

Topic 3.2

Where are the effects of climate change felt, and what is their impact?

Key Concepts

- Climate change affects aquatic ecosystems.
- Climate change affects terrestrial ecosystems.
- Both positive and negative impacts of climate change are occurring worldwide.

Key Skills

Inquiry
Literacy
Numeracy

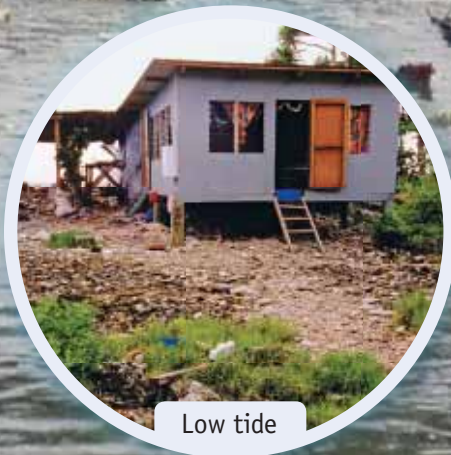
Each day, the impacts of climate change affect millions of lives around the world. While you may not feel these impacts yourself, take a moment to imagine that you live on the small island nation of Tuvalu in the South Pacific Ocean. You and the other 11 000 inhabitants of these low-lying islands see the impact of climate change every day. Climbing temperatures are melting glaciers and snow packs on a global scale. The melt water makes its way to the oceans, causing sea levels to rise. During high tides, water washes over the islands of Tuvalu. As a result, all the roads and yards in your neighbourhood are flooded by the ocean twice a day. With each passing day, you realize that the islands are shrinking. Within your lifetime, your nation may be completely submerged. Soon, you and your fellow Tuvaluans will have to find a new home. But in this overcrowded world, it is uncertain where you will go.



High tide

Starting Point Activity

As a class, brainstorm all the impacts of climate change that you know of. Using a different coloured sticker for each impact, place one or more stickers on a map of the world to show where these impacts are occurring. Add to this map as you continue to study climate in this unit.



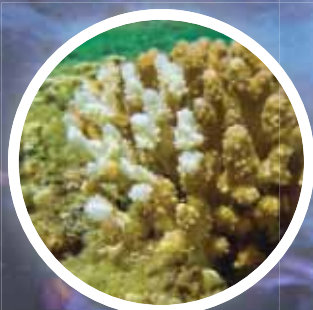
Low tide

Climate change affects aquatic ecosystems.

Oceans. Some scientists consider them the last great unexplored frontier on Earth. They are mysterious and home to life that is both beautiful and bizarre. They are also being affected by climate change. Explore some of these effects in the text that follows.



A consequence of melting sea ice



Coral bleaching from warmer oceans



A violent hurricane

Melting Sea Ice The north and south polar regions are the coldest regions on Earth, and they are experiencing the most warming. In these regions, sea ice that has existed since the last ice age is melting. In the south, giant ice sheets are collapsing due to higher temperatures. In the north, the melt is less dramatic. However the gradual loss of sea ice is threatening the survival of species such as polar bears that hunt off the ice. The Inuit also travel over and hunt off the sea ice. The disappearance of the ice poses a threat to their traditional way of life.

New Food Chains As sea ice disappears, so do the tiny animals at the bottom of the aquatic food chain: krill. Krill feed on microscopic plants called plankton that thrive under sea ice. There are now 20 percent less krill than there were 30 years ago. Since many organisms make krill their main meal, this poses a threat to the diversity of life in our oceans. Warmer waters are also forcing larger aquatic species to migrate to more habitable areas. For example, sockeye and pink salmon were observed for the first time at Banks Island in the Northwest Territories in 1993. This is well outside the normal range of these species—a move that affects both the food chains the salmon leave behind and the ones they enter in these new waters.

Warmer Oceans As the planet warms, so do the world's oceans. This is leading to the destruction of an important nursery and shelter for all kinds of sea life: coral reefs. Corals are animals that live in a close association with algae. The algae provide the corals with food through photosynthesis. But as the water warms, corals expel their food producers and die. In this process, called bleaching, the once-colourful corals turn white.

Warming of the world's oceans is also slowing down ocean currents. Cold water is denser than warm water, so the cold water sinks lower in the ocean. This motion helps drive major currents. As water becomes warmer, currents begin to slow down. This may affect the important roles that currents play in warming and cooling nearby land masses.

Rising Sea Level Scientists predict global sea levels could rise 20 cm to 40 cm in the next 100 years. What is causing this sudden increase? As temperatures increase, water molecules in the ocean begin to move more quickly. As their speed increases, they collide more often and take up more room. As a result, the water expands and sea level rises. At the same time temperatures are warming on land, causing glaciers and snow packs on mountains to melt. This water eventually flows into the ocean, increasing sea level further. Rising sea levels are forcing organisms (including humans) that live in low-lying coastal areas to find new homes.

More Violent Storms As seawater in many regions warms, storms such as hurricanes will become more severe. Why is this the case? Warm water transfers its heat to the air above it, which makes the air less stable and more favorable for the development of tropical storms that can build into hurricanes. The warmer the water gets, the less stable the air gets, and the more powerful the hurricane can become. One hurricane packs enough energy to generate electrical energy to supply the whole Earth 200 times over!

LEARNING CHECK

1. Identify three impacts of climate change that occur in aquatic ecosystems.
2. Explain how food chains can change as sea ice melts.
3. Europe is warmed by a large ocean current called the Gulf Stream. Explain how this continent's climate might change if oceans continue to warm.
4. As a result of the collapse of large sheets of ice in Antarctica, new organisms are moving in that have never lived in this region before. Why do you think this is happening?

ACTIVITY LINK

Activity 3.4, on page 210

Literacy Focus

Activity 3.2

ELEPHANT SEAL E-MAIL

Elephant seals are among the deepest divers in the world. Scientists are making use of their ability to reach deep ocean waters to learn how climate change is affecting oceans. They inject each seal with a tranquilizer and secure a computerized tag to its head. The tag's sensors record data about water temperature, salt level, and more. A satellite transmitter in the tag then relays these data to the scientists.

Do you think it is right to use animals to learn more about climate change? Create a table listing points both in favour of and against this research. Then write an e-mail to the IPCC, an international organization dealing with climate change issues, explaining your views on this research. Be sure to include your reasoning.



Climate change affects terrestrial ecosystems.

Most species on our planet, including humans, live on land. However, like the world's oceans, Earth's forests, deserts, prairies, and other terrestrial ecosystems are experiencing the impacts of climate change. Some examples are given below.



Changing Organisms A changing climate means changing living conditions for many organisms. Some are able to adapt by altering their habitat or behaviours. Others are not. As a result, more than one million species may be endangered worldwide due to climate change. Climate change is also affecting bird migration in Canada. Due to warmer temperatures, fewer migratory birds, such as the summer tanager, are making their annual trip south for the winter. Since rising average temperatures don't always mean a warm Canadian winter, many of these stay-at-home birds do not survive to see spring.

Melting Land Ice Ice found on land, including glaciers and permafrost, is melting at a rate that alarms many scientists. If temperatures continue their climb, as much as 25 percent of the world's remaining glacial ice will be gone by 2050. Permafrost, the permanently frozen layer of soil found in Canada's far north, is experiencing a similar fate. Canada's north is warming faster than anywhere on Earth. As a result, quickly thawing permafrost causes the soil around it to shift. Houses lose their solid foundation and collapse, while trees tilt or fall over, earning the name "drunken forests."



New Deserts In many parts of the world temperatures are rising while rainfall is decreasing. Southern Alberta is one region experiencing this problem. While seasonal lack of rain can result in temporary drought, this climate combination is expected to lead to desertification. Desertification refers to the spread of deserts. Desertification affects all organisms living in an area, including humans. Once-farmable land may no longer support crops. Reservoirs and ground water used for drinking water may run dry. Unless these climate trends change, desertification will lead many nations to experience food and drinking water shortages in the near future.

More Flooding How can climate change cause both desertification and flooding? Climate involves the complex interaction of different systems. Temperature, precipitation, and other aspects of climate vary greatly from one region to the next. Some areas may experience heavy rainfall that causes floods. Others may flood due to severe storms such as hurricanes. In other regions, climate change may lead to flooding more indirectly as rising sea levels may flood low-lying coastlines with seawater.

Effects on Human Health Heat waves, floods, hurricanes, and severe storms—these are all examples of extreme weather events that are becoming more frequent as climate changes. They often come with risk of injury or illness. Following these events, many people are also left homeless and more vulnerable to disease. As well, certain diseases are thriving in areas where climate has become wetter and warmer. These conditions are favourable for the diseases themselves as well as the insects, rodents, and other animals that carry them. West Nile virus, a mosquito-borne illness that can also harm humans, is an example of such a disease. The virus first appeared in North America in 1999 in the New York City area. Since then, it has been moving north and is now found in Ontario and other regions of Canada.

LEARNING CHECK

1. Describe two ways climate change affects human health.
2. Use the term climate change to explain why permafrost is no longer as permanent as its name implies.
3. More than one million species may be threatened worldwide as a result of climate change. Use examples from page 206 and other examples that you know of to explain how the loss of so many species could affect other species.

Numeracy Focus

Activity 3.3

WORRYING ABOUT WATER

As a result of desertification and flooding caused by climate change, many countries are already experiencing water shortages. People living in these areas often have to travel long distances to get the water they need to survive. North Americans use more water than anyone else on the planet—and that's not just for drinking. We use water for manufacturing, industry, growing crops, raising livestock, and more. See if you can match the amount of water estimated to be needed to produce each of the following:

one apple	1 kg of chicken meat
1 kg of rice	1 cup of coffee
1 kg of soybeans	1 L of milk
one hamburger	

Answers (not in the correct order):

1000 L of water; 3900 L of water;
1800 L of water; 2400 L of water;
140 L of water; 3400 L of water;
70 L of water



Both positive and negative impacts of climate change are occurring worldwide.

The impacts of climate change can be both positive and negative, both for humans and for other organisms. The map in **Figure 3.6** highlights many of the impacts that have been occurring around the world. Use the legend to locate the different impacts on the map.

Changing Organisms The milder winters and a longer growing season are having a positive impact on Canada's maple syrup industry. Production has tripled in Canada while farther south in the United States, warmer temperatures are threatening the industry.

Melting Sea Ice Melting ice in Canadian Arctic waters is opening new shipping lanes for travel across the top of the world. Similarly, new oil and natural gas resources are becoming available. However, development of these resources may further disturb this already fragile ecosystem.

Warmer Oceans Warming oceans are putting the tufted puffins that live on the coast of British Columbia at risk. The small fish that the puffins eat are moving to cooler waters. The puffins follow them, abandoning their young. This means fewer puffins grow to become adults each year.

Rising Sea Level Sea turtles spend almost their entire lives at sea. They only touch dry land when they return to the beach where they hatched to lay their own eggs. As sea level rises, many of these beaches may disappear, causing the numbers of these endangered animals to fall even further.

LEARNING CHECK

1. Describe two ways aquatic organisms are being affected by climate change.
2. Explain the positive and negative impacts increased rainfall will have on Zambia.
3. Rising sea level will affect many organisms. Explain two ways it might affect humans as well.

Melting Land Ice Iceland is home to Europe's largest glacier, Vatnajökull. Large enough to cover Prince Edward Island entirely, this massive glacier is shrinking as a consequence of warmer temperatures. The glacier retreats at one meter per year, adding this melt water to the already rising oceans.

◀ **Figure 3.6** Map showing areas most affected by climate change impacts around the world.

New Deserts China is planting a great Green Wall of China in the largest reforestation project in the world. This tree planting initiative hopes to keep the Mongolian Gobi Desert at bay. The desert has been taking over grassland in China at a rate of 3600 km² a year.

More Flooding More than any country, Bangladesh is threatened with extensive flooding due to climate change. Not only does the low lying nation have to contend with rising sea levels, but increased storm activity is causing freshwater flooding as well.

Effects on Human health Increased rainfall in African countries such as Zambia have led to a marked increase in the water-borne disease cholera. On the plus side, however, more rain in Africa may mean increased crop growth and less risk of famine.

- Rising Sea Level
- Warmer Oceans
- Melting Sea Ice
- Effects on Human Health
- Melting Land Ice
- Changing Organisms
- New Deserts
- More Flooding

Activity 3.4

HOW A HURRICANE WORKS

You have learned that as oceans warm, storms such as hurricanes become more severe. This is because warm water transfers its heat energy to the air above it. The warmer the water, the more heat is transferred to the air. But how does this affect the development of a hurricane? Complete the activity below to find out how changes in air temperature affect the formation of one of the most damaging aspects of hurricanes, a change in sea level known as a storm surge.

Safety Precautions



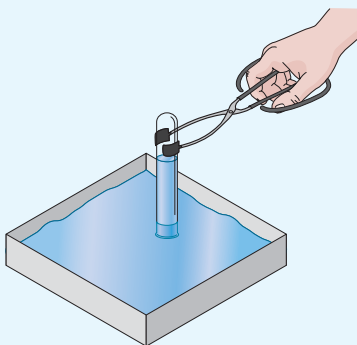
This activity must be performed with a test tube designed to withstand sudden temperature changes, such as a Pyrex™ test tube. A regular glass test tube may shatter with the sudden temperature change.

What You Need

- Pyrex™ test tube
- Bunsen burner
- large flat tray
- tongs
- china pencil
- ruler

What To Do

1. Create a data table to record your findings. Hint: Read the following steps to determine what your dependent and independent variables are. These must be recorded in your table.
2. Fill the tray with warm water.
3. Invert the test tube so its open end is facing down. Insert the open end just under the surface of the water as shown in the diagram below.



4. Mark the level the water reaches in the test tube with the china pencil.
5. Measure the distance from the open end of the test tube to this mark. Record this value.
6. Add 1 cm of water to the test tube. Place the bottom of the test tube in the flame of the Bunsen burner for 1 min.
7. Quickly invert the test tube over the tray of water. Insert its open end just under the surface.
8. Mark the level the water reaches in the test tube with the china pencil.
9. Measure the distance from the open end of the test tube to this mark. Record this value.
10. Add 1 cm of water to the test tube. Place the bottom of the test tube in the flame of the Bunsen burner until the water has evaporated.
11. Quickly invert the test tube over the tray of water. Insert its open end just under the surface.
12. Mark the level the water reaches in the test tube with the china pencil.
13. Measure the distance from the open end of the test tube to this mark. Record this value.

What Did You Find Out?

1. Identify the independent and dependent variables in this experiment.
2. Write a hypothesis explaining why you got the results you did in this activity.
3. Would warmer or cooler water result in a greater storm surge during a hurricane? Explain.
4. As air warms, its molecules begin to move faster. As a result, they have more frequent collisions that force them farther apart. Because there is more space between the molecules, fewer molecules are pressing down on any land or water below. In other words, air pressure has decreased. Describe how this could explain what happens during a storm surge.

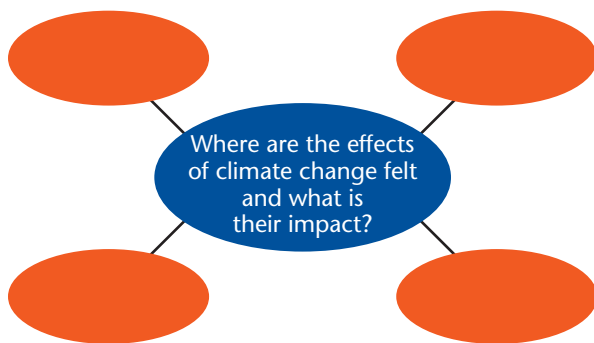
Topic 3.2 Review

Key Concept Summary

- Climate change affects aquatic ecosystems.
- Climate change affects terrestrial ecosystems.
- Both positive and negative impacts of climate change are occurring worldwide.

Apply the Concepts

1. **K/U** Answer the question that is the title of this topic. Copy and complete the graphic organizer below in your notebook. Fill in four examples from the topic using key terms as well as your own words.



2. **K/U** List three ways in which climate change affects terrestrial ecosystems.
3. **K/U** Describe two reasons why Bangladesh will experience more flooding in the future.
4. **K/U** Explain why many countries may experience water shortages as climate changes.
5. **A** Malaria is a tropical disease that is carried by mosquitoes. Explain why this disease might affect more people as a result of climate change.
6. **A** Explain how fisheries in the Arctic Ocean could be affected by warming temperatures.
7. **A** Describe how the climate change impact in this photo can have both a positive and a negative effect on society.
8. **C** Write a “to the editor” e-mail to a popular scientific magazine that describes how desertification is affecting both China and Canada.
9. **A** Review your answers in Activity 3.3. If you have not done this activity, do it now.
 - a) What other costs are involved with growing crops and raising livestock?
 - b) Some people are trying to buy food that is grown or raised within 100 km of where they live. Aside from cost, what other factors could this practice affect? Use a concept map to illustrate how this practice could affect climate and the environment.
 - c) How practical is a 100-km diet for your life and lifestyle? If it is impractical, suggest a way to make it more practical.

