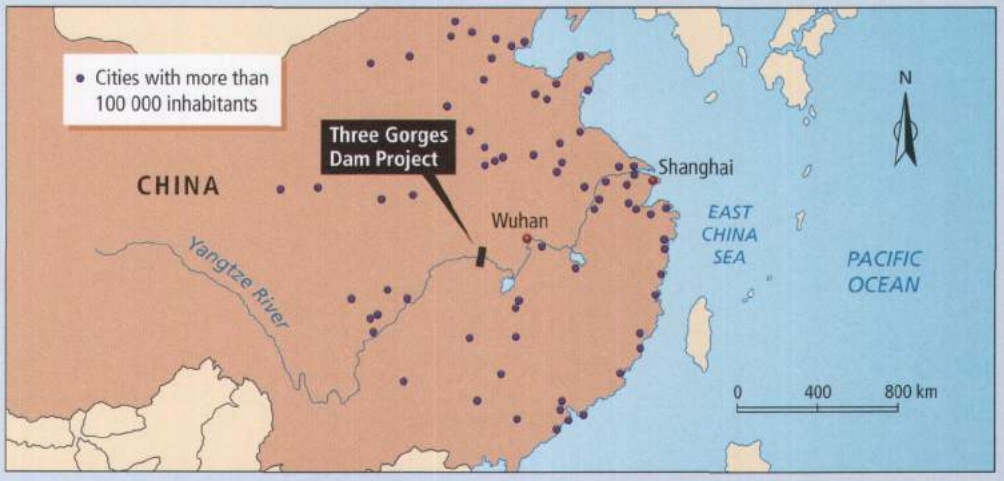
River and Continent	Length (km)	Outflow	Outflow Location
Nile (Africa)	6670	Mediterranean Sea	Egypt
Amazon (S. America)	6570	Atlantic Ocean	Brazil
Yangtze (Asia)	5980	East China Sea (Pacific)	China
Mississippi–Missouri (N. America)	5970	Gulf of Mexico	U.S.A.
Yenisey (Asia)	5870	Gulf of Kara Sea (Arctic)	Russia
Amur (Asia)	5780	Tatar Strait (Pacific)	Russia

ZOOM IN

The Yangtze, China's Changing River

The Yangtze River is the world's third-longest. It begins high in the Tanggula Mountains of eastern China at an altitude of 4880 metres. The Yangtze flows rapidly through scenic gorges, high-walled canyons cut deep into the land, and then crosses a wide, flat plain.

This fertile region is home to several hundred million people. Ocean ships can carry trade goods far inland, from the Yangtze's outflow near the port of Shanghai to the city of Wuhan, located 1100 kilometres upriver.



Why are there so many large cities close to the Yangtze River?

The Gorges area of the Yangtze will be greatly changed by the building of the new dam.

Shanghai, a port city of 18 million people, is located at the mouth of the Yangtze River.

China is changing its great river. The Chinese government is spending the first decade of the 21st century constructing an enormous dam across the gorge section. The Three Gorges dam will be the largest hydroelectric power project in the world. It will also help control the problem of flooding downstream, and make it easier for ships to navigate upstream from the East China Sea.

There are heavy costs to the Three Gorges project. China must borrow to pay for the multi-billion dollar dam and the relocation of thirteen cities. (They are below the water level of the 700-kilometre-long reservoir that will back up behind the completed dam.) Environmentalists warn of great damage to natural habitats. They estimate that the livelihoods of 75 million farmers and fishers in the valley could be threatened.

Drainage Patterns

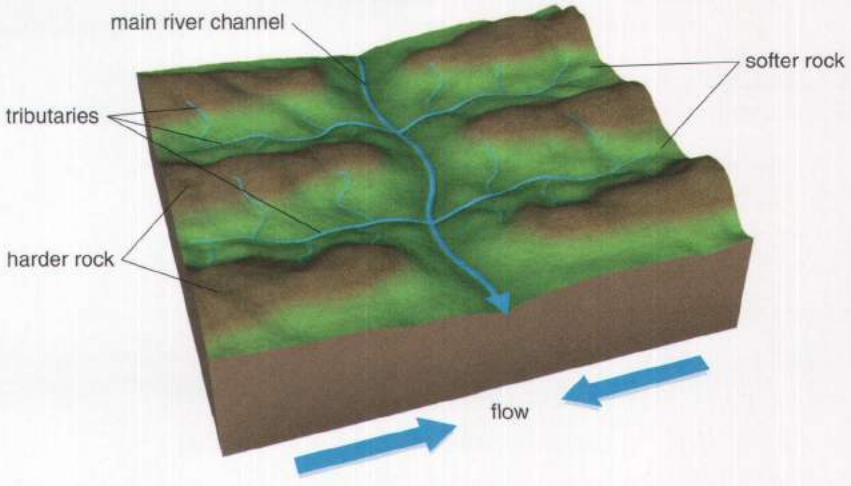
Rivers are part of a larger natural system that continually recirculates the earth's water. Canadian rivers are fed by melting snow in the early spring and by rainfall the rest of the year. Rivers carve two different patterns as they carry surplus moisture from the land. Dendritic and trellis drainage patterns are the result of different landforms and underlying rocks.

WORDS MATTER

dendritic drainage the tree-like drainage pattern created if rivers cross a gradual slope over one basic type of rock

trellis drainage the rectangular drainage pattern created if rivers flow through alternating bands of hard and soft rock

Dendritic drainage: the most common type. If rivers cross a gradual slope over one basic type of rock, this tree-like pattern will be cut into the landscape. The main stem of the river points downstream to the river mouth, and each branch joining the main river is called a tributary.



Trellis drainage: not as common as dendritic. If rivers flow through alternating bands of hard and soft rock, a rectangular drainage pattern develops. This often occurs when a large river cuts through parallel fold mountain ridges, such as the Appalachian Mountains of eastern North America.

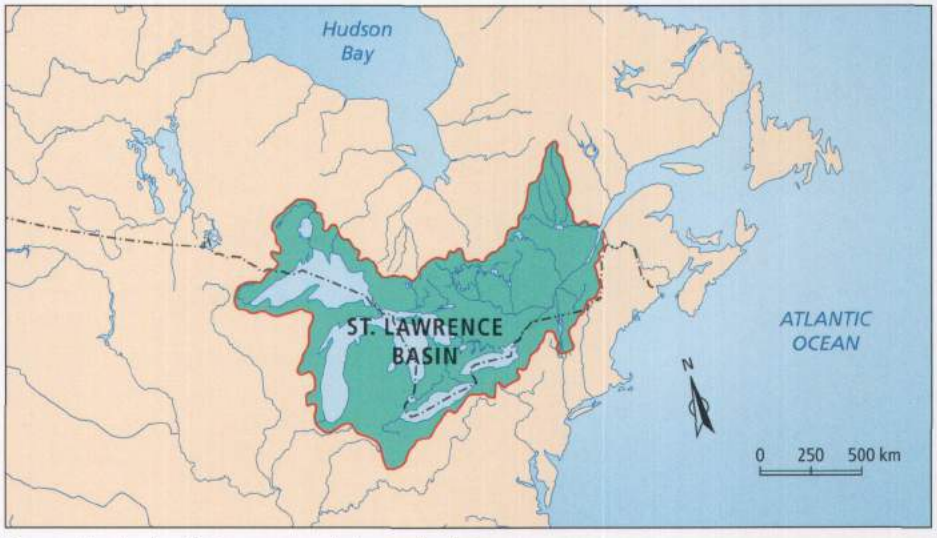
The Pollution of Drainage Basins

In Chapter 2, you learned about the watershed areas drained by individual streams and rivers. The term **drainage basin** refers to the entire region drained by one river system. For example, the St. Lawrence drainage basin covers a large area of the United States and Canada, including all the rivers that empty into the Great Lakes.

Pollution can easily accumulate in drainage basins because the waters are connected. This is a particular problem in the St. Lawrence system, because of the Great Lakes. Heavy industrial sludge and agricultural fertilizers contaminate the waters and are passed downstream. Millions of people live near the Great Lakes, and they rely on the same water for residential uses and recreation. Dangerous chemicals collect in channels and lake bottoms, threatening natural habitats and human health. The St. Lawrence drainage basin presents many serious management questions to the governments of Canada and the United States.

WEB LINK

For more information on drainage basins, visit www.pearsoned.ca/on7geography.



Do you live in the St. Lawrence drainage basin?

THINKING It Over

1. Make a two-column chart to compare the benefits and problems of the Three Gorges Dam project. Discuss your views on the subject with a partner. k t
2. Use an atlas or wall map to classify each of the river systems in the chart on page G 82 as either a trellis or dendritic pattern. k
3. Ask four questions to investigate the effects of Great Lakes pollution on the lives of people who live in the region. See the Skills Tool Kit feature "Asking Questions" on page S 4 for help. t

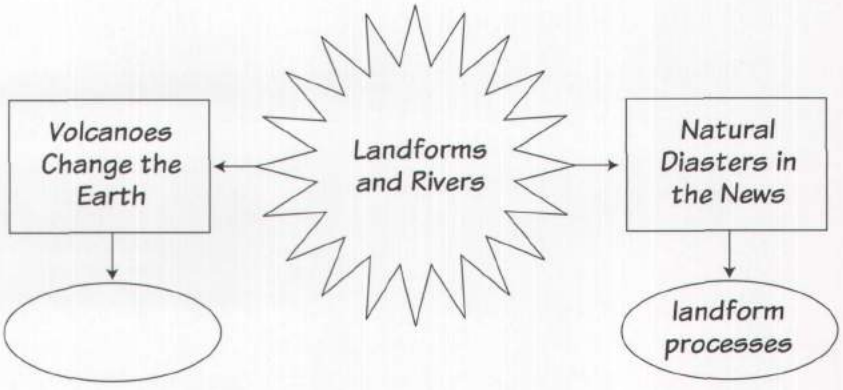
CHAPTER IN BRIEF

After READING

Tie It Together

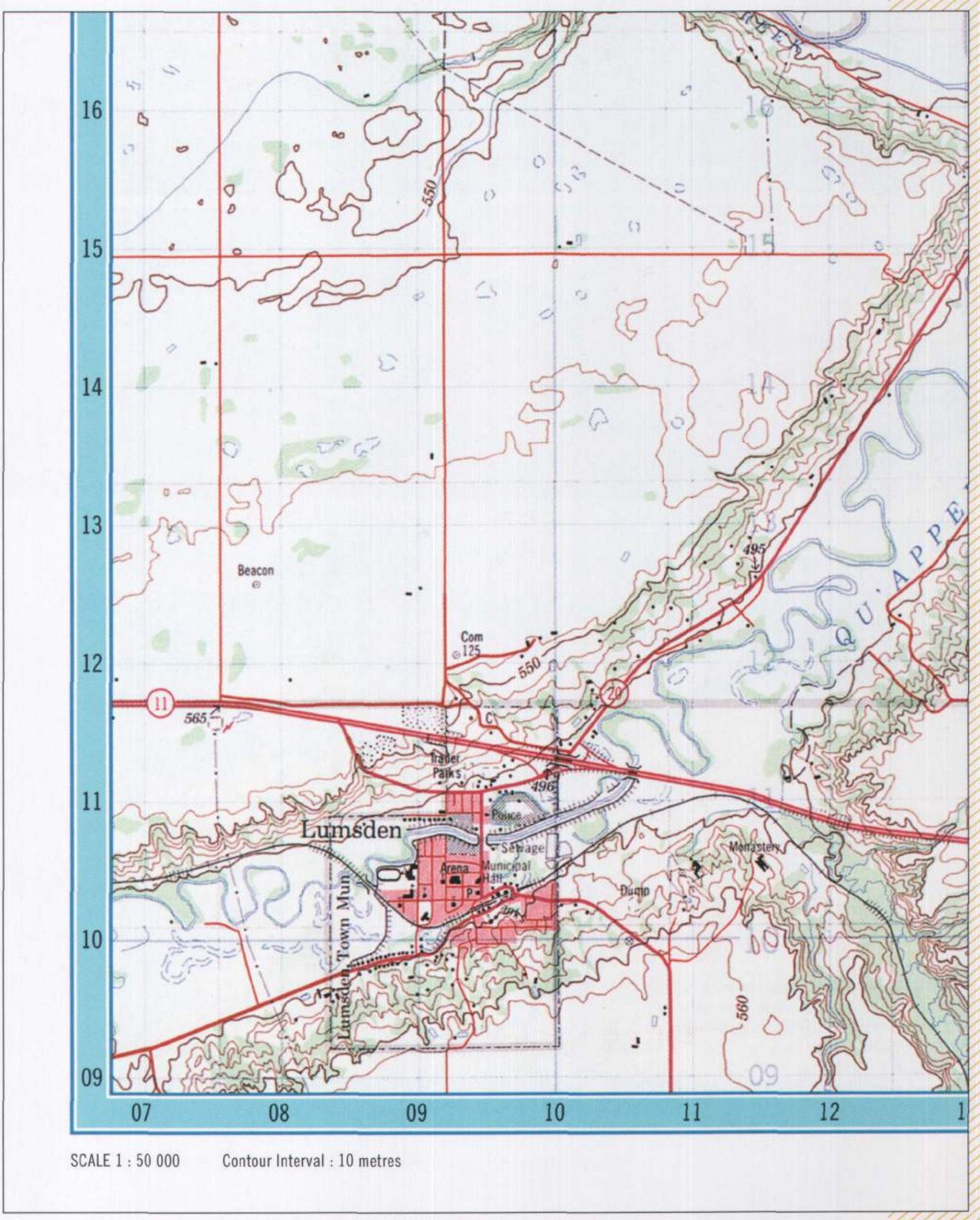
If you have not completed your graphic organizer (a sample is shown here), complete that and use those notes to write a summary of the chapter.

This chapter has explained how mountain-building and erosion create landform features. You learned that ancient shield regions were formed from volcanic activity. Erosion wore down the shields and sedimentary rock layers were formed in the surrounding seas. Stable regions eventually emerged as plains and lowlands. Elsewhere, plates were dragged together by currents in the mantle zone. This caused earthquakes and tsunamis while raising up volcanoes and fold mountains. In this chapter, you interpreted contour lines and drew a cross-section diagram from contours. You will demonstrate both these skills in the activity that follows.



PUTTING It All Together

1. The distance between the contour lines represents 10 metres of elevation. How deep is the Qu'Appelle River valley? (k)
2. Is the land beyond the river valley mountainous or a plain? Use map evidence. (k)
3. Comment on whether or not different landforms shown on this map are suitable for farming. (a)
4. Is the drainage pattern dendritic or trellis? Use map evidence. (k)
5. How has the river valley affected human settlement and transportation? (t)
6. Complete a labelled cross-section along a straight line parallel to Highway 11, but about 1 centimetre north of it. (t) (m)



SCALE 1 : 50 000 Contour Interval : 10 metres

Map of the Qu'Appelle River valley, just northeast of Regina, Saskatchewan.

CHAPTER 5

Global Climates: Global Warming

How will global warming change the way we live?

Before READING

Making Connections

A rant is a loud, strongly worded opinion. It is often a list of reasons, well thought out, but rattled off without thinking about the organization of the piece.

Write a rant explaining why we should care about the global climate.

WORDS MATTER

greenhouse gases gases that capture solar radiation; this acts somewhat like a "roof" on the lower atmosphere

fossil fuels fuels, such as coal, oil, and natural gas, that are formed from the remains of ancient plants and animals

GREENHOUSE GASES SET RECORD

GENEVA (AP)—Heat-trapping **greenhouse gases** in the atmosphere reached a record high in 2005 and are still increasing, the UN weather agency said yesterday.

The measurements coordinated by the World Meteorological Organization show that the global average concentrations of carbon dioxide, or CO_2, and nitrous oxide, or NO_2, reached record levels last year and are expected to increase even further this year, said Geir Braathen, a climate specialist at the Geneva-based agency....

There is 35.4 per cent more carbon dioxide since the late 18th century primarily because of human burning of **fossil fuels**, the WMO statement said.

Scientists say that carbon dioxide and other gases, primarily from burning of fossil fuels, trap heat in the atmosphere and have warmed the Earth's surface an average one degree in the past century.

A report this week by the British government warned that global warming would devastate the world economy on a scale of the world wars and the Great Depression if left unchecked.

The Observer, Sarnia ON, November 4, 2006.

What You Will Learn in This Chapter

- What are the causes and effects of hurricanes and tornadoes?
- How can I identify global patterns of climate?
- What factors cause global climate patterns?
- Where can I locate information, using a variety of different types of sources?
- How can I construct, interpret, and compare climate graphs?

Thinking About LITERACY

When you read for cause and effect, you can look for patterns, or the way information is organized. Sometimes, the cause will be given first, followed by one effect or a list of effects. Sometimes, the opposite happens: we read about one or more effects and then we read about the cause or causes.

We can also look for signal words that tell us that we are reading a cause-and-effect relationship.

Use a cause-and-effect organizer like this one to make notes on this chapter.

"What I Will Learn" Point	Causes (note page numbers)	Effects (note page numbers)
What are the causes and effects of hurricanes and tornadoes?		

Global Warming: What's the Problem?

Do you think there is intelligent life on planets orbiting other stars? If there is, these planets would need to have atmospheres around them to regulate the stars' heat. Otherwise, life forms would need to adapt to tremendous day–night temperature differences. During the day, earth's atmosphere protects the planet from the full strength of the sun's heat energy. At night, when half the earth is in shadow, the atmosphere keeps that heat energy from escaping into space. This means our atmosphere helps to cool down daytime temperatures and maintain the temperature at night. But, there is a problem. For the past two centuries the atmosphere has been capturing more solar energy, causing a slow increase in temperature on the earth's surface, known as **global warming**. The sun isn't burning brighter or hotter. So, where is the extra heat coming from? And what effects will this have on the planet if it continues?

WORDS MATTER

global warming the gradual increase in the temperature of the earth's surface

solar radiation energy from the sun

greenhouse effect the heating of the earth's surface caused by gases creating a "roof" over the lower atmosphere

Could there be intelligent life on other planets, as depicted in the movies?

Greenhouse Gases

Gases are made up of tiny particles called molecules that absorb the sun's heat energy. The name "greenhouse gases" comes from the way gases such as carbon dioxide (CO_2) and nitrous oxide (NO_2) capture **solar radiation**. They act somewhat like a "roof" on the lower atmosphere, like the glass roof of a gardener's greenhouse. This is why it is called the **greenhouse effect**.

There are many similarities in the two diagrams on the next page. First, sunlight reaches the earth as short-wave radiation,

WEB LINK

For more information on greenhouse gases, visit www.pearsoned.ca/on7geography.

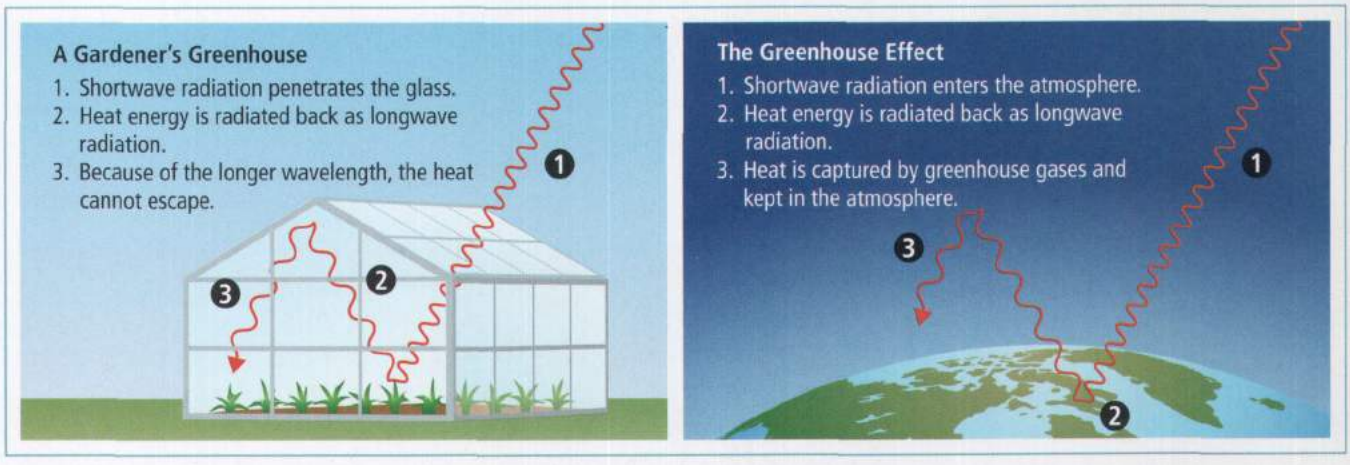
which can penetrate both the greenhouse roof and the greenhouse gases of the atmosphere. (That's why you can get a sunburn on a cloudy day.) Next, the greenhouse floor and the earth's surface warm up and give off heat as long-wave radiation. Notice how these longer waves cannot pass back through the greenhouse glass or the greenhouse gases. This causes temperatures to rise both in the greenhouse and in the earth's lower atmosphere.

CO_2 in the atmosphere has increased by 35.4 percent since the late 1700s. This dates back to the Industrial Revolution, when people learned to burn coal to power machines. The burning of fossil fuels such as coal, oil, and natural gas causes increased amounts of greenhouse gases. More greenhouse gases mean that more heat energy from the sun is captured in the lower atmosphere.

During READING

Checkpoint

The signal words in this paragraph are *first, that's why, next,* and *this causes.*



Heroes and Villains | *David Suzuki*

Dr. David Suzuki.

Dr. David Suzuki is the best-known scientist in Canada today. He speaks fearlessly for the environment, and has made some enemies by doing so. Suzuki has hosted television series about nature since the 1970s. His message is that people can easily upset the fragile balance of nature. He warns that "whatever we do to our surroundings, we do to ourselves."*

In 1990, he organized the David Suzuki Foundation to help people make wise environmental choices. One of the main problems the Foundation highlights is global warming. Dr. Suzuki urges people to switch to clean energy sources that do not add greenhouse gases to the atmosphere.

* Canadian Geographic, "Canadian Environment Awards 2005," page 16 (booklet)

During READING

Checkpoint

The first sentence tells you the effect; it signals that you are about to read the causes.

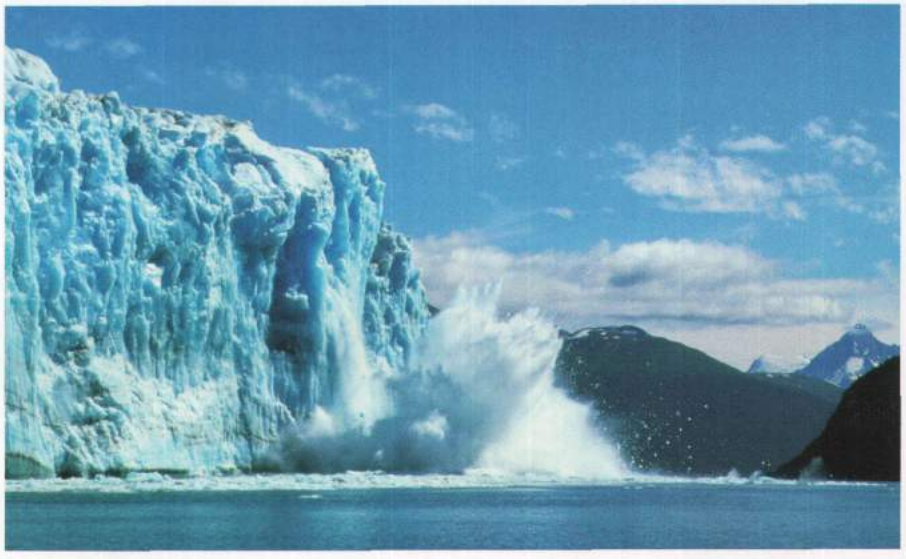
The Effects of Rising Temperature

Global warming is causing major changes in the surface of the earth. They include

- temperature increases of 8°C in Arctic regions, causing much melting of polar ice
- melting glaciers in mountain areas because of hotter summers and less winter snow
- more ocean icebergs as the Antarctic ice shelf and Greenland glaciers break up
- rising sea levels around the world as frozen water is released into the ocean
- more unpredictable weather as the sun raises ocean temperatures in the tropics
- rapid changes in natural vegetation patterns and in wildlife habitats, such as that of the polar bear

WEB LINK

For more information on global climate change, visit www.pearsoned.ca/on7geography.



How will more icebergs affect ocean shipping in the future?

THINKING It Over

1. Why is the atmosphere so important to life on earth? Why are temperatures in the lower atmosphere rising? K
2. Think of different examples to show how each of the six effects of global warming can affect plants, animals, or humans. Use think-pair-share to compare your ideas. t

Is Global Warming a Threat?

Most climate scientists believe that global warming is a serious threat that must be reduced through global cooperation. Some scientists, however, do not agree. Patrick J. Michaels is one.

The Way of Warming

Patrick J. Michaels.

The planetary average surface temperature is warmer than it was 100 years ago.... If that warming were in the coldest air of winter—rather than the heat of summer—the effect might be beneficial.... [I]s more precipitation really a bad thing? What if the increase in precipitation occurs through more gentle spring rains and less severe hurricanes?... No known mechanism can stop global warming in the near term. International agreements such as the Kyoto Protocol would have no detectable effect on average temperatures within any reasonable policy time frame of 50 years or so.... We simply cannot predict our future. The more serious question provoked by the facts on global warming is this one: Is the way the planet warms something we should even try to stop?

Patrick J. Michaels, Paul C. Knappenberger, and Robert E. Davis

—*Regulation* magazine, Vol. 23, No. 3, 2000, p. 14.

Grade 10 student Allyson Fuller believes global warming is serious.

Letter to the Editor

Allyson Fuller.

Patrick J. Michaels may make a good point with his information on global warming... but we must realize who this man is, and who he works for. [He] is senior researcher in environmental studies at the Cato Institute [which]... "has received financial support from energy companies—including Chevron Companies, Exxon Company, Shell Oil Company and Tenneco Gas..." (*Media Matters*). His denial of global warming may be because of the fact that he is milking all his financial aid from companies that are in some way contributing to the process of global warming. These companies are producing oil and/or gas, which are ultimately burned by consumers, producing carbon dioxide and other polluting emissions... Why should we believe this man?

Allyson Fuller, Ontario Grade 10 student

—*The Observer*, Sarnia, ON., December 15, 2006, p. A4.

What do YOU think?

1. Why did Allyson criticize the scientist's background rather than his arguments? t
2. Do you think Allyson's criticism is fair, or not? Explain. t
3. Compare Patrick Michaels' views with David Suzuki's. Which do you find more credible? Why? t

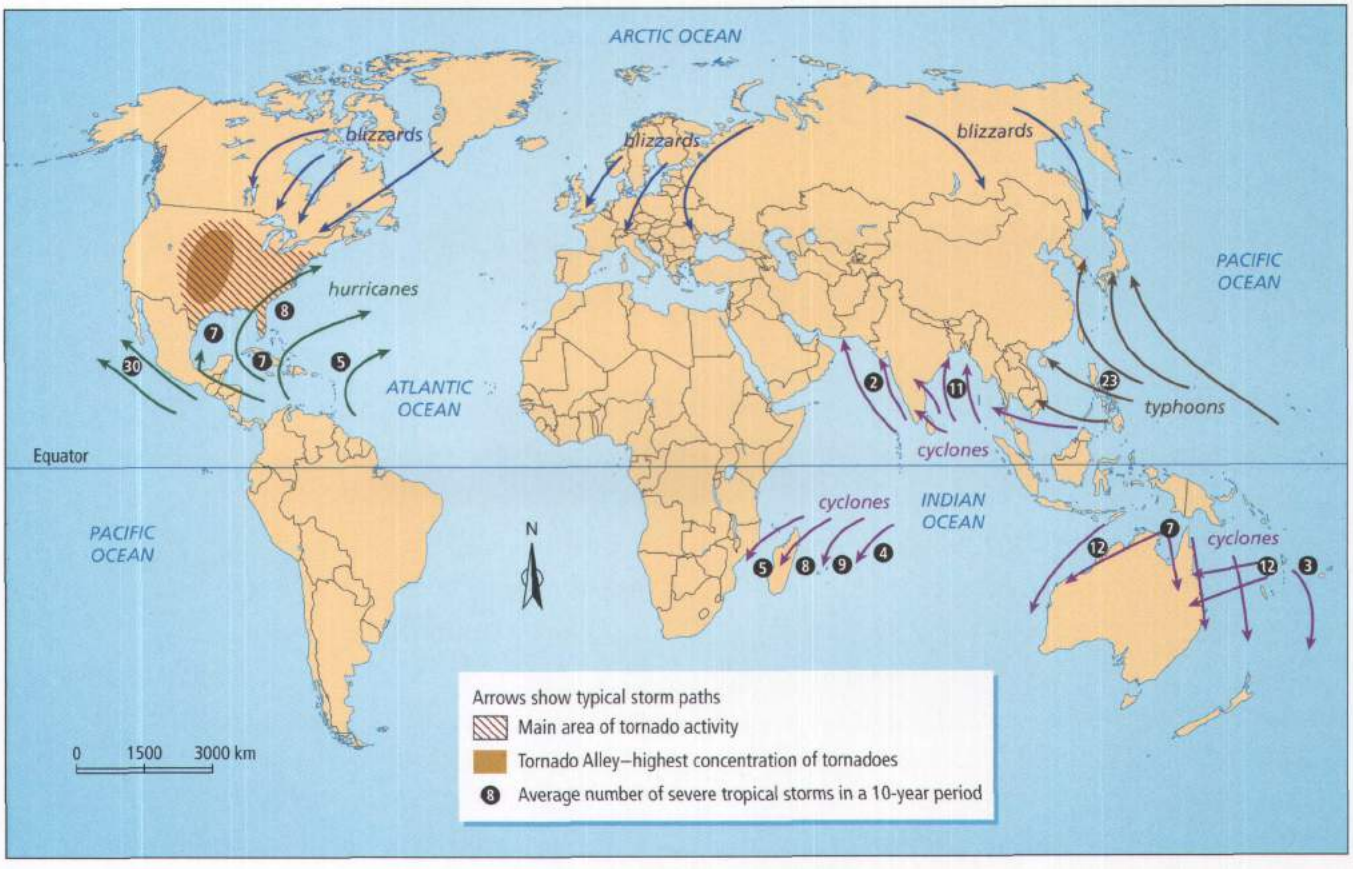
See page S 12 for help with points of view.

Powerful Storms

WORDS MATTER

tropical storm a storm originating in the tropics and marked by high winds and often heavy rain, such as hurricanes, cyclones, and typhoons

The atmosphere is in continual motion, with swirling masses of air that create our weather. This movement of air masses happens for two reasons: the earth is spinning in its daily rotation, and its surface is unevenly heated. Powerful storms sometimes occur as a result. **Tropical storms** (called hurricanes, cyclones, or typhoons), tornadoes, and blizzards all have the potential to destroy property and human life.



World storm locations.

During READING

Checkpoint

Scanning is reading up and down and zig zag, without reading every word. Scan this paragraph for words that signal cause and effect before you actually read it.

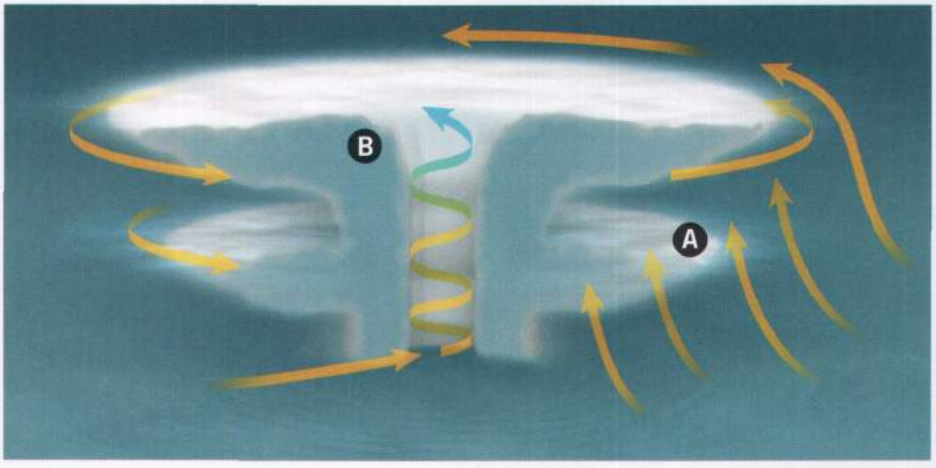
Tropical Storms

From the map, you can see that hurricanes, cyclones, and typhoons all begin in oceans on each side of the equator. From there, they sweep toward the mid-latitudes, sometimes reaching as far as Nova Scotia. These tropical storms originate from warm ocean waters. Think of them as swirling mountains of warm, moist air heated by the sun. As a mound of warm air rises from the ocean surface,

cooler air blows into the base of the air mass. A **tropical disturbance** is set up. As the new air is heated and rises, the tropical disturbance grows larger and spins faster. It is upgraded to hurricane status. The sun's energy is responsible for tropical storms. North America could be powered for half a year on the energy of one hurricane season!

WORDS MATTER

tropical disturbance a weather phenomenon originating from warm ocean waters as cool air blows into the base of swirling mounds of warm, moist air heated by the sun



A Warm air rises and is replaced by cool air.
B Cold air blows inward in a spiral, creating a tropical disturbance.

Tropical storms move outward from warm ocean regions. Hurricanes affecting the Caribbean and eastern North America originate off the coast of Africa. Cyclones form over the Indian Ocean, and typhoons start in the Pacific Ocean. The power of all three kinds of storms is measured with the Saffir-Simpson Scale, named for the scientists who created it. The scale indicates wind speed and storm surge, two dangerous ways in which energy is released. The storm surge is the sudden rise in sea level caused by high winds pushing water toward coastlines. It is like a continuous tsunami, though not as high.

The Saffir-Simpson Scale

Category	Wind Speed (km/h)	Severity	Height of Storm Surge (m)
1	75 to 152	weak	1.2 to 1.5
2	153 to 176	moderate	1.8 to 2.4
3	177 to 208	strong	2.7 to 3.6
4	209 to 248	very strong	3.9 to 5.4
5	Above 248	devastating	Above 5.4

The Global Warming Link

In 2004 and 2005, twice as many hurricanes as predicted rose in the Atlantic Ocean. So many hurricanes occurred in 2005 that scientists completed the alphabet of names before the season ended. For additional names, they used the names of Greek letters: Alpha, Beta, Gamma. That year, five hurricanes grew to Category 4 and 5 in size. The season caused 2280 hurricane-related deaths and US$100 billion in property damage. Is global warming responsible for more and larger tropical storms?

Many scientists believe that global warming is causing changes in hurricane activity. Tropical storms are fed by surface waters that have been heated to 28°C. Since 1970, average ocean surface temperatures have increased by more than half a degree. This may not seem like much, but it brings the Atlantic hurricane region right up to that 28°C level that can spawn tropical storms. Sometimes water surface temperatures are much higher; for example, in 2005 the Gulf of Mexico reached almost 35°C in places.

WEB LINK

For more information on hurricanes, visit www.pearsoned.ca/on7geography.

Two recent studies found that the number of Category 4 and 5 tropical storms has almost doubled in the past 30 years. And recent laboratory experiments by the U.S. National Oceanographic and Atmospheric Association (NOAA) demonstrate that later in this century, hurricanes will be even stronger, with much more rainfall. The reason: increasing ocean temperatures due to global warming.

THINKING It Over

1. Use the world map of storms to compare hurricanes, cyclones, typhoons, tornadoes, and blizzards in a chart like this: *k*

Type of Storm	Origin	Regions Affected
Hurricanes		

2. In your own words, or with drawings or diagrams, explain the following. (Use your Cause-and-Effect chart to help you.) *t*

   a) What causes a tropical storm to develop?

   b) How is this linked to global warming?

   c) Why is the storm surge so dangerous?

ZOOM IN

Katrina Drowns New Orleans

By late August of 2005, two severe hurricanes had already ripped into North America. Surely, Dennis and Emily had dealt enough destruction for one season. But Katrina had even more in store: one of the worst hurricanes in U.S. history.

New Orleans was once a city of half a million people. Most lived behind protective earthen walls (called levees) because most of the city lay at or below sea level, close to the Gulf of Mexico. The winds were violent as Katrina roared off the over-heated Gulf, pushing a six- to ten-metre storm surge. Water rose to the top of the levees. They began to leak and soon collapsed, flooding 80 percent of the city. Nearly 1600 people died in Louisiana and another 200 died along the nearby Gulf coast. Almost all of them drowned, many trapped in homes and attics by rising waters.

The effects of Hurricane Katrina were severe. A year and a half later, New Orleans remained a disaster area. Flood debris was still scattered through entire abandoned neighbourhoods and business areas. Six of the city's nine hospitals and more than half the schools remained closed. At least 200 000 people had not returned. They likely never will; they have left the dangerous Gulf of Mexico hurricane zone for northern Louisiana, Texas, and other states.

Floodwaters rush over the top of a levee into a New Orleans neighbourhood.

Tornadoes

Sometimes people confuse tornadoes and tropical storms. Both are deadly weather spirals caused by rising warm air. But, beyond that, these two weather events are very different. Tornado season spans spring and summer; tropical storms occur in the summer and autumn. Tornadoes develop over land, not water, so they do not create dangerous storm surges. They drop down from the clouds, rather than arriving on land, like a hurricane. The spiral of a tornado is its trademark, much tighter and faster-spinning than the hurricane. Tornadoes can occur worldwide, but most happen in the United States (1200 annually) and Canada (100).

The map of North America shows that tornadoes occur over the eastern part of North America, including Canada. During the 1980s, "twisters," as they are sometimes called, tore into Barrie, Ontario, and Edmonton, Alberta, taking a total of 38 lives. The states of Kansas and Oklahoma are the heartland of tornado country, the so-called "Tornado Alley" that spawns at least a dozen significant tornadoes every year.

A tornado is one of the fastest-moving natural phenomena on earth. The severity of a twister is measured by the Fujita Scale, developed by a leading weather scientist. Originally it was called the

WORLD RECORDS

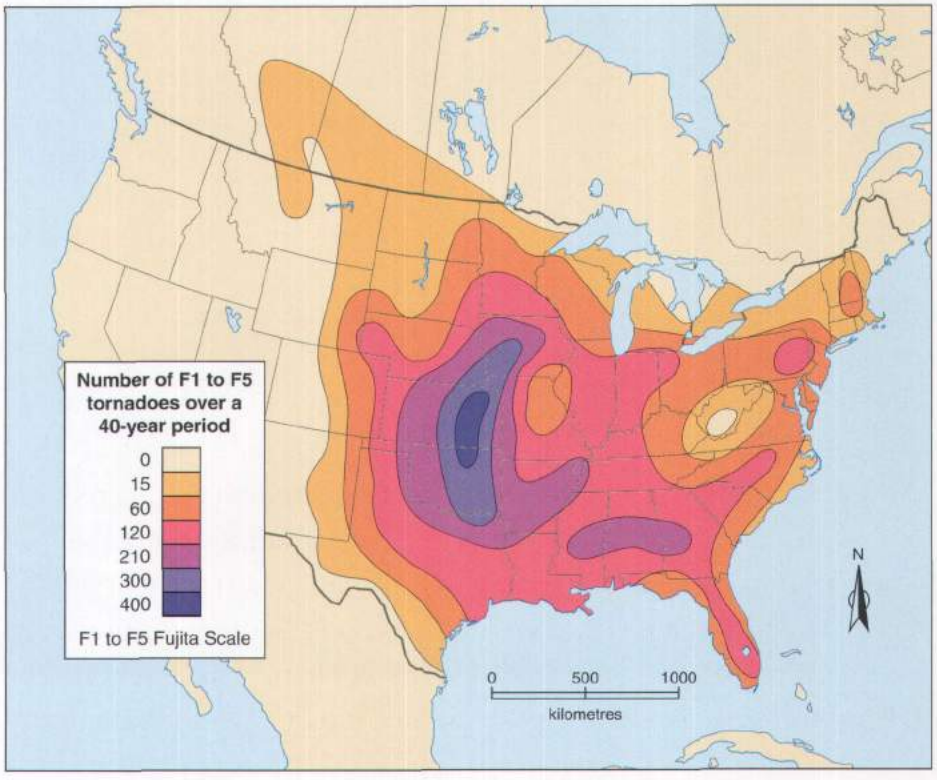
The Worst Tornado

The infamous "Tri-state" tornado of March 18, 1925, swept through the northern part of Missouri and southern Indiana and Illinois. It moved along a 350-kilometre track at speeds of 100 to 120 km/h. This tornado caused F5 damage and took 695 lives in the area. Weather conditions in the area that day spawned six more tornadoes, which killed 51 more people and caused widespread damage.

WEB LINK

For more information on tornadoes, visit www.pearsoned.ca/on7geography.

North America: 40-Year Tornado Frequency



A funnel cloud and flying debris.

Severe damage shows the path of a tornado.

F-Scale. On February 1, 2007, the U.S. National Oceanic and Atmospheric Administration (NOAA) updated it as the EF-Scale. The E stands for "enhanced." Scientists believe that the former scale was inconsistent, with wind speeds often over-estimated. Instead, the new EF-Scale is based on very detailed damage assessment. However, the old scale is still the one used to describe past tornadoes.

The Enhanced Fujita (EF) Scale

Rating Scale	Wind Speed (km/h)	Type of Damage Frequency	Percentage of Tornadoes
EF0	104–136	minimal	28
EF1	137–176	moderate	40
EF2	177–216	significant	24
EF3	217–264	severe	6
EF4	265–320	devastating	1 to 2
EF5	Over 320	incredible	Less than 1

What Causes a Tornado?

Tornadoes are most likely to occur when warm, humid air and colder air are close to one another. This often happens during the North American spring, when moist air from the Gulf of Mexico flows north, while colder Arctic air is still nearby. As humid air rises during the daytime, columns of colder air rush down to the ground to take its place. Sometimes, the rising warm air begins to rotate around a cold air column. This forms a funnel of spiralling warm air called a **vortex**. These are the rapid winds of the tornado. Normally, a tornado passes along the ground at about 60 km/h or less. The following diagrams show the step-by-step growth of a tornado.

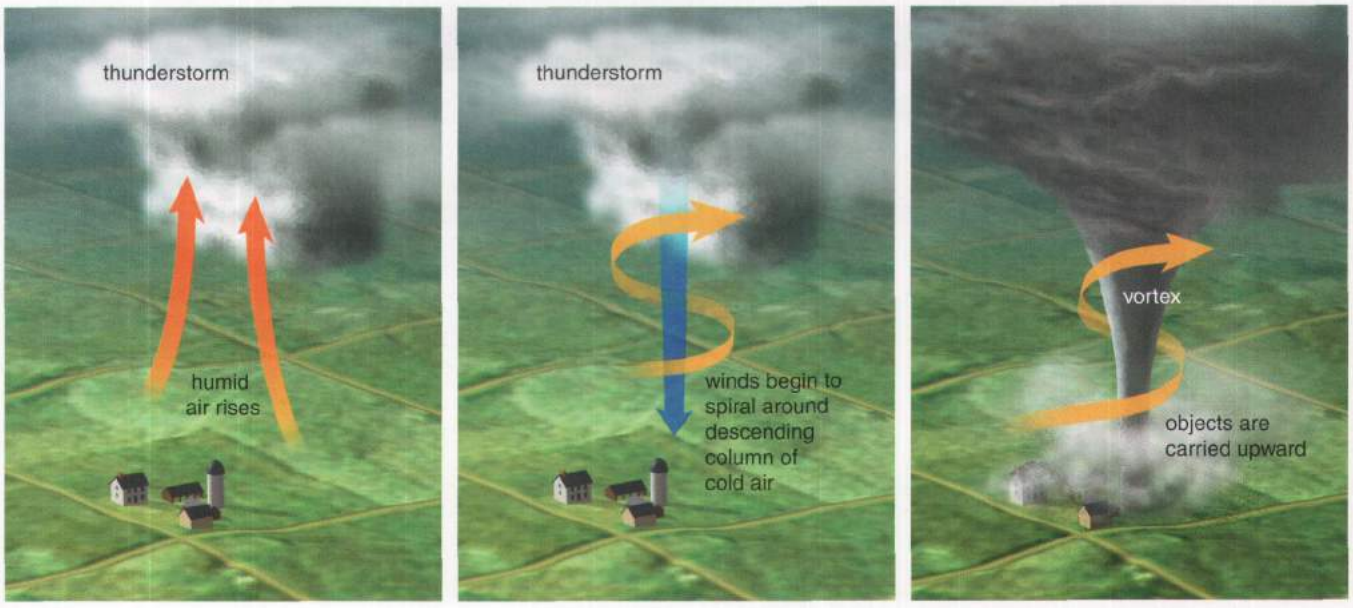
During READING

Checkpoint

Continue looking for and writing down causes and effects.

WORDS MATTER

vortex the rapid, spiralling winds of the tornado



Formation of a tornado.

Are Tornadoes Linked to Global Warming?

Tornadoes are caused in part by rising warm air from the Gulf of Mexico. Oceans and seas are warming, which has led some people (including the Sierra Club, a major environmental group) to conclude that global warming will probably cause more severe tornadoes. To date, scientific research has not proved the connection. Tornadoes appear suddenly and disappear almost as quickly, making them difficult to study.

Weather scientists expect that damage levels from tornadoes will remain as high as ever, but believe that death and injury rates should become much lower. Tornadoes are very localized weather events. Sophisticated **Doppler radar** can pinpoint storm bursts very closely, and satellite communication systems can alert people in the affected areas. Most people should be able to take cover before the tornado strikes.

WORDS MATTER

Doppler radar electronic soundings that measure the speed and rotation of winds and wind drafts

THINKING It Over

1. Make a Venn diagram to compare a tornado to a tropical storm. K
2. Ontario is sometimes struck by tornadoes. Prepare a community Tornado Emergency Plan to a) prepare people in advance, and b) alert people if a tornado is sighted nearby. C
3. Use the Internet, CD-ROMs, or magazines to gather six pictures of tropical storms and tornadoes. Mount them as a display, with a detailed caption to go with each picture. C

GEO SKILL

Interpreting and Graphing Climate

Geographers often make graphs and interpret climate statistics. A climate graph shows typical temperature and precipitation information by month at a particular place. It is a long-term average of daily weather conditions. The climate graph combines a line graph and a bar graph. A red line (like a thermometer) is used to show temperature, and blue bars (like cylinders of water) indicate monthly precipitation.

Interpreting Climate Statistics

Climate graphs are drawn using monthly statistics collected over many years. This information can be used to make calculations for comparison with other places.

Toronto, Canada (44° North latitude)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature (°C)	–5	–4	1	8	14	19	22	21	17	11	5	–2
Precipitation (mm)	55	53	65	65	68	67	71	83	76	63	76	77

Approximate Average Temperature

Add the highest and lowest temperatures together and divide by two. Remember that for colder places the winter temperature will be a negative number. For Toronto, the answer is $(22 + (-5)) \div 2 = 8.5°C$.

Temperature Range

Temperature range is the difference between the highest and lowest temperatures, and is calculated by subtraction. Remember that for colder places the winter temperature will be a negative number. For Toronto, the answer is $22 - (-5) = 27°C$.

Total Precipitation

To find total precipitation, simply add up the precipitation figures for each month. For Toronto, the answer is 819 mm.

Drawing a Climate Graph

A climate graph is easier to read than monthly statistics because it gives a total view of a typical year. These graphs are especially useful when comparing different places. Follow these six steps to construct a climate graph.

Step 1: Mark the Months

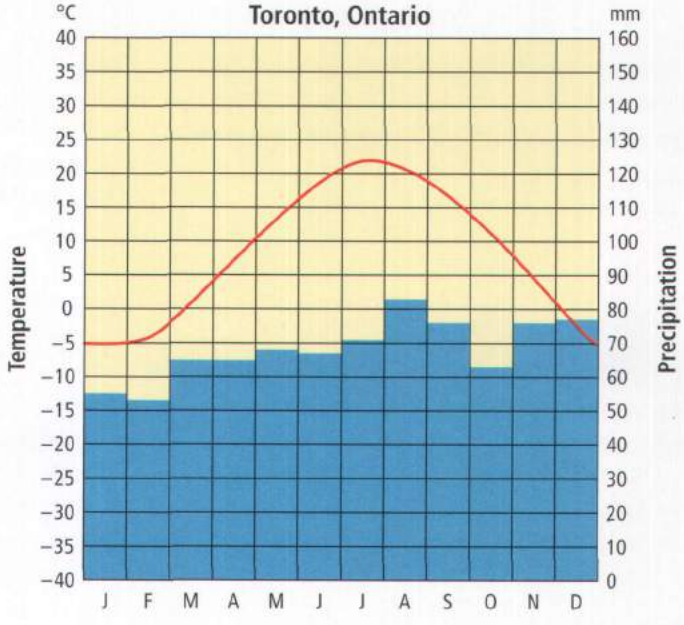
Use only their first letters to mark the months across the bottom of a graph page.

Step 2: Label the Temperature Scale

Label the temperature scale on the left side of the graph page. Start with 0°C about half way up the graph. Then, number by 5s above and below the 0°C point on the scale. Be sure to put a negative sign in front of freezing temperatures, as shown on the following sample.

Step 3: Plot the Temperature Information

Use this scale to mark the temperature data onto the graph. Put a dot for temperature in the middle of each month. Connect the dots with a smooth red line that continues right out to the edge of the graph.



Step 4: Label the Precipitation Scale

Label the precipitation scale on the right side of the graph. Start with 0 mm at the bottom line of the graph and go up at 10 mm intervals (coinciding with the 5° intervals of temperature on the left-side scale.)

Step 5: Plot the Precipitation Information

Use this scale to mark the precipitation statistics on the graph. Make a short horizontal line to show this information for each month. Construct monthly bars and shade them blue to represent water.

Step 6: Add All Labels

Complete your climate graph with a title and labels, as shown in the example.

APPLY It

1. Use the information below to calculate the following:
   - **a)** approximate average temperature
   - **b)** temperature range
   - **c)** total precipitation
2. Neatly draw and label a climate graph for Wellington, New Zealand.
3. Toronto is in the northern hemisphere, and Wellington is in the southern hemisphere. How has this affected their temperature lines? Do you know why?

Wellington, New Zealand. The seasons are reversed in the southern hemisphere.

Wellington, New Zealand (41° North latitude)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature (°C)	18	18	17	14	12	10	9	10	11	13	15	16
Precipitation (mm)	67	48	76	87	99	113	111	106	82	81	74	74

What Causes Different Climates?

During READING

Checkpoint

Go back to your Cause-and-Effect chart. Add the causes and effects to each What I Will Learn point.

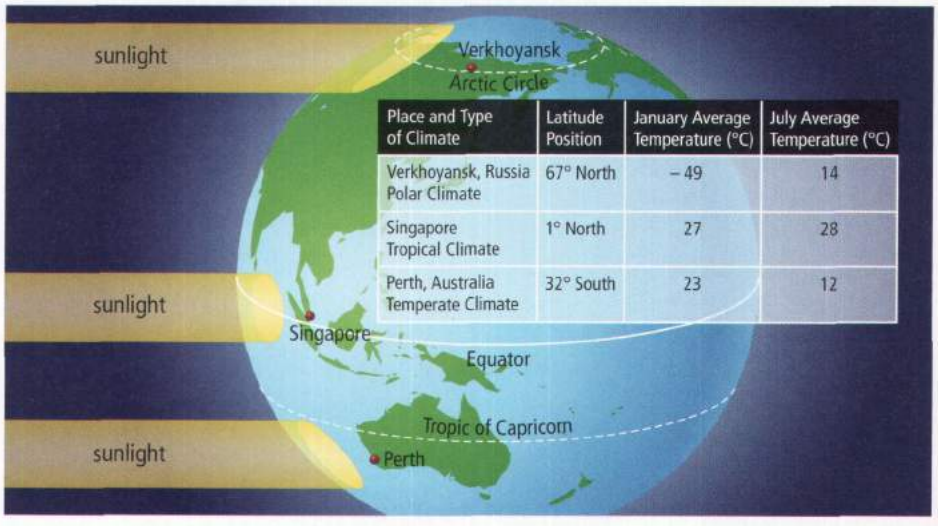
There are many different types of climates on earth. In this section, you will learn how five major factors cause some of the main climate regions.

The factors are

- the effect of latitude
- the effect of moving air (winds and pressure)
- the effect of water bodies
- the effect of mountains
- the effect of ocean currents

The Effect of Latitude

The sun is the most important factor affecting the world's climates. Generally, the coldest places in the world are in Antarctica and near the Arctic Ocean. Some of the hottest places are close to the equator. The diagram below shows that places at different latitudes on earth's surface receive very different temperatures. This is because the sun's rays are more intense near the equator, and less concentrated at latitudes closer to the North Pole and the South Pole.



Place and Type of Climate	Latitude Position	January Average Temperature (°C)	July Average Temperature (°C)
Verkhoyansk, Russia Polar Climate	67° North	−49	14
Singapore Tropical Climate	1° North	27	28
Perth, Australia Temperate Climate	32° South	23	12

Bundles of sunlight strike the earth at different angles depending upon latitude.

Polar Climate

You can see from the diagram that earth's curved surface is the reason places at various latitudes have different temperatures. When the sun's rays fall close to the poles, they are widely scattered because they strike the sphere at a sharp angle. In winter, light reflecting upward into the sky, creates the northern lights. Verkhoyansk, like most of Siberia, has a **polar climate**.

Tropical Climate

The same diagram shows that at the equator, the sun's rays strike earth from directly overhead. Concentrated solar radiation year-round means that areas near the equator have hot temperatures in every season. Singapore is situated almost on the equator and has a hot and wet **tropical climate**.

Temperate Climate

Perth, Australia, is located between the equator and the South Pole. It has a mid-latitude location and has a **temperate climate**, one that is moderate in every season. The sun's rays hit earth's curved surface at a slight angle, enough to make solar energy less intense at Perth than at Singapore. Notice that Perth's temperature is warmer in January than in July. The seasons are reversed in the southern hemisphere. This is caused by the seasonal migration of the overhead sun. During the Canadian winter, Australian students are enjoying their summer holidays.

WORDS MATTER

polar climate severe winters and cool summers

tropical climate hot temperatures in every season and a lot of moisture

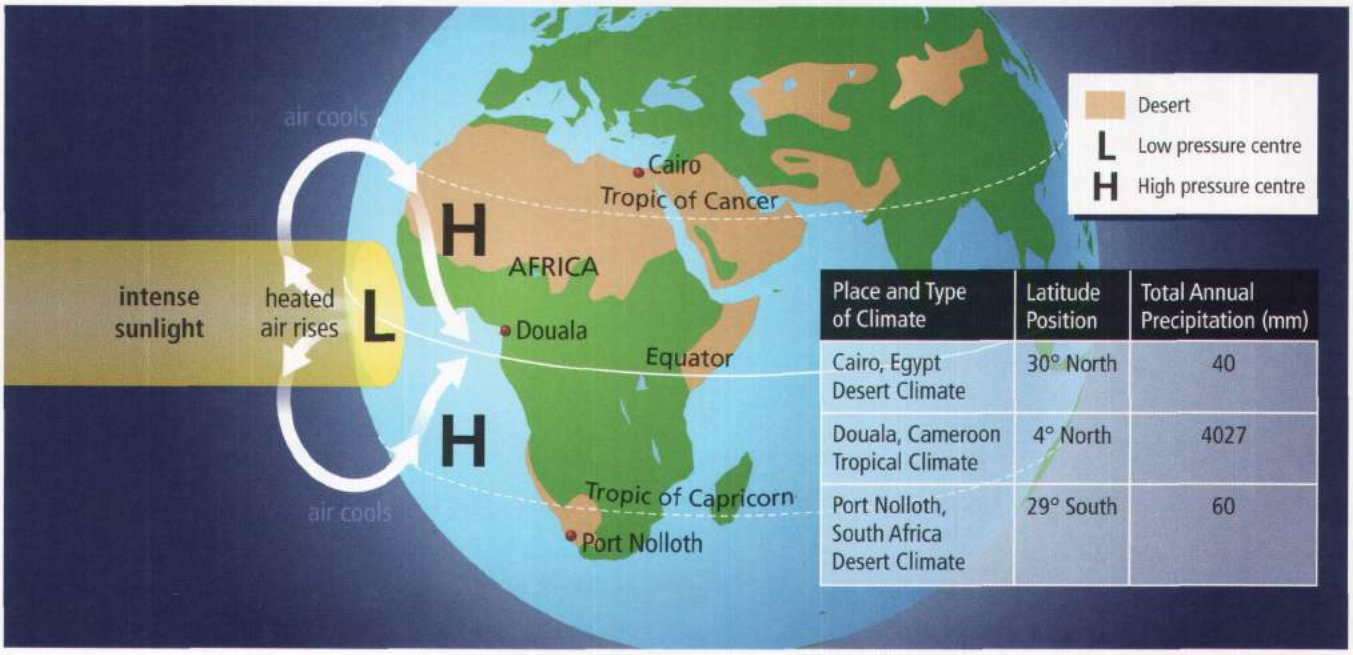
temperate climate moderate temperature conditions year round

The Effect of Moving Air

The heat of the sun creates another important climate factor. If your home has a basement, you know that it is cooler than the main floor. This is because warm air is light and rises, while cool air is dense and sinks. The following diagram of Africa shows how moving air (wind and pressure) causes a repeating pattern of climate above and below the equator.

You know that the sun's heat is most intense at the equator. In the diagram, you can see that this heated air rises, just as it does in your home. When air rises, it cools, and water droplets form clouds. Intense cloudbursts occur most afternoons in Douala, Cameroon, which receives more than four metres of rain each year!

Air Circulation near the Equator



Place and Type of Climate	Latitude Position	Total Annual Precipitation (mm)
Cairo, Egypt Desert Climate	30° North	40
Douala, Cameroon Tropical Climate	4° North	4027
Port Nolloth, South Africa Desert Climate	29° South	60

The movement of air is one reason why climate patterns repeat themselves on opposite sides of the equator.

WORDS MATTER

air pressure a measure of the density of air

desert climate very dry weather conditions

Different **air pressures** are found at the equator compared to the Tropics. Light, rising air at the equator creates a region of low pressure. Farther north and south, descending air results in high pressure zones. Winds move between these different pressure systems.

Desert Climate

Intense rainfall occurs at the equator; then the air moves northward and southward, as shown in the diagram. The air gradually cools, so by the time it reaches the Tropic of Cancer or the Tropic of Capricorn, it sinks and returns to the equator as surface winds. (The Tropics are imaginary lines that mark the limits of the seasonal migration of the overhead sun, 23.5° on each side of the equator.) The descending air is very dry, so clouds and precipitation are rare. Cairo and Port Nolloth, shown on the diagram, both have a **desert climate**.

The Effect of Water Bodies

On a hot summer day, it is nice to go to the lake or the ocean to cool off. Even if you don't go swimming, you will feel cooled by the onshore wind. Bodies of water make temperatures more comfortable. Places near large water bodies often have a moderated **maritime climate**, with warm summers and cool winters. They will have plenty of precipitation when winds blow onshore. However, places located far inland are not moderated by water bodies. They have a **continental climate**, with hot summers and cold winters. This climate is drier than a maritime climate.

The photos and climate information below compare two Canadian cities. They are located at almost the same latitude, yet their temperature and moisture conditions are very different. One has a maritime climate, while the other has a continental climate. Match the photos and the climate information to decide which city experiences the maritime climate and which experiences the continental climate.

WORDS MATTER

maritime climate warm summers and cool winters

continental climate hot summers and cold winters

Vancouver, Canada (49° North latitude)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature (°C)	3	5	6	9	12	15	17	17	14	10	6	4
Precipitation (mm)	154	115	101	60	52	45	32	41	67	114	150	182

Maritime climates are moderate, and continental climates are more extreme.

Winnipeg, Canada (50° North latitude)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature (°C)	–19	–16	–8	3	11	17	20	18	12	6	–5	–14
Precipitation (mm)	21	18	23	39	66	80	76	76	53	31	25	19

During READING

Checkpoint

Using this table, you can tell what type of precipitation a region will get by looking at the temperature. Will Brazil be getting rain or snow?

WORDS MATTER

mountain climate cooler than places at lower altitudes; often with heavy precipitation if located near coastlines

The Effect of Mountains

Mountain climbers need insulated clothing and oxygen tanks to reach the world's highest peaks. There is less oxygen to breathe and fewer molecules in the air to trap solar heat. Places at high altitudes are much cooler than nearby places at lower altitudes. A **mountain climate** changes with both altitude and exposure to the sun. The back of a mountain will be much cooler than the side receiving solar radiation. Mountain climates often receive heavy precipitation when they are located near coastlines.

The photos and climate statistics show two South American cities, located near the equator. One has a mountain climate, while the other has a tropical climate. Match the photos to the statistics to decide which place has been affected by mountains.

Manaus, Brazil (Elevation: 44 m)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature (°C)	28	28	28	27	28	28	28	29	29	29	29	28
Precipitation (mm)	249	231	262	221	170	84	58	38	46	107	142	203

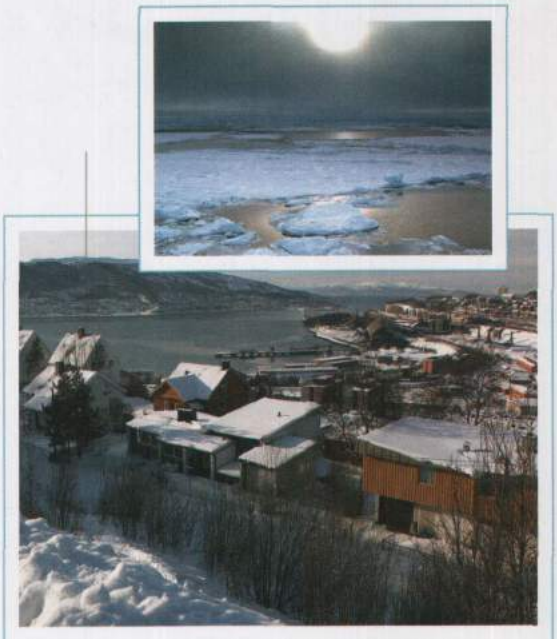
Places located in the mountains have a much cooler climate than lower places at the same latitude.

Quito, Ecuador (Elevation: 2879 m)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature (°C)	15	15	15	15	15	14	14	14	14	14	14	15
Precipitation (mm)	99	112	142	175	137	43	20	31	69	112	97	79

The Effect of Ocean Currents

The surface winds of the planet help circulate the water in the oceans. Currents of warm water flow away from the equator along the coastlines of the continents. Meanwhile, cold currents flow back toward the equator from the polar oceans. Ancient peoples and the European explorers learned to use these currents to speed their ocean voyages.

Warm and cold currents affect coastal temperatures. Look at the photos and climate information for these places. One place is affected by the cold Labrador Current out of the Arctic Ocean. The other is warmed by the Gulf Stream from the tropical Atlantic Ocean. Match the photos and climate information to decide which ocean current affects each place.



Ocean currents can be either warm or cool.

Narvik, Norway (73° North latitude)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature (°C)	–4	–4	–2	2	6	11	14	13	9	4	1	–3
Precipitation (mm)	55	47	61	45	44	65	58	84	97	86	59	57

Nain, Canada (57° North latitude)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature (°C)	–19	–18	–12	–5	1	6	10	11	7	1	–5	–13
Precipitation (mm)	78	56	87	72	57	80	87	69	77	65	79	86

THINKING It Over

1. In your own words, explain why latitude position is the most important factor affecting global climates. Use some examples to support your explanation. Remember to use correct geographic subject vocabulary K
2. Look at the map of World Climate Regions on page G 116. Describe the following climate regions and explain their location: K

   a) polar **b)** tropical **c)** desert
3. Make a summary chart to compare seven types of climate: polar, tropical, temperate, desert, maritime, continental, and mountain. This will help you summarize what you learned in this chapter. C
4. Work in a group of three. Each person should draw and label climate graphs to compare the two paired places to see the effect of mountains, water bodies, or ocean currents. Explain your climate decisions to one another when the graphs are finished. M

CHAPTER IN BRIEF

After READING

Tie It Together

Review your Cause-and-Effect chart. Rewrite your questions from your first column without the answers. Exchange questions with a partner. See if you can use your chart to answer your partner's questions.

You started this chapter by looking at the causes and effects of global warming. This is the most newsworthy aspect of climate, except when natural disasters such as hurricanes and tornadoes strike. You learned why and where these extreme-weather events occur, and considered the connection between increased hurricanes and global warming. There are several different types of climate, ranging from tropical to polar. They are the result of a combination of factors, including latitude, air movement, ocean currents, water bodies, and mountains. You learned to draw climate graphs, and used them to recognize the difference between various climate regions.

"What I Will Learn" Point	Causes (note page numbers)	Effects (note page numbers)
What are the causes and effects of hurricanes and tornadoes?		

"Mystery City" is a modern metropolis with almost 12 million people.

PUTTING It All Together

Here is your chance to prove that you know how to graph and interpret climate. Almost 12 million people live in "Mystery City" (an actual place on earth).

1. Use graph paper to neatly draw and label a standard climate graph for the city. C

2. Look at the graph or the climate statistics to answer these questions: t

   a) Is Mystery City in the northern or the southern hemisphere? How can you tell?

   b) Is this a tropical, temperate, or polar climate? How can you tell?

   c) Is this a maritime, continental, or desert climate? How can you tell?

3. Use the climate information to calculate the following: t

   a) average temperature

   b) temperature range

   c) total precipitation

4. Explain how this climate has been affected by each of these factors: K

   a) latitude

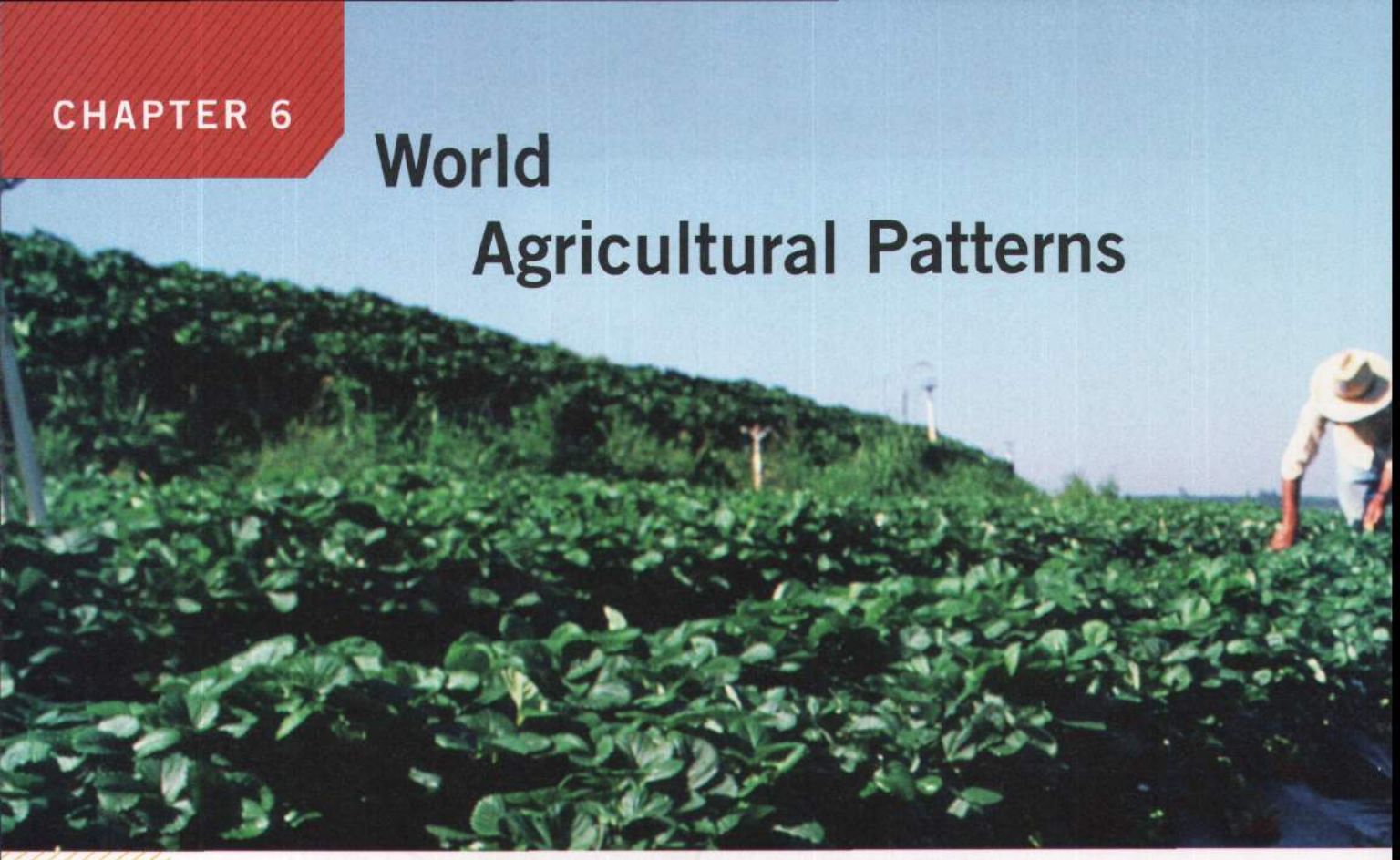
   b) water bodies

5. From the information on these two pages, would "Mystery City" be an appealing vacation destination for the Canadian traveller? Explain your answer using factual evidence. A

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature (°C)	23	23	21	17	13	9	10	11	13	15	19	22
Precipitation (mm)	79	71	109	89	76	61	56	61	79	86	84	99

CHAPTER 6

World Agricultural Patterns



The foods you eat come from many parts of the world.

Before READING

Making Connections

Why do people who live in different parts of the world eat different foods? Where do the foods used to make your breakfast come from? How does your breakfast connect to geography?

Turn to a partner and take turns sharing the answers you can think of. Come back to these questions after you read the chapter and try them again.

Now, that is a great looking breakfast! What did you have for breakfast today? Where did your breakfast foods come from before they ended up on store shelves or in your cupboards? How did agriculture contribute to your breakfast? Did eating breakfast make you think about geography?

Geography has a lot to do with what you eat. Climates, soils, landforms, and water are important factors in agriculture. They affect what crops grow in which regions and how the foods are transported to various parts of the world.

What You Will Learn in This Chapter

- What physical conditions favour agriculture?
- What world physical patterns support specialized farming?
- What are the characteristics of three basic types of agriculture?
- What factors affect commercial farming?
- How can I interpret agricultural patterns from thematic maps?

Thinking About LITERACY

In the previous chapter, you looked at how people have affected the earth. In this chapter, you will look at how we interact with the geography of our region.

You have used webs and charts to collect information. This time you are going to use a two-column chart to collect your notes.

Use an organizer like this one. Write down just enough information to remind yourself what you were reading. You may take out words like "a" and "the." You may use pictures as symbols if you want.

Main Ideas	Details
Anything that can be explained, defined, or is important	*The definition, explanation, and importance of the idea*

The Geography of Food

WORDS MATTER

agriculture growing crops and raising animals

Geography studies the connections between people and the earth. We all must eat, so food is a highlight in this relationship. In this chapter, you will consider the physical and human factors that support farming in different parts of the world. First, you will see how climate, soil, and natural vegetation combine to create the conditions most favourable for **agriculture**. Next, you will see that different cultures have developed three types of farming: subsistence, commercial, and specialized. Later in the chapter, you can play a game that shows all the environmental and economic risks that farmers face. Along the way, you will get a closer look at different regions of the world that put food on your table.

During READING

Checkpoint

In your notes, write how geography relates to what we eat.

The Food We Eat

We all need to eat, yet most of us don't grow food. Instead, we rely on a worldwide network of producers whose food comes to us through the grocery store. We can buy coffee from Kenya in Africa, bananas from Costa Rica in Central America, and orange juice from Florida, at reasonable prices. At the same time, we can pick up bread made from prairie grain, and eggs, milk, and butter produced in Ontario. Canadian farm prices are very low. In fact, this breakfast on page G 113 would cost about $5 to $7 in most restaurants and less than a few dollars to make at home.

By any standard, Canadians are well fed. The Canada Food Guide identifies four food groups that make up a balanced diet: grains, fruit and vegetables, dairy products, and protein. A person your age should eat about 2000 calories of food energy daily. Unfortunately, many Canadians do not eat a balanced diet, and often partly ignore the fruit and vegetables and dairy products groups. On average, we eat 125 percent of our daily food needs. To make matters worse, we have become less active, so we don't burn up that extra food energy.

Recommended Number of Food Guide Servings per Day

	Children			Teens		Adults			
Age in Years	2-3	4-8	9-13	14-18		19-50		51+	
Sex	Girls and Boys			Females	Males	Females	Males	Females	Males
Vegetables and Fruit	4	5	6	7	8	7-8	8-10	7	7
Grain Products	3	4	6	6	7	6-7	8	6	7
Milk and Alternatives	2	2	3-4	3-4	3-4	2	2	3	3
Meat and Alternatives	1	1	1-2	2	3	2	3	2	3

The chart above shows how many Food Guide Servings you need from each of the four food groups every day.

Having the amount and type of food recommended and following the tips in *Canada's Food Guide* will help:

- Meet your needs for vitamins, minerals and other nutrients.
- Reduce your risk of obesity, type 2 diabetes, heart disease, certain types of cancer and osteoporosis.
- Contribute to your overall health and vitality.

Do you follow the recommendations of the Canada Food Guide?

IN MY WORLD

The Supermarket

A hundred years ago, Canadians could eat fresh fruit and vegetables only when they were in season. Today, we can buy them all year long.

You can trace where fresh produce comes from by observing signs on grocery store displays and product boxes for messages such as "Product of Chile."

Check the produce department of the local supermarket to see how many different places our fresh fruit and vegetables come from. Ask produce department staff, if you need some help. You will probably be surprised by the diverse origins of fresh foods.

Fresh food item	Place of Origin	Price
e.g., Tangerines	Florida	

THINKING It Over

1. Use the Canada Food Guide to evaluate what you ate and drank yesterday. Start by making a recording chart like this one, and then use the guide to see how balanced your intake was. t

	Breakfast	Lunch	Supper	Between Meals
Food				
Drink				

2. Work with a partner to record different examples of the ways in which agriculture can show the five themes of geography: k
   a) place/location **b)** movement **c)** environment
   d) interaction **e)** region

3. Visit a supermarket (or use store advertisements) to collect information about fresh produce. Mark the source countries you've identified on a world outline map, with straight lines drawn to your community. What pattern(s) do you see? m

Physical Conditions for Agriculture

During READING

Checkpoint

Did you know that more than 70 percent of Canada is not suited for farming? What do you notice about the parts of Canada that are good for farming?

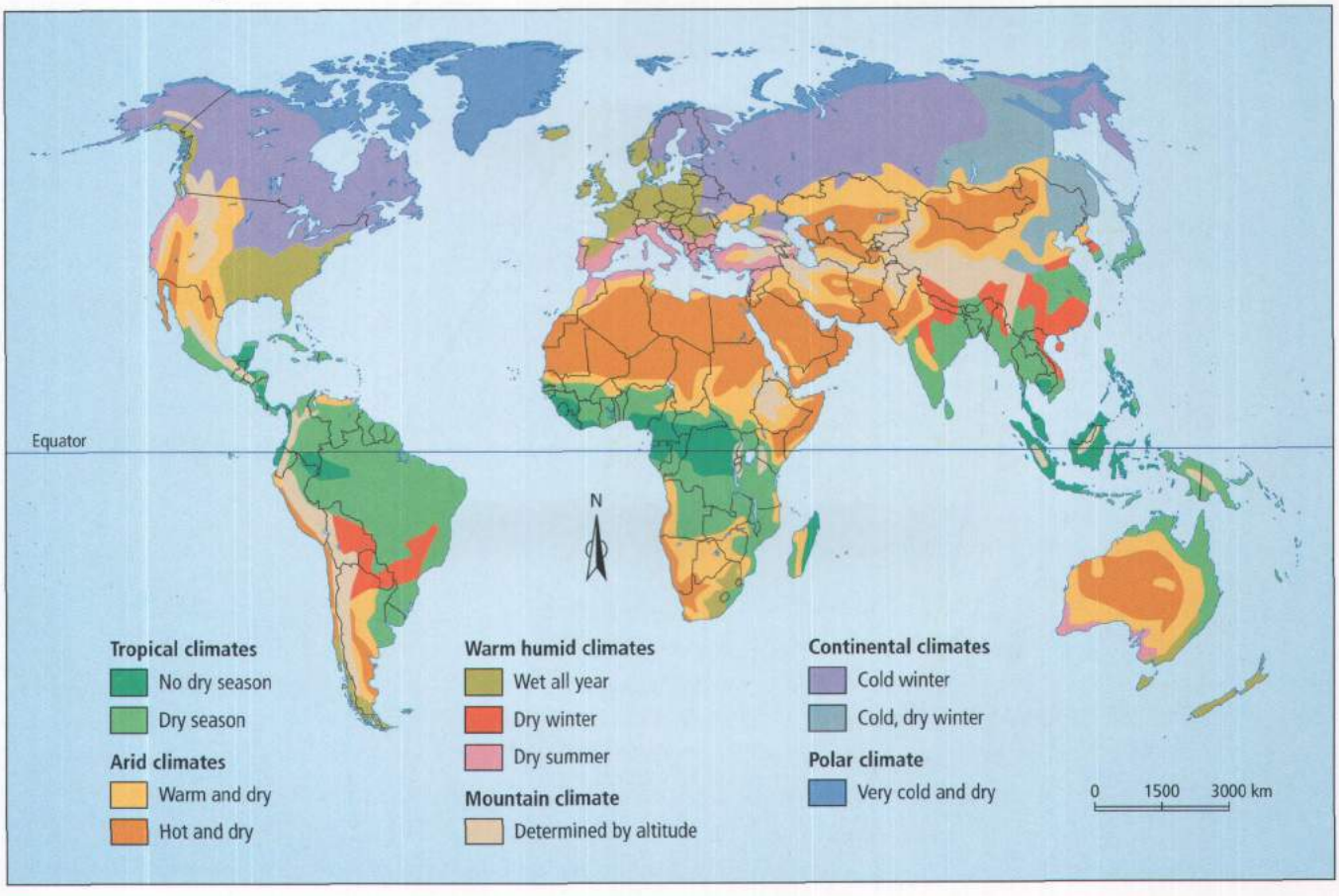
Climate, soil, and natural vegetation are important physical requirements for producing food. People have shown that they can overcome environmental obstacles; for example, by using canals to bring water to dry land. However, the earth itself has a strong impact on successful agriculture.

The Effect of Climate

Long-term weather conditions are tied to farming in two ways. Climate is the main agent that creates the soil. A favourable climate is necessary for plants and animals to flourish. The map of world climate regions below suggests which areas may be suited for farming and which are not.

Water, ice, and wind create the eroded sediments that form soil. Heavy rainfall and tumbling streams steadily wear down rock faces. Some rocks, such as limestone, are broken down by water. When water in rock crevices freezes, it acts as a wedge, splitting

World Climate Regions



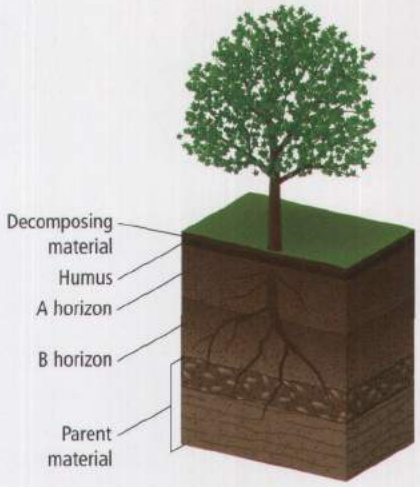
the rock. A moving glacier works like rough sandpaper, as embedded rocks beneath it grind over the land. Wind is important too, sandblasting rock faces with flying bits of sand and grit. Climate causes the forces of erosion that produce soil.

Decomposing organic material: mostly plant material that has accumulated in the past months

Humus: a dark layer of organic material from the decay of previous generations of leaves and plants

Horizons: layers of different materials within the soil profile. *Lower horizons contain less humus than upper horizons.*

Parent material: broken down rock material in the base of the soil profile



The Effect of Soil

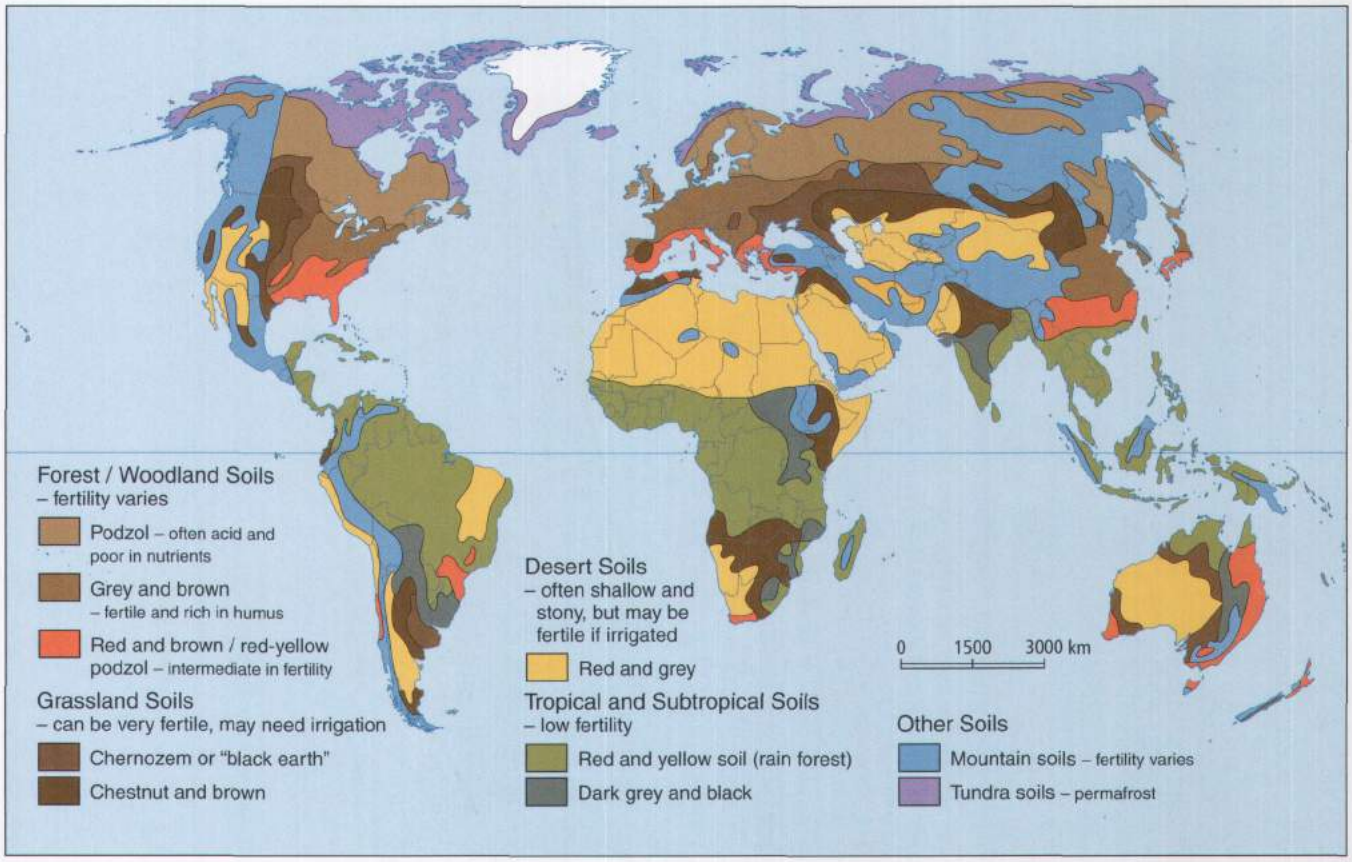
Most soils have different levels from top to bottom. A **soil profile** is marked by horizontal bands of colour, which generally become a lighter brown with increasing depth. The general rule is the darker and thicker the upper soil layers, the greater the soil fertility. In polar and cold continental climates, soil profiles have a thick layer of permanently frozen ground. This is called **permafrost**, and it severely limits the depth to which plant roots can reach. As a result, the natural vegetation in these tundra regions is mostly low shrubs, and summer flowers.

WORDS MATTER

soil profile a cross-section of the upper layers of the earth's crust

permafrost permanently frozen ground

World Soils



The Effect of Natural Vegetation

Natural vegetation is the trees, grasses, and other plants originally found in an area. Often, it has been cleared away for roads, buildings, and farms. The pattern of natural vegetation found in a region resulted from the interaction of landforms, climate, and soil. Aboriginal peoples and pioneer farmers often used these plants to predict the suitability of an area for crops.

Broadleaf forests and natural grasslands both contribute plenty of decaying organic material to the soil.

WORDS MATTER

shifting cultivation a type of temporary farming practised by indigenous farmers in the rainforest

Natural vegetation has an important effect on soil fertility. Decomposing leaves, grasses, and needles produce the soil's humus layer. Natural grasslands and broadleaf forests drop organic material, resulting in fertile agricultural soils. Coniferous trees do not produce much organic material. Their needles are acidic, leaving the soil with limited fertility. You might expect thick tropical rainforests to have rich soils beneath them. Unfortunately, heavy rainfall carries most of the nutrients very deep into the ground. Tropical soils are often poorly suited for anything but **shifting cultivation**, a type of temporary farming that will be described later in the chapter.

THINKING It Over

1. Use the World Climate Regions map and legend to list four climates that would *not* be suited to agriculture. (Review the Skills Tool Kit checklist "Using and Making Maps" on page S 6.) k
2. Use the World Soils map and legend to identify three types of soil that would be fertile enough for farming. k
3. With a partner, compare the two maps. How are the patterns on the two maps similar? Give examples from different continents. t

GEO SKILL

Understanding and Interpreting the Seasons

Seasons have an important effect on agriculture. The growth cycles of plants are connected to the amount of energy coming from the sun at different times of the year. Farmers in hot climates can grow crops year-round; those far from the equator have just one short growing season. Seasons occur because of the movements of the earth.

Step 1: Understand that the Earth Is a Spinning Sphere

More than 2000 years ago, the Greeks figured out that the earth is a sphere. We know that it spins on its imaginary centre-post (the **axis**), making one rotation every 24 hours. Because the earth spins toward the east, the morning sun is first seen in that direction. At any time, half the earth faces the sun, while the other half experiences night.

WORDS MATTER

axis the imaginary centre-post of the earth

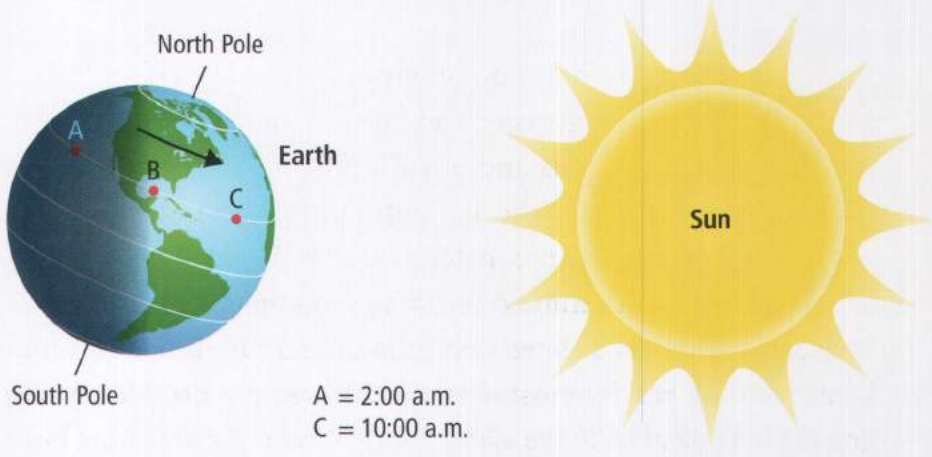


Figure 1: Daily rotation gives the earth day and night.

Step 2: Understand that the Earth Is Tilted on its Axis

For reasons not really understood, the earth leans at a 23.5° angle on its axis. This affects the amount of **solar radiation** received at different locations, as shown in the diagram. In Chapter 5, you learned that the intensity of sunlight varies by latitude because of the earth's curvature. In the diagram on the next page, you can see that as the earth rotates,

WORDS MATTER

solar radiation energy from the sun

the zone north of the Arctic Circle (at 66.5° North latitude) will continue receiving sunlight all day. This is called the "midnight sun." Meanwhile, at this time of year, the zone south of the Antarctic Circle (at 66.5° South latitude) remains dark all day.

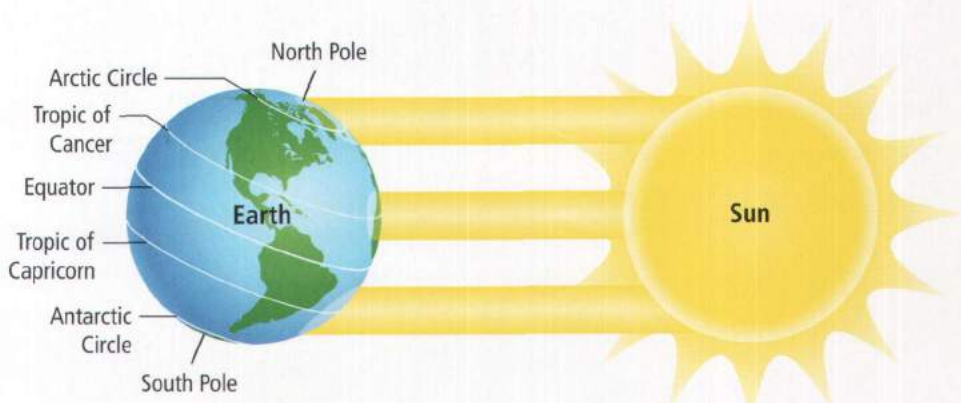


Figure 2: The Arctic and Antarctic Circles mark the limits of the midnight sun and 24-hour darkness.

Step 3: Understand that the Earth Orbits Around the Sun

As it rotates, the earth also completes an annual orbit around the sun. This combines with the tilt of the axis to cause the seasons. The diagram below shows the earth at two times of the year, six months apart. On the left, the direct overhead rays of the sun fall at 23.5° North latitude, the Tropic of Cancer. Six months later, they strike at 23.5° South latitude, the Tropic of Capricorn. These two lines mark the limits of the zone that receives the direct overhead rays of the sun. Summers in the northern and southern hemispheres occur six months apart. Note that the earth always tilts in the same direction.

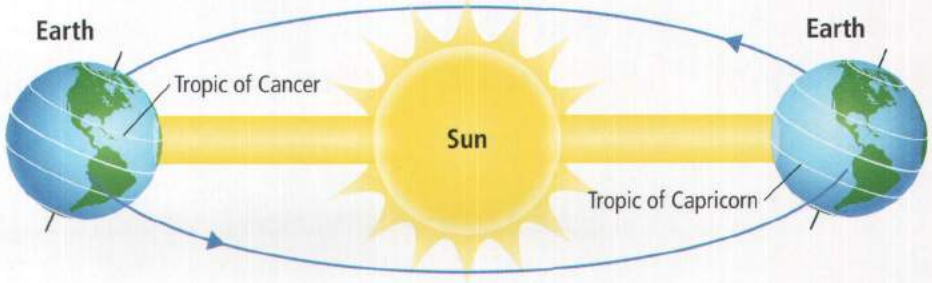
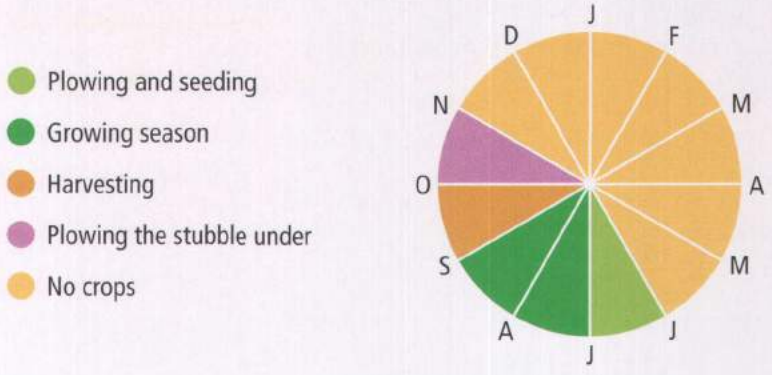


Figure 3: The tilt of the earth and its orbit around the sun create the seasons.

Step 4: Understand that Seasons Directly Affect Agriculture

Each season of the year brings different temperature conditions, especially away from the tropical region bounded by the Tropics of Cancer and Capricorn. Crops that require either intense sunlight or many months of uninterrupted heat to ripen can be grown in the tropical region. In the mid-latitudes, the annual cycle of agriculture cannot begin until there is no longer danger of frost. Geographers often use a circular diagram to show the annual cycle of farming. It directly reflects the seasons of the year.



WEB LINK

For more information on the seasons and agriculture, visit www.pearsoned.ca/on7geography.

Figure 4: The growing season in this location is affected by its position above or below the equator.

APPLY It

Answer the following question by interpreting the diagrams:

1. Figure 1: Calculate the approximate time at Point B on the diagram.

2. Figure 2:

   a) Why do the areas inside the Arctic and Antarctic Circles experience the "midnight sun" each year?

   b) Why will the northern hemisphere have a longer period of daylight than the southern hemisphere in this diagram?

3. Figure 3:

   a) Which diagram of the earth shows our summer? Explain your answer.

   b) Why are the seasons reversed above and below the equator?

4. Figure 4:

   a) In which hemisphere, northern or southern, is this farm located? Explain your answer.

   b) How long is the crop in the ground here? What does this suggest about the distance of this farm from the equator?

Human Factors in Farming

WORDS MATTER

intensive farming agriculture in which much labour is used to get food from small plots of land

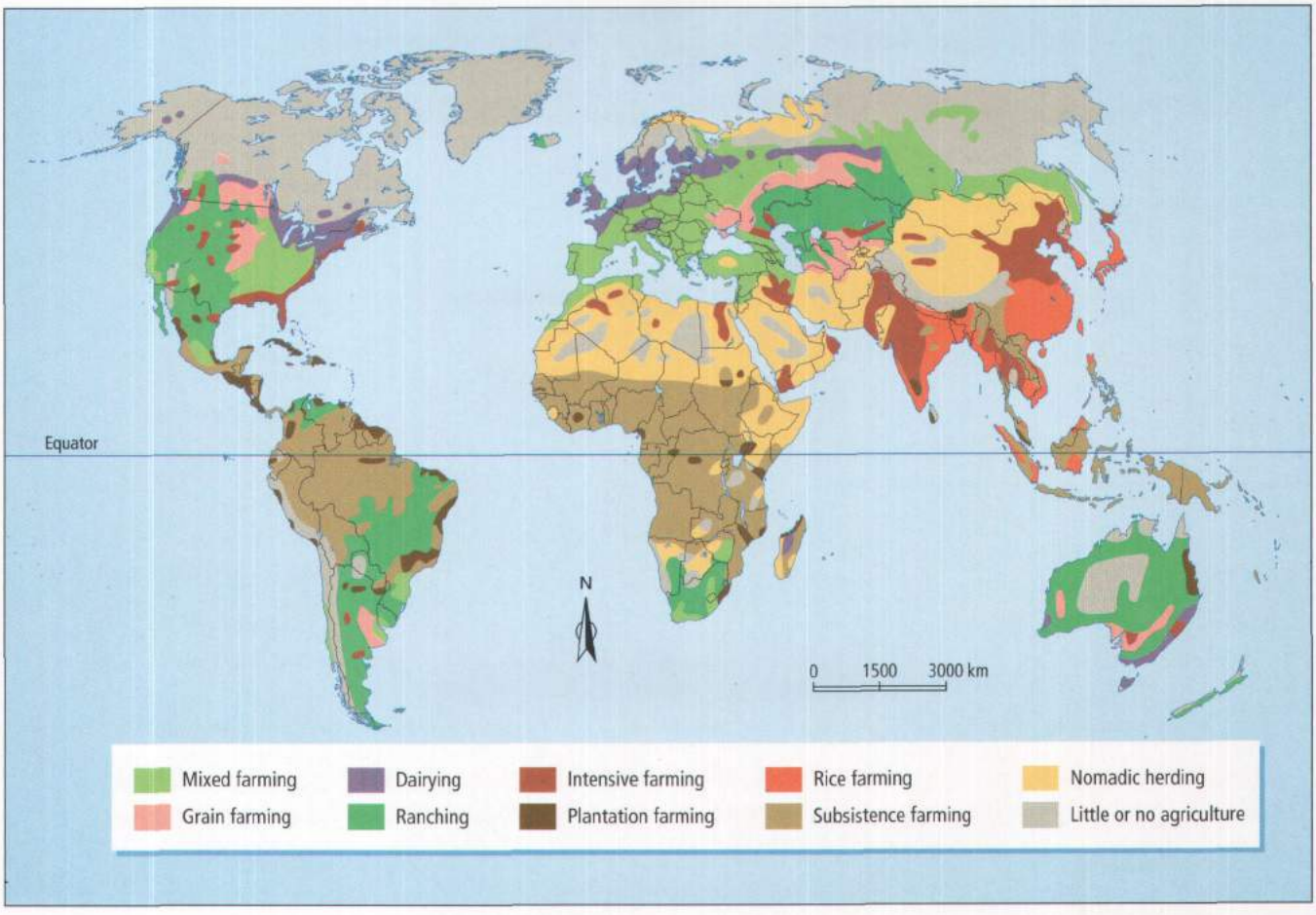
extensive farming agriculture in which little labour (but often large machinery) is used to work big farms

subsistence agriculture farms that produce only enough for the farm family

The types of agriculture practised on earth are affected by human factors. Cultural food preferences affect farming. At the same time, the availability of foods affects cultural tastes. The map below shows that South Asians favour rice production, while North Americans prefer cattle ranching and grain. Population is also a large factor. About half the world's population is concentrated in South Asia. Most agriculture there is **intensive farming**. Rice, vegetables, and poultry are raised this way. On the other hand, North America's agriculture is mostly **extensive farming**. Wheat, corn, and beef cattle are produced this way.

There are three basic types of farming. One is **subsistence agriculture**, when farmers can produce only enough for their own family. All other types of agriculture are either commercial or specialized.

World Agriculture



Subsistence Agriculture

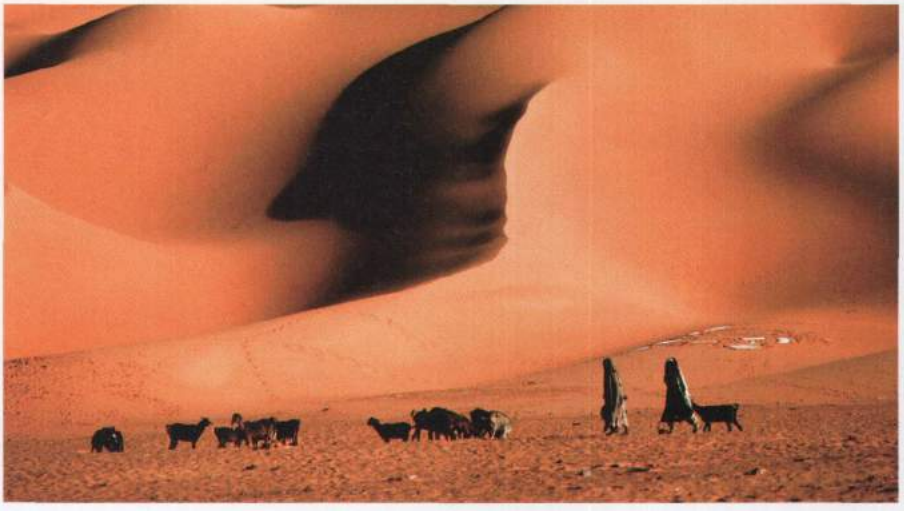
To subsist means to survive. Subsistence farmers work full time as a family unit to feed themselves, using mainly animal power and their own labour. Subsistence agriculture is often practised where there is great population density (e.g., China, India) or on lands not suited for commercial agriculture. This includes mountain, rainforest, and desert regions. There are three types of subsistence farmers.

During READING

Checkpoint

Use the photos and captions to make notes on details of the main idea in the subsistence agriculture section.

Nomadic Herders



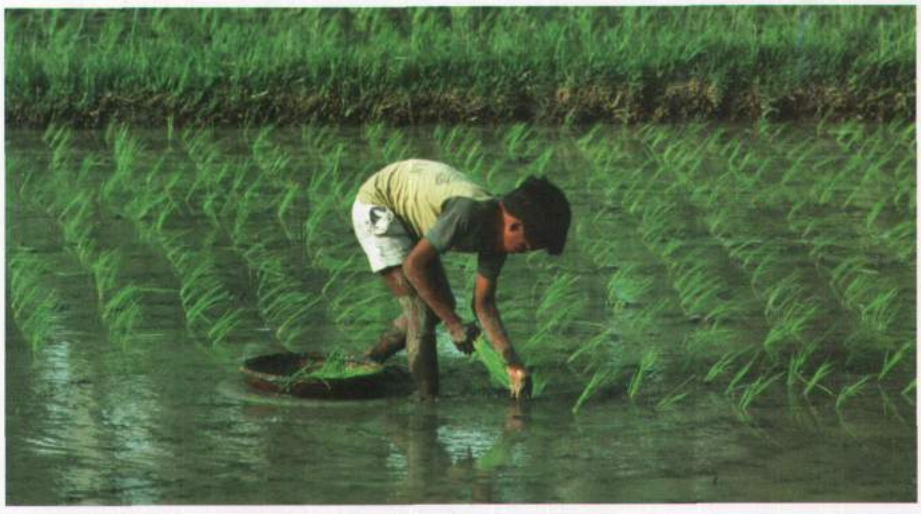
Herds of goats, camels, or cattle are the prized possessions of nomadic herders in Africa, central Asia, and the Middle East. These are desert or semi-desert regions, and the livestock supplies many of the nomads' needs. For example, camels and goats provide African and Middle Eastern herders with milk, meat, hides, and hair (for tents and clothing). Live animals can be bartered for coffee and other small luxuries at oases. Nomadic herders survive on their ability to find patches of grass and small watering holes to support their animals.

Shifting Cultivators

Some groups in the tropical rainforest regions of South America, Africa, and South Asia are shifting cultivators. They use fire and sharp machetes to clear small patches of jungle and work them for a few years, a method also called "slash-and-burn" farming. Root crops such as yams (sweet potatoes) and cassava (a starchy root) are raised, as well as corn and other grains. After a few years, the soil fertility drops and the farmers move on to another patch. Soon, the forest reclaims the clearing. However, soil erosion can be a problem when the rural population of a rainforest region rises.

Small Landholders

Many people in Mexico, South America, Africa, and South Asia have small, permanent farms. They cultivate corn, rice, vegetables, and other grains, and there is often some livestock. Everyone in the family participates in the hard work of farming. If there is a small surplus from the farm, it will be sold or bartered (traded) at the local market. Small landholders often live close to the edge of poverty, and weather conditions can make the difference as to whether or not the family survives.



Heroes and Villains | *Shifting Cultivators*

Are shifting cultivators responsible for the destruction of the tropical rainforests? They do share some of the blame. But these subsistence farmers are few in number compared to the large areas of rainforest. Their cycle of farming often has a limited impact. Much of the real damage is caused by commercial farming and rural settlement. This satellite image of Brazil shows the effect of building roads (brown lines) through the rainforest (dark green area). Smoke from fires (red dots) indicates forest being burned off for permanent farms and cattle ranches. Elsewhere, logging companies clear large forest areas.

THINKING It Over

1. Use the World Agriculture map to find the major subsistence farming and nomadic herding regions. Compare their locations to the World Soils map on page G 117. What do you observe? *k*

2. Use these headings in a comparison chart for the three types of subsistence farming: a) location b) characteristics c) food products d) surplus production. *t*

Commercial Agriculture

Most farming in the developed nations is **commercial agriculture**. The aim is to produce a large surplus of one or a few types of crop, livestock, or other farm product, and sell it for a profit. Little, if any, of the produce is actually used by these farmers. Instead, they buy much of their food at the local market or grocery store. The farmers' families may or may not work on these farms. In fact, some of them are huge corporate operations, called agribusiness, worked entirely by managers and employees.

Some commercial farms specialize in **organic foods**. Many consumers are willing to pay the extra costs that farmers face in moving into organic farming. In 2003, Canadians spent a billion dollars on organics, 1.6 percent of all our food purchases. In 2006, government regulations began to certify these farms, and their produce now carries the new "Canada Organic" label.

In this section, you will learn about five important factors that affect the fortunes of commercial farms.

WORDS MATTER

commercial agriculture farming that produces a large surplus of one or a few types of crop, livestock, or other farm product, and sells it for a profit

organic foods foods produced without chemical fertilizers, pesticides, additives, preservatives, growth hormones, or genetic alteration

Location and Climate

The conditions at a location are probably the most important influences affecting commercial agriculture. Physical characteristics such as climate, soil fertility, and natural vegetation vary widely from place to place. The best opportunities for successful commercial farming are found where local temperature and moisture patterns are suited to certain crops and livestock.

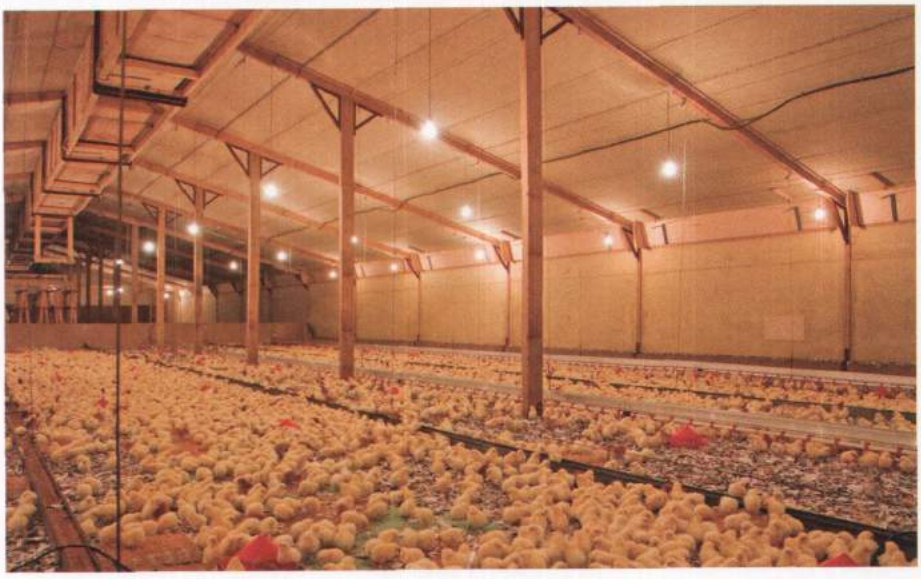
WEB LINK

For more information on Canadian agriculture, visit www.pearsoned.ca/on7geography.

Commercial crops such as tender fruits (peaches, plums, pears, cherries, and grapes) cannot survive in harsh conditions. Fruit orchards are found only in locations protected from cold winds and heavy freezing. The Niagara fruit belt is located right next to the moderating influence of Lake Ontario, between Hamilton and Niagara Falls. The lightly textured soils of the former lake bottom are fertile, and the orchards are sheltered by the 75-metre high Niagara Escarpment, which blocks cold winds from the north and west. This is an important fruit-growing and wine-making region in Canada.

Raw Materials

Commercial agriculture requires a reliable supply of raw materials, called farm inputs. Most poultry farms do not raise their birds right from eggs. Instead, they buy large batches of very young chicks from specialty breeders. They are kept under warming lights and fed grains to grow. Other farmers buy calves and fatten them to sell for meat. Animal feed and bedding are other raw materials livestock farmers need. Crop farmers use different raw materials. They buy scientifically developed seeds and treat them with chemical fertilizers. Pesticides control weeds and insects that threaten food crops.



Labour and Machinery

The balance of labour and machinery differs widely from one type of commercial farming to the next. Intensive farming uses a great deal of hand labour to produce food from small- to middle-sized farms. This is the opposite of extensive agriculture, which relies on large machinery to do the work of many hands. Vegetable farms have a different mix of labour and machinery than a large Prairie wheat farm.

In North America, commercial fruit and vegetable farms require more labour than can be provided by the farmer. This is hard work, often done in the heat of the day. While most vegetable crops are grown from machine-planted seeds, others have been started in greenhouses. These need to be transplanted into the fields. During the growing season, small machines and hand labour are used to keep the fields free from weeds. So many pickers are needed at harvest time that migrant workers (people who move from another area for work) are often brought from other parts of the country or from Mexico and the Caribbean region.

Transportation

Grains such as wheat and corn are the major food crops outside of South Asia. Canadian wheat farms in Alberta, Saskatchewan, and Manitoba are usually very large, family-owned operations. Most of the work is done using tractors, plows, combine-harvesters, and other machinery. The wheat is trucked to railroad points. Long trains of special self-dumping railway grain cars take it to port terminals. Without this network of roads, railroads, and ships, wheat could not get to Canadian or foreign markets.

Market Forces

The customer plays a key role in deciding the success or failure of a commercial farmer. Beef competes with pork, poultry, lamb, fish, and other protein sources. Consumer tastes determine how much steak will be sold compared to fish. Prices are set by the forces of supply and demand. For example, if little steak is available during barbecue season, prices will rise. If there's too much steak, prices will fall to attract more buyers. Producer marketing boards sponsor advertising and Web sites to promote beef, milk, cheese, and other farm products.

THINKING It Over

1. How much extra would you pay for organic foods? Discuss with a partner, starting at 0, and increasing by 10 percent increments. Explain your decision. t

2. Imagine that you and a partner plan to operate either a horse farm or a fruit orchard. Construct a chart to apply the five factors you learned in this section to the type of commercial farm operation you choose. t c

3. **a)** Why are fruit farms located in the southern part of Canada? k

   b) Why are dairy farms often found close to major urban centres? k

   d) Why do Canadian grain farmers use large machinery instead of more labour? k

The Beef Debate

Television host Oprah Winfrey touched off a storm in 1996 when she said that she would not eat another hamburger. Texas cattlemen tried unsuccessfully to sue her. Today, beef is under attack from many activists who argue that world hunger could be eliminated if North Americans would eat more grains and less meat. Here, you will compare the views of a major church hunger program and a powerful beef producers group.

Presbyterian (Church) Hunger Program

Translate your burger
into grain, forest, and water

=

approximately 5 kilograms of grain

+

approximately 5.2 square metres of rainforest

+

approximately 9500 litres of water

Some people believe that raising beef cattle consumes too many other resources.

National Cattlemen's Association (U.S.A.)

Myths about Beef

Grain: The estimate is based on the incorrect idea that beef cattle are fed grain all their lives. Only 2.6 pounds (1.2 kilograms) of grain is needed to produce 1 pound (454 grams) of beef.

Rainforests: According to a U.S. government report, less than one percent of America's beef supply came from "rainforest countries" in 2001.

Water: It takes only 435 gallons (1750 litres) of water to produce a pound (454 grams) of beef.

World Hunger: "First, the grain in question is feed grain, not the higher-quality food grain consumed by humans.... Unless someone is willing to buy this grain and ship it to third world countries, it would not even be purchased."

Others feel that activists have exaggerated the problem and used faulty statistics.

What Do YOU Think?

1. Use a chart to summarize four conflicting points in the beef debate.
2. Which viewpoint do you find most credible? Why? Review the Skills Tool Kit checklist "Detecting Bias" on page S 11.

Specialized Agriculture

Specialized agriculture is commercial farming focused on one type of product. Look at the World Agriculture map on page G 122. You will see scattered small patches of red (plantation farming) and orange (intensive farming) on almost every continent. These are places where one particular farm specialty is favoured by a unique combination of physical and human factors. There are many different specialized farms that do not produce food. Tobacco, cotton, and flower farms are just a few examples. The following crops show how both physical and human factors affect specialized agriculture.

WORDS MATTER

specialized agriculture
commercial farming focused on one type of product

During READING

Checkpoint
What do you see in these photos that shows human and physical factors in farming?

Orange Groves: Climate and Market

Florida ranks second only to Brazil as the world's leading orange grower. Orange trees and fruit are easily damaged by freezing temperatures. Due to killing frosts, Florida's groves have steadily shifted southward, where there is less risk. There are many different types of oranges, each with a different maturation rate. This allows growers to offer fresh fruit year round. Today, about 80 percent of the Florida crop is squeezed into juice. The orange producers' association has created a demand for orange juice through a half-century of advertising campaigns.

Nurseries: Location and Raw Materials

Nurseries supply trees, flowers, and other plants to beautify properties. Most are found close to urban areas, near their customers. Locations must have lightly textured, well-drained soils suited to many different types of plants. Greenhouses are often used to grow flowers and ornamental grasses from seed in hot, moist conditions. Nursery raw materials include seedlings (very young trees), fertilizers, peat moss, and mulch (the last two prevent plants from drying out).

Coffee: Location and Labour

Coffee is produced in the tropical climates of Central and South America, Africa, and South Asia. The trees need plenty of sunlight, without too much heat. They grow best in well-drained soils, on hillsides 1000 to 2500 metres above sea level, where it is cooler. Each tree produces enough beans for 0.7 kilograms of roasted coffee. Both small landholdings and large plantations grow coffee trees. A great deal of hand labour is required to pick and dry the product before it is mechanically sorted and roasted.

Fair Trade Products

All farmers are paid only part of the actual price of our food. Specialty farmers in developing countries often receive very little for their coffee, cocoa, tea, or fruit. For example, only about 10 cents of every dollar spent for a cup of coffee goes to the grower. It is not enough for a decent standard of living.

Fair trade products are different. First, farmers are organized into cooperative groups, to fully process the product themselves. Then, they sell it to fair trade importers at a guaranteed price, often twice as much as individual farmers would normally receive. These buyers ship the product to developed countries and offer it as a special brand. For example, a cup of fair trade coffee costs an extra 10 cents. More and more customers ask for fair trade products when they learn that it is fairer for growers in developing countries.

WORDS MATTER

fair trade a pricing system that gives food growers in developing countries a fairer price for their products

During READING

Checkpoint

The next time you go into a restaurant, check the price of a cup of coffee. Using the information from the diagram shown here, figure out how much the farmer will make from a cup of coffee.

WEB LINK

For more information on fair trade products, visit www.pearsoned.ca/on7geography.

A Cup of Coffee

Total: $1.00

Growers receive a tiny part of the cost of a cup of coffee.

ZOOM IN

Costa Rican Bananas

The Central American country of Costa Rica is a world leader in exporting bananas. Most are produced by large plantations along the Caribbean coast, within easy shipping distance of world markets. Big corporations—Del Monte, Dole, and Chiquita—have cleared large areas of rainforest and built decent rental housing for worker families. Field hands earn about $10 per day, and many come from neighbouring countries—where wages are lower—to work there.

Costa Rican plantations export more than half a billion dollars' worth of bananas annually. These "sun grown" banana trees get much fertilizer to increase the size of their fruit. Pesticide sprays are used to kill spiders and other insects. The bananas are picked green when huge refrigerated ships arrive in coastal harbours like Limon. That way, the fruit will not be overripe when it reaches North American grocery stores.

A small part of the Costa Rican crop is fair trade product. About 1500 families in the community of Bri Bri produce their own bananas for the *Happy Planet*® label. Each family harvests the fruit from a 10- to 15-hectare section of rainforest. These "shade-grown" bananas are organically grown, without chemical fertilizers or pesticides. They are pureed when ripe, that is, reduced to a thick paste. This fair trade product is exported for making "smoothies" (fruit drinks).

Are these plantation or rainforest bananas? How can you tell?

THINKING It Over

1. Use the World Agriculture map to describe the following agricultural patterns: m
   - **a)** plantation farming
   - **b)** intensive farming
2. Use what you learned in this section to explain why the following are considered specialized farming: k
   - **a)** dairy farming (milk and cheese)
   - **b)** rice farming
3. Make a chart to compare "sun-grown" and "shade-grown" banana crops. What are the social and environmental benefits of "shade-grown" fair trade bananas? Why will some people pay a bit more for fair trade products? t c

PLAY

The Farm Risk Game

This game shows how random factors affect a farmer's success in a given season. The most successful player in a group of three or four will have the highest total of his/her best card in each suit.

Materials

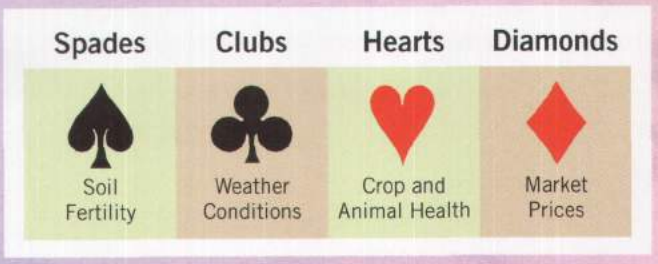
A shuffled deck of 52 cards

Suit	Face Value	Representing
Spades	2 to 10	The condition of the soil
Clubs	2 to 10	The weather conditions that season
Hearts	2 to 10	The health of crops or animals
Diamonds	2 to 10	The value of market prices

How to Play

1. Begin with the tallest player drawing a card from a shuffled deck turned upside down. Play moves to the right.

2. As you draw your cards, place the cards numbered 2 through 10 face up in four piles in front of you, according to suit.



3. If you draw a jack or a queen, check its suit. You must give the card from the top of your pile of that suit to the player on your right. Put the face card into a discard pile.

4. If you draw a king or an ace, you can draw two more cards. Put the king or ace onto the discard pile.

5. The game ends when all the cards in the deck have been drawn.

6. Find the most valuable card in each of your four suit piles. Add up the face value of these four cards (maximum value 40) to find the game winner.

THINKING It Over

1. Which factor—soil, weather, health, or prices—was most successful for you? Which was least successful? *k*

2. Make a chart to show how this game is both like and not like the real world factors affecting farmers. *t*

CHAPTER IN BRIEF

You learned that climate, soils, and natural vegetation are important in locating any farming activity. And, you saw that subsistence, commercial, and specialized agriculture reflect different types of human societies. Unexpected changes in weather, markets, and other factors make farming difficult.

Main Ideas	Details
Anything that can be explained, defined, or is important	*The definition, explanation, and importance of the idea*

After READING

Tie It Together

Revisit Making Connections. Think of these bigger questions:

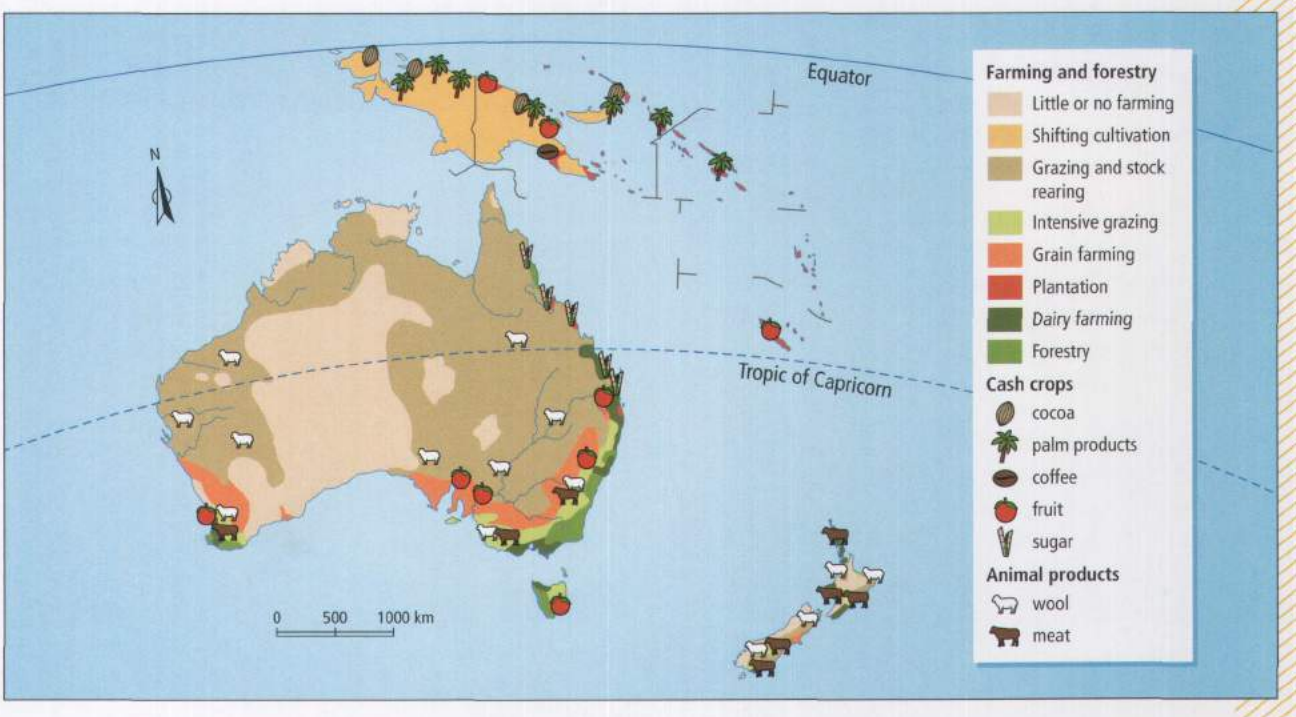
- What would happen if Canadian farmers could no longer produce food?
- What could cause that?

PUTTING It All Together

As part of a group, use the questions below to research and report on one type of commercial farming in Oceania. Choose from a) plantation agriculture/cash crops, b) sheep ranching, c) cattle ranching, or d) grain farming. See page S 2 in the Skills Tool Kit for help.

1. How have the landforms, climate, and soil affected this type of farming? t c a
2. How do human factors affect this agriculture (raw materials, labour, transportation, and markets)? t c a
3. What special problems are there? t c a
4. Construct a seasonal cycle diagram to show the effect of climate. t

Agriculture in Oceania



Back to the Big Idea

At the start of this unit, you learned about Vancouver's bid for the 2010 Olympic Winter Games. You saw that the region had a winning combination of landforms, climate, and transportation. You predicted other ways in which physical geography would influence human activities.

Now that you have finished the unit, using your notes, review what you have learned.

- Examine your predictions of ways in which landforms and climate can affect human activity. Which of these were seen in the unit? What other examples can you add?
- What have you learned about decision making in geography? How might this help you choose the best location for a human activity, such as a winter vacation?

Collingwood, Ontario

Chichén Itzá, Mexico

Epcot Theme Park, Orlando, Florida

Varadero Beach, Cuba

Show That You Know

Before the International Olympic Committee could choose a Winter Games location, it had to decide what was important. You will be doing the same sort of thing in this activity. First, you will research the physical and human characteristics of a winter vacation destination. Then, working with a group, you will compare several possible travel locations to pick a favourite. The winter destinations are at popular locations in Canada, the United States, Mexico, and Cuba. Enjoy your vacation research!

Step 1 Choose one winter destination from the regions shown in the photos.

Step 2 Research the physical and human characteristics of the region, and describe your most important findings in a concise report.

Tip: Before you start, review "The Inquiry/Research Process" (page S 2).

For physical features find information about the landforms and climate of the region (not just one place). Highlight the effects of the physical environment on winter tourism there.
For human characteristics, find information about transportation facilities, attractions, and accommodations that cater to winter tourists in the area.

Step 3 Make neat maps and graphs to show important physical and human characteristics of the tourist region.

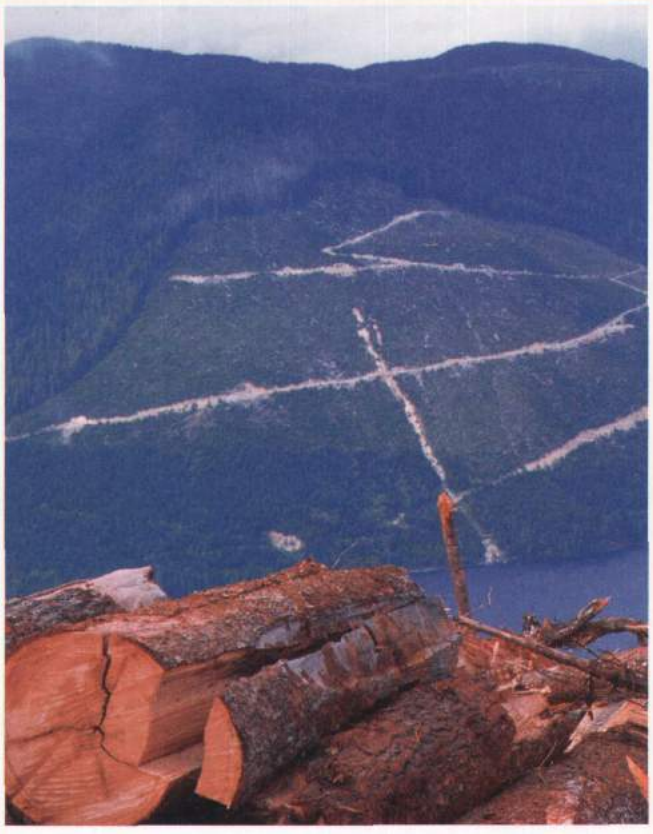
Tip: Before you start, review the following skills:

- Creating a Small Area Map (page G 52)
- Constructing a Climate Graph (page G 101)

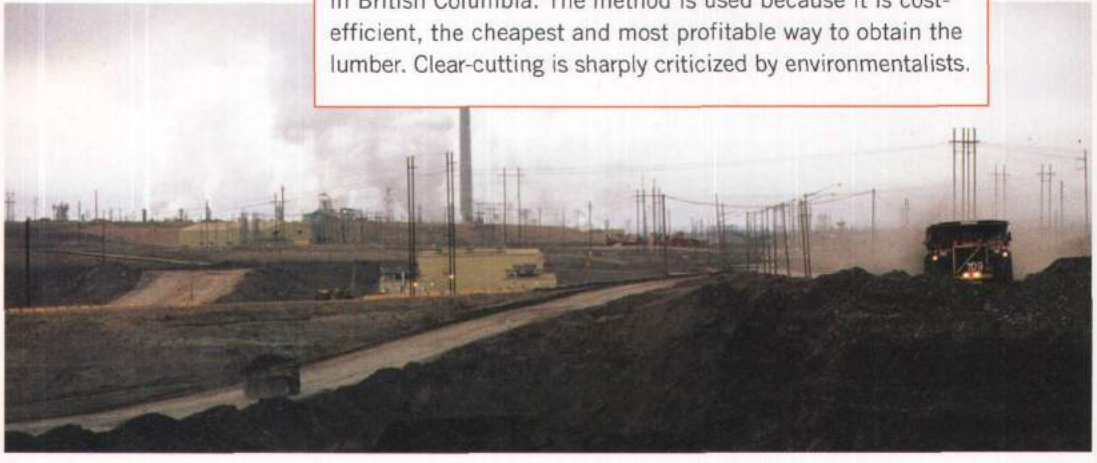
Step 4 Work with other students to create or apply criteria to compare the various winter vacation destinations.

Rate the destinations you have researched, starting with "Best Ranked."

UNIT 3 Natural Resources



Forests are an example of a renewable resource, and the forest industry is very important to Canada's economy. This photo shows the clear-cut logging method being used in British Columbia. The method is used because it is cost-efficient, the cheapest and most profitable way to obtain the lumber. Clear-cutting is sharply criticized by environmentalists.



Minerals are examples of non-renewable resources. The open-pit mining method shown in this photo is used in the huge oil sands project in northern Alberta. Much of the area is mined this way because each grain of sand is coated with oil and water.