Climate Change Agreements: What's the Big Deal?

Weather has always been a hot topic of conversation. We talk about whether it is hot or cold, windy or calm, snowy or dry. We listen to the radio to figure out if the weather will be different tomorrow. We look out the window in the morning to see if the weather has changed since yesterday.

Changes in weather are different than changes in the climate. Weather is the day-to-day stuff we experience and climate is the long-term pattern of weather in a region. Another way to put it is that weather is what you *get*, climate is what you *expect* to get! Weather can change daily but the climate in an area is usually pretty much the same year to year.

Although people have always talked about changes in the weather, it is changes in the climate that are making headlines around the world. Climate change is the topic of international conferences and intergovernmental negotiations. We hear about how climate change is affecting our environment, wildlife, and our way of life. Many are saying we need to change our behaviour to help stop the changes in the climate.

This backgrounder is the first in a series of 17 back-grounders on climate change. This one gives you an overview. It explains how climate change is impacting our world and outlines some of the things we can do about it. The rest of the backgrounders go into details on specific topic areas. Read on!

Things are Heating Up!

Since the world was formed, it has shown patterns of warming up and cooling down. For example, Canada has been covered with large glaciers several times in the last 1,000,000 years. The ice has melted each time as temperatures have warmed up.

Up until the last hundred years or so, the Earth's climate had been in a stable stage for 10,000 years. Little changed. But in the past 100 years, something different has been happening. The rate of global temperature change has been far more rapid than at any other time in the last 10,000 years!

How do we know what happened 10,000 years ago?

There are a number of things that people do to figure out what our climate was like way back when. Researchers take ice cores out of glaciers and examine the layers of volcanic ash, dust, carbon dioxide, and other chemical elements within the ice to get clues about past climates. They take muck out of the bottom of lakes and get a sense of historical climates from pollens, fossilized insects and other stuff. They look at rings inside trees to figure out what years were warmer than others. They research written and oral records from ancient cultures.

A lot of the information on climate change is reviewed by the "Intergovernmental Panel on Climate Change" (IPCC). This panel involves over 2,000 of the world's climate experts. Many of the climate change facts and future predictions we read about come from information reviewed by the IPCC.

To get the full story on "How do we know," check out Backgrounder 5.

The world's climate is getting warmer. The average temperature of the globe increased by about 0.6° C between 1900 and 2000. Many regions of the Arctic have warmed up by as much as 5° C in the same 100 year period!

Hot Facts

- Worldwide, people have kept temperature records since 1860. Since that time, we know that eight of the ten hottest years on record have occurred since 1990. 1998 was the hottest of all.
- Based on ice cores and other data, 1998 is believed to have been the warmest year in the last 1,000 years!
- The effects of climate change are greater in the north. Temperatures in the Canadian Arctic were, on average, 5° C above normal in 1998.
- Most areas of the Arctic have seen an average 1.5° C rise in temperature in the last century. (However, the mountainous region of the eastern Arctic has actually cooled slightly since 1970. This is part of what happens with climate change – some areas get cooler as global weather patterns change).
- Most of Canada has seen an increase in precipitation (rain and snow) in the last 50 years.
- Sea ice in the Arctic Ocean is estimated to be 40% thinner and cover 6% less area than it did in 1980.
- By 2100, global temperatures are predicted to rise by 1.4° to 5.8° C. Average temperatures in most northern parts of the world are expected to increase even more!

Climate Change and Global Warming: Same or different?

People sometimes call the warming up of the world "global warming."

However, "climate change" describes the full range of changes that are happening. We are getting more than just warmer weather:

- Some places will get more rain than usual while others will become drier.
- Some regions can even become cooler.
- Climate change also affects things like wind patterns, cloud cover, and ocean currents.

So climate change includes global warming. Climate change is the bigger picture.

Hey! Warmer Weather Sounds Pretty Good to Me!

Warmer temperatures may sound kind of nice, especially in the winter. However, climate change is about a lot more than just warmer temperatures! Here are a few things that are already happening because of climate change:

- *Melting permafrost:* Some northern buildings and roads are shifting and sliding as the permafrost they are built on melts. The melting is also causing landslides and slumping riverbanks.
- *Earlier break-up of sea ice:* Wildlife, like polar bears or walruses that live on the ice, are already being affected by disappearing ice. So are human hunters. But earlier break-up also means that ships can travel into Northern coastal towns for more weeks in the year.
- *Rising sea levels:* Communities along the coast are losing land to the ocean.
- *More forest fires:* Hotter temperatures are drying things out and larger areas of forest are burning, and burning more often.
- *New plants, fish, animals, and insects:* All sorts of new species are being found in northern areas. Warmer temperatures are making it easier for southern species to survive farther and farther north. But some northern species are finding it harder to survive as their environment changes.

Worldwide, there are more "extreme" weather events like hurricanes, floods and extended dry periods (called droughts). These extreme events can damage buildings, injure or kill people and wildlife, and destroy food crops. As average temperatures continue to rise, some of these impacts will happen more and more often. *(For more details on the impacts of climate change, see Backgrounders 6 to 12)*.

What's a Few Degrees?

If the world continues along its present course, scientists predict the average global temperature is expected to rise by 1.4° to 5.8°C between 1990–2100. So what's the big deal with a few degrees?

Well, in the last ice age, the world was only about 4° to 6°C cooler than it is today. This difference in temperature caused huge areas of the world to be covered by ice. Some animal species disappeared completely. So a few degrees can make a big difference!

And in the North, it is predicted our temperatures will change even more than temperatures in southern Canada. By 2080, winter temperatures over the land areas in the Arctic could rise 2.5° to 14°C above current normal temperatures. Summer temperatures are expected to increase by 4° to 7.5°C above what we now usually get. Remember, a few degrees can make a big difference!

Doesn't the Climate Always Change?

It is true that the world's climate has always changed. There have been ice ages and there have been warm periods. Isn't this latest increase in temperature just part of the natural change in the climate? It doesn't look like it.

Climate change in the past has been caused by natural forces. Sometimes the sun put out more energy. Other times, large volcanoes erupted and the ash they spewed into the air shaded the world from the sun's warmth. However, since the last ice age – about 10,000 years ago – our temperatures have been pretty stable. That is, they have been stable until the last 100 years or so.

The big difference between warming after the last ice age and current global warming is that this latest change doesn't appear to be caused by the sun or by volcanoes. It seems to be caused mainly by human activity. And the change is happening very quickly.

So Just How Are We Heating Up the World?

The earth is surrounded by a layer of gases we call the atmosphere. When the sun shines down on our world, some of the sun's energy is reflected back into space by the atmosphere but most of the sun's energy travels down to us. The land and water also reflect a bit of this energy back into the atmosphere. However, most of the sun's energy – its heat – is absorbed by the land and water. This absorbed heat is slowly released back up to the atmosphere during day and night.

"There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activity."

—

The Intergovernmental Panel of Climate Change (IPCC), a United Nation's organization involving over 2,000 of the world's scientists.

The atmosphere helps trap some of the heat in. If the atmosphere was not there, the world would get really cold every night. The atmosphere acts like a blanket or a greenhouse. It holds the sun's heat in and slows down it release into space.

Some of the gases in the atmosphere are key to keeping this heat in. They have been called "greenhouse gases" or GHGs for short. Carbon dioxide, methane and nitrous oxide are the three most common GHGs.

However, you can have too much of a good thing. We need the right amount of GHGs in the atmosphere to keep the right amount of heat in. Too much heat – or too little – can hurt humans and our environment.

The problem is that human activities are adding too many heat-trapping GHGs to the atmosphere. We are tipping the natural balance and that is why our climate is changing.

We put these extra GHGs into the environment in many ways. For example, we put carbon dioxide (CO_2) into the atmosphere when we burn gas, diesel, propane and other "fossil fuels." We burn these fuels to get around in planes and cars, to create electricity, to heat our homes, or to run our industries. When we use these fossil fuels, they release a lot of carbon dioxide into the air.

Trees and plants help take carbon dioxide out of the atmosphere when they make food through a process called "photosynthesis." But we are cutting down more and more of the world's forests so we are reducing the number of plants and trees that can help absorb some of the carbon dioxide. *(This is a shapshot of the greenhouse effect and greenhouse gases. For more details see backgrounders 2 and 3)*.

Fossil fuels

Fossil fuels come from the remains of plants and other organisms that were buried in the mud and other sediments millions of years ago. These organic remains were heated and compressed by the earth's crust. This changed them into carbon-rich substances like oil, gas and coal.

How Can We Turn Down the Heat?

The good news is that if humans are the main cause of this latest change in the climate, then we can help slow down these changes! There are many things that we can do at home or at school. Businesses and governments from around the world are also taking action to reduce the GHGs going into the atmosphere.

For example, people are developing better ways to use renewable energy like the wind and sun so that we don't have to use as much fossil fuel. Also, new types of fuels are being created from things like sugar cane or cow manure that release fewer GHGs! New cars that can travel much farther on one tank of gas are already on the road. All of these efforts help to reduce the GHGs going into the atmosphere.

Much of the electricity in the world is produced by burning fossil fuels like diesel or coal. So reducing how much electricity you use at home can help reduce the GHGs going into the atmosphere. This can be as simple as turning off lights or computers when you're not using them. It may mean washing clothes in cold water because it takes electricity or fuel to heat the water. People are also putting more insulation into the walls and attics of their houses so that they will use less oil or gas for heat.

The less electricity and heat you use, the less carbon dioxide you put into the atmosphere. And the less money you spend on electricity and heat! Bonus!

These are just a few ideas about how people can reduce their use of fossil fuels. (*For more ideas on solutions to climate change, see backgrounders 13 to 17)*. Can you think of other things people are doing to reduce how much energy they use?

Wrap-up

So climate change is going to have a big impact on our lives and it is something we can't ignore. This backgrounder provided an overview of what climate change is, how it might impact us, and what we can do to help slow down the changes. For more details on all of these topics, check out the rest of the backgrounders!

Key Points

- ★ The planet's climate is changing. The world can expect a 1.4° to 5.8°C temperature increase on average in the next 100 years. (A drop of only 4° to 6°C triggered the last ice age!)
- ★ The North will warm up even more than the rest of the world.
- ★ The warming climate is already having an impact on our communities, forests, wildlife, sea ice, permafrost and more.
- ★ The climate has always changed but recent changes are caused by human activity. We are putting too many greenhouse gases (GHGs) into the atmosphere.
- ★ There are many things people can do – and are doing – to help reduce climate change.

Want to Know More?

There are many websites on climate change. Here are some starters:

- **Climate Ark Portal (Vital Climate Graphics):** http://www.climateark.org/vital/ – A collections of graphics and information on climate change.
- **EPA Global Warming Kids' Site:** http://www.epa.gov/globalwarming/kids/index.html – A fun site with backgrounders, games, and links.
- **Government of Canada Climate Change Website:** http://www.climatechange.gc.ca/english/index.shtml – Includes all kinds of background information, including maps and graphics, on Climate Change, how it will affect us, and what we can do.
- **David Suzuki Foundation (Climate Change Section):** http://www.davidsuzuki.org/Climate_Change/ – Scroll down to "Learn More" and click on the individual topics to get a complete overview.
- **US Environmental Protection Agency:** http://yosemite.epa.gov/oar/globalwarming.nsf/content/index.html – Click on a whole list of climate change topics for in-depth answers.
- **US Global Change Research Information Office:** http://www.gcrio.org/ipcc/qa/index.htm – Gives answers to basic questions about climate change.
- **Yukon Department of Environment:** http://www.environmentyukon.gov.yk.ca/epa/climate.shtml – Good backgrounders on climate change, especially in the Yukon.

Climate change backgrounders in this Series:

- **OVERVIEW OF CLIMATE CHANGE: Backgrounder 1**
- **BASICS OF CLIMATE CHANGE: Backgrounders 2 to 5**
  2. The Greenhouse Effect
  3. Greenhouse gases
  4. Weather & Climate
  5. How do we know?
- **IMPACTS OF CLIMATE CHANGE: Backgrounders 6 to 12**
  6. A Changing Land
  7. The World of Ice and Water
  8. Northern wildlife
  9. Fish and Fowl
  10. Northern marine life
  11. Northern Communities
  12. Global impacts
- **CLIMATE CHANGE SOLUTIONS: Backgrounders 13 to 17**
  13. Renewable Energy
  14. What You Can Do
  15. What Schools Can Do
  16. Agreements and Disagreements
  17. Walking the talk (Governments and Businesses)

Basics of Climate Change | High School Backgrounder 2

The Greenhouse Effect

We know that climate change is being caused by the warming of our planet. But what causes this warming? Who – or what – is in control of the thermostat?

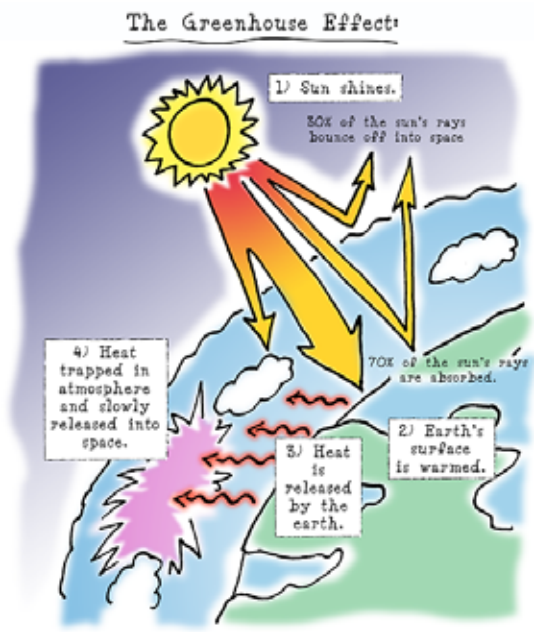
This backgrounder provides the answers to these questions.

You Think the North is Cold!

If you went for a walk on Mars during the day, you'd probably want to wear a bathing suit and a lot of sunscreen, as it would be about 37°C. But at night, the warmest parka wouldn't do you much good as temperatures would plummet down to a nippy –123°C or so!

Why does Mars cool off so much at night? It's because the sun's heat scoots right back out into space when the sun goes down. Mars doesn't have much of a blanket to keep the warmth of the day in.

A Blanket Around Our World



Down here on Planet Earth, about half of the sun's heat that reaches us is absorbed by the land and water. When the sun goes down, the absorbed heat is slowly released into the air. We also have an atmosphere – a layer of gases surrounding the earth – that absorbs some of the sun's heat and also helps keep the released surface heat from floating quickly off into space. The atmosphere is like a blanket that surrounds the world.

This atmosphere also lets in just the right amount of the sun's heat (about 70%) and reflects the rest – sending it packing back out into space.

Most of the atmosphere is made up of nitrogen and oxygen. As you know, oxygen is pretty important as it allows us to breathe! However, it is the water vapour in the atmosphere and a tiny amount of trace gases that keep us from frying and freezing on Planet Earth.

The trace gases make up less than 0.1% of the atmosphere. These gases include carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). Although the trace gases make up just a tiny part of our atmosphere, they are big-time players when it comes to keeping the world at temperatures we can survive. *(For more details on these trace gases, check out Backgrounder 3)*.

Riding the waves: Solar travel to Earth

Details on the Natural Greenhouse Effect

Incoming!

The sun's energy comes to earth as solar radiation in short and medium wavelengths.

- Most of the short wave radiation (called gamma rays, x-rays, and Ultraviolet (UV) light) is absorbed by the mid to high regions of the atmosphere.
- The medium waves are visible light and travel pretty much uninterrupted through the atmosphere to earth.
- These waves are absorbed by the Earth's surface and by the carbon dioxide and water vapour in the lower atmosphere.

Some gets reflected
When the sun shines on Earth, about 31% of the incoming visible light is reflected back into space. Clouds and suspended solid materials reflect about 22%, while land and ocean surfaces, particularly snow and ice, reflect about 9% of visible light upwards.

And some gets absorbed
The 69% of the sun's visible light that gets through is absorbed mostly by land and water on the earth's surface (49%) and by the clouds and atmosphere (20%).

And released later
Heat absorbed by the surface is radiated back as long-wave infrared (IR) radiation. This warms the air immediately above the earth's surface.

To be trapped again – for a while
Water vapour and other greenhouse gases in the atmosphere absorb this IR radiation, holding it in. The trapped heat is also radiated up, down and all around. Eventually it disperses to outer space.

This is called the Greenhouse Effect because the atmosphere acts like the glass in a greenhouse. It helps to trap in the sun's heat, slowing its release into the colder space.

Hanging Out in the Greenhouse

Like the plastic or glass covering a greenhouse, water vapour and trace gases trap the heat radiated from the sun. If we didn't have these Greenhouse Gases (GHGs for short), the earth would be an icebox. Our average temperature would be about -18°C. This is the average temperature of Antarctica. If this were the earth's temperature, there would be very little (if any) liquid water anywhere on the planet. It's likely there wouldn't be any living organisms either!

People refer to this heat-trapping role of the atmosphere as the "greenhouse effect". It's a natural process that allows us to live on earth.

However, too much – or too little – of a good thing can be bad for you. We need just the right balance of GHGs in the atmosphere. Unfortunately, there are starting to be too many GHGs in the atmosphere. This means that more heat is being trapped by the atmosphere. And our greenhouse is starting to get a little too warm for comfort.

Balancing the Carbon Teeter-Totter

To understand why we are getting too warm in our greenhouse, let's look at carbon dioxide (CO_2), one of the most important GHGs. Carbon dioxide makes up about 25% of the natural greenhouse effect and is therefore a key player.

A number of things put carbon dioxide in the atmosphere:

- Forest fires or erupting volcanoes are natural sources of carbon dioxide.
- Trees and plants also contain a lot of carbon. When they die and decompose (rot) half of the carbon contained in the trees and plants is released into the atmosphere as carbon dioxide. The other half is absorbed by the soil. However, soils also slowly decay, especially if they are disturbed by fire and other processes. This releases more carbon dioxide into the atmosphere.
- Humans, animals and insects consume plant materials that contain carbon. Much of the carbon in the plants is eventually released into the atmosphere when humans, animals and insects breath-out carbon dioxide.

- Oceans contain and release huge amounts of carbon dioxide that bubble into the air from their surfaces.

Some things also *remove* carbon dioxide from the atmosphere.

- Plants and trees take in carbon dioxide when they turn the sun's energy into food (through photosynthesis).
- Oceans also absorb large amounts of carbon dioxide into their surface waters. The carbon dioxide dissolves in the ocean like the fizz in a soft drink.
- Phytoplankton – a big name for little organisms that float around in the ocean – take up a large portion of the ocean's carbon dioxide through photosynthesis (though much of this is later released).

This removal of carbon dioxide from the atmosphere helps keep things in balance.

Over the past 10,000 years, the balance between the annual atmospheric release and removal of large amounts carbon dioxide has been remarkably stable on average.

Imagine two kids playing on a teeter-totter. At one end, the child weighs the same as the amount of carbon dioxide *removed* from the atmosphere. The child on the other end weighs the same as the amount of carbon dioxide *put into* the atmosphere. The teeter-totter was essentially in balance for about 10,000 years

Out of Balance

However, things have not always been in perfect balance. If you had been hanging around for the last 400,000 years, you would have seen four major periods of time where very warm clothes would have been in high demand as the teeter totter dropped to one side!

Each of those times, the amount of carbon dioxide in the atmosphere decreased naturally (from about 275 parts per million down to about 220 parts per million). In other words, the kids on the teeter-totter changed their diets. The kid that removed carbon dioxide took some of the other kid's carbon dioxide away and the balance tipped. The one putting carbon dioxide into the atmosphere got thinner.

Less carbon dioxide in the atmosphere meant that less of the sun's heat was trapped by the atmosphere. This caused the average temperature of the world to cool by about 5°C. Each time, this temperature drop was enough to start an ice age!

You might want to keep in mind that during the last ice age – just over 10,000 years ago – most of North America and Europe were covered by ice. So a few degrees can make a big difference!

Tipping the Other Way

Since the end of the last ice age, the amount of carbon in our atmospheric blanket has been pretty stable and temperatures on earth have been pretty comfortable. That is, until the last 200 years or so.

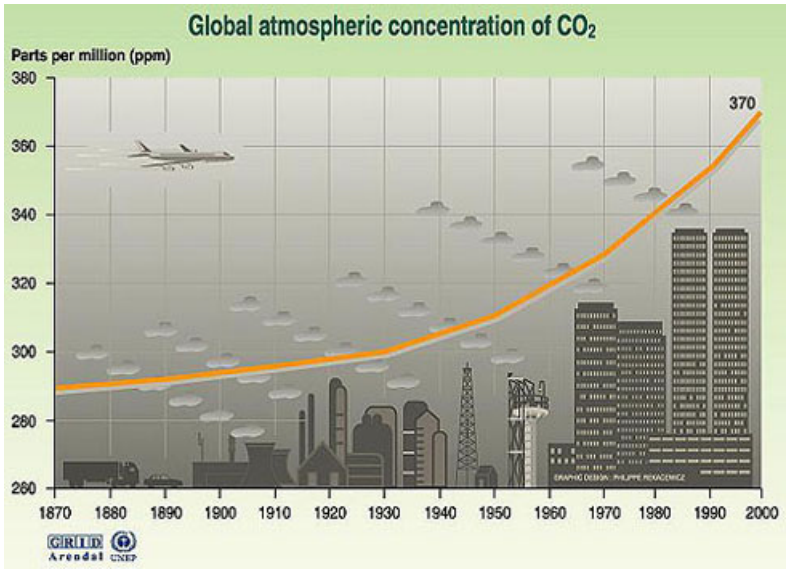
Unfortunately, when the industrial revolution began in the late 1700s, people started to add billions of tonnes of extra carbon dioxide to the atmosphere.

People put carbon dioxide into the atmosphere when we run our industries, heat our homes and drive our cars. This is because when we do these things, we usually burn fossil fuels – oil, gas and coal. These fossil fuels are made from the carbon of plants and animals that decomposed millions of years ago. Over time, these decomposed materials were buried by layers of soil and other decomposed material. Heat and pressure helped to turn decomposed plants and animals into what we now call oil, gas and coal.

So these fossil fuels are made up of a lot carbon – carbon that was trapped below the surface of the earth for millions of years. When we bring carbon – in the form of oil, gas and coal – back to the surface and burn it as fuel, it combines with oxygen to release a lot of carbon dioxide into the atmosphere.

Based on studies of ice cores from glaciers, scientists believe that there is much more carbon dioxide in the atmosphere now than there has been for a very, very, very long time. We have now reached about 370 parts per million (ppm) of carbon dioxide in the atmosphere and its still increasing. Scientists believe that in the last 400,000 years, carbon dioxide has never been much above 300 ppm. So this is a big jump in the amount of carbon dioxide in the atmosphere. The teeter-totter has now tipped the other way. The kid who puts carbon dioxide into the atmosphere is now much heavier than the kid that takes carbon dioxide out of the atmosphere. And the one putting it in keeps getting heavier and heavier.

Having this much carbon dioxide in the atmosphere is kind of like throwing a much thicker blanket on your bed – things can get a little too toasty for comfort. It is time for the kid putting carbon dioxide into the atmosphere to go on a diet!



Graph showing changes in CO_2 since industrial revolution.

It's not like we learned this yesterday!

In 1824, French physicist Jean Fourier first described how the atmosphere acted like a greenhouse and trapped the sun's heat in.

In 1896, Swedish physicist Svante Arrhenius argued that increases in carbon dioxide in the atmosphere enhanced the Earth's greenhouse effect and led to global warming. He calculated that historical volcanic eruptions could have caused carbon dioxide concentrations in the atmosphere to double over time. He believed that this increase in carbon dioxide could cause an average temperature increase of 5° to 6°C.

The first real warning that humans were putting too much carbon dioxide into the atmosphere came in 1957. Two scientists, Roger Revelle and Hans Seuss, wrote a scientific paper. It described the build-up of carbon dioxide in the atmosphere as "a large-scale geophysical experiment" with the earth's climate.

Little was done about the increasing carbon dioxide in the atmosphere for many years. But in 1992, many countries signed the first international agreement that dealt with GHGs in the atmosphere. It was called the United Nations Framework Convention on Climate Change (UNFCCC)
(see Backgrounder 16)

Why would the Northern part of the greenhouse get hotter?

The increase of GHGs in the atmosphere is expected to cause global temperatures to go up an average of 1.4° to 5.8°C in the next 100 years. However, temperatures in the Arctic are expected to rise more than the average. For example, winter temperatures over the land areas in the Arctic could rise 2.5° to 14°C above current normal temperatures. What's up with that?

Less reflection, more absorption: The snow and ice in the North normally reflect back a lot of the solar heat that gets to the earth surface. This is one reason why the north stays cooler than the rest of the world. Unfortunately, a lot of snow and ice will melt, as the world gets warmer. This means there will be less reflection – and more absorption – of the sun's heat by the land and open water. As more heat is absorbed in the North, even more of the North's snow and ice will melt... which means even more of the sun's energy will be absorbed (this is called a positive feedback effect).

The loss of snow and ice to reflect away the sun's heat is one of the main reasons the north will see dramatic increases in temperature. We will likely always have some snow and ice and so we will stay cooler than many other parts of the world. However, our temperatures will change more than the places in the world that don't have any snow and ice to lose in the first place.

Warmth from the polar oceans: In winter, the polar oceans are much warmer than the very cold air above them. As warmer climates cause the ice on the oceans to form later in the fall, break up earlier in the spring, and become thinner during the winter, much more heat escapes to warm the air above. That is why winters are expected to warm so much more over polar regions, particularly over the Arctic Ocean, than in regions closer to the equator.

Moisture carries warmth: As climate change happens, warm air from the tropics – that moves northward – will likely carry more moisture with it. The moisture in the air is actually water that has been warmed and turned into vapour. When the moist vapour eventually cools over the arctic, it will fall to earth. When it does this, it will transfer the heat it carries into northern regions.

Greenhouse on Steroids?

When we add more GHGs to the atmosphere we get what is called the "enhanced greenhouse effect". We are changing the natural processes of the world and making it difficult for the atmosphere to keep a balance.

This enhanced greenhouse effect isn't making us sweat buckets yet, but it is starting to change the climate and the world we are used to. To get a sense of these changes, check out the other backgrounders to learn more about the role of GHGs and the impacts of climate change.

Key Points

- The atmosphere helps trap the heat of the sun close to earth. The atmosphere, together with the Earth's surface also reflects 31% of the sun's heat back into space.
- It is the greenhouse gases (GHGs) in the atmosphere that absorb and trap the heat. Water vapour is the main GHG. Carbon Dioxide (CO_2) is the next largest GHG.
- Trees and plants, as well as oceans, help remove carbon dioxide from the atmosphere.
- Many natural things put carbon dioxide into the atmosphere: forest fires, volcanoes, decomposing trees and plants, and gas bubbles from ocean surfaces.
- Humans are now also releasing carbon dioxide by burning fossil fuels. Carbon dioxide concentrations in the atmosphere have been going up steadily since we started burning fossil fuels over 200 years ago.
- More carbon dioxide and other GHGs in the atmosphere, means more heat is trapped and absorbed. This causes global temperatures to increase.

Want to Know More?

Here are some websites to help you find out more about the Greenhouse Effect:

- **The Australian Greenhouse Office:** http://www.greenhouse.gov.au/education/factsheets/what.html – Contains a wealth of information about different aspects of climate change
- **BBC World Service:** http://news.bbc.co.uk/hi/english/static/in_depth/sci_tech/2000/climate_change/default.stm – Click on 'Greenhouse Effect' for an animated explanation
- **Encyclopaedia of the Atmospheric Environment:** www.doc.mmu.ac.uk/aric/eae/english.html – Find write-ups on all aspects of climate change by clicking on 'Climate Change' or 'Global Warming.'
- **EPA Kids' Site (Greenhouse Effect):** http://www.epa.gov/globalwarming/kids/greenhouse.html – Has a great animation that takes you through the whole process
- **Living Landscapes:** http://royal.okanagan.bc.ca/mpidwirn/atmosphereandclimate/greenhouse.html#a – Gives a good overview, complete with pictures and graphs.
- **A Climate Change Timeline:** www.ec.gc.ca/climate/timeline-e.html



Greenhouse Gases (GHGs)

Trace gases in our atmosphere act like the glass in a greenhouse. These trace gases trap much of the heat from the sun close to earth at night.

These gases are called Greenhouse Gases (GHGs) and they help keep our world's temperatures in balance. Without these GHGs, our planet might be like a freezer.

But too much of a good thing can turn into a bad thing! Unfortunately, we are putting too many GHGs into our atmosphere and these gases are trapping too much heat.

So these GHGs are rather important. We need to understand how they affect our world's temperature and where they come from in the first place. This backgrounder dives into the details of some of the key gases floating about above our heads.

The GHG Club

There are many GHGs in the atmosphere that affect our climate There are four main ones and a bunch of smaller ones.

Water vapour

If you have gone into a bathroom after someone has showered and felt the dampness on your skin – the humidity in the air – then you have been surrounded by water vapour, the most common GHG. Water vapour causes about 65% of the natural greenhouse effect.

When water in rivers, lakes and oceans gets warm it evaporates. This means it becomes water vapour and rises into the atmosphere. Water vapour helps to keep the sun's energy that is absorbed by land and water from escaping back into space. It can form clouds that reflect some of the sun's energy back into space. The clouds also act like a blanket and trap heat close to earth.

When water vapour in the atmosphere cools, it condenses into rain and snow and then falls back to earth. That is how water cycles back into rivers, lakes and oceans.

Carbon dioxide

If you have smelled the fumes from a car or snowmobile, you have got a nose full of carbon dioxide (CO_2) at the same time. Smoke from a woodstove or a forest fire also contains a lot of carbon dioxide as it heads up to the atmosphere. Humans and animals breathe out carbon dioxide. Trees and plants breathe in carbon dioxide when they make their food through a process called photosynthesis. The same trees and plants then give off carbon dioxide when they breathe, and when they die and decompose.

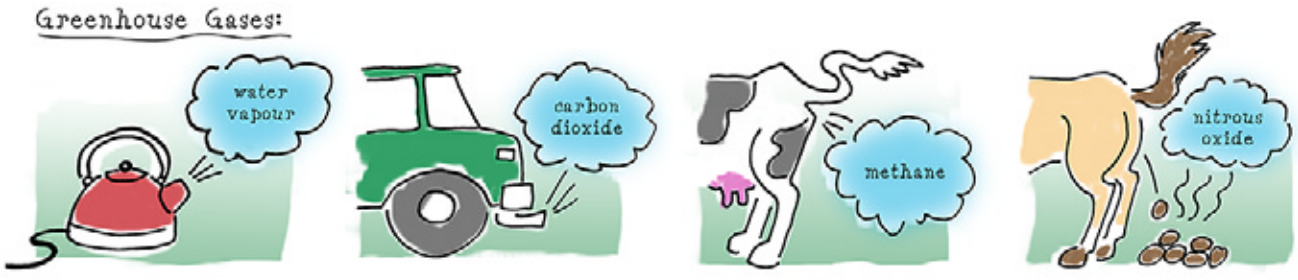
Carbon dioxide is the second most common GHG. Carbon dioxide makes up about 25% of the natural greenhouse effect.

Methane

If you have seen a herd of bison, muskox or cows grazing, then you have seen methane, the third most common GHG on the list, being produced!

Methane is created when organic matter decomposes (rots) without any oxygen present ("anaerobic" decomposition).

Animals like cows, bison, muskox, sheep, goats and camels are called "ruminants" (they have multiple stomachs to digest food). In the large fore-stomach of these animals, their food is broken down by little microbes. This creates gas – methane – and it is released the way most of us release stomach gas! Humans also produce methane, but not nearly as much as ruminants.



Another source of methane is natural gas, a fossil fuel we often use to heat homes and run some types of vehicles. Natural gas is also formed by the decay of organic matter (plants and animals) but these plants decomposed thousands of years ago! Natural gas is found 3,000 to 15,000 feet below the earth's surface.

If you put your food scraps in a sealed bucket and let them rot, you will release methane into the air when you finally open the lid. When our leftovers from dinner, grass clippings from our lawns or even waste paper from last year's school assignments decompose in the community dump, they will release methane (unless the waste is turned frequently so that oxygen is mixed with the organic waste as it breaks down).

Nitrous oxide

If you have horses or other livestock, pile a lot of horse manure up and let it rot. You will produce nitrous oxide (N_2O), the next most important GHG.

When farmers use chemical fertilizers that are nitrogen-based, nitrous oxide can be released as the fertilizer breaks down. Nitrous oxide is also stored in soil. When farmers turn the soil to prepare the land for crops, nitrous oxide is often released.

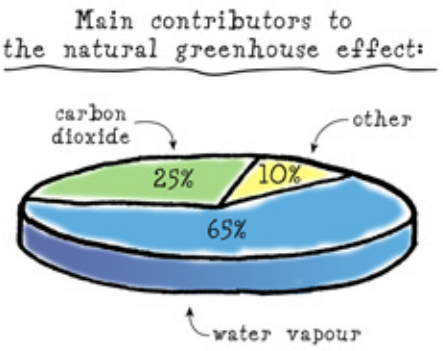
Nitrous oxide is also created when ammonia is being made by catalytic converters in automobiles.

The other bunch

Other GHGs, such as chlorofluorocarbons (CFCs) and hydrofluorocarbons (HFCs), do not make up as much of our atmosphere as the main four, but they still play a role.

Size Isn't Everything

As we've learned, GHGs are found naturally in the atmosphere. But GHGs make up a very tiny part of it. Water vapour can make up to 4% of the atmosphere in humid parts of the world. However, the other three GHGs all together still make up less than 0.1% of the atmosphere.



Although they are tiny in volume, these GHGs have a big influence on our climate. They help keep some of the sun's heat in so the earth doesn't turn into an icebox. However, because humans have been adding more GHGs

to the atmosphere, more heat is being trapped close to earth and our greenhouse is getting too hot for comfort.

Although water vapour is the biggest member of the GHG club, it isn't much of a concern. That's because water vapour only occurs naturally. The amount of water in the world is limited and cycles between the atmosphere, oceans, rivers and lakes. There is little we can do to change the amount of water vapour in the atmosphere.

On the other hand, carbon dioxide, methane and nitrous oxide are produced both naturally and by humans. These three GHGs have been in the atmosphere naturally pretty much since we have had an atmosphere.

But more recently, humans have been pumping a lot of these GHGs into the atmosphere by doing things like burning oil, gas and coal, farming on a large-scale, letting waste rot in dumps, and so on. These human produced GHGs are changing the natural balance of things. Although the climate has always changed, over the history of the earth, things are warming up this time because humans have been putting too many GHGs into the atmosphere.

Not All GHGs Are the Same

Although carbon dioxide, methane and nitrous oxide are all part of the GHG club, they are as different as squirrels, caribou and bears. To understand the differences, there are three main things to consider:

- How long do they stay in the atmosphere?
- How much heat can they trap?
- How did they get into the atmosphere?

Comparing the GHG club members

GHG	How long does it hang out in the atmosphere?	Global warming potential over 100 years (when compared to CO_2)	What percentage of climate change over the past century did it cause?	Where does it come from?
Carbon Dioxide (CO_2)	50–200 years	1	54.9	Burning of oil and gas (for heat, transportation, industry), cement manufacturing, deforestation and other land uses. Also occurs naturally through photosynthesis, volcanoes, forest fires.
Methane	12 years	23	18.0%	Oil and gas production, coal mining, rice paddies, dams, landfills. Occurs naturally as things decompose and from livestock digestion.
Nitrous Oxide	120 years	296	5.6%	Burning of oil, gas, coal, and wood, fertilizers, coal mining. Also occurs naturally.
Other GHGs	Varies	Varies	20.3%	Refrigerator coolants, industrial pollution.

According to the table "Comparing the GHG club members," methane has 23 times more "global warming potential" than carbon dioxide. What does that mean?!

Just as different types of blankets keep different amounts of heat in, different GHGs work differently. Some keep more heat in than others. And some last longer than others!

If you think of one bit of carbon dioxide as being one blanket, then one bit of methane would be equal to 23 blankets of the same type. Nitrous oxide would be one big stack of 296 blankets!

So when we're talking about GHGs we are putting into the atmosphere, we need to consider the warming potential of each GHG, not just how much we are pumping up, up and away.

Cycling Carbon

Carbon dioxide is an important GHG to focus on because there is so much of it in our atmosphere and humans put a lot of it there!

As you've read, there are a number of things that add carbon dioxide to the atmosphere naturally. There are also natural processes that take these gases out of the atmosphere. This adding and subtracting of carbon dioxide is what has helped to keep things in balance for thousands of years.

Sinks Are For Cleaning Up

Areas that absorb and hold onto lots carbon dioxide are called carbon "sinks". There are three main carbon sinks in the world:

Sink #1: Oceans

Mostly, the oceans take up carbon dioxide by absorbing and dissolving it into the water, the way that carbon dioxide is stored in a bottled soft drink! Much of this ends up in the deep ocean. Almost as much carbon dioxide is released again from the ocean surface into the atmosphere through bursting bubbles and other processes.

Like trees in the forest, little organisms floating in the world's oceans also use carbon dioxide to make their food (through photosynthesis). These organisms are called phytoplankton.

In recent decades, these processes have helped the oceans to absorb a bit more carbon than they released each year. So the oceans are currently socking away a lot of carbon.

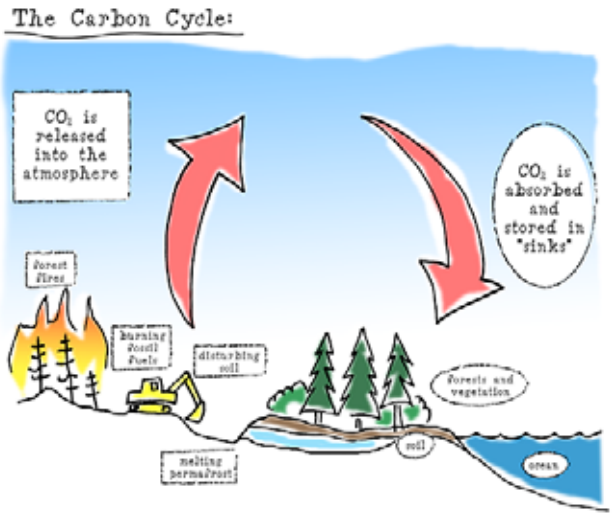
Sink #2: Soil

Dirt is more than just dirt. Pick up a handful and you will be holding billions of micro organisms and bacteria. These microscopic things nibble on plants and trees as the vegetation dies and break the plants and trees down into carbon and nutrients. This carbon is stored in the ground everywhere in the world, even in permafrost areas. But when we disturb the soil, we speed up the release of the stored carbon. Logging and farming are two large-scale ways we disturb the soil. Melting permafrost will also release carbon dioxide.

Sink #3: Forests and Vegetation

Plants and trees breathe in and absorb carbon dioxide as they turn the sun's energy into food through a process called photosynthesis. When trees and plants die or burn in fires, they release this absorbed carbon to the soil and to the atmosphere.

Plants also breathe out some carbon dioxide when they are living. On the whole, however, plants and trees absorb more carbon dioxide than they release to the atmosphere when they are growing. This means they help to take some of the extra carbon out of the atmosphere.



However, as the world warms up, more forest fires are predicted and this could release large amounts of carbon into the atmosphere.

A carbon "sink" can become a carbon "source". For example, a growing forest is a carbon sink as it absorbs more carbon than it releases. But when it burns, it becomes a carbon "source" as it releases lots of carbon into the atmosphere.

Not so permanent?

Permafrost – that layer of frozen ground that is found in most of the North – might not be so permanent in some areas.

The temperature of permafrost in much of the north is usually only a few degrees below zero. So if climate change warms up the north by 5° in the next 50–100 years, there is going to be a whole lot of melting going on!

This will cause a lot of changes. For example, our roads and buildings will shift as some of the layers of permafrost in the ground under them melt. Shorelines will become less solid as permafrost melts so ocean waves and river currents will erode more land by the water's edge.

Permafrost also keeps carbon dioxide and methane locked in the ground. Of all carbon stored in the soil around the world, about one third of it is frozen in the permafrost! This makes permafrost areas very important carbon reservoirs.

But when the permafrost starts to melt, more GHGs could be released into the atmosphere. and the world's greenhouse could warm up even more. This would cause still more permafrost to melt, and then even more GHGs could go into the atmosphere. This chain reaction is called positive feedback.

Where to From Here?

So we know that the atmosphere is like a big greenhouse that keeps the world's temperatures, on average, just right for humans, animals and plants. To keep that greenhouse working well, we need the right balance of greenhouse gases (GHGs) in the atmosphere.

However, humans have been adding a lot of GHGs to the atmosphere as we take oil and gas out of the ground and burn it for energy. We also put GHGs into the atmosphere when we disturb the soil, cut down trees, or pile-up our garbage.

This is having a lot of impact on our climate and causing temperatures to rise. To read more about the effects of climate change, look for the backgrounders in this series on

impacts. To see what you and others can do to help reduce GHGs in the atmosphere, check out the backgrounders on solutions to climate change.

Key Points

- Water vapour is the main Greenhouse Gas (GHG). It is produced naturally, as part of the world's water cycle.
- Carbon dioxide is the second most important GHG. It is produced naturally, and by humans. Methane and Nitrous Oxide are also important GHGs. They occur naturally and are produced by humans.
- Areas that absorb and hold onto lots of carbon are called "sinks". There are three main carbon sinks in the world: oceans; soil; and forests and vegetation.
- Permafrost stores a lot of carbon and methane. Some of these GHGs might be released when permafrost melts.

Want to Know More?

Check out these websites to learn more about greenhouse gases:

- **Energy Information Administration:** http://www.eia.doe.gov/oiaf/1605/ggccebro/chapter1.html – Good information on greenhouse gases, primarily in the U.S.
- **Environment Canada:** http://www.ec.gc.ca/pdb/ghg/gases_e.cfm – A basic overview of greenhouse gases with lots of links to more in-depth information.
- **U.S. Environmental Protection Agency:** http://yosemite.epa.gov/oar/globalwarming.nsf/content/emissions.html – Here you can get into as much detail about these gases as you want.
- **Your Planet Earth:** http://www.yourplanet.org/terms/details.php3?term=Greenhouse+Gases – Good overview, with links for more follow-up.

Impacts of Climate Change | High School Backgrounder 6

A Changing Land

When you look out the window, you expect that the land will look different depending on the time of year. Snow comes and goes. Plants grow and die. Fall colours flare and then fade. These are the natural seasonal changes we all notice.

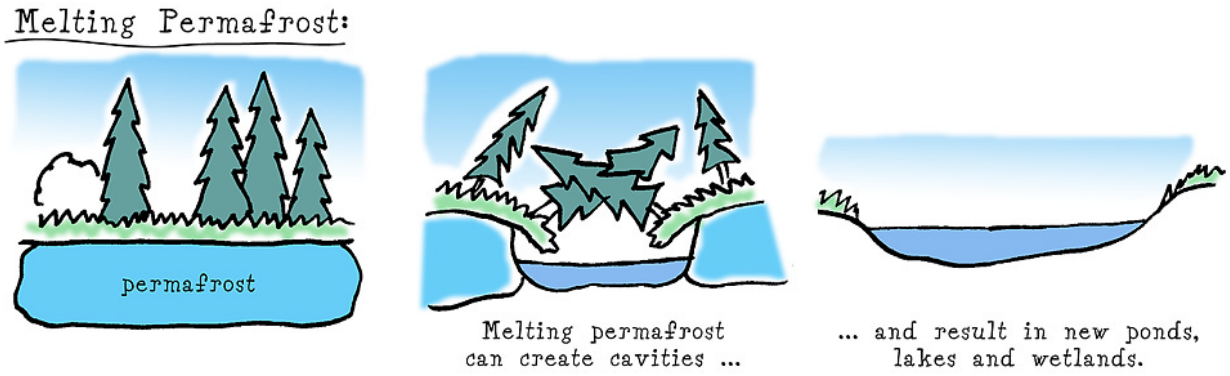
However, if you live in places like Resolute Bay, Nunavut or Paulatuk, NWT, you don't expect to open your curtains one morning and see a forest instead of the arctic tundra! But forests are slowly expanding north thanks to climate change. The shape of the land is also changing and shifting.

These changes are happening slowly and you might not notice them from day to day. Still, the land around us is changing! This backgrounder takes you on a tour of some of these changes.

Disappearing Act: Permafrost

Permafrost is a layer of permanently frozen ground that is under nearly half of Canada! It exists wherever ground temperatures remain below 0°C (on average) throughout the year. When it is above freezing the top layer – called the "active" layer – may melt. But it will freeze again in the colder temperatures.

By 2080, winter temperatures over the land areas in the Arctic could rise 2.5° to 14°C above current normal temperatures. Summer temperatures are expected to increase by 4° to 7.5°C above what we now usually get. So there's going to be a whole lot of melting of permafrost going on!



When ice-rich sections of frozen ground melt, underground cavities are created. Unfortunately, there isn't a permafrost dentist that can come and fill these cavities. So, as the ice melts and the water flows away, the ground above sinks and slumps into the cavities. Trees can topple and ponds can be created in these new low areas. This can have an impact on wildlife that live in the neighbourhood.

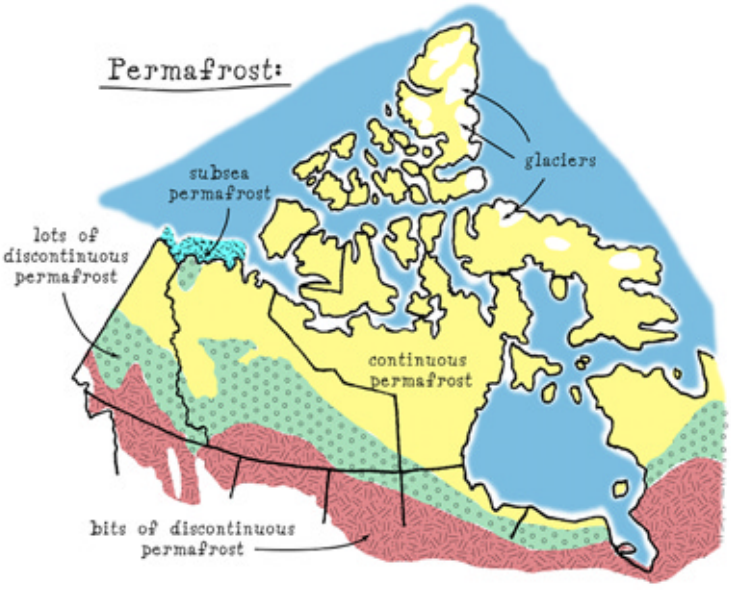
For example, in some areas near Fairbanks, Alaska, the permafrost has melted underneath forested areas. The trees have toppled and new low areas have filled with water. So now, instead of forests, these areas are mostly grasslands and wetlands. This change has attracted moose and ducks which like the new habitat, but the woodland caribou have moved away to forested areas because that is what they prefer. This means local people have had to change their hunting practices as the species around them have changed.

"Permafrost is melting. There are lots of slides, some really big ones especially along the highway. I bet it's blocking up some creeks. Someone got a video about that. Can't do anything about that. Affects the fish too."

—

Participant from Fort MacPherson, Arctic Borderlands Ecololgical Knowledge Co-op 7th annual Gathering, 2002.

People in the north have also seen more landslides because of melting permafrost. Like warmed icing on the side of a cake, the wet, melted slopes slide downwards. Sometimes melted riverbanks give way and fall into the water. This causes more dirt – more sediment – to go into streams and rivers. Increased sediment in the water can harm some types of fish as it makes it harder for them to breathe. Increased sediment can also bury spawning sites.



Withering Wetlands?

On the one hand, melting permafrost can create new wetlands (like the ones near Fairbanks) because new low areas are created that will fill with water. And some climate models project that the Arctic will get more rain and snow than it used to.

On the other hand, warmer temperatures caused by climate change could also mean some wetlands will dry up. This is because more water will evaporate as temperatures rise. In addition, if permafrost under the wetlands melts, water can quickly drain away. If the water level in some wetlands drops, the plants and wildlife that currently thrive in these wetland areas could have a hard time surviving.

"Models predict that land areas in the Arctic will receive substantially increased snowfall in winter and that the climate will be markedly warmer. Summer could be much warmer and wetter than present.... [S]mall rises in temperature will result in increased melting of snow and ice, with consequent impacts on the water cycle…. There will be more ponding of water in some areas, but peatlands may dry out because of increased evaporation and transpiration from plants."

—

Climate Change 2001: Impacts, Adaptation and Vulnerability, Intergovernmental Panel on Climate Change

Right now, wetlands cover about 14% of Canada. Most of these wetlands are found in the Prairies and southern NWT but there are also important ones in the northern Yukon. All of Canada's wetlands provide important homes to rare or threatened species. Huge numbers of birds hang out in the wetlands in the summers, having their babies and fattening up for winter.

A few years ago, the Gwitch'in people from Old Crow argued that the wetlands in their area were drying up. So government scientists looked at satellite images of these internationally significant wetlands taken in 1973 and 1999. The satellite images confirmed what the Gwitch'in were saying – the wetlands in the Old Crow Flats had lost about 6.8% of their surface area in the 26-year period.

Plants and Trees on the Move

When plants and trees start to move into new places, it is not like you can sit and watch them travel by your door. But trees might not be as slow as you think!

Do you currently spend time near the edge of the boreal forest? Some computer models predict that an expected increased temperature of just 0.2°C per decade could create growing conditions that would allow the boreal forest to move northward an average of 30 kilometres every ten years! If these computer models happen to be right, by the time you are ten years older, you should notice that the edge of the forest has moved further north!

However, other computer models look at more than just temperature and moisture levels when they try to predict what our forests will look like in the future. These other models also look at things like soil conditions and how plant and animal species migrate. These models say we can't really be sure how fast the forests will move north. But it is safe to say that the most of the species in the forests will move northward. How fast and how far they will move is up in the air.

As forest ecosystems move north, this means they will take up space that tundra ecosystems now occupy. This will affect the plants and animals that call the tundra home. Tundra plants and animals may get squeezed out by new forests and have to move even farther north.

The vegetation in northern Canada is already changing in some areas. Shrubs and vegetation that need more moisture have been seen farther north as the north has been getting more rain and snow. Willows are one example of a shrub that has been observed farther north than usual. Moose do well where willows and other shrubs grow so they are benefiting from this increase in shrubs. Berries have also been reported to be more plentiful after wetter weather, which is good news for the animals – including humans – that eat them!

A forest is more than trees!

It's important to remember that a forest is more than plants and trees. For example, a healthy forest needs little microbes – bacteria and fungi – to live in the soil because these microbes help turn dead plants into nutrients in the soil. These nutrients help the live plants and trees grow.

Some people think that the microbes in the soil will not be able to travel northwards quite as fast as the trees and shrubs. So, although the warmer weather will help new plants and trees survive farther and farther north, they need their microbe buddies to come along if they are going to make a healthy forest.

The boreal forest is also made up of many different tree and plant species. The seeds of some of these species are spread by the wind. The seeds of other plants and trees are spread by birds and animals. So even if the temperature and moisture levels improve over time in the north, the rate of spread of the different seeds will influence how far and fast the forest moves north.

The amount of water, the amount of nutrients in the soil, the frequency of fire and the number of insect outbreaks are also things that could affect how fast forests move northwards.

In other words, plants and trees will need more than just warmer weather before they can speed north. A forest is a connected network and all the parts in the network need to be able to make the trip. This is why some scientists don't think the forests will move very quickly towards the North Pole.

However, mosses and lichens, important foods for caribou, are declining as the climate changes and as other species move into their space! This is bad news for the caribou and, therefore, for people and other animals that eat caribou!

Plants and trees react mostly to two things – temperature and moisture. A banana tree can't survive outdoors in the north, as the temperature is too cold. A lodgepole pine tree can't survive near the equator, as the temperature is too hot! And plants that can live in a desert, can't survive in a wet coastal area.

In other words, every plant and tree needs a certain temperature range and amount of water to survive. As climate change is all about changes in temperatures and amounts of precipitation, it is bound to have an impact on our plants and trees.

If the temperature and moisture levels change quickly, plants have two options for survival: adapt or move. However, a plant can't just pull up its roots and move to a place with better conditions. If a species of plant or tree can't adapt quickly enough to changes in the climate, or migrate fast enough to a more suitable area, then it may die out. Competition for space from other, newer species can also cause problems for native plant or tree species.

Have you noticed any changes in the plants and trees in your area? Have you heard others tell stories of new plants or shrubs?

Too hot for comfort

The forests in the north are called boreal forests. They are made up mostly of spruce, pine and aspen trees. The boreal forests are drier than the temperate or coastal forests you would find in wetter regions in Canada.

Right now, forest fires in the boreal forests of Canada burn an average of 2.5 million hectares every year. Fire is a natural part of the life cycle in a boreal forest. It helps shape the landscape and provides a rich patchwork of young and old forests, each with different types of vegetation.

However, as climate change will result in warmer temperatures, forests will likely be drier than usual. With drier forests, we can expect to get bigger and more frequent forest fires.

Larger and more frequent fires will have a number of impacts. For one, if forests burn more frequently, it will mean that forests don't get a chance to get as old as they used to. This will impact birds and animals that are suited to living in old, mature forests because there will be fewer old forests around. For example, some birds only nest in holes in old, dead trees. They won't be able to find a place to nest in a young forest!

More fires will also cost more money to fight and threaten more communities.

More forest fires will also release more carbon dioxide (a greenhouse gas that causes climate change) into the atmosphere. Even though trees breathe in a lot of carbon dioxide when they are alive (through a process called photosynthesis), when they burn they release a lot of the carbon they absorbed (see Backgrounder 3).

The Intergovernmental Panel on Climate Change estimates that two-thirds of the world's boreal forests could disappear – from fires and insect damage – if we continue to put lots of greenhouse gases in the atmosphere.

So What Else is Happening in the North?

As the land changes, and the plants and trees come and go, the animals that live on the land will be affected. To get a better idea of what northern wildlife might be facing with climate change, read Backgrounder 8. Check out Backgrounder 8 for information on how the northern world of ice and water is being affected by climate change.

Key Points

- ★ As the climate warms up, a lot of the permafrost that is in the ground in the north will melt. This will cause trees to topple and new wetlands to be created.
- ★ Although the north is expected to get more rain and snow as the climate changes, some wetlands will dry up or get smaller as warmer temperatures will cause more water to evaporate, or permafrost under them to melt so they drain.
- ★ Plants, shrubs and trees will move northwards as the temperatures warm up and moisture levels change. However, the speed of movement will depend on a number of factors.
- ★ As forests move northwards, they will replace the tundra environment. This will affect plants and animals that now live on the tundra.
- ★ There will be larger and more frequent forest fires as the climate warms up.

Want to Know More?

Check out these sites to find out more about the impacts of climate change in the north and the rest of Canada:

- **Arctic Borderlands Ecological Knowledge Co-op:** www.taiga.net/coop/projects/plantcol.html – Do it yourself project! Start a community plant collection.
- **Climate Change in Canada Poster Site:** http://adaptation.nrcan.gc.ca/posters/ – Click on regional names under the Canadian map to bring up lots of information about climate change specific to Nunavut and Western Arctic (Yukon and NWT).
- **Climate Impacts Map** – http://www.climatehotmap.org/ – Click on the map in your region, and you'll link into a description of climate change indicators in that area.
- **Community Adaptation and Sustainable Livelihoods:** www.iisd.org/casl/projects/inuitobs.htm – Don't miss the video, *Sila Alangotok: Inuit Observations on Climate Change*. You can view a short version at this site, or get information on buying it.
- **Government of Canada Climate Change (Regional Impacts):** http://www.climatechange.gc.ca/english/affect/prov_territory/ – Click on northern sections of the map to see what the impacts are in NWT, Yukon and Nunavut.
- **NASA Earth Observatory:** http://earthobservatory.nasa.gov/Study/BorealMigration/boreal_migration4.html – All about boreal forest migration.
- **Plantwatch Canada:** www.devonian.ualberta.ca/pwatch – A plant-watching project for classes.
- **UNEP (Report on impacts in the Polar regions):** www.grida.no/climate/ipcc_tar/wg2/592.htm – An amazing collection of scientific information on climate change imparts in the Arctic and Antarctic.

Impacts of Climate Change High School Backgrounder 7

The Changing World of Water and Ice

Everyone needs water to survive. Humans, wildlife, birds, fish and plants all need water. Some live in the water, on the water or near the water. It keeps us all alive one way or another.

We also use water to travel on – sometimes when it is open, sometimes when it is frozen. Polar bears hunt on the sea ice. Seals and walruses raise their young on the ice and use it as place to rest. People in northern communities get to their camps, traplines and other towns by travelling across frozen rivers and lakes. Companies exploring for oil, gas or minerals use winter roads that cross frozen lakes, water channels and land.

This backgrounder looks at how climate change is affecting the world of water and ice.

Shrinking Sea Ice

When you think of the Arctic, what comes to mind?

Ice is likely one of the main things; solid ice, floating ice, icebergs, and then bears, seals and walruses on ice. These are all images of the Arctic. Most of the year, the ocean water in the Arctic is covered by ice. Even in the summer, many areas of the Arctic Ocean are ice-covered.

However, recent studies show that the sea ice in the Arctic is both shrinking and getting thinner and thinner than it used to by the end of summer. It's like a human losing weight and getting shorter at the same time. The ice in the Arctic is shrinking as the temperatures in the north increase.

Sea ice in the Arctic covers about 10–15% less area in the spring and summer than it did in the 1950s

The ice is now also estimated to be about 40% thinner in the late summer and early fall than it was in recent decades. That's quite the diet!

More open water means even more ice will melt

Have you ever watched a pond or lake melt? After the snow goes, the ice gets shiny. Then a dark spot appears where the ice is thin and the darker water can be seen underneath. Suddenly, the melting seems to speed up and the ice is soon gone!

The shinier, white ice reflects most of the sun's heat away. But where the darker coloured water shows through, the sun's heat is absorbed and the remaining ice above it melts. It's like when you wear darker clothes and stand in the sunshine. Darker colours make you warmer than you are when you wear light coloured clothes. The sun shining on the thinning ice works this way too.

Once the darker water starts absorbing the heat, the ice at the edges of the open water quickly melts away and the darker area gets bigger. This bigger area absorbs more heat, and then gets even bigger. The melting speeds up.

This melting pattern is likely happening on the Arctic Ocean. As climate change causes warmer temperatures, more ice will melt simply because the air is warmer. But the open water will also directly absorb the sun's heat and speed up the rate of melting of the sea ice around it.

So what's the big deal with less ice? Well, less ice means there is less ice on which humans and animals can travel, hunt or rest. Thinner ice also makes travelling on ice more dangerous *(see Backgrounders 10 & 11)*.

> "It used to be calmer out when the ice was around more; now we stay closer to shore when we go out."
>
> L. Carpenter, Sachs Harbour quoted in *Climate Change and Arctic Communities: Impacts and Adaptations in Sachs Harbour, Banks Island, NWT* (August 2000)

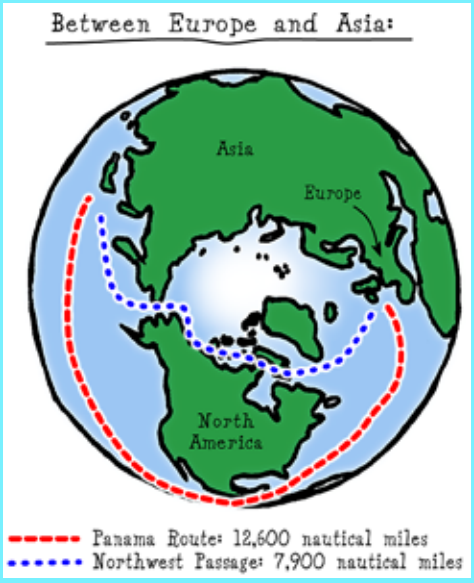
Cruising the Arctic Oceans

Some scientists predict that there might not be any Arctic sea ice in the Northwest Passage and other areas in the late summer months by the year 2050. This could mean that more ships will be able to travel around parts of the Arctic Ocean without any assistance from icebreakers (icebreakers are ships that are designed to clear a path through the ice).

Some people are excited by the economic development that this might create for northern communities along the coasts. It could reduce the cost of bringing in things like construction materials and food. It could make it easier to ship out natural resources like oil and gas or minerals. And more tourist ships will likely venture north into the open Arctic waters.

Canadians are not the only ones interested in new shipping opportunities! Other countries are also very interested in seeing the Canadian Arctic's Northwest Passage become a regular shipping route.

Currently, most ships carrying goods between Europe and Asia travel through the Panama Canal. This route is about 12,600 nautical miles long. If the same ships could go through the Northwest Passage, the trip would be only about 7,900 nautical miles. A shorter trip would save many businesses a lot of money!



Right now, the Canadian government considers the Northwest Passage to be in Canadian waters, but some countries are challenging this idea. The United States of America has even had a military vessel in these waters without the Canadian government's permission. Usually countries request permission to enter another country's waters.

continued on next page

Cruising the Arctic Oceans (continued)

However, shipping through this route might not be as safe as some people claim it will be. The long, dark days of winter will ensure that the Arctic will always have winter ice cover. So shorter trips for ships will only be possible in the months of late summer and early fall.

And even if the Northwest Passage does become free of ice most summers, there may still be cold summers where the ice won't clear completely. At anytime, there may also be chunks of super hard pack ice floating in from other parts of the Arctic Ocean.

These hard chunks of pack ice can easily knock holes in ships. If this were to happen, it could threaten the safety of people on board, result in the loss of a ship's cargo and cause pollution in the sensitive northern environment. Sending in rescue and clean-up crews to remote locations would be expensive and take time.

So even if it gets easier to take ships through the Northwest Passage, the risks might outweigh the cost savings. What do you think?

Sea Levels

Canada has over 240,000 kilometres of coastline. If you look at a map, it's easy to see that most of this coast line is in the north, along the shores of the mainland and the islands of Nunavut and the Northwest Territories.

Over the last 100 years, the sea levels in the world have risen by about 10–25 centimetres. These levels are projected to rise by up to 88 centimetres by 2100 (check that out on a ruler!).

There are two main reasons the sea is rising:

- More of the ice on land has been melting and draining into the ocean as climate change causes temperatures to increase.
- When things warm up, they expand. This is called "thermal expansion." Water in the ocean will do the same thing. If the water warms more than usual with climate change, it expands more than usual. This means sea levels will be higher than usual.

Even though less than one metre of sea level rise might not sound like a lot, it can cause a lot of damage. Can you think of some of the impacts that higher sea levels might have? Some of the key impacts are:

- More flooding in coastal areas. This can damage heritage resources and coastal ecosystems. It could also cause ground water to get salty.
- More erosion of the coastline. Higher sea levels mean that the waves will hit the shore higher than they used to so they can do more damage. This can destroy buildings and roads that are along the coast.
- More areas of land will be permanently covered by the ocean.

Earlier break-up changes derby date!

In the coastal town of Coral Harbour, Nunavut there used to be a local ice-fishing derby in mid-April. However, for three years in a row, participants kept getting their snow machines stuck in slush as they travelled out onto the ice in April. Spring was happening earlier in the year. So the derby is now held in March.

Can you think of any winter or spring events that have been cancelled or changed because of early or late break-up?

Rivers and Lakes

In 1960, the ice on the Mackenzie River in the NWT typically broke-up during the first week of June. Now it's more common to see it break-up in mid to late May. By 2050, it is predicted that the ice-free season on the Mackenzie could be up to a month longer than it is now!

The ice on most lakes and rivers in the north will break-up earlier than it used to because climate change is causing temperatures to rise.

It's also predicted that most of the Arctic will get 10–20% more precipitation (rain) in the summer months. Some extra snow will also fall in the winter but the amount will vary depending on where in the Arctic you are. So the pattern of rain and snowfall will be different in different areas in the north. Some parts of the Arctic may be wetter or drier than others.

You might think that the areas that get more rain and snow would end up having more water in the lakes and rivers. But that might not happen. Can you think why this might be?

It's because warmer temperatures will cause more water to turn into water vapour (to evaporate) and travel into the atmosphere. Also, because the ice is melting earlier and freezing later in the year, there will be more weeks in the year when the water in lakes and rivers isn't covered by ice. This means that water will have more time each year to evaporate. So more rain and snow doesn't necessarily mean more water in the rivers and lakes!

Warmer temperatures also cause more rapid melting in the spring. If things melt too quickly, there will be more flooding. This flooding will affect rivers and streams, and nearby communities.

What does snow cover have to do with ice thickness?

Did you know that the depth of the snow affects how thick the ice will get on a lake or river? Do you know why?

When the water in rivers and lakes is directly exposed to the freezing cold air, it freezes. However, once the snow starts landing on the new ice, the snow acts like a blanket and insulates the ice from the cold air. If it is blanketed by snow, the ice won't thicken as quickly. And the deeper the snow, the slower the new ice forms.

For example, in winter in the NWT, about 30–40 centimetres of snow piles up on the lakes close to the town of Inuvik. The average ice thickness on these lakes is about one metre. To the north of Inuvik, only 10–20 centimetres of snow piles up on the lakes near the Arctic coastline because the coastal winds keep blowing the snow inland. On these coastal lakes, the ice is twice as thick as the ones close to Inuvik that are covered by more snow!

So more snow means thinner ice! If the north is going to get more precipitation – more snow – in the winter because of climate change, this means the ice may be thinner that it used to be in the winter. This could create dangerous conditions for people and animals that travel across the ice.

If you'd like to set up your own project to measure the thickness of ice on lakes near you, check out http://www.taiga.net/coop/projects/lakeprotocol.html

Glaciers

Surprisingly, glaciers and ice caps in the Canadian Arctic are expected to change little as the climate changes. Although glaciers in the far north will likely melt more because of the warmer weather, the same glaciers will gain back what they lose! This is because more snow and rain is expected to fall at higher elevations. It will make up for what melts at other times of the year.

Alaskan glaciers add 13.2 trillion gallons of melted water to the seas each year – the equivalent of more than 13 million Olympic-sized swimming pools.

Kansas City Star, July 31, 2003

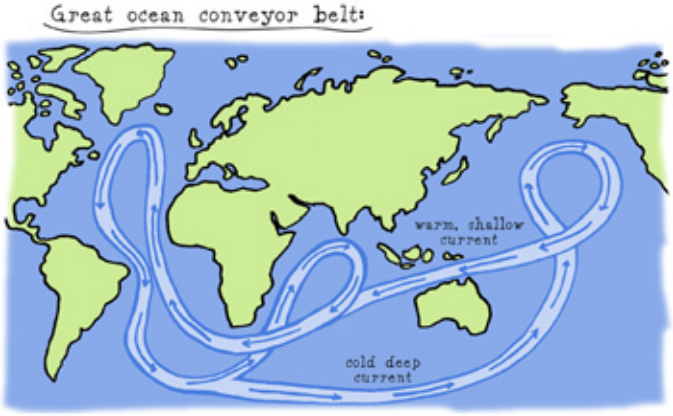
However, glaciers at lower elevations and glaciers farther south won't be so lucky. These glaciers are expected to lose more from melting than they will gain back from more snowfall. Southern and lower elevation glaciers are expected to start shrinking and retreating with climate change. Many glaciers are already getting smaller and more climate change is expected to speed up the pace of their retreat.

Freshwater Could Interrupt Ocean Currents

Water slowly moves around the world's oceans. The movement is driven by a system of ocean currents. Both wind and the rotation of the Earth help to determine the flow of surface currents. They also influence how water moves from the surface down to deeper waters.

The biggest force in the ocean is something people describe as an ocean conveyor belt. The fancy name for this movement of ocean water is the "thermohaline circulation."

This moving conveyor belt of water moves warm water from the tropics towards the north and south poles. When the warm water reaches cooler parts of the world, it cools down. The water sinks when it gets to the colder regions of the world because cold water sinks below warmer water. Warm water travels on top towards the poles, and lower, colder water, moves back towards the tropics. This is what creates the conveyor-belt-like action.



But climate change will likely slow down, and could turn off the conveyor belt. As more glaciers melt, and more rain and snowfalls, more fresh water than usual will enter the ocean. Fresh water floats on top of salt water. This fresh, cold water won't be able to sink through the salt water so it may block the movement of the conveyor belt.

If the conveyor belt stops or slows down, it would have a huge impact on ocean life. It would also change how much heat moved from tropical areas to northern areas. Some areas of the northern hemisphere could start cooling down instead of warming up.

What's This Mean for People and Critters of the World?

To find out more about how the changing world of water and ice will affect animals that live on or by the oceans, read Backgrounder 10. To find out how northern people and people around the world will be affected, check out Backgrounders 11 and 12.

Key Points

- ★ Sea ice in the Arctic is getting thinner and covers less area by late summer.
- ★ Sea levels are rising – which is affecting coastal areas.
- ★ Ice on rivers and lakes is breaking up earlier in the year, and freezing later in the fall.
- ★ Climate change should cause more rain and snow to fall in most areas of the Arctic. But warmer temperatures will also cause more evaporation, so the extra water might disappear into the atmosphere.
- ★ Southern glaciers and ones at lower elevations will likely get smaller because of the warmer temperatures. Glaciers at high elevations or in the far north should stay about the same size.

Want to Know More?

Check out these websites for more information on water, ice, and climate change:

- **Canadian Arctic Resources Committee:** http://www.indelta.com/cgi-bin2/carcpub.cgi?http://www.indelta.com/carc/whatsnew/writings/amitchell.html – *Globe and Mail* article on the impact to Canadian sovereignty if Northwest Passage becomes a trade route.
- **Community Adaptation and Sustainable Livelihoods:** www.iisd.org/casl/projects/inuitobs.htm – Don't miss the video, *Sila Alangotok: Inuit Observations on Climate Change*. You can view a short version at this site, or get information on buying it.
- **Greenpeace Archives:** http://archive.greenpeace.org/climate/arctic99/reports/seaice3.html – A comprehensive scientific article on what's happening to Arctic ice, and why.
- **Icewatch:** www.naturewatch.ca/english/icewatch – Information on the current state of ice.
- **Arctic Borderlands Ecological Knowledge Co-op:** www.taiga.net/coop/indics/water.html – Water levels in Old Crow Flats – how the levels have changed, and why.

Impacts on Northern Wildlife

We know that climate change means temperatures are getting warmer and we can likely expect more precipitation. As a result of climate change, permafrost is melting and sea ice is getting thinner. Rivers and lakes are freezing later in the year, and melting earlier in the spring. These are a few ways that our northern world is starting to change as the climate changes.

So what will this mean for our wild friends like caribou, moose and even the pesky mosquitoes? What will happen as their home environment starts to change? This backgrounder describes how climate change might affect northern wildlife.

How Are the Caribou Dealing with Climate Change?

An Inuit legend about the origin of the caribou

Once upon a time there were no caribou on the earth. But then there was a man who wished for caribou, and he cut a great hole deep into the ground, and up through this hole came caribou, many caribou. The caribou came pouring out, till the earth was almost covered with them. And when the man thought there were caribou enough for mankind, he closed up the hole again. Thus the caribou came up on earth.

Told by Kibkarjuk and recorded by Knud Rasmussen in "1930 Observations on the Intellectual culture of the Caribou Eskimos." Report of the Fifth Thule Expedition, 1921–1924, vol. VII, no 2, Copenhagen, Gyldendalske Boghandel.

In all three of Canada's northern territories, there are large herds of barren ground caribou. These herds are sometimes made up of 100,000 to 300,000 caribou!

Caribou herds travel great distances, season to season, from their wintering grounds to their calving grounds, and back again. Caribou travel to different areas because different places provide particular conditions that allow them to survive the season. If climate change affects the travelling conditions, it will affect the caribou.

For example, the calving grounds for the Porcupine Caribou Herd are located on the Arctic plain in northern Alaska. The Gwich'in people who are strongly connected to the Porcupine Herd believe the calving area in northern Alaska is sacred ground. Like clockwork, the Porcupine Caribou herd heads to this area in Alaska every spring from their wintering grounds in north and central Yukon, eastern Alaska or northwestern NWT.

However, as climate change warms things up and possibly causes more snow to fall, the snow may become deeper and heavier than normal. Have you tried walking through deep, wet snow? It's much harder than walking through dry, fluffy snow, isn't it?

So when the snow gets heavy and wet, it might be too difficult for some of the caribou to get to the Arctic plain in the spring. Caribou that can't make it all the way to the Arctic plain will have their babies away from their traditional calving grounds. These cows and calves will not have all the benefits of their normal calving grounds – the nutrient rich food and safety from wolves and bears. So fewer newborn caribou will survive.

Other northern herds like the Beverly Caribou Herd also travel great distances every year, sometimes as far as 2,000 kilometres one–way. The Beverly herd spends time in northern Saskatchewan, NWT and Nunavut. The Qamanirjuaq Caribou Herd also travels far and wide, from Nunavut and NWT down into northern Saskatchewan and Manitoba. These caribou herds need to travel great distances to find the different types of summer and winter habitats that they need to survive. Travelling through heavy, wet snow would make these journeys much harder.

Earlier break–up and thinner ice

Travel for the caribou is also getting harder because warmer temperatures in the spring are causing rivers and lakes to break–up earlier.

Inuit Elders in the Bathurst Inlet area in Nunavut have reported how warmer weather in the 1990s affected the Bathurst Caribou Herd. (A research project called the "Tuktu and Nogak Project" collected Inuit observations on this herd). The elders believed that the Bathurst caribou shifted their migration routes to avoid rivers full of rushing water and chunks of ice. The elders also noted that more caribou were drowning as the caribou fell through ice that was thinner than usual.

Its not just the caribou whose travel plans are interrupted

In 2000–2001, Vuntut Gwitchin residents of Old Crow, Yukon reported that, "We had only about two cold spells before Christmas. Because of the snow depth, it left the lakes and river with a lot of overflow, open water and hard to travel. There were a lot of problems with wet snow."

Arctic Borderland Ecological Knowledge Co-op, Report Series Number 2001–2.

Digging for food

The heavier and deeper snow that is expected to result from climate change may also make it harder for the caribou to dig through to get to their food (mostly lichen) that is buried under the snow. Another problem is that as temperatures warm with climate change, there will likely be more cycles of thawing and freezing of snow during the winter. This will create ice that the caribou will have to dig – and walk – through.

Depending on the snow conditions, caribou may have to spend more time digging for food than actually eating it. What do you think might happen to the caribou if they have to spend so much energy travelling and digging in the snow?

More bugs to avoid

As climate change causes temperatures to increase, mosquitoes and parasites will be able to survive farther north and higher up the mountains – in places where it used to be too cold for them to live. Caribou hate mosquitoes and will go out of their way to seek windy areas because the wind keeps the mosquitoes away. If there are more of these little pests around, the caribou will likely spend even more energy trying to get away from them. If the caribou spend more time avoiding mosquitoes, and less time eating, their health will be affected.

Some good news! Plants grow sooner

Climate change may also have some benefits for the caribou. People have noticed that the snow is melting earlier in the spring than it used to. This means that vegetation can start growing earlier in the year.

Elders in Nunavut have noticed that the Bathurst caribou have changed their migration in order to move to areas that are greener and lush earlier in the year.

Scientists in Alaska have looked at satellite images of the calving grounds of the Porcupine Caribou Herd that were taken between 1983 and 1996. These images clearly showed that things had started to get greener earlier in the spring as the years passed. Studies have shown that more calves are surviving in this herd and researchers believe it is likely because the nutrient–rich food is available earlier in the year. The new growth in the plants provides the energy the new caribou moms need to produce their milk.

Although more calves in the Porcupine Caribou Herd are surviving, more of the caribou cows are dying. Starting in 1989, the herd started to decrease in size. Since that same time, the weather has also been getting warmer. During this time period, the temperature has been above zero about twice as often as it used to be. This has made travelling conditions much harder for the caribou and it is likely why more cows are dying.

If caribou are affected, so are many communities

Communities in the range of all of these caribou herds depend on the migrating caribou for food. Caribou have been central to the culture and life of many northern aboriginal people for thousands of years.

If the caribou change their migration routes or decrease in numbers, this will have a serious impact on people in many northern communities. For example, caribou meat is a healthy – and inexpensive – source of food. If hunting caribou becomes too difficult, this will affect the health of northern people who currently eat a lot of caribou. It will also change a long tradition of how people live on the land.

Meandering Moose?

Moose usually live in the boreal forest, eating willows and other shrubs. Moose are not usually considered an "arctic" species because they prefer the cover of forests and brush to the open tundra.

However, lately, people are seeing moose more and more along the North Slope and Arctic coast in the northern Yukon. Moose have also been seen traveling out to the Beaufort Sea in the summer. This is not where you would expect to find moose!

Moose were counted in the Northern Richardson Mountains (along the border of the Yukon and NWT) and the nearby coastal plain in March 1989 and again in March 2000. Over this time period, moose numbers in this area increased by 67%!

There might be more moose in this area because their usual predators – wolves – continue to focus on eating caribou and the other animals that the wolves are used to. These northern wolves may not have added moose to their menu – yet! So, without anyone eating moose for dinner, the moose population can increase. That would change if local wolves added moose to their menu plans!

However, moose could also be increasing in numbers in part because of climate change. Elders in Aklavik, NWT have reported that there are more willows – which the moose eat – than there used to be on the Yukon's North Slope. The increase in willows is partly caused by warmer temperatures caused by climate change. As the willows move north with warmer temperatures, the moose may also be following their food north.

Other Northward Bound Animals

Other animal species are also moving farther north, possibly because of the warming climate. In some areas of the Yukon and NWT, whitetail deer, coyotes and cougars are already being observed farther north than usual.

One reason these animals might be moving north is because the plants that some of them eat are also moving north as the weather gets warmer *(see Backgrounder 6)*. And when the animals that eat the plants – the herbivores like moose and deer – move north, then the animals that eat the herbivores – predators such as cougars and coyotes – will also follow their food north!

Climate Change and the Little Critters

Did you ever wonder where all the small animals like ground squirrels and mice live in the winter? Many make their winter homes under a blanket of snow.

The small mammals can breathe under the snow because air can travel through dry and fluffy snow. But if the weather is warm and the snow becomes layered with ice, then the carbon dioxide that the animals breathe out (and the carbon dioxide the soil slowly releases) could start to suffocate these little creatures. If this happens the small mammals would have to travel to the top of the snow to get some fresh air. Above snow, the predators or freezing temperatures can get them.

But Arctic ground squirrels could also benefit if we get deeper snow – without the icy layers. Studies in the Yukon have shown that when the snow is deeper in the winter, ground squirrels successfully raise more babies.

This Should Bug You!

Insects that hang out in southern Canada will also start moving north as the weather warms. And the northern pests that already live here will likely be able to move further up the mountains and into more northerly (areas where it used to be too cold for them to survive). So warmer weather will mean a buggier north!

New parasites will also likely travel north. Some of these might travel in on the backs of other species that are heading north: animals like the whitetail deer. And species of parasites that already survive in the north can be expected to increase in number as the climate gets warmer. Parasites live off of many types of wildlife and can seriously affect the health of animals like caribou and moose. So getting more parasites could harm our wildlife.

Insects and parasites can also affect plants and trees. Around Kluane National Park in western Yukon, spruce bark beetles have killed large areas of mature white spruce forest. A number of mild winters and springs provided good breeding conditions for the beetles and allowed them to survive the winters and multiply rapidly. Over 200,000 hectares of forest were affected by these beetles between 1994 and 1999.

> Traveling back to Whitehorse from Vancouver one year and I came upon a bull moose lying on the road.... It was full of bugs. Later I saw the moose walk around it had no hair on it. It was eaten up. Where do the bugs come from?... It isn't only the moose that has it, its caribou, sheep and lynx too.
>
> *Johnny Smith, Elder's Panel during climate change workshop at the Council of Yukon First Nations, February 2003.*

So, Is It Good or Bad News?

As you can see, climate change will cause both some positive and some negative impacts. Moose might like having more food to munch on but might not be so keen about having more parasites to deal with. Caribou will have more trouble traveling in the snow, but earlier springs will mean good food arrives earlier too!

Northern people and other researchers are still trying to figure out exactly just what will change, how quickly the changes will occur, and how easily plants and animals will be able to adapt.

To understand how a changing climate is changing the land on which the wildlife discussed in this backgrounder rely, read Backgrounder 6. To read more about climate change impacts on other animals, like polar bears, seals, walruses and other ocean–based animals, check out Backgrounder 10. For information on fish and birds, see Backgrounder 9.

Key Points

- Barren ground caribou in northern Canada travel great distances every year. However, travelling conditions for the caribou are becoming harder with climate change because the snow is getting deeper and heavier. Ice on lakes and rivers is also thinner and breaking up earlier in the year which is dangerous for the caribou.
- Climate change also means there will be more insects to harass caribou. On the good side, plants that caribou eat are growing earlier in the spring.
- Moose and other animals like coyotes, white-tailed deer and cougars are being seen farther north.
- Smaller mammals may find it difficult to live under the snow if climate change makes the snow icier than usual.
- Insects and parasites are expected to increase in numbers with warmer weather.

Want to Know More?

Here are some websites to help you find out more about the impacts of climate change on northern wildlife:

- **Being Caribou Homepage:** http://www.beingcaribou.com/ – Two Canadians follow the Porcupine Caribou from Old Crow. Follow them on their journey.
- **Defenders of Wildlife:** http://www.defenders.org/wildlife/arctic/oildevelopment.html – Links oil development in the north with increased global warming, and increased problems for Arctic wildlife.
- **Greenpeace Archives:** http://archive.greenpeace.org/climate/arctic99/reports/seaice3.html – A comprehensive scientific article on what's happening to Arctic ice, and its effects on Arctic wildlife.
- **Greenpeace USA (Climate Chaos):** http://www.greenpeaceusa.org/climate/speciestext.htm – Good overview of the effects of climate change on wildlife. Click on the bottom links to read more about caribou and salmon.
- **Taiga Net: Caribou:** http://www.taiga.net/top/caribou.html – A page of great caribou links, including a slide show and a population model.
- **West Kitikmeot Slave Study:** http://www.wkss.nt.ca/HTML/08_ProjectsReports/08_index.htm – Click on the two Caribou topics to read about what traditional elders say about the caribou and changing habitat.

Impacts on Fish and Fowl

All creatures, great and small, are impacted by climate change. This backgrounder highlights how the changing climate is impacting some creatures that live in water – fish, and some that live on it – ducks.

Fried Fish Anyone?

Some fish live in the salty water of our oceans and some hang out in the freshwater of our lakes and rivers. For example, trout only live in fresh water but salmon live mostly in the ocean, until they travel into fresh water to spawn. Different species can survive in each type of water.

Different species also live in different temperatures of water. For example, some species, like Arctic Char, are better adapted to living in cold water than other fish are.

However, it is cold-water fish like the Arctic Char that might have the hardest time with climate change. This is because as the climate warms, the waters the fish live in will warm also. Cold-water fish will need to find colder waters or adapt to the warmer waters. If the char and other cold-water species move on to colder waters somewhere else, how do you think this might affect the people and animals that usually eat them?

A warmer climate also poses problems for salmon as they move upriver to spawn. Salmon stop eating and rely on stored fat when they enter fresh water for the swim upstream. Salmon are cold-blooded – their metabolism is tied to the temperature of the surrounding water. If the water is too warm, salmon use up their energy stores and are unable to reach their spawning grounds. Warmer waters also increase the risk of bacterial and fungal infections in salmon.

Excerpted from "Salmon in Hot Water," a poster by Natural Resources Canada

Fish that survive in warmer water may actually benefit from climate change. For every 1°C increase in water temperatures, warmer water fish species are expected to move up to 150 kilometres north into waters that are too cold for them right now.

There are a few other ways that climate change might affect fish:

- Some parasites that live on fish may survive and reproduce faster in warmer water. In 1999, Chinook salmon in the Yukon River were found to be carrying a parasite (*Ichthyophonus hoferi)* that had never been seen in northern wild salmon before. More parasites could threaten the health of some fish
- Warmer weather will cause more water to evaporate. More evaporation could lower water levels in lakes and rivers. If this happens, salmon may not have enough water in the rivers and creeks to get to where they need to go to spawn. Streams and creeks that get their water from melting glaciers shouldn't have a problem with water levels because glaciers will melt even more with climate change and keep the streams full…unless of course the glacier completely melts! If this happens, then there may be no more water for these streams.
- Warmer water in spawning streams could also affect the hatching of fish-eggs because there is less oxygen in warm water.
- Warming temperatures are causing permafrost to melt. This melting permafrost is already causing more landslides and erosion along riverbanks *(see Backgrounder 6)*. This causes more dirt – also called sediment – to fall into the water. This dirt can cover up the gravel areas in which some fish need to spawn. More sediment in the rivers can also make it more difficult for fish to breathe.

"At the mouth of Prince River [in Nunavut] there used to be a lot of fish and you used to be able to get char. There's been a lot less fish because there's not as much water anymore. And we used to be able to get a lot of fish all the time at Qikiqtaujaq and all the other places where you can get fish. The fish were more plentiful and they used to be bigger. Now you hardly get char anymore at Prince River or any of these fishing places because the water level has gone down."

L. Arngaa'naaq, Baker Lake. Quoted in "These Things are Really Happening: Inuit Perspectives on the Evidence and Impacts of Climate Change in Nunavut" by Shari Fox. The Earth is Faster Now: Indigenous Observations of Arctic Environmental Change, *edited by Igor Krupnik and Dyanna Jolly, 2002.*

Lucky – or Unlucky – Ducks?

Climate change seems to create both winners and losers in the world of birds. Climate change is allowing some bird species to expand their range further north. On the other hand, climate change is making it harder for other birds to survive in places they usually hang out.

As regions of the Arctic warm, some birds that used to be rare in the far north are now being seen more often. For example, an increase in both Shoveler and Ring-necked ducks has been recorded in the Old Crow Flats in northern Yukon over the past 20 years. Ring-necked ducks had never even been seen in this area before 1983.

The presence of new duck species farther north is likely a sign that the habitat has become more suitable for warmer weather ducks. It is also possible that destruction of habitat in areas farther south has caused ducks to move north in search of suitable habitat. As temperatures continue to increase, summers will be longer than they used to be, so more vegetation will be around for more weeks of the year. This means more food for young birds so that more will survive and be ready for the long flight south in the fall.

Longer summers also mean there is more time to nest and raise babies before the ducks have to fly south again. Perhaps it's not surprising that more duck species would move north to take advantage of this warming trend.

In the Eastern Arctic, temperatures are currently cooler than they used to be. This is part of natural variations that happen in the Arctic's climate. These shorter-term cooling periods are also having an impact on local birds. For example, some researchers believe that snow geese that used to nest in areas like southwest Baffin Island or Southampton Island are spending more time farther south because it is currently too cold in their old stomping grounds.

So these snow geese are setting up their nests and having their babies in the western Hudson Bay coastal flats north of Churchill, Manitoba. Because there are so many more birds spending time in this part of Hudson Bay, the plants in the area are becoming overgrazed. The fragile arctic ecosystem in the area is having a hard time supporting all the birds that are flocking to it!

In the area around Sanikiluaq (an island of Nunavut that is found in the eastern part of Hudson Bay), recent cooling trends have also meant there is more ice on the water. People on this island have noticed that the Eider ducks, which depend on open water for food and warmth, have been suffering.

This cooling trend in the eastern Arctic will change. Like most of the world, over time this region should experience an increase in the average temperature because of climate change.

What About the Other Critters?

To learn more about other animals that live in or by the waters of the ocean, check out Backgrounder 10. You can also read more about the animals that live on the land in Backgrounder 8.

Strange birds

"There were some strange birds that have never been seen before. A flock of I don't know what kind of birds, they'd never been seen before. They captured a turkey vulture this fall, I don't know what it's doing here!"

Participant from Fort MacPherson, NWT at the 7th Annual Gathering of the Arctic Borderlands Ecological Knowledge Co-op (2002).

Key Points

- As climate change warms northern waters, warm water species will benefit and likely expand their range north. However, cold-water species might have a harder time surviving.
- Warmer temperatures should lead to more evaporation from lakes and rivers. This could have a negative impact on fish that need enough water to travel to their spawning areas.
- In the Eastern Arctic, weather has been cooling and some birds, like snow geese, are nesting further south than they used to. However, this region is also likely to begin to warm in the coming decades.
- Warmer weather in parts of the Arctic is resulting in new duck species being seen in the North.

Want to Know More?

Check out these websites for more about what's happening to fish and fowl in the Arctic:

- **Arctic Borderlands Ecological Knowledge Co-op:** www.taiga.net/coop/indics/ocduck.html – Information about changing duck populations the Old Crow flats.
- **CBC News:** http://www.cbc.ca/stories/2002/08/06/char_020806 – This article – "Landlocked Char Suggest Climate Change – explains what's happening to the char and why."
- **Community Adaptation and Sustainable Livelihoods:** www.iisd.org/casl/projects/inuitobs.htm – Don't miss the video, *Sila Alangotok: Inuit Observations on Climate Change*. You can view a short version at this site, or get information on buying it.
- **Taiga Net (Climate Change and Fish Habitat):** http://www.taiga.net/reports/dfo1.html – A discussion of the possible effects of climate change on northern aquatic habitats in the Upper Yukon River Basin.
- **Book**: Krupnik, Igor and Jolly, Dyanna (eds). 2002. *The Earth is Faster Now: Indigenous Observations of Arctic Environmental Change*. Fairbanks, Alaska: Arctic Research Consortium of the United States.

Impacts on Northern Marine Life

As our planet warms up, there will be many changes in our northern environments, including ocean (marine) environments. For example, the oceans are getting warmer and the sea ice is getting thinner.

These changes are already having some significant impacts on animals that live in or by the oceans. This backgrounder describes how the lives of these animals are being affected.

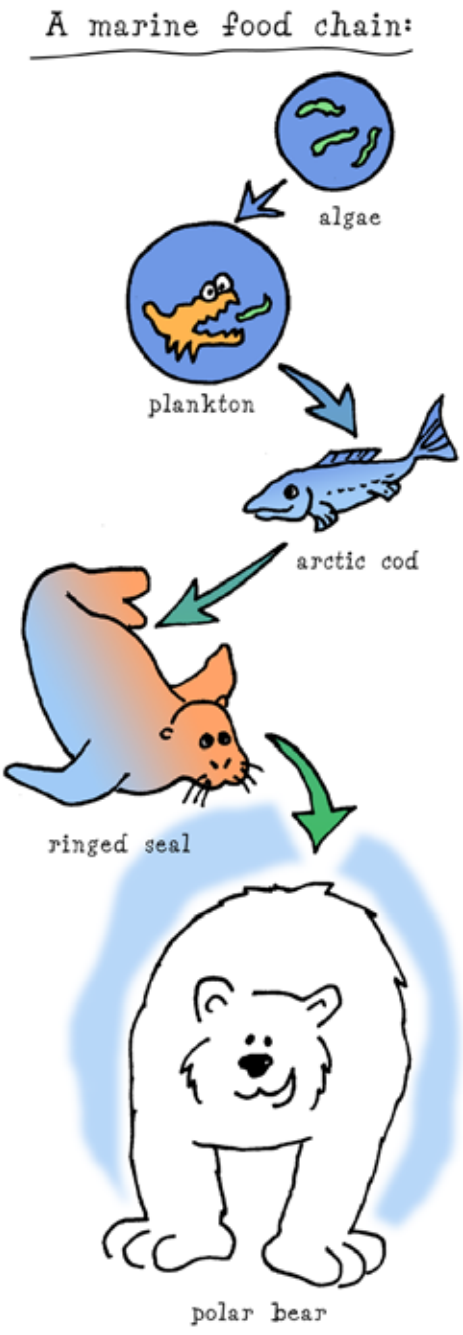
The Marine Food Chain

In the Arctic Ocean, tiny plants called algae grow under the sea ice. The algae are food for small floating organisms called plankton. The plankton, in their turn, are food for Arctic codfish. Ringed seals like to eat cod, and polar bears chow down on ringed seals. This set of links – between eaters and eaten – is called a food chain.

In warmer parts of the world, food chains are usually much more complex as there are more plants and animals to make links in the chain. But the Arctic food chain is short and simple.

Because there are fewer links in the Arctic food chain, any changes to one link in the chain can have a serious impact on the rest of the chain.

In this example, the polar bears are at the top of the chain. So if there were less plankton, then there would be less food for the cod and their numbers would decrease. Then the seals would suffer. And if seal numbers went down, the polar bear would start to get pretty hungry. So the polar bears' survival is dependent on every other link in the food chain staying strong.



A strong food chain also needs the connections between the links to be strong. For example, if there were a lot of seals hanging out on the sea ice, but the polar bears couldn't get out to the sea ice, then the chain would be weak. There would be no direct connection between the seals and the polar bears. It would be like having your dinner waiting for you on the table but not being able to get to it because you are locked out of the house!

In a way, this is what is happening to polar bears in the Hudson Bay area. There are a lot of seals in Hudson's Bay for these polar bears to eat, but the bears are having a harder time getting to where the seals hang out in order to chow down!

Read on to see what is making it hard for these polar bears to get to their dinner table.

Polar Bears on a Diet

Polar bears are well suited to living on snow and ice. For instance, a polar bear's very large paws spread out like natural snowshoes and distribute the bear's weight over a large area. These big feet allow polar bears to walk on ice that a person might fall through. Polar bears are also white like the snow and ice, which makes it harder for their prey – mainly ringed seals – to see them coming.

In other words, polar bears are adapted to a specific climate. If the climate changes, they either have to adapt, or move to other places where the climate fits their physical nature.

Polar bears live in many northern countries around the world. The ones that live near Churchill, Manitoba, in the Western Hudson Bay area, are at the southern edge of where polar bears are found in the world.

The Hudson Bay Polar Bear

Ian Stirling, a wildlife biologist from the University of Alberta, has been studying polar bears in the Hudson Bay area for almost 30 years. His studies help us to understand how these large bears might be affected by climate change.

In the Hudson Bay area, polar bears are at their lowest weight in March. The bears start packing on the weight in April by eating young seal pups that are born out on the sea ice.

The seal pups are 50% fat when they are just six weeks old so they are a huge source of energy for hungry polar bears!

The bears keep eating the seal pups until the annual sea ice breaks up in the early summer. The bears hunt the seals when the seals are in the birth lairs (their dens) in the ice, at the holes in the ice where the seals come up to breathe, or when the seals are lying out on the sea ice.

But something has been changing and these polar bears are not able to get as fat as they used to in the spring. Since 1981, the weight of the Hudson Bay polar bears has been decreasing. Studies show that these polar bears are about 90 kilograms lighter than they were 15 years ago.

Seal populations have not really changed during this time. So there are still lots of seal pups for the bears to munch on.

The likely reason for the decrease in the polar bears' weight is that they can't get to the seal pups. Polar bears need to be able to travel on the sea ice in the spring because that is where the fat little seal pups are found. But records show that the sea ice in the Hudson Bay area has been breaking up earlier and earlier in the year. This means that the bears can't get to their dinner table for as many weeks as they used to. Their mealtime is being cut short by the early break-up of the ice and the bears aren't getting as much hunting time to fatten up.

After the ice melts, and the bears can't get to the seals, these Hudson Bay polar bears travel inland and basically do not eat. They hang out, trying not to overheat in the warmer summer weather. The fat the bears pack on from feasting on the seal pups helps them get through this time.

Although the Hudson Bay polar bears are losing weight because of the earlier break-up of the ice, researchers have not noticed a significant decrease in the actual number of polar bears in this area since 1981.

However, Ian Stirling believes the condition of these bears will continue to go downhill if climate change continues to make the ice melt earlier every year. He doesn't think the

bears will be able to survive if that happens. He worries that this population of polar bears he has studied for so long may not be around the Hudson Bay area in 30–50 years.

And as this population of polar bears gets hungrier, they might increase their trips into nearby camps and towns in search of food. No one likes to have a hungry polar bear barging into their tent or wandering the streets of their town!

Not all polar bears stop eating during the summer months like the Hudson Bay polar bear. But polar bears everywhere in the north spend most of their hunting time on the ice. As global temperatures increase, this will mean less and less ice. What people are now seeing with the Hudson Bay polar bear could also happen to other polar bear populations in the north.

Limited accommodation?

Female polar bears used to den in snow banks near Coral Harbour on Southhampton Island in Nunavut. However, people who live in Coral Harbour have noticed that permanent ice and snow on the hills to the east of town have gone. The bears don't use this area any more as there is not enough permanent snow to make their dens.

In the north Yukon, 75% of Yukon polar bears make their dens on drifting pack ice. Sometimes these dens are found up to 550 kilometres offshore. Thinning and smaller pack ice could reduce the number of places they have to make their dens.

It is expected that warmer winters will mean heavier snowfalls in some northern areas. Too much snow (or even rain) in the late winter could cause polar bear dens across the north to collapse. This could trap mothers and cubs that might be hibernating at that time.

Other Life in the Sea

Seals

- Thinning sea ice will likely have a negative impact on seal populations as seals mate and have their babies on the sea ice. They also use the ice as a place to rest and a platform to hunt from. As the ice thins, there will be less ice surface for the seals to use.
- Seals make their lairs (their dens) in the sea ice along the coast (which is also called land-fast ice). After they are born, the seal pups nurse for about six weeks. However, this important nursing period could be shortened when the land-fast ice breaks up earlier in the year. If the seal pups don't get to nurse for as many weeks as they used to, this will lower their chance of survival.

Walruses

- Walruses can weigh up to two tons each! As the sea ice thins, some areas may not be able to support the weight of the walruses, especially when they hang out in a group. This means the walruses will lose important habitat because they need ice to rest on and have their young.
- Walruses feed mostly on mollusks (clams and mussels) and other spineless creatures (invertebrates) that live on the sea floor. Warmer weather will cause the sea ice to melt and retreat farther from land so the edge of the ice will end up being over deeper water. This means nursing mothers and their young will have to swim farther to reach their food.

Other marine animals

- Less ice could benefit beluga and bowhead whales. Their populations should stay the same or even possibly increase. This is because the whales should have more open water to move around in which means they should have more access to food.
- Some large breeding colonies of sea birds like the Common Murre and Northern Gannets in Newfoundland will be threatened by rising sea levels. Increased storms could destroy nests, chicks and eggs.

No One Knows for Sure, But You Can Find Out More!

This backgrounder highlights some of the impacts that climate change might have on animals that live on or by the ocean. A lot is still unknown and uncertain. Many people continue to study and observe animals across the north to see how they are being affected by climate change.

You can read about the impacts to animals that live on land – like caribou, moose or even ground squirrels – in Backgrounder 8. To read about those that have scales or feathers (fish or ducks), check out Backgrounder 9. To learn more about how the world of water and ice is changing, look for Backgrounder 7.

Key Points

- The food chain in the Arctic is short. Each link in the chain is important and the connections between the links need to be strong.
- Polar bears in the Hudson Bay area are losing weight as they have fewer weeks in the spring to fatten up on seal pups. This is because the sea ice is breaking up earlier in the year.
- Thinning and shrinking sea ice is affecting seals and walruses.
- Some ocean species like whales may benefit from climate change, as there will be more open water so they can move about more and have access to more food.

Want to Know More?

Here are some websites to take you further in your research on the impact of climate change on marine wildlife in the north:

- **CBC TV (The Shrinking Polar Bears):** http://www.tv.cbc.ca/national/pgminfo/warming/bears.html – Documents the effects of climate change on the polar bears of Churchill, Manitoba.
- **Polar Bears & Ice Backgrounder**: Refer to Student Handout 3 in lesson plan Polar Bears and Ice in this resource for more information on polar bears and shrinking arctic ice.
- **Climate Change Connection:** http://www.climatechangeconnection.org/pages/wildlife.html#closetohome – Check this Manitoba-based website for a list of linked articles about the effects of climate change on wildlife in the Arctic and around the world.
- **Defenders of Wildlife:** http://www.defenders.org/wildlife/new/threatspb.html – Learn more about threats to the polar bear.
- **Polar Bear Tracker:** http://www.panda.org/polarbears/ – Track Lena and Yana, two polar bears, as they journey through the Arctic. Be sure to click on 'Polar Bears at Risk' (top bar) and 'Impact of climate change' (right section) for more background information.

Impacts of Climate Change — High School Backgrounder 11

Northern Community Impacts and Adaptations

So climate change is causing the world to warm up. "What's the big deal?" you might ask. "How is it going to affect me?"

No one is *exactly* sure how you and your community will be affected because no one knows *exactly* how things will change. But we do know things on the ground have changed during the past few decades. And people's lives are already being affected.

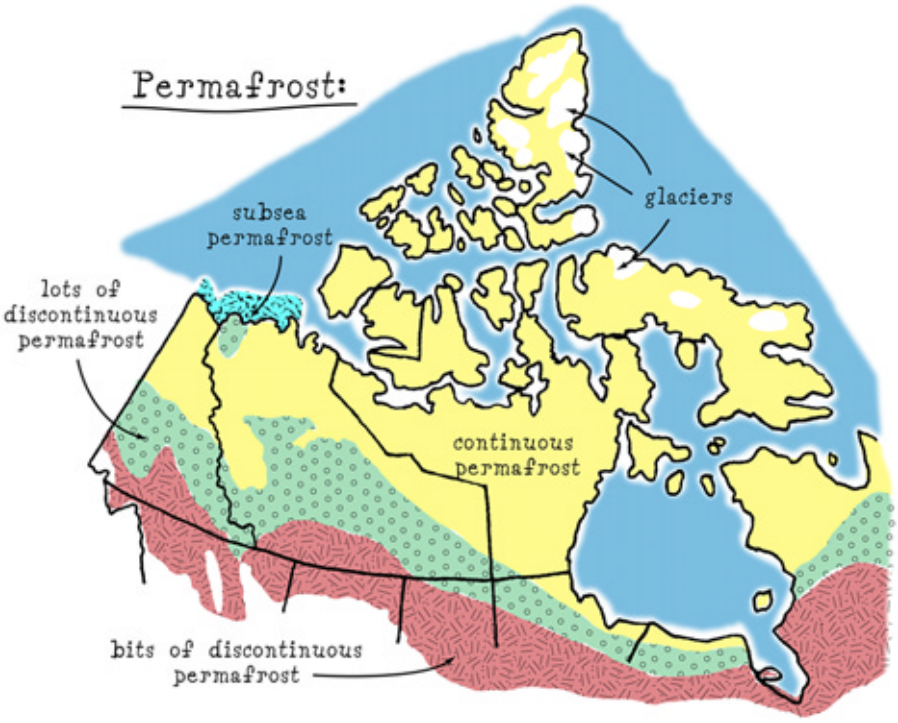
Folks are getting a pretty good idea of what the future might bring based on the changes that are happening now and based on the information that is being collected across the north and around the world.

Read on to see how the expected impacts of climate change might affect you, your friends and community.

An Underlying Problem

When many northerners go for a walk or drive, they are cruising over permafrost. This permanently frozen layer of ice in the ground lies under most of Nunavut, Northwest Territories and Yukon. Even where there isn't solid permafrost, there are often patches of what's called "discontinuous permafrost."

As global temperatures increase, some of this frozen ground will start to melt... and things will become topsy-turvy. Roads and airstrips can turn into mini roller coasters. Buildings, water lines, and power poles can all get bent out of shape. It can cost a lot of money to try and straighten things out again.



Over 50% of Canada's land is underlain by permafrost. To stay frozen it needs to maintain a temperature below 0° Celsius all year long.

A lot of Canada's permafrost has an average temperature that is between 0°C and –2°C. By 2080, winter temperatures over the land areas in the Arctic could rise 2.5° to 14°C above current normal temperatures. Summer temperatures are expected to increase by 4°to 7.5°C above what we now usually get. So a lot of permafrost will likely melt.

The speed of change

Hunters, trappers, fishers and berry gatherers use generations of knowledge to survive on the land. For example, this knowledge helps them know where the animals and berries can usually be found. People on the land have learned when to expect rivers and lakes to freeze. They know what kind of weather to prepare for at different times of the year. People understand the connections between all the parts of the environment and the weather.

However, people on the land today are finding it difficult to predict conditions on the land or sea ice or where animals will be. Thinner ice, heavier snow, and melting permafrost are also making travel on the land more difficult and dangerous. New wildlife species are appearing and old ones are changing their behaviour. Salmon are being caught in areas they have never been seen before. Ice is thawing completely in ocean bays, making it difficult for hunters to hunt seals. Caribou are changing their migration routes to deal with different ice or snow conditions and some communities have empty freezers when they should be full of caribou meat.

Although change is normal year to year, the speed of change caused by a warming climate is making it difficult for wildlife and people to adapt. Life on the land is becoming more challenging and uncertain.

"The weather never change that much years ago… it is always cold. Not like today. You can't even tell when the weather is going to change. Years ago we know when the weather is going to change – mild weather it is going to get storm come, we get ready for it even. But today it changes so much… boy we expecting a big storm. Next day, clear as can be. I can't predict weather anymore like we used to years ago."

Peter Esau, Sachs Harbour, 1999. Quoted in "We can't predict the weather like we used to: Inuvialuit Observations of Climate Change, Sachs Harbour, Western Canadian Arctic." By Dyanna Jolly et al. in The Earth is Faster Now: Indigenous Observations of Arctic Environmental Change, *edited by Igor Krupnik and Dyanna Jolly, 2002.*

The Good, the Bad... and the Uncertain

We aren't sure just how hot it will get, or how fast things will change, or how much rain or snow we will get. So it is hard to be specific about the impacts of climate change.

Here is a list of some of the potential changes we *could* experience. Some are already happening or are likely to happen; the risks of others happening is still very uncertain. Some might be positive impacts... and many might not be. You decide!

- **Cheaper heating costs.** Warmer winters will mean heating costs for our homes and businesses should go down a bit.
- **New shipping routes.** As the ice pack in the Northwest Passage melts, ships should be able to travel farther into the north without help from icebreakers. This would create new economic development opportunities – such as more tourism, more export of oil, gas and minerals, and cheaper transportation costs – in some areas. But there are also risks associated with more shipping in the Arctic's fragile ecosystems. A shipping accident in the Arctic waters could have a big impact *(see Backgrounder 7)*.
- **Increased safety outdoors.** For people who work and play outside in the winter, warmer temperatures could mean less risk of frostbite and hypothermia. But before you celebrate, remember that warmer temperatures can also cause thin ice that can be dangerous for people travelling on rivers, lakes and sea ice.
- **More farming opportunities.** Longer growing seasons in the north could be good news for someone who wants to farm or garden! However, before you start running out and planting seeds, keep in mind that northern soils do not have a lot of nutrients that crops need to thrive. And there are no guarantees that rain will come at the right time in the growing season.

- **Shorter season for winter roads and ice bridges.** Some northern communities rely on their winter roads to bring in supplies. These roads are built on top of snow and ice. However, as our winters become shorter and milder, our winter roads won't last as long. Melting and slumping can create dangerous conditions which means more time has

to be spent maintaining the roads. It has already become more expensive to maintain winter roads like the one to Rae Lakes in NWT. Also, it is taking longer in the early winter for ice bridges to get thick enough for safe travel.

- **Eroding towns.** Towns along ocean coasts might have to pack up and move farther inland as the land under their feet washes into the ocean. Already Tuktoyaktuk, NWT is seeing more erosion along its shoreline. The community's curling rink was destroyed in the 1980s. The school was closed and torn down in the 1990s, and rebuilt farther inland. Coastal erosion like this is happening more frequently as permafrost melts and sea levels rise. The waves and storms end up washing the melted shoreline away.
- **Cancelled flights.** More storms and fog can mean more cancelled flights between communities and to remote work areas (like mine sites).
- **Impacts on mining.** Many mines in the north rely on permafrost to keep groundwater out of their pits. Also, toxic mining waste might be released into the environment if there is permafrost in the walls of tailings ponds. If the permafrost in the walls melts, the walls wash away. Melting permafrost can also affect the construction of oil and gas wells.
- **Less water for hydropower.** Warmer weather will mean more evaporation of water from our lakes. In some places in the north, like Whitehorse, in the Yukon, electricity is made by hydropower. Hydro dams need water in their reservoirs (the lakes that form upstream of the dam) to make power. If more water is evaporating, then there could be less water to make this power – unless there is a large increase in precipitation to balance what is being lost from evaporation. (Hydro dams can't use all of the water upstream as this would damage fish and wildlife habitat.)
- **Impacts on human health.** Because the north is usually a cold place, we don't have as many types of insects, parasites and diseases as places farther south. As the temperatures warm up, we can expect to see more types of insects, parasites and diseases in the north. People may also suffer more on really hot days. Additionally, a lot of northern people currently eat a lot of healthy country foods (such as berries and wild meat). If climate change affects the availability of the northern plants and animals that people eat, this will likely have a negative impact on people's health, both physical and spiritual.

- **Impacts on traditional cultures.** Many northern people are finding it more difficult to hunt, fish, trap and gather berries. Climate change is making weather and wildlife movements less predictable. The environment is changing. Traditional cultures have always adapted to change, but if future changes are too rapid, it will be difficult for aboriginal cultures to adapt quickly enough. Rich traditions may be lost.

Do these stories sound familiar?

The SnowChange Project collects observations of climate change from indigenous people in the north. Elders in NWT and Nunavut have told the SnowChange project that the weather isn't as cold as it was when they were young. In some areas the elders say there is less snow while in others the snow is melting earlier. Often the elders say the ice isn't as thick as it used to be. Igloos are harder to build and there is a greater risk of going through the ice. Check out www.snowchange.org for more stories like these from Canada and other northern countries.

The Arctic Borderlands Ecological Knowledge Co-op is a community-based monitoring project involving six communities in northern Yukon, NWT and Alaska. People involved in this project have described how it is harder to travel on the land because there is more frost on the trees and willows or there is more overflow on the rivers. They have talked about how the wind on the coast makes it harder to travel in boats. They have told stories about warmer weather in Old Crow Flats that made it harder to get to people's camps and how people couldn't hunt until it was very late in the fall. For more details go to www.taiga.net/coop.

So What Do We Do?

We can do a number of things to help slow climate change *(see Climate Change Solutions Backgrounders 13 to 17)*. However, we also know that temperatures will continue to increase for a while even if we all stopped putting any greenhouse gases (GHGs) into the atmosphere today.

So we need to learn how to live with some changes in our climate. We need to adapt.

Some adaptations can be simple. For example, people in Sachs Harbour report using ATVs more often in the spring to go to their camps (they used to only use snowmobiles at that time of year). They also used to use the frozen rivers to get to their camps. However, as these rivers are breaking up earlier, some people are travelling the long way around – along the coastal sea ice – to get to their camps. Everyone in Sachs Harbour is being more careful about going out on the pack ice as it is thinner and breaks up sooner. Changing ways of going out on the land is one way of adapting to climate change.

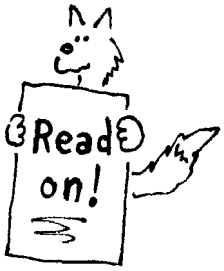
Tuktoyaktuk is adapting to its eroding shorelines by moving buildings and changing their community plan. By planning ahead for climate change, Tuktoyaktuk is helping to minimize the future impacts of climate change.

Builders and contractors can adapt to climate change by changing the designs of the foundations for their buildings and other projects. These designs need to account for melting permafrost. For example, work on the airport runway in Yellowknife involved digging down 4 metres into the earth – right into the permafrost – and laying down 100 mm of rigid insulation. The insulation is then covered with sand, a special liner, crushed rock and other materials. Then it will all be resurfaced. This should protect the permafrost from melting further.

Climate change isn't the only thing impacting our northern environments and communities. There are also other forces of change at work. For example, the north is affected by pollution and contaminants that travel on the winds from southern Canada and other countries. An increase in mining and oil and gas developments in some northern areas is also bringing changes to the natural world and to northern communities.

If a lot of change happens at once it is harder for our plants, wildlife and people to adapt. To make it easier for the natural world to adapt to climate change impacts, decision makers need to find ways to minimize the impacts of other types of change that they can control. For example, they can protect caribou migration routes and limit disturbance to critical wildlife habitat.

Read On!



All around the world, people are trying to figure out exactly what the impacts of climate change will be. Right now, researchers can predict a range of possible changes in temperature, precipitation and other weather patterns. They do this by using different climate models. But no one is 100% sure exactly how climate change will affect different regions of the world. There are just too many unknowns right now. But we do know stuff is happening!

People are making changes and planning ahead to help reduce the impacts of climate change. Many are also collecting information that will help us figure out what individuals, communities, businesses, and governments need to adapt to. For more details on how some of this information is being collected, check out Backgrounder 5. To find out how other people around the world are being impacted by climate change, read Backgrounder 12.

Key Points

- ★ A warmer climate is going to have a range of impacts. Some of the impacts might be positive, while some will be negative.
- ★ Melting permafrost will create some of the biggest changes. It will affect our roads, buildings and industries.
- ★ People on the land are already noticing changes that are affecting their hunting and trapping lifestyles.
- ★ We need to learn how to prepare for the changes that may be coming, even if we can't be 100% sure of what they will look like.

Want to Know More?

Here are some websites to help you look further into impacts of climate change on northern communities:

- **CKUA Radio Network:** http://ckua.com/climatechange/singleshow13.html – Listen to an online interview with Andy Carpenter, Inuvialuit elder and mayor of Sachs Harbour about how climate change is affecting their way of life.
- **Government of Canada Climate Change (Regional Impacts):** http://www.climatechange.gc.ca/english/affect/prov_territory/ – Click on northern sections of the map to see what the impacts are in NWT, Yukon and Nunavut.
- **Northern Climate Exchange Knowledge Site (Matrix Maker):** http://yukon.taiga.net/matrix/index.html – Use this amazing matrix to see the impacts of climate change on things like waste management, transportation, and other aspects of community life in the north.
- **Snowchange Project:** http://www.snowchange.org/ – Current stories of changes being experienced by Arctic communities.
- **Yukon Department of Environment:** http://www.environmentyukon.gov.yk.ca/epa/climate.shtml – Click on 'Climate Change in the Yukon' for information about Yukon communities.

Impacts of Climate Change — High School Backgrounder 12

Global Impacts of Climate Change

We've been learning that climate change is warming up and changing this planet we call home. We know that temperatures in the northern areas of the world will climb faster than temperatures in other areas of the planet.

However, as the climate is changing everywhere, people around the world will have to deal with many of the same types of impacts that northerners are already starting to tackle.

For example, worldwide, new plants or wildlife species will appear in some areas and old ones may disappear if the species can't handle the new climate. Weather patterns will change. Lakes and rivers may lose water as warmer temperatures cause more water to evaporate.

People in other countries may also experience some impacts that northerners won't have to deal with because of different environments or ways of life.

To learn what climate change will mean for people in other areas of the world, read on!

Rising Waters, Disappearing Lands

Thirty of the world's biggest cities – cities like London and New York – are very close to sea level. This means they are built on land that is almost at the same level as the surface of the ocean. Hundreds of islands in the world are also just above sea level – the land on some islands only rises a few metres above the place where the waves hit at high tide.

Now imagine living on one of these islands or coastal towns elsewhere in the world. Maybe you have a beachfront home. Or maybe you have a business that makes money from the tourists that come to suntan and play on the beaches in your area. Or maybe you have a family farm in a low river delta that is just not much higher than the ocean shore.

What makes the sea rise?

Can you think of the reasons the water level of the oceans might rise? One reason is that glaciers and the polar ice caps are melting more because temperatures are increasing. This means more freshwater is flowing into the oceans.

The other reason is that most things expand in size as they heat up. Warm water simply takes up more room than cold water. So, as climate change is warming up our oceans, the oceans will expand in size and the levels will rise.

Then imagine learning that climate change is supposed to make sea levels rise by up to 88 centimetres in the next 100 years.

Tens of millions of people who live in these low-lying areas near the ocean will have to start packing their bags and moving to higher ground. For some island people, this might mean moving to a whole new island or country as their entire island is expected to disappear under water!

Some places are already building huge barriers to keep the ocean from washing away their shorelines. But the high seas will likely still get around many of these barriers and many low-lying areas will get more flooding in the future.

These floods will carry salt water into areas that just have fresh water now. As many people farm in these low areas, the occasional incoming salt water could harm farm crops because many plants can't grow in salty soil. The salt water will also affect other plants and animals that live in these low-lying areas.

Wet Times

In some parts of the world, climate change is expected to increase the amount of rain and snow. Much of the Arctic, for example, will likely get more rain and snow. Some of the areas of the world that are expected to get a lot more rain – or get the rain in more intense downpours – will likely see an increase in the number of floods and landslides. Drastic events like floods and landslides can wipe out towns, killing people and damaging homes, property, crops and ecosystems. This will result in major social, environmental and economic impacts in these areas.

Dry Times

Other areas of the world will get less rain than they used to because of climate change. In Africa, there have already been more droughts (long periods without any rain). When it gets really dry, crops won't grow. Cattle and other farm animals can die from thirst. This means there is less for people to eat. Many will starve and millions will move to other areas if the droughts continue. It will be tough for other countries to feed and house so many new people.

As things get drier, deserts and grasslands are expected to expand in many places around the world – at the expense of forests. Extended dry periods and more heat can also have some long-term impacts on streams and rivers. For example, Mount Kilimanjaro, Africa's tallest mountain, now has snow on it all year round. Every year, some of the snow melts and provides water for the nearby streams and rivers. Normally, this melted snow is replaced by more snowfall in the cooler times of the year.

However, increased temperatures from climate change have caused the snow on Kilimanjaro to melt faster than usual. Because climate change has also made this area drier, there is not enough new snow to replace what melts each year. So the ice field is shrinking. The ice field at the top of Kilimanjaro is 82% smaller than it was in 1912.

If the ice field completely disappears, there will be no more snow and ice to melt year round so the streams and rivers that flow from this mountain will also disappear – for at least part of the year.

The loss of snow, and water, could also happen in other areas of the world, such as the Himalayan Mountain region of Asia. The loss of snow on all of these peaks – whether in Africa or in Asia – would affect a lot of the people and wildlife that live in these mountain areas. There would be less drinking water. There would also be less water to help farm crops and other plants grow. This would create food shortages.

Some dry areas of the world already have a shortage of fresh water for drinking and farming. Unfortunately, the warmer temperatures caused by climate change will make even more water in the lakes and rivers evaporate (turn into vapour and rise into the atmosphere). In countries where there is already a shortage of water, a combination of increased evaporation and less rainfall will mean the shortage and quality of water will get worse.

We all need water to survive. If it starts to disappear in some regions, people in these areas could start fighting over what is left. This would be a very sad impact of climate change.

More Bugs!

Some things grow much better in warm weather... including insects and diseases!

Tropical diseases like malaria and yellow fever might spread northwards with warmer temperatures, into places that are currently too cold for these diseases to survive.

Some of the diseases, insects and parasites that will spread will harm humans. Other types of diseases and insects can harm farm crops and animals. If these crops and animals are damaged or destroyed, this will make it tough for some people in the world to put food on their table.

New insects and diseases can also affect forests, wildlife and fish. If these things in the natural environment are negatively affected, they can then negatively impact people. For example, forestry companies may not be able to log trees that have been damaged by insects. Hunters and trappers may find that the animals they kill are too full of parasites or too sick to eat or sell.

So even if the spread of insects, parasites and diseases doesn't directly hurt people, the new pests and diseases might hurt the things people eat or from which they make a living.

Environmental refugees

In 1998, more than 25 million people had to leave their homes because of floods, drought, deforestation or other environmental problems! That is a lot of people on the move! This was the first time in recent history that more people in the world left their homes because of environmental disasters than because of wars or other conflicts.

Most of these environmental disasters (such as floods, droughts, or other extreme weather events) may be linked to the changing climate.

Losing Life in our Oceans

Coral reefs

Coral is a living organism that grows and dies naturally. A lot of coral in one place is called a "reef" and these reefs are like large cities, full of diverse life. The world's coral reefs are home to over half of all of the species that live in the ocean! The coral is a hugely important ocean habitat.

Unfortunately, these coral reefs are doing more dying than living these days. The reefs are dying because the coral can't survive in the warmer ocean water that climate change is causing, and because of increased pollution.

When the coral dies, it can get eroded and washed away by waves. When this happens, the fish and other species that live in these coral reefs lose their habitat (their home) which means their populations will likely go down.

Phytoplankton

Other important things found in the ocean are the small plant-like organisms called algae or phytoplankton. Like plants on land, phytoplankton capture sunlight and grow using photosynthesis and nutrients in their surrounding environment.

Phytoplankton are also an important food source for many fish and other species in the ocean.

However, phytoplankton can die off if ocean water warms up too much *(see Backgrounder 3)*. If phytoplankton disappear, some of the other species in the ocean may starve.

For example, phytoplankton in the ocean near South America have died off when the warm ocean currents of El Niño mixed with cooler water in this area *(see Backgrounder 4)*. When this happened, the fish in the area that ate the phytoplankton also decreased in numbers. Then the seals that ate the fish that ate the phytoplankton also decreased in numbers!

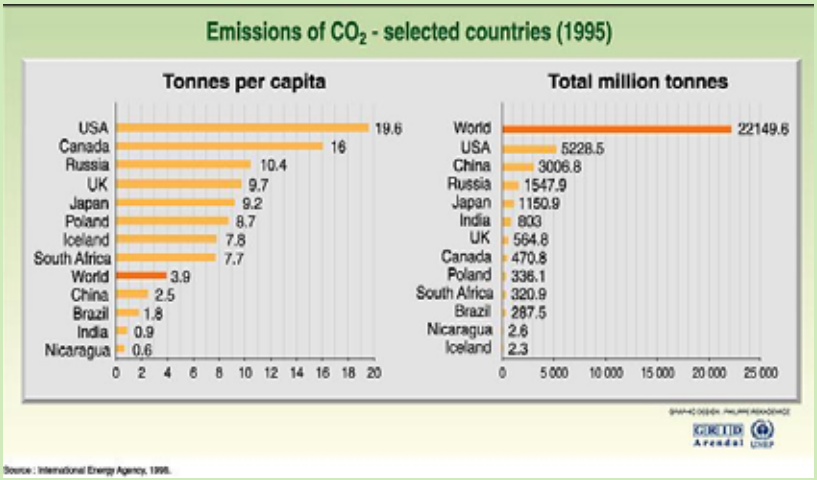
Oceans cover 70% of the earth and provide a source of food for millions and millions of people in the world. As the marine life in the water is affected by climate change, people around the world who rely on the oceans for their dinners will also be affected. So this is a serious global issue!

Poor countries face biggest impacts but rich countries produce most emissions!

The poorest countries in the world might also be the hardest hit. Poorer countries are located in parts of the world that can expect more droughts, diseases, insects and higher sea levels. Many of these poorer countries already have few resources and little money to feed their people or to develop their economies. It will be hard for these countries to respond to the changes that climate change will cause.

However, most of the greenhouse gas emissions that are causing climate change come from the richer countries in the world – the ones with lots of cars and industries. So these richer, industrialized countries are the cause of many of the climate change impacts in the poorer countries.

At the same time, poorer developing countries are trying to improve their standard of living so they are becoming more industrialized. They are starting to emit more and more greenhouse gas emissions. Developing countries are expected to be responsible for half of the world's emissions by 2025. The challenge for developing countries is to improve their quality of life *and* control their greenhouse gas emissions. Do you think the richer, industrialized countries should chip in and help them do this?



Traditional Cultures

In the north, people who live off the land are already dealing with rapid changes in the climate. This is also happening in other countries. Indigenous people living in the Amazon forests in Brazil and nomadic cultures living in Africa are all being impacted by climate change. Indigenous people living near the ocean are losing parts of their traditional lands as sea levels rise.

The changing climate is affecting the weather, land and wildlife that many cultures have come to know over generations. This makes it harder to maintain a way of life that has depended upon detailed knowledge of the local environment.

So What Can We Do?

Almost everyone in the world – especially those in industrialized countries – contributes to greenhouse gas emissions every day. We do this when we travel, heat our homes, or buy new products. If you want to find out what you, your school, your governments and businesses can do to reduce greenhouse gas emissions, check out the Climate Change Solutions Backgrounders 13–17!

Key Points

- Climate change will cause sea levels to rise. Some land will disappear and people will have to move. Flooding from salt water will affect farms and the environment.
- Some parts of the world will get more rain and snow that will cause floods and landslides.
- Other areas of the world will get less rain and snow. This will mean less drinking water for people. There will also be less water for farms crops and animals.
- Insects, parasites and diseases will likely spread as climate change causes temperatures to warm up.
- The coral reefs and phytoplankton in our oceans are dying partly because the ocean is warming up.
- Traditional cultures around the world are being affected by the changing climate.

Want to Know More?

To learn more about the global impacts of climate change, go to these websites:

- **BBC Climate Change Site:** http://news.bbc.co.uk/hi/english/static/in_depth/sci_tech/2000/climate_change/impact/default.stm – Click on different world areas to find out the impacts of climate change.
- **CKUA Radio:** http://ckua.com/climatechange/singleshow15.html – Listen online to an interview about how the South Pacific island of Tuvalu is being affected by rising sea levels.
- **Global Warming: Focus on the Future:** http://globalwarming.enviroweb.org/ishappening/ishappening_frameset.html – Be sure to check out the backgrounders on issues such as rising waters, health, food and water.
- **Suzuki Foundation (Impacts):** http://www.davidsuzuki.org/Climate_Change/Impacts/ – Click on the links for a good overview on different kinds of climate change impacts throughout the world.
- **Union of Concerned Scientists (Climate Impacts Map):** http://www.climatehotmap.org/ – Click on the map in any region, and you'll link into a description of climate change indicators in that area.

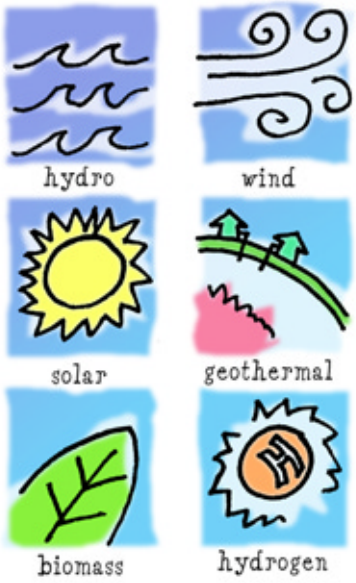
Solutions to Climate Change — High School Backgrounder 13

Renewable Energy Opportunities

We use energy to run our vehicles, heat our homes, turn on our lights, harvest our food, run our industries, fly our planes.... Get the picture? Energy helps make the world go round!

But some types of energy also help put those nasty climate changing greenhouse gases (GHGs) into the atmosphere. Fuels like oil, gas, and coal are the main culprits as they put loads of GHGs into the environment when we use them.

There is a fixed amount of fossil fuels – there is only so much oil, gas and coal in the ground. So eventually we will run out. We call these fuels "non-renewable" fuels, because once we use them, they're gone.



"Renewable energy" is energy that that is usually available in a never-ending supply. It is made by capturing energy – from things like the sun, wind and falling water. Also, many of the renewable energies don't produce GHGs or other forms of pollution when we use them. So renewable sources of energy are endless and generally cleaner.

This backgrounder describes some of the renewable energy sources we can use instead of fossil fuels to help reduce GHG emissions in the world.

Where Does Your Power Come From?

When you flick on your lights at home, do you know where the electricity comes from?

In many northern communities in Canada, there are large generators that burn diesel (a fossil fuel) to create electricity. These generators send a lot of GHGs and other air pollutants into the atmosphere.

Also, the diesel is usually transported into the community by a truck, plane or barge. All of these forms of transportation burn fossil fuels. So GHGs are produced both when the diesel is brought into the community and when the diesel is burned in the generator. A bit of a double whammy!

In some northern communities, flowing water is used to create electricity. This is called hydroelectric power and it can be a GHG-free source of power. In Canada, 61% of all of the country's electricity is produced by hydropower, while less that 10% of the electricity in the United States is generated by hydropower.

It is important to remember that hydropower causes some environmental concerns that should be considered. For example, most hydroelectric projects involve building a dam across a river. This dam interferes with the natural flow of a river and floods a lot of land upstream of the dam. People now know that the flooded areas (hydro reservoirs) can end up producing significant amounts of carbon dioxide and methane (both GHGs). This can occur for decades after the dam is built as flooded trees, plants and other organic materials – the vegetation and soils that were present in the flooded forests and wetlands – slowly decay under the water (*see Backgrounder 3)*.

So there are a few trade-offs to think about even with hydroelectric power. But it's usually way better than burning diesel.

DOWN With GHGs, UP With Renewables!

Although most northern communities use diesel generators or hydro-power for most of their electricity, many types of renewable energy can be used for electricity for our lights, heat for our homes, or fuel for our machines and vehicles.

The following descriptions outline some of the main forms of renewable energy that are being used – or could be used – in the north.

What's a turbine!?

Basically, a turbine is a thing that spins to create power. It is made up of a rotor with blades or cups that are turned by moving water, air, steam or gases. This spinning action can turn a generator to produce electricity. A windmill that is used to create electricity is a type of turbine.

Micro-hydro

Although many hydroelectric projects involve building dams that change the flow of a river, there are smaller hydro projects that can produce power by using the natural flow of a river or stream. Small turbines can either sit in the flow of the river, or water can be piped to them to generate power.

These "micro-hydro" projects don't have to dam a river. These smaller projects produce much less power than the big dams, but they also have less impact on the natural environment.

Blow me over!

A wind turbine is a great example of renewable energy power technology that has been around for hundreds of years in some countries. It is the fastest growing source of power in the world.

There are a few "wind farms" in Canada, where hundreds of wind turbines use the free wind to make electricity. Canada produces 137 megawatts of wind power, enough to power about 37,000 homes.

This really isn't very much. Germany produces 6,100 megawatts of wind power! The small country of Denmark creates 2,140 megawatts, about 20% of its energy needs. So Canada has a long way to go to before it is taking full advantage of the free power of wind!

Watt's that?!

A watt is a measurement of electricity.

1 watt = one Christmas lightbulb

1 kilowatt = 1,000 watts

1 megawatt = 1,000 kilowatts (or 1,000,000 watts)

1 gigawatt = 1,000 megawatts (or 1,000,000,000 watts)

1 terawatt = 1,000 gigawatts (or 1,000,000,000,000 watts!)

Wind turbines are also showing up in the North! In Whitehorse, there are two. The smaller one was erected in 1993 and it can produce enough electricity each year for about 23 homes. The bigger wind turbine was put up a few years later and generates enough power every year for 130 homes. It would take about 350,000 litres of diesel to produce this much power! By using wind instead of that much diesel, greenhouse gas emissions are reduced by 900 to 1,000 metric tonnes per year.

Rankin Inlet in Nunavut is an isolated community that has to ship in diesel fuel three to four times a year to run its diesel generator. However, the community has also set up a new wind turbine that is expected to reduce their use of diesel by about 50,000 litres a year. This will save the community about $25,000 per year. It will also keep about 150 tonnes of GHGs from going into the atmosphere. That is like taking 50 small cars off the road!

Catch those rays!

The sun is a huge source of free power. It can be used to generate both electricity and heat.

Have you seen pictures of solar panels that sit on a roof and use the sun to create energy? These panels use technology called solar photovoltaics – or PV for short – to make electricity. In the north, these panels are a great way for hunting camps, cottages, research stations, or others to generate electricity, especially if they are too far away from an area's main source of power (like diesel or hydropower). In the aboriginal community of Kitcisakik, Quebec, solar panels provide enough electricity to meet the needs of 18 families and a community centre!

Other types of solar panels can also be used to heat water. A hotel in Whitehorse, the Gold Rush Inn, heats up all of its water with solar panels most months of the year. The panels on the hotel roof can heat enough water even when all 106 rooms are full in the summer and everyone is taking showers and doing laundry! When the hotel owner installed a special type of solar panel that uses vacuum tubes to heat the water, his utility bill (for power) dropped by $16,000 in the first year!

The sun is also used in many places to help heat buildings. The simplest way is to put most of the windows in a building on the south side so that the sun can passively shine in and heat up the building. North facing windows only let heat out of the building – they don't help any of the sun's heat come in.

There is also a newer technology, called the Solarwall, that helps use the sun's heat to warm the inside of a building even in northern winters. A dark coloured metal with lots of tiny holes in it is placed on a sunny outside wall of a building. The outside air travels through the small holes and is warmed up by the metal (which is warmed up by the sun's heat). This pre-heated air is then moved into the building with fans.

A hot fact

The amount of energy produced by the sun in a two-week period equals the combined stored energy of all the coal, oil and natural gas reserves known to humans.

The Weledeh School in Yellowknife, NWT and the recreation centre in Fort Smith, NWT both have Solarwalls. Even in the short, darker days of December, Fort Smith's Solarwall (combined with something called a heat recovery ventilator) is able to meet 75% of the recreation centre's heating needs! As the sun gets stronger in January and February, the Solarwall provides 100% of the centre's heat!

Now this rocks!

Did you know that you can get heat out of the ground, even in the middle of winter!?

Below the frost line, the ground temperature stays the same season to season. In the middle of winter, the ground below the frost line is actually warmer than the air.

A technology called a ground-source heat pump (or geothermal heat pump) uses a bunch of buried pipes to move that heat from the ground and into a building! A liquid coolant in the pipes – like the one used in your fridge – helps to capture the ground's heat and move it into homes and other buildings. In hotter weather, the process can be reversed so that the cooler ground is used to help cool a hot house!

Some places also have warm or hot water under the ground that can be used to help heat buildings. The warm water is circulated through pipes to help warm up buildings. Studies are being done in Haines Junction, Yukon to see if the 17° C water that flows below the town can be used to heat the buildings above ground! About 40% of the energy in Iceland is produced by hot water extracted from volcanic rocks!

Many northern communities in Canada may also have warm water under them. Studies need to be done to figure out the temperature, how much water is available, and whether or not it is economic to use it as a source of heat.

Bio-what?

Biomass fuel is basically a fuel that is made from any type of biological matter.

Wood

One form of biomass is wood. Wood waste from sawmills or trees from a forest fire area can be burned to create heat or generate electricity. If the same amount of wood we use for energy is allowed to grow again in our lifetime, it is a renewable form of energy.

Ethanol

Another type of biomass fuel is called ethanol. This is an alcohol that is made by fermenting sugars from agricultural crops like corn or wheat. Even fields of grass can be harvested to make ethanol. In Brazil, 24% of the fuel they use is ethanol that is made from sugarcane!

Ethanol can be used to run cars and to make chemicals and plastics. It's true that burning ethanol produces carbon dioxide like other fuels. However, the biological things used to make ethanol (like trees, crops, or grasses) also take carbon dioxide out of the atmosphere when they are growing. So ethanol is much better to use than fossil fuels (like oil and gas) because fossil fuels only put carbon dioxide into the atmosphere. The materials used to make ethanol generally take as much carbon dioxide out of the atmosphere as they later put in when burned as a fuel.

In Ontario, Quebec, the western provinces and the Yukon you can buy gasoline that has some ethanol added to it. This makes the gas burn a little cleaner. Approximately 5–10 percent of Canadian gasoline contains ethanol. Currently, the Canadian ethanol production capacity is 238 million litres.

A high-speed fact!

Ethanol burns very cleanly. It also delivers more power than gasoline so Formula 1 racing cars use ethanol to run their engines!

Bio-Gas

Every human creates gas as they digest food.... It's a gas that none of us likes to smell! Imagine capturing this gas to create energy!

People aren't actually using human farts to create energy. But they are using the same process that our digestive system uses to create a renewable gas that can be used to create energy!

Bacteria in our digestive system help to break down food. As digestion takes place, a gas called methane is produced. Methane is also created when food and other organic materials in a community's dump break down (rot). You could also create methane if you put a bunch of cow manure in a container, added some water and kept the lid on.

And this is exactly what people are doing around the world! Animal and plant wastes on farms are put in sealed tanks with special bacteria. This is creating methane gas. The methane is captured and used for things like cooking and heating.

This isn't rocket science!

People have been using biogas for a long time! In the days before electricity, biogas was drawn from the underground sewer pipes in London and burned in street lamps. Now you know why they were called "gaslights"!

Communities are also putting pipes into their waste dumps to help capture and use the free methane that is being created by rotting food and other waste. Methane is a greenhouse gas that increases climate change so capturing the methane before it escapes into the atmosphere helps to reduce a community's greenhouse gas emissions! A double bonus!

It's a gas!

Do you know what is:

- 14 times lighter than air;
- found in 90% of the matter in the universe; and
- found in water?

The answer is hydrogen. If you take two parts of hydrogen and one part of oxygen you get H_2O... the chemical formula for water! Hydrogen is also found in fossil fuels, biomass, ethanol and much, much more.

When hydrogen is separated from water or the other things it is found in, it can be used to generate electricity or run vehicles. The good news is that when you use hydrogen, you don't produce any GHGs!

Part of the trick right now is that it takes energy to get hydrogen out of water (or other things in which hydrogen is found). Unfortunately, sometimes the energy we use to extract hydrogen comes from burning fossil fuels that produce GHGs. But inventors are exploring more efficient ways to separate out the hydrogen without creating GHGs!

The other challenge is that hydrogen is a very explosive gas and will catch fire easily. To be safely stored, it needs to be cooled to a chilly -253° C so it will form a liquid. Liquid hydrogen is then stored in specialized containers and pumped through high-tech valves and tubes. This makes hydrogen expensive and difficult to handle.

However, hydrogen fuelled cars and buses are cruising the roads right now in some places. The city of Vancouver, BC was the first place to test out the hydrogen fuel cell in its public buses. The government of Iceland is working on their dream of having all of the country's cars and buses run on hydrogen. Iceland even wants its fishing boats to be using hydrogen by the year 2040. If successful, Iceland will be able to stop importing oil and gas to their island.

Why Don't We All Have Solar Panels and Wind Turbines?

By using the different types of renewable energy, individuals, communities and countries can help to reduce the number of greenhouse gases we are all pumping into the atmosphere. However, it can cost money to switch from one source of energy to another.

For example, if your community already has a diesel generator, is it going to want to spend more money on setting up wind turbines or solar panels? The upfront costs of switching over to a new source of energy can be a barrier for many homeowners and communities.

However, many who have made the investment in new renewable technologies end up saving a lot of money every year on their energy bills! You have to pay money to run an oil furnace or a diesel generator. But energy provided by the sun, wind, and ground heat is free!

So it might cost more money to set up a new renewable source of energy, but the annual cost of running it will be a lot lower than the non-renewable technology. Eventually, the upfront cost of installing a new technology will be recovered from the annual savings in energy costs!

Where to Next?

Switching to renewable energy offers some exciting opportunities for the future. New businesses are already taking advantage of the shift to more renewable and cleaner forms of energy. These businesses are growing quickly.

Some people argue against making the shift to renewable energy. It makes you wonder if these same people had been alive in the past, would they have argued that the car would never replace the horse and buggy? A couple of centuries ago we made the shift to using mostly fossil fuels for our energy. There is no reason we can't make another shift to new energy and cleaner sources! But all of us need to start asking energy companies, businesses and governments to begin that shift!

To find out more about what you and your family can do to reduce your own GHGs, check out Backgrounders 14 and 15. To find out what governments and businesses are doing, look at Backgrounder 17.

Key Points

- Renewable energy can be used over and over again and it usually doesn't produce any greenhouse gas emissions.
- Non-renewable energy is something that can only be used once. Most non-renewable sources of energy (oil, gas and coal) produce greenhouse gases when they are used.
- Water can be used to create hydropower, a renewable energy. Large hydropower projects can create some environmental problems but smaller "micro-hydro" projects usually have a low impact on the environment.
- Other sources of renewable energy include: wind, sun, heat from the ground (or from water under the ground), biomass, biogas and hydrogen fuel.

Want to Know More?

Learn more about the basics of renewable energy and specific forms of renewable energy by checking out these sites:

- **CanREN Youth Site:** http://canren.gc.ca/school/index.asp – Links to about 20 sites on renewable energy, ranging from wind power to solar cookers.
- **Energy Solutions Centre:** http://www.nrgsc.yk.ca – Links to Green Power and Energy Efficiency initiatives in Yukon.
- **Re-Energy:** http://re-energy.ca – Background information, and project instructions for all kinds of renewable energy projects: solar cars, turbines, biogas generators, and more.
- **Solar School:** http://das.ee.unsw.edu.au/~solar/index.html – An animated Australian site, with background information on climate change and renewable energy, plus some interesting Australian examples of solar energy projects.
- **Yukon Department of Environment:** http://www.environmentyukon.gov.yk.ca/epa/climate.shtml – Click on 'Reducing Home Energy Use' and 'Transportation and Greenhouse Gases' for some great ideas on how to reduce your greenhouse gas emissions.

Solutions to Climate Change High School Backgrounder 14

Helping in Your Own Way

The Intergovernmental Panel on Climate Change says that climate change is caused mostly by people – because we are adding too many greenhouse gases (GHGs) to the atmosphere. So what can we do?

We can stop adding GHGs to the atmosphere!

This won't stop the problem immediately as the GHGs we have already put up there will continue to change the climate for quite a while. But we can slow down the changes. We've got to start somewhere! We've got to start now!

This backgrounder outlines how many GHG emissions individuals put into the atmosphere. It also provides some ideas on how you and your family can reduce your GHG emissions.

Just How Many GHGs Are We Putting Up There?

In 1995, Canada was producing about 600 megatonnes of greenhouse gases a year. Individual Canadians doing things such as driving cars, heating homes, heating water, or playing video games produce about 25% of Canada's GHGs. About 75% comes from things such as heating commercial and government buildings, running industries or trucking food and goods around the country.

On a person-by-person basis, Canadians put more GHGs into the atmosphere than people in most other countries in the world! Canada produces about two per cent of all the world's emissions – yet we only have about 0.5% of the world's population! It's time to go on a greenhouse gas diet!

How do you weigh a greenhouse gas?

Although carbon dioxide is a gas that makes up part of the air we breathe, it is something that we can weigh:

- One tonne = 1,000 kilograms
- One megatonne = 1 million tonnes (or 1 billion kilograms!).

The One Tonne Challenge

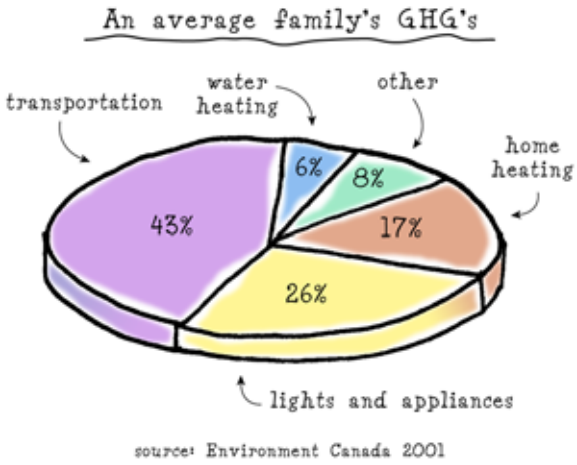
So what does one tonne of carbon dioxide look like? Well, one tonne would completely fill the inside of an average home.

The average Canadian puts over five tonnes of greenhouse gases (GHGs) into the atmosphere every year (carbon dioxide is the main GHG we pump out). This means that we each fill up about five houses a year with carbon dioxide and the other GHGs.

The Government of Canada is challenging every Canadian to see if they can knock one tonne of GHGs out of their lives by 2008–2012. Do you think you are up for it?

How Can We Cut the GHG Habit?

Individuals produce about 25% of all of Canada's GHG emissions. We can shrink those GHG emissions by doing some simple things at home, such as changing how we get around, and making different day-to-day choices.



Now that's heavy!

One litre of gasoline for our cars and trucks weighs about 0.75 kilograms. However, when it is burned in your vehicle, it produces about 2.4 kilograms of carbon dioxide! (That is because each carbon atom in the gasoline, when burned, attaches to two oxygen atoms from the atmosphere to form carbon dioxide). Each year, the average car in Canada produces three to four times its own weight in carbon dioxide!

Getting Rid of the Gas Guzzlers

For most Canadians, half of the GHGs we create are produced when we travel around in cars, trucks, planes, snowmobiles or other forms of transportation. One of the main "bad guys" in the climate change story is the personal vehicle – cars and trucks.

If we drove 10 percent less, we would reduce greenhouse gas emissions by 0.2 to 0.8 tonnes per car, per year (depending on how much gas our vehicle uses, and how much we drive).

Another major climate change villain is the airplane, something we use a lot in the north. Plane travel in Canada was responsible for over eight percent of the emissions in the transportation sector in 1999.

It's not like we all have to stay home to reduce how many GHGs we produce. But we do need to be a bit smarter about how we get around. Here are a few ideas about how you can reduce your GHGs whenever you go somewhere:

- Walk or ride your bike instead of hopping in a car or on a snowmobile.
- Encourage your family to buy a fuel-efficient vehicle. Over time, a new efficient car will save your family a lot of money on gas.
- If your family uses snowmobiles or boat engines, look at getting a new 4-stroke engine. They use much less fuel than older two-stroke models.
- Carpool with friends and neighbours. If you are all going to the same place, why not pile into one car instead of two or three!?
- Take the bus – if there is one in your community – instead of a car.
- Instead of idling your car or truck while you wait for someone, turn off your engine (or ask your driver to).

It's not just the type of car; it's the type of driver!

A well-tuned car with properly inflated tires can improve your car's fuel efficiency by 5-15%. Energy efficient driving habits, such as minimizing idling, driving within the speed limits, and accelerating and decelerating gradually, can improve your fuel consumption by up to 25%.

From: "Taking Charge: Personal Initiatives" David Suzuki Foundation, 1997.

Two Strokes and You're Out?

Many people in the north use boats, all-terrain vehicles (ATVs) and snowmobiles to get around. However, many of these vehicles use two-stroke engines (chainsaws and lawn mowers also use two-stroke engines). These two-stroke engines put out a lot of GHG emissions. Up to one-third of the fuel can pass through two-stroke engines unburned so they can also waste a lot of expensive fuel! This also causes a lot of pollution in the water and on the land.

But manufactures have been making new four-stroke outboard motors and snowmobiles. These four-stroke engines use a lot less fuel and pump out much fewer GHG emissions. The four-stroke engines are also a lot quieter! So next time you or someone in your family is buying an off-road vehicle or a boat, try to make sure it has a four-stroke engine!

High five to the hybrid!

If you have to have a car in your life, consider getting a hybrid!

This is a car that uses two forms of power – batteries and gas. When you cruise the highway, the car uses gas and charges up batteries at the same time. When you are driving at slower speeds around town, the batteries kick in and you are gas-free!

These hybrids get twice the mileage that the average car gets. They can get up to four or five times better mileage than some SUVs and trucks! Driving a hybrid instead of a regular car can help reduce the amount of GHGs you put into the atmosphere.

Idling gets you nowhere!

Can you guess how much time Canadians jointly spend idling their cars each day in the middle of winter!?

- ❑ 1 million minutes a day?
- ❑ 15 million minutes a day?
- ❑ 75 million minutes a day?

A recent study of Canadian driving habits indicated that, all together, Canadians idle their cars for a total of 75 million minutes a day in the winter! That is the same as idling one car for 144 years! Even in warmer summer weather, we still idle about 46 million minutes a day.

So why do we do it? Most people would probably say that it is better for the vehicles if you let them run to warm up in the winter. However, with computer-controlled, fuel-injected engines, you need no more than 30 seconds of idling on winter days before driving away. If you idle your vehicle, only the engine warms up. If you drive it, all the parts warm up and that is better for the car!

If a vehicle is going to be idling for more than 10 seconds, the driver should turn it off (unless they are in traffic). You will use less fuel restarting it than if you keep it running. This is true for vehicles that use gasoline or diesel.

So let's kick the idling habit! It will save money and prevent a lot of carbon dioxide from going into the atmosphere!

Getting GHG-Smart at Home

> Nunavut's 27,000 inhabitants burned a staggering 36 million litres of imported fuel last year to brighten homes, chill food, cook meals, wash dishes, launder clothes, surf the Net and watch television. Even more was burned – 58 million litres – to keep warm. And that's not counting the three million litres of gasoline used to power the growing numbers of boats, snowmobiles and cars.
>
> *From: "A burning question: Taming Nunavut's addiction to fossil fuels," by Dwane Wilkin, Nunatsiaq News, January 10, 2003*

On the home front, Canadians produce most of their GHGs when they keep their houses warm. This is particularly true in the north because of our longer, colder winters. We produce these GHGs when we heat our homes because we usually burn oil or propane in our furnaces and heaters (an efficient wood stove does not produce extra GHGs if it is used right).

Watching TV, playing video games or turning on the lights often produces GHGs (if your electricity is produced with a non-renewable resource like diesel) *(see Backgrounder 13 on renewable energy)*. Heating up our water for showers, dishes or laundry is another way we can also create GHGs.

Here are some ways you and your family can reduce your GHG emissions at home:

- Keep the heat in. Ensure you have good weather-stripping around doors and windows and put caulking in the cracks. Think about putting more insulation in your walls and ceiling.
- Keep the heat down. Set the thermostat at around 18°–19° during the day, and turn it down at night. It's better to put on a sweater than to turn up the heat!
- Reduce your hot water use. Install low-flow showerheads, and keep showers short. Use cold water for washing clothes.
- Get your family to buy energy-efficient appliances (like washing machines, stove, and fridges). New models generally use less energy. For example, a new refrigerator uses 40 per cent less energy than a model produced before 1993.

- Use compact fluorescent light bulbs in place of regular, incandescent bulbs. Compact fluorescents use one quarter of the electricity, and last a hundred times longer than incandescent bulbs!
- Reduce how much energy you waste. For example, use energy-efficient lights, and turn them off when they're not needed. Don't keep the fridge open longer than necessary. Turn off your computer and video games when you're finished. And don't heat up the whole oven for one snack. You can probably think of more, right?

Day-to-Day Choices – To Emit or Not to Emit, That is the Question

Our everyday choices affect how much energy we consume.

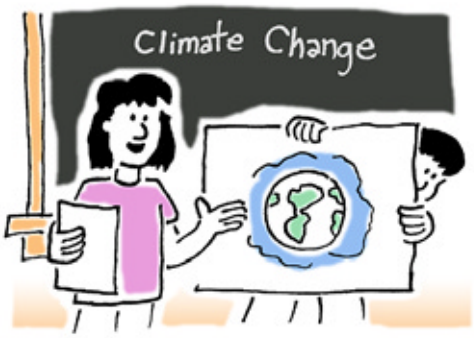
For instance, the average food item in Canada today travels some 2,000 km just to get to our tables (and even farther for northerners). Think of how far a banana has travelled next time you eat it! Could you maybe eat something from closer to home next time? After all, the further the food travels, the more fuel will be burned – so more GHGs will go into the atmosphere.

GHGs are also created when things like running shoes, computer games, or millions of other manufactured goods are made, packaged and moved from factories to stores. When you decide *not* to buy something, you're helping to reduce your GHG emissions.

This is because everything we use requires energy to make and usually when you use energy, you create more GHGs. Energy is used by the workers who might drive to work to make the product, by the factory when it produces the item and by the truck or plane that transports the item.

The stuff that we throw away can also add to greenhouse gases. When it goes to the dump, it decomposes and generates methane gas, a strong GHG. Most North Americans throw away about two kilograms of garbage every day. So it helps if you reduce, reuse and recycle to keep things out of the dump!

Pass It On!



Perhaps the most important thing you can do is tell other people about why it's important to reduce GHG emissions and slow climate change. Start with your family. Then think about how your school and community could be encouraged to change.

You may even want to move up to a higher political level. Politicians need encouragement to make the necessary changes. You might ask them to expand public transit options, to set up recycling programs or to support alternative energies. Writing a letter to your Member of the Legislative Assembly or Member of Parliament will encourage them to press for changes. You can make a difference!

Key Points

- The average Canadian produces about five tonnes of GHGs every year.
- We create about half of our GHGs when we travel in cars, planes, snowmobiles or trucks.
- We also create a lot of GHGs at home. Most of this comes from burning fuel to heat our homes. It also comes when we use electricity (if the electricity is produced by non-renewable energy).
- GHGs are produced to make and transport most of the food and products we use in our day-to-day lives. By buying things made closer to home, using less and recycling more, we can help to reduce our GHG emissions.

Want to Know More?

Here are some websites filled with ideas about individual actions you can take to combat climate change:

- **Anti-Idling Toolkit:** http://oee.nrcan.gc.ca/idling/tool_kit/tool_kit.cfm – Background on why not to idle, and a program to help you conduct an anti-idling campaign in your school or community.
- **Climate Change Solutions:** www.climatechangesolutions.com – Ideas on what you, your community, and the businesses in your community can do. Lots of success stories, too.
- **Edmonton Bicycle Commuters:** http://www.freenet.edmonton.ab.ca/ebc/winter.htm – Tips on winter cycling.
- **Go for Green:** www.goforgreen.ca – Practical suggestions for outdoor physical activities that protect the environment.
- **Government of Canada Climate Change (What Can we Do?):** http://climatechange.gc.ca/english/otc/ – A whole list of things you can do. Click on the links.
- **Natural Resources Canada (NRCan), Office of Energy Efficiency:** http://oee.nrcan.gc.ca/English/ – Ideas to save energy, save money and reduce greenhouse gas (GHG) emissions.
- **Suzuki Nature Challenge**: http://www.davidsuzuki.org/WOL/Challenge/10steps.asp – A challenge to take personal action to slow climate change. Click on any of the 10 points, and find an explanation on why this action is important.
- **Taking Charge: Personal Initiatives:** www.davidsuzuki.org/files/Hornung_full.pdf – A detailed (51 page) pdf file filled with information and good ideas.
- **Your Yukon:** http://taiga.net/yourYukon/col310.html – Article on winter cycling in the Yukon.