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## TOPIC 9. WATER — VULNERABLE TO CLIMATE CHANGE

### Chapter 9

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#### Purpose

To help students understand how changes in their lives might occur because of changes in climate; and to help them see that some climate changes are caused by people and could be prevented.

#### Subject areas

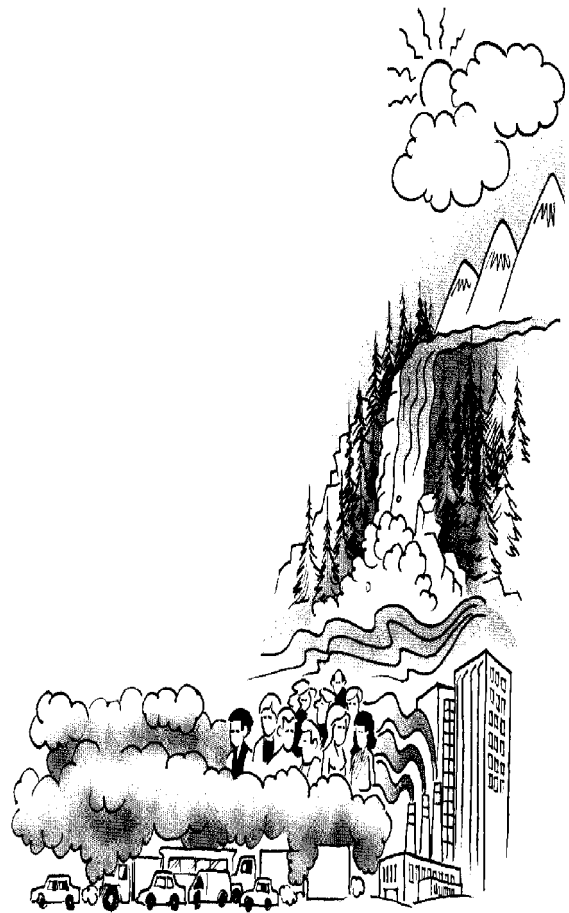
Science, Geography, Language Arts, Art, Current Events, Environmental Studies, Social Studies

#### Procedure

1. Focus the attention of students on climate and changes in weather patterns with the following quote from K. Hubbard, an American humourist: "Don't knock the weather. Nine-tenths of the people couldn't start a conversation if it didn't change once in awhile."

Point out to students the differences between weather and climate as discussed in their Student Information sheets.

2. Ask students for other examples of conversation about the weather, if not from real life certainly from old movies or TV shows. For example:
  - "Can't remember when it was this hot (cold, wet . . .)."
  - "Hot for May, what?"
  - "We had snow like this back in . . ."
  - "Cold enough for you?"
  - "You think this is hot! This is nothing . . ."
3. Stress that changes in weather patterns are normal. We have all experienced a green Christmas or a cool summer. Ask students for examples of natural weather phenomenon they have experienced, such as extreme heat, cold, snow, rain, thunderstorms, floods, and drought.



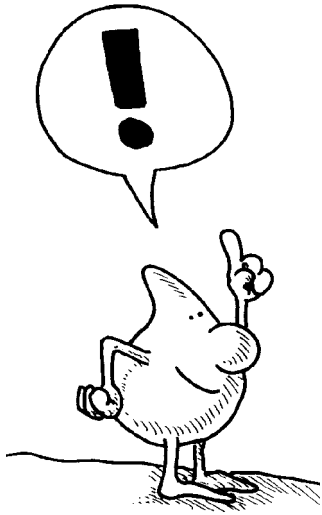
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4. Guide their discussion to the greenhouse effect and the more serious change of global warming — which is caused by people. Point out to students that although scientists may differ about the extent of global warming, they generally agree that it is occurring and will probably continue.
  5. Ask students what effect they think climate change could have on water, and ask them how it could affect their lives. Point out that some changes could be good, and some not so good.
  6. One activity asks students to look at population growth and scarce water resources. This activity may be for more mature students but it could be used as a discussion topic for the class.

### Vocabulary

<i>aquatic</i>	<i>drought</i>
<i>climate</i>	<i>permafrost</i>

### References

- Freshwater Series A-9: "Water — Vulnerable to Climate Change"
- *A Primer on Fresh Water: "Water — Forever on the Move"*
- "Did You Know We Live in a Greenhouse?" Atmospheric Environment Service, Environment Canada



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### What makes climate?

If a person from another country were to ask you about the **climate** of Canada, you might answer that it really depends on where you live in Canada. For example, if you live in parts of British Columbia such as Vancouver or Victoria, you may see a bit of snow during the winter months, but not a whole lot.

However, if you come from many other parts of Canada, you will likely see lots of snow — often more than you really want.

The odds are strong in this country of ours that you will shovel some of the white stuff between November and March. But usually between May and September you will have no snow and lots of hot weather. Usually. So, on average, you would be able to tell a stranger what to expect from Canada's climate.

How do you know this? It's simple. Since weather conditions have been pretty much the same for centuries, you can usually forecast climate conditions for winter and summer.

### What is the difference between weather and climate?

When you combine the average weather conditions and weather patterns over a long period of time, you find out what the climate of an area is. And this knowledge helps you decide where you will take a winter vacation; you know where to find snow for skiing and warm sunshine for swimming.

But climates can change.

We know that weather conditions can vary from year to year because we have experienced or read about **droughts**,

floods, bad storms, and the like. But what about long-term climate change? What about things like global warming where scientists expect serious changes in climate?

The climate of any region can be altered from causes such as changes in the gaseous content of the atmosphere or changes in the amount of sunlight reaching the earth's surface. These are natural causes. Unfortunately, climate can also change because of human activity.

## Why is everyone so concerned about climate change?

If you have been paying attention for the past few years, you will have heard about climate change, global warming, and the greenhouse effect. Many people are quite concerned about these possible changes

and how they will affect humans, animals, and plant life. They are also concerned about the ways people have caused (and continue to cause) the problems that bring the changes.

## Isn't climate change natural?

Another question you might be tempted to ask is: what's the big deal about climate change? After all, in your lifetime you have seen winters where there hasn't been enough snow for skiing in February; you have been frustrated by a green Christmas where you couldn't try out your new toboggan; and you have slogged your way through summers that have been miserably wet, cold, and depressing.

Aren't these events part of living in Canada? Don't they give people something to talk about?

- "In the winter of '79 we wore shoes all winter."
- "Yep. We had snow in June that year."
- "Didn't see one drop of rain from May till October."
- "If you don't like the weather, wait a minute."

Yes, changes in some climate patterns are natural. Variations occur in every climate, and as human beings we have learned to accept these shifts and to adapt to them when they occur.

But what about the changes in climate patterns that are unnatural — changes that people cause? Even though some changes seem to bring short-term improvements, are there other changes that are harmful?

Many scientists predict there will be global warming and related climate changes within the next four or five decades. Human activities that are increasing greenhouse gases and reducing natural vegetation will cause these changes. And the changes in our climate may be both harmful and helpful.

## Just what is meant by global warming?

Global warming is the term scientists use to describe what happens to the earth's climate when people and industries add greenhouse gases to the atmosphere. These scientists estimate that temperatures, as a global annual average, will likely increase from 1°C to 5°C.

While the scientists may disagree about how much global warming will occur or how much the climate will change in different parts of the world, they do agree that there has already been some global warming and there will likely be more.

## What are greenhouse gases and how do they affect the climate?

Some greenhouse gases are normal in the atmosphere. They trap the sun's heat in a blanket of air around the earth and keep it from escaping into space. This keeps the earth's temperatures just right for people, animals, and plants to live and grow — something like the way a greenhouse helps plants grow.

But, problems occur when we use more and more of the world's energy, adding large amounts of gases to the atmosphere by burning fossil fuels in our industries, cars, and homes. These gases trap heat near the earth's surface and add to global warming.

The main greenhouse gases are:

### *Carbon dioxide (CO<sub>2</sub>)*

Human source: Comes mostly from burning fossil fuels (oil, gas, and coal) for electricity and in cars and factories. Also from burning forests.

Annual increase: 0.5%

Life span: 50-200 years

### *Methane (CH<sub>4</sub>)*

Human source: Bacterial decomposition of organic matter (without oxygen) in rice paddies, swamps, garbage dumps, and intestines of ruminants like cows and sheep. Also from burning wood, mining coal.

Annual increase: 1%

Life span: 10-12 years

### *Chlorofluorocarbons (CFCs)*

Source: Chemically synthesized for use as coolants in refrigerators and air conditioners. Also used in foam insulation, aerosol sprays.

Annual increase: 4%

Life span: up to 10 000 years

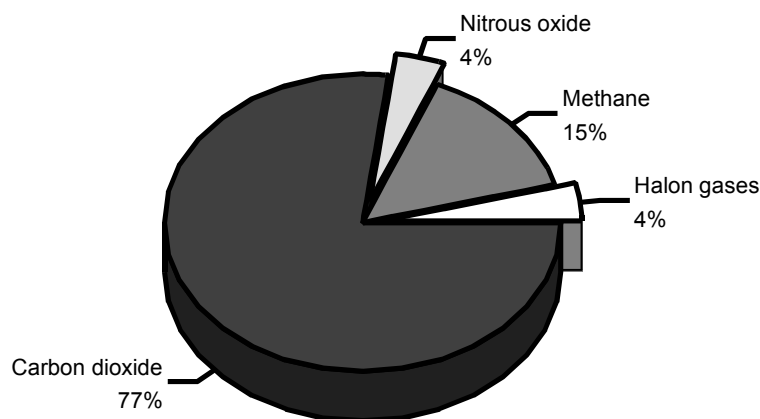
### *Nitrous oxide (N<sub>2</sub>O)*

Human source: Bacterial reactions in soil and water and from the breakdown of nitrogen-based chemical fertilizers. Also from burning fossil fuels and wood (deforestation).

Annual increase: 0.4%

Life span: 150 years

Current greenhouse gas emissions



As well as the warmer temperatures mentioned above, scientists are predicting some of the following changes because of global warming:

- more precipitation in winter and less in summer for some areas of Canada
- melting polar ice caps, causing a rise in sea level and possible flooding of coastlines — or even the disappearance of small islands

### **What might this global warming mean for Canada?**

So, what's it all about, you ask. Should I, in Canada, be upset if the climate is going to change and get warmer? After all, think about some of the benefits:

- fewer trips to Florida in the winter because we will have the perfect climate here. As well, more tourists will come here because of our warmer temperatures
- a longer growing season in parts of Canada where the summer is currently too short to grow many crops, and a longer shipping season in the north and Great Lakes because of less ice
- more precipitation in the north, which would increase the water supply in northern watersheds and thus increase hydroelectric power
- warmer weather, which would mean less demand for electric power for heating (however, it could increase demand for electric fans and air conditioners)

There may be no doubt in your mind that some of these changes could be very good for Canadians.

### **What about changes that may not be as welcome?**

As well as some of the "beneficial" changes mentioned above, such as warmer weather and longer growing seasons, scientists predict some of the following changes, which might not be too welcome, in the different regions of Canada:

#### **Pacific Coast**

- A rise in sea level would threaten low-lying coastal lands, such as the Fraser River delta, with possible flooding and erosion
- More precipitation would promote landslides and flooding

- Warmer river temperatures could cause fish to die; however, warmer ocean temperatures could encourage species such as tuna, hake, and squid to migrate from the south
- A warmer climate could allow insects, pests, and disease to migrate northward and stress the forests, while the same forests would become drier and more vulnerable to fire

### Prairie Provinces

- Higher temperatures and increased transpiration and evaporation could bring more drought to the Prairies. This would likely lead to increased irrigation, which would bring salts to the surface of the soil and thus degrade it
- Agriculture could move northward where the climate is more humid but the soils are not as good

### Great Lakes and St. Lawrence Basin

- Higher temperatures would mean more evaporation and drier soils. Water levels in the Great Lakes could fall by between half a metre and a metre. The St. Lawrence outflow could be reduced by 20 percent
- Lower water levels could reduce the amount of cargo that ships could carry per trip
- Industries in this region relying heavily on water are:
  - electric power
  - primary metals
  - chemicals
  - food processing
  - timber products
  - shipping (particularly of grain and metal products)

These could all be affected by changes in water levels.

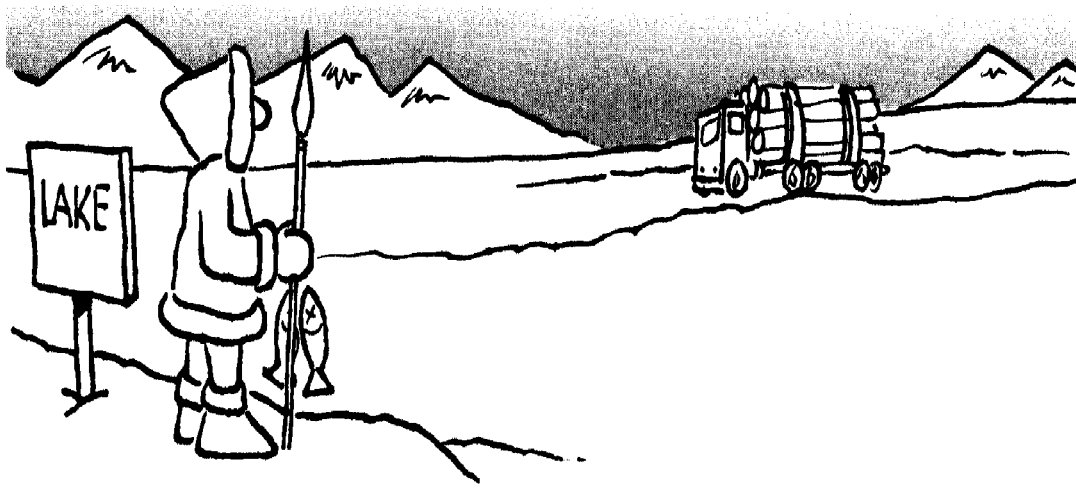
- Higher temperatures could affect the health of forests in the region and dry out marshes, thus reducing wildlife habitat
- Some fish species could disappear from the lakes while other species could move northward
- Less snow could shorten the ski season for southern Quebec and Ontario

### Atlantic Coast

- A rise in sea level could bring flooding, thus affecting residences, transportation, and industrial facilities in low-lying areas, as well as regions along rivers such as the Saint John
- Saltwater intrusion could contaminate groundwater aquifers (the main source of regional water supplies), disturb sensitive ecosystems, and displace freshwater fish populations
- A rise in ocean temperatures could affect the distribution and makeup of the fish population, limiting some species, encouraging others

### The North

- A rise in sea level would also flood low-lying areas in northern Canada, for example, the Mackenzie River delta. It could also erode shorelines and change near-shore ecosystems
- Milder winters and longer summers would shorten the season for ice roads and thus reduce access to remote settlements and timber stands
- Gradual melting of the **permafrost** would change water drainage patterns and destabilize the land, thus affecting roads, pipelines, and buildings
- Greater precipitation would result in a greater buildup of snow, which could mean extensive flooding in spring





### **Did You Know?**

An increase of 3° C may not seem like much. However, around 1000 A.D. a climate slightly warmer than today's allowed the Vikings to settle Iceland and Greenland. About 500 years later their colonies had disappeared, partly because of a temperature drop of about 1° C.

### **What can we do?**

Different people give different answers.

Some argue that since we cannot predict how climate will react to changes in the atmosphere and biosphere, we should not worry because global warming may not happen.

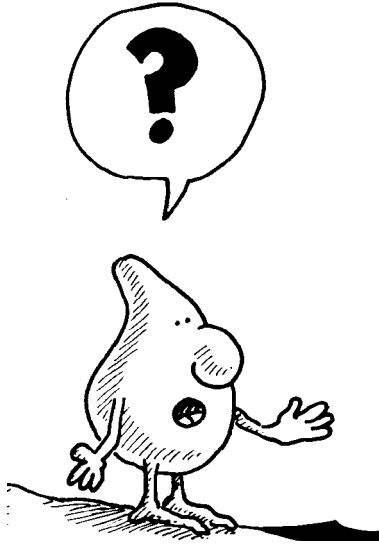
Others say that because we do not know how water supply will be affected, there's no point in spending time and resources on what may not happen.

But scientific experts recommend two general strategies:

1. Prevent or limit the cause of climate change by cutting back on production of greenhouse gases and planting more forests.
2. Expect the change and adapt to it as it comes, for example, by moving from low-lying coasts, or planting the kinds of crops suited to a warmer, drier climate.

It would make sense to follow both of these strategies. Both involve conservation methods and more efficient use of our resources.





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*Activity 1 — Geography,  
Current Events, Atlas Use*

Variations from normal weather happen frequently and news bulletins are always reporting on natural disasters such as floods and droughts.

Check your newspapers or listen to the news on television or radio. Prepare a report using the following questions as a guide:

- What's in the news about flooding and/or droughts?
- Where is this happening? In Canada or in other countries?
- What are the effects of massive flooding? How are people affected when there is a severe drought?
- Why does it concern us if there is drought in Ethiopia? What other countries around Ethiopia are affected?
- Are these droughts similar to the droughts on the Canadian prairies?
- What can we learn from flooding in Bangladesh?



*Activity 2 — Environmental Studies, Research*

Read other literature from Environment Canada about global warming and the greenhouse effect. Find out what could happen if temperatures rise around the world. How could it affect water flow, the melting of ice caps, **aquatic** life, human life, etc.?

Recommend what we can do to deal with the problem of global warming.

Look back at the two recommendations made by scientists (to adapt, or to limit and prevent). Write your point of view about these recommendations. Explain which would make you a better environmental citizen.

### *Activity 3 — Language Arts, Environmental Studies*

#### **Weather, climate change, and you**

1. Fact or fiction? Check this out:

Many teachers can tell there is going to be a change in the weather because of student behaviour. Some students become "unsettled" during low pressure times.

- What is the difference between high pressure and low pressure? When are you likely to get rain?
2. Your grandparents were very aware of the weather. They studied it carefully and tried to predict, through signs, what was going to happen. They had old sayings or beliefs (some people would call them superstitions) that described the occurrence. Some of these related to water are:
    - When the dew is on the grass, rain will never come to pass.
    - If it rains on the last Friday of the month, the next month will be rainy.
    - The bigger the beaver dams are built, the drier the season will be (certainly downstream from the beaver dam).
    - It is a sign of rain when cattle bunch together, or when cattle lie down.
    - Cats will not want to go outdoors when they feel it is going to rain.
    - You all know about the groundhog. . . .
    - People with arthritis know that when their knees ache it is going to rain.
  - Try to find other old sayings related to water and the weather. Ask older people if they can remember any of these.
  - Look at the list above. Some of these you know right away are superstitions, but are there any that might be based on fact?

- Do you have any "internal barometers" that tell you when it is going to rain? Make your own weather prediction; for example, if you plan a picnic it will probably rain, or if you wash the car or water the lawn, it is certain to rain.
- Take one of the weather predictions or superstitions above and draw a picture to illustrate it.

### *Activity 4 — Geography, Science*

- Regions that do not have much water but have growing populations are always needing to find new sources of fresh water. Some of their schemes sound a bit farfetched right now but with changes in technology, there is no telling what might happen in the future.
- One such plan focuses on Canada's glaciers, which contain more water than the Great Lakes. This plan involves towing parts of the glaciers, or giant icebergs, south to the United States.
- Look at a map of North America. How far would such a block of ice have to be towed to get from northern British Columbia to California? What problems can you see? What could happen to climate patterns along the way if such a massive project could be carried out? What do you think about the idea? If not that particular idea, can you think of a plan which might work? Sell your idea to the class.

### *Activity 5 — Research, Environmental Studies*

Select one or more of the following topics to research and prepare a presentation on:

- Find out how farms contribute to global warming. Use the following vocabulary to guide you in your research: methane, nitrous oxide, fertilizers.
- Explain how car and factory emissions contribute to global warming.
- Explain how deforestation and land-fill sites contribute to greenhouse gases.
- How can saving energy reduce emissions of greenhouse gases?
- Prepare explanations showing how you and your family contribute to greenhouse gases.

For whichever topic you choose, draw up a short list of things that good environmental citizens can do to cut down on the greenhouse gases we add to the atmosphere.

### ***Activity 6 — Art***

You can have an impact on the way human beings treat our environment. Create a visual message to make a strong point about global warming and the greenhouse effect.

Design posters, buttons, T-shirts, bumper stickers. Tell people what to do to help.

### ***Activity 7 — Social Studies***

#### **Why should you care about climate change?**

Climate affects almost everything you do.

Take a moment and think about climate and you. Because of the climate you live in you wear certain kinds of clothing, live in a special kind of house, and take part in specific kinds of recreation.

Prepare a profile of yourself, your climate, and your life, and pretend you are sending it to someone who lives in a completely different environment.

How could your life change if world climates became warmer through global warming?

### ***Activity 8 — Environmental Studies***

We have made a lot of references to the "greenhouse effect" without talking much about what a greenhouse is.

Conduct some research. Find out what exactly a greenhouse is and prepare some kind of presentation to show the class how a greenhouse works. This could be a scientific experiment, an oral report with illustrations, or a more dramatic presentation.

### ***Activity 9 — Research, Geography, Environmental Studies***

Permafrost is the term used to describe permanently frozen ground, which is said to be beneath one fifth to one quarter of the world's land. Permafrost underlies much of the Mackenzie Basin in Canada's north.

Find out more about this large area of Canada's north and prepare a research project examining some of the following topics:

- the geographic area of permafrost
- people who live on permafrost
- how the unique features of permafrost affect the lives of people in the north
- the provinces, territories, and governments involved with permafrost
- industries on permafrost
- how climate change could affect permafrost
- how the effects of climate change on permafrost could affect greenhouse gases and further climate change
- how changes in permafrost could affect the supply, quality, and levels of water.

### ***Activity 10 — Social Studies***

People who study the world population predict that if it continues to increase at the same rate, it will double by 2050. How old will you be then?

#### **Research**

- Approximately how many people currently live in the world? What might this population be by 2050?
- Already there are stresses on the world's water supply. What do you think are some of these stresses? (Think about less developed countries, where there are few water treatment facilities, or places where they do not have the supply of water we have).
- What extra stresses do you predict by 2050? What are problems that can be caused by these stresses?
- What solutions do you recommend? (Should we look for ways to share our resources? Should we be giving more money to poorer countries to help them take

care of scarce water supplies? Should we charge more for our own water and wastewater treatment?)

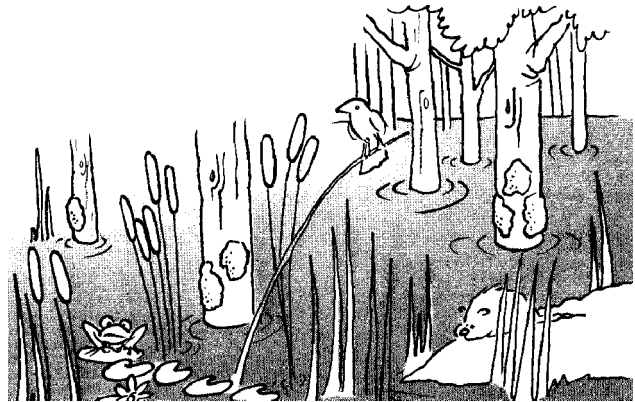
Prepare a paper to be presented to the United Nations committee on conserving our resources.

### ***Activity 11 — Environmental Studies, Research***

"Wetlands are the only ecosystem selected for conservation by agreement around the world."

Find out more about wetlands by researching and answering the following questions.

- What is a wetland? There are different kinds: how many can you name?
- What kinds of animals and plants live in wetlands?
- Wetlands are considered valuable for a number of reasons. How many reasons can you find?
- In what ways are wetlands being threatened?
- What ways are being used to conserve wetlands?
- Are there wetlands in or near your community? How do people use them?

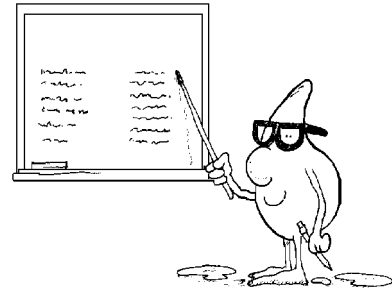
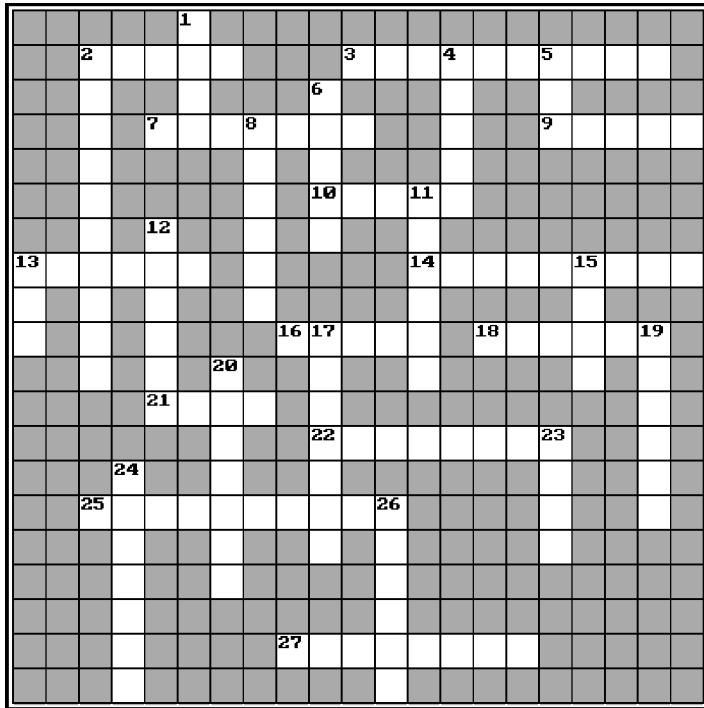


### ***Activity 12 — Science, Environmental Studies***

Check back in the Student Information sheets where they discuss the changes that could occur in different areas of Canada if the climate got warmer. Prepare a report outlining what might happen in your part of the world; how could these changes affect your way of life?



TEST 5  
Crossword Puzzle



Across

- 2. The \_\_\_ of Seven.
- 3. This slows down when rivers are blocked by sediment.
- 7. He painted nature in Algonquin Park.
- 9. Confederation \_\_\_.
- 10. Without water we cannot \_\_\_.
- 13. \_\_\_ warming may increase world temperatures by 1 to 5 degrees.
- 14. He wrote "The Wreck of the Edmund Fitzgerald."
- 16. The Rocky Mountains have high \_\_\_.
- 18. A large river in Western Canada.
- 21. Canada is a good source of fresh and \_ water.
- 22. Rivers can deposit sediment and create \_\_\_.
- 25. Permanently frozen ground.
- 27. Thousands of years ago, these covered much of Canada.

Down

- 1. Fast flowing water is said to \_\_\_ downstream.
- 2. A layer of air traps heat around the earth and acts as a \_\_\_ for people, animals, and plants.
- 4. A native of Northern Canada.
- 5. Water in our homes comes out of a \_\_\_.
- 6. Native art form from Canada's West Coast.
- 8. Pauline Johnson was born of a \_\_\_ father.
- 11. "Splish, \_\_\_, I was taking a bath..."
- 12. Canada has beautiful, high mountain \_\_\_.
- 13. Fossil fuels create a greenhouse \_\_\_.
- 15. A creature that breathes through its gills.
- 17. The first stage of the sediment cycle.
- 19. A fast moving part of a river.
- 20. Weather patterns make up our \_\_\_.
- 23. A form of frozen precipitation.
- 24. A river will eventually drop, or \_\_\_, its sediment.
- 26. Chemical pollutants.

### Fill in Blanks

1. The first stage in the sediment cycle is \_\_\_\_\_.
2. Water transports soil from one place to another in the form of \_\_\_\_\_.
3. \_\_\_\_\_ is the term used to describe the phase of the sediment cycle in which water drops its load downstream.
4. Glaciers, wind, and water wear away small particles of rock through a process called \_\_\_\_\_.
5. The term that means thousands of years is \_\_\_\_\_.

### True or False

- T F 1. The poem "The Song My Paddle Sings" was written by Tom Thomson.
- T F 2. When early explorers and settlers first came to Canada, rivers were the main transportation system.
- T F 3. Alexander Mackenzie was a painter of Canada's waterways.
- T F 4. The Fraser River is named after Fraser Thompson.
- T F 5. Poets such as Charles G.D. Roberts, Bliss Carman, Archibald Lampman, and Duncan C. Scott were members of the Group of Seven.
- T F 6. Native people of Canada selected sites for villages because they were close to water.
- T F 7. Rivers in mountainous regions carry greater loads of sediment than rivers in the Prairies.
- T F 8. The St. Lawrence River transports more sediment than the Fraser River.
- T F 9. Glaciers covered much of North America over 10 000 years ago.

### Question Time

How would you answer the following questions in one or two sentences?

1. Why is there less river-deposited sediment in eastern Canada than in western Canada?
2. What are two sources of toxic chemicals carried by sediment?
3. Why is sediment a problem for navigation?
4. How can sediment affect fish eggs?
5. What bad effects does sediment have on water supply?
6. How does construction of roads and buildings affect the environment?
7. What is the difference between weather and climate?
8. What "natural causes" can lead to changes in the climate of a region?
9. What is meant by "global warming"?
10. How do some greenhouse gases help us?
11. What problems are associated with greenhouse gases?



## True or False

1. False. The poem "The Song My Paddle Sings" was written by Pauline Johnson.
2. True. When early explorers and settlers first came to Canada, rivers were the main transportation system.
3. False. Alexander Mackenzie was an early explorer.
4. False. The Fraser River is named after Simon Fraser.
5. False. Poets such as Charles G.D. Roberts, Bliss Carman, Archibald Lampman, and Duncan C. Scott were members of a group referred to as the Confederation poets.
6. True. Native people of Canada selected sites for villages because they were close to water.
7. True. Rivers in mountainous regions carry greater loads of sediment than rivers in the Prairies.
8. False. The Fraser River transports almost ten times as much sediment as the St. Lawrence River.
9. True. Glaciers covered much of North America over 10 000 years ago.

## Question Time

1. Why is there less river-deposited sediment in eastern Canada than in western Canada?
  - Much of the land is bedrock.
2. What are two sources of toxic chemicals carried by sediment?
  - Agriculture and industry.
3. Why is sediment a problem for navigation?
  - If sediment from fast moving rivers is deposited downstream, eventually it builds up and makes the water shallow.
4. How can sediment affect fish eggs?
  - Settling sediment can bury and suffocate fish eggs.
5. What bad effects does sediment have on water supply?
  - Sediment in the water can wear out pumps and turbines, which can increase the cost of keeping things in good repair.
6. How does construction of roads and buildings affect the environment?
  - Sediment from construction sites can find its way to sewers and streams and can increase the costs of water treatment or affect aquatic life.

7. What is the difference between weather and climate?
  - Climate is determined from the average of weather conditions and patterns over a long period of time (more than 30 years).
8. What "natural causes" can lead to changes in the climate of a region?
  - Changes in the gaseous content of the atmosphere and changes in the amount of sunlight reaching the earth's surface can both affect climate.
9. What is meant by "global warming"?
  - This is the term scientists use to describe what happens to the earth's climate when people and industries add greenhouse gases to the atmosphere.
10. How do some greenhouse gases help us?
  - They trap the sun's heat in a blanket of air around the earth and keep it from escaping into space. This keeps the earth's temperatures just right for people, animals, and plants to live.
11. What problems are associated with greenhouse gases?
  - Problems occur when we add large amounts of gases to the atmosphere by burning fossil fuels in our industries, cars, and homes. These gases trap heat near the earth's surface and add to global warming.