GLACIERS AND FEEDBACK (Part I)

GRADE Grade 8

PART 1 of 3

TOPICS Climate change, glaciers, water cycle

CURRICULAR CONNECTIONS

Grade 8 Science

Unit E – Freshwater and Saltwater Systems

2. Investigate and interpret linkages among landforms, water and climate
    - Identify evidence of glacial action, and analyze factors affecting the growth and attrition of glaciers and polar ice caps
4. Analyze human impacts on aquatic systems; and identify the roles of science and technology in addressing related questions, problems and issues
    - Illustrate the role of scientific research in monitoring environments and supporting development of appropriate environmental technologies
    - Provide examples of problems that cannot be solved using scientific and technological knowledge alone

KEEP WATCHING

National Geographic has produced a series of educational resources called about climate change called *Climate 101*. These resources include a video about the different types of glaciers and the way they form (Run Time – 4:06), available at bit.ly/2JmeoQ9 or by searching for *"National Geographic Climate 101 Glaciers."*

OVERVIEW

In this introductory lesson on glaciers, students will learn about how glaciers form and transform over time through a number of hands-on activities. Students will also gain an appreciation for the diverse and important roles that glaciers play in the lives of people around the world, including residents and visitors to the Bow Valley.

OBJECTIVES

- Students will understand how glaciers are formed
- Students will understand the important environmental, sociocultural and economic role of glaciers for different communities

KEY TERMS

- **Alpine glacier** – a glacier that is formed among mountains and moves slowly downwards through valleys
- **Firn** – granular snow, especially on the upper part of a glacier, where it has not yet been compressed into ice
- **Ice sheet** – permanent layer of ice covering a broad expanse of land (greater than 50 000 km^2)

GUIDING QUESTIONS

- How does snow change over time to form glaciers?
- Why are glaciers important to residents of and visitors to the Bow Valley?

BACKGROUND ESSAY

Glaciers are formed over hundreds or thousands of years when more snow accumulates in the winter than melts in the summer. Each year, additional layers of snow bury and compress the previous layers. Over time, light snowflakes are transformed into round ice pellets that resemble sugar. As the weight of the additional snow continues to compress the underlying ice pellets, pockets of air are squeezed out and the ice increases in density. The snowpack needs to grow to about 50 metres thick before these ice pellets – called **firn** – are fused into a solid mass of ice. For most glaciers, the process of formation takes more than one hundred years. Whether a glacier retreats or advances depends upon the amount of snow accumulation, evaporation or melt.

When enough snow and ice accumulate, gravity and the weight of the glacier are enough to cause it to flow very slowly downhill. Sometimes a glacier slides over a thin layer of water between the base of the glacier and the rock that lies beneath it. This thin layer of water may be the result of pressure from the weight of the glacier ice or from water that makes its way through cracks in the ice. This water layer makes it easier for the glacier to move across the land, much like a slow moving river. While it might not be apparent to the naked eye, glaciers are incredibly dynamic and are constantly changing.

There are two types of glaciers: **alpine glaciers** and **ice sheets**. Alpine glaciers form on mountainsides and are very slowly pulled down valleys by the force of gravity. Ice sheets on the other hand are not limited to mountainous areas and exceed 50 000 km^2. They form broad domes and travel outward from their centres.

DURATION 15-20 minutes

MATERIALS

- Large marshmallows
- Jar
- Cardboard disc to fit inside jar
- Small weights

ACTIVITY – GLACIAL PRESSURE

In this simulation of glacial formation, students will recreate the formation of a glacier using marshmallows and weights.

1. Place 5 or 6 large marshmallows inside a jar. Place a cardboard disc of slightly smaller diameter than the jar on top of the marshmallows.

2. Place a weight on top of the disc and observe what happens to the marshmallows. Incrementally add additional weight and observe the effects.

3. Discuss with the students what happened when weight was added to the marshmallows. Some prompting questions to consider:
   - Is there evidence that the marshmallows spread outward?
   - Is there evidence that the marshmallows adhere to one another when they are compressed? How does this compare to snow?
   - What would have happened if the sides of the jar were not there to contain the marshmallows?
   - If the marshmallows were snow, what form would they have assumed as a result of the pressure that was applied to them?
   - Does this experiment more closely resemble the formation of an alpine glacier or an ice sheet? Why?
   - What forces cause a glacier to move? (gravity, mass)

This activity has been adapted from "Glacial Pressure" from TeacherVision. View the original lesson plan at www.teachervision.com/science/glacial-pressure.

KEEP READING

For a map of the distribution of Canada's glaciers, visit bit.ly/2WOZAlg or by searching for *"NRCAN Distribution of Freshwater – Glaciers and Icefields."*

BACKGROUND ESSAY

Outside of the massive ice sheets in Greenland and Antarctica, Canada has more glacial cover than any other nation on Earth. Glaciers cover an estimated 2% of Canada's landmass. About a quarter of these glaciers are located in mountainous areas in Western Canada.

So why are alpine glaciers important to people? Around the world, an estimated 1.9 billion people live downstream of mountain glaciers and rely on them for freshwater resources. For this reason, mountains are sometimes called the "water towers of the world." Glacial meltwater and runoff contribute to water flow downstream, thus affecting the availability of freshwater resources for ecosystems, human consumption, crop irrigation and hydropower generation. Glacial meltwater acts as a buffer in dry, hot years when there is not a lot of snowfall or rainfall. Glaciers essentially work like a bank account for downstream areas during hot summers when water is scarce.

In addition to the freshwater resources that glaciers provide to downstream users and ecosystems, glaciers in Western Canada are also important for social and cultural reasons. Glaciated mountains have long attracted mountaineers and tourists from all over the world and continue to do so today. Many of the first Europeans to visit the Bow Valley did so in pursuit of mountain climbing, an endeavour that frequently required crossing glaciers. Every year hundreds of thousands of people flock to the Icefields Parkway in Banff and Jasper National Parks to gaze upon the glaciated peaks that line the highway.

DURATION 30-45 minutes

MATERIALS

- Snow shovel, preferably with a flat blade
- Magnifying glass
- Black laminated index card

ACTIVITY – SNOWPACK ANALYSIS

While the formation of glaciers takes place over many years, students can investigate how snow changes shape, texture and density over a shorter time scale by looking at a snow profile. A snowpack is made up of different layers that are created each time it snows. The layers are impacted by the weather, changes in pressure and temperature. These are the same processes that create glaciers, albeit over a longer period of time and at a much larger scale.

1. Dig a pit in the snow that extends to the ground. The pit should be dug so that the wall that you will be investigating is as near to vertical as possible (Figure 1). Make predictions about how the grains of snow might differ in shape or texture through the snowpack. How does the density of the snowpack change as you get closer to the ground? Test density by making a fist and trying to gently push it into the wall of the pit. If you are unable to penetrate the wall with a fist, try pushing four gloved fingers straight in, followed by one finger, the sharp end of a pencil, and finally a sharp blade such as the edge of a shovel or index card.

2. Ask students to view the snow grains under a magnifying glass by placing some of the grains onto a black laminated card. *Avoid touching the grains with bare skin as body heat may transform or melt the grains.*

3. Have students sketch the different snow grains that they have seen. How do the grains on the surface compare to those in the middle or close to the ground? What comparisons can be drawn between the snow pit and the transformation that snow in a glacier undergoes over time? How do they differ from one another?

4. Ask students to visualize filling a container with the different snow grains that they have observed. Which would have more air between the grains?

KEEP READING

There are many fantastic resources for studying features of the snowpack like snow grain metamorphism, grain form and snowpack density (also called snow hardness) that have been developed by avalanche forecasters. Understanding the water that is bound up in snowpack is a great way to teach about future water supplies, natural resource issues and climate change.

The National Snow & Ice Data Center is a great place to start learning more about the characteristics of snow and ice. Resources are available at nsidc.org/cryosphere/snow.

Figure 1: Snow pit (Source - Bridgeport Avalanche Center)

REFERENCES

Jurt, C., Brugger, J., Dunbar, K. W., Milch, K., & Orlove, B. (2015). *Cultural values of glaciers*. (pp. 90-106) Cambridge University Press.

National Snow & Ice Data Center. (2020). *All About Glaciers.* Accessed 28 March 2020. nsidc.org/cryosphere/glaciers.

GLACIERS AND FEEDBACK (Part II)

GRADE Grade 8

PART 2 of 3

TOPICS Climate change, glaciers, water cycle, feedback loops, greenhouse effect

CURRICULAR CONNECTIONS

Grade 8 Science

- Unit E – Freshwater and Saltwater Systems
  2. Investigate and interpret linkages among landforms, water and climate
     - Identify evidence of glacial action, and analyze factors affecting the growth and attrition of glaciers and polar ice caps
  4. Analyze human impacts on aquatic systems; and identify the roles of science and technology in addressing related questions, problems and issues
     - Illustrate the role of scientific research in monitoring environments and supporting development of appropriate environmental technologies
     - Provide examples of problems that cannot be solved using scientific and technological knowledge alone

OVERVIEW

Students begin this lesson by learning about the impact that the enhanced greenhouse effect is having on glaciers and how this is expected to change in the future. By studying the retreat of the Athabasca Glacier they will gain a deeper appreciation for the ways in which climate change is having tangible consequences for local landscapes and people. Following this students will connect the immediate impacts of climate change to the knock-on effects that are expected to happen through climate feedback loops.

OBJECTIVES

- Students will understand how rising global temperatures impact glaciers
- Students will explore the possible consequences of glacier retreat for downstream users
- Students will understand how climate feedback loops amplify or diminish the initial drivers of climate

KEY TERMS

- **Climate –** the weather conditions in an area of the earth for a long period of time (generally defined as about 30 years). Weather conditions include temperature, humidity, wind and rainfall
- **Climate feedback loop** – processes that can either amplify or diminish the effects of the initial drivers of climate
- **Enhanced greenhouse effect** – human activities adding to the warming of the atmosphere due to the greenhouse effect
- **Greenhouse gas** – gases in the atmosphere that trap energy from the sun. These include water vapour, carbon dioxide and methane

GUIDING QUESTIONS

- How is climate change impacting glaciers?
- How are the effects of climate change made worse by climate feedback loops?

BACKGROUND ESSAY

Mountain ecosystems are among some of the environments most hard hit by rising average surface temperatures on Earth. These rising temperatures are the result of the **enhanced greenhouse effect**, which refers to greenhouse gas producing human activities that are adding to the warming of the atmosphere due to the greenhouse effect. While heat-trapping **greenhouse gases** like carbon dioxide are necessary to sustain life on Earth, the concentration of carbon dioxide in the atmosphere has increased by 30% since the industrial revolution in the mid-eighteenth century. This has led to changes in the earth's **climate**, including temperature rises and altered rainfall patterns.

The impact of global warming on glaciers is twofold. Remember that glaciers are formed when more snow falls in the winter than melts in the summer. Warmer temperatures in the summer are expected to increase the amount of melting and indeed have already been doing so for decades. At the same time, more precipitation is expected to fall as rain rather than snow in the winter. This means that less snow is accumulating on glaciers over time to replace the ice that has been lost to melting. The combined impact is unprecedented rates of glacial retreat that are being observed around the world.

When glaciers shrink, they release water that was previously being stored within the glacier. Eventually, as the glacier shrinks further, it no longer acts as a reservoir of water resources. This could lead to more severe droughts during dry years and increased risk of forest fires. What could shrinking glaciers mean for people who rely on them for drinking water, irrigation, hydropower or recreation?

Researchers studying glaciers take core samples which provide year-by-year information about past climate and allow them to make predictions about how climate may change in the future. Photographer James Balog has described glacier ice as the canary in the coal mine, where we can hear, see, feel and measure climate change as it occurs. Alpine glaciers are simultaneously our record of climate change and a visualization of the consequences of human activities.

DURATION 30 minutes

MATERIALS

- Overhead transparency grid
- Athabasca Glacier images
- Dry erase marker
- Cloth/paper towel
- Measuring Glacial Retreat Student Activity Sheet

ACTIVITY – MEASURING GLACIAL RETREAT

The Athabasca Glacier is one of the most visited glaciers in North America. Every year, thousands of tourists climb aboard snow-coaches that drive onto the glacier. Glacier monitoring provides researchers with valuable information about the effects of global and regional climate change. Students will measure the extent to which the Athabasca Glacier has retreated and estimate the rate of change.

1. Divide the class into groups based on the number of sets of glacier images and overhead transparency grids that you have available.

2. Place a transparency grid over the image of the Athabasca Glacier from 1870 and tape the corners of the transparency down.

3. With one person holding the image in place, trace the outline of the glacier onto the transparency grid. Remove the transparency grid and count the number of squares contained within the outline.

4. Working from the upper left to the upper right across each row, put a dot in each square that you have counted. *Discuss with*

students how they will count squares that are only partially covered by adding multiple squares together.

5. Erase the dots and outline from the transparency grid and repeat steps 2 to 4 for the image of the glacier from 2019.

6. Use the information that you have collected to calculate the percentage change in glacier cover and the rate of change from 1870 to 2019.

7. Collect all of the students' results and write them on the board. Use these to calculate class averages. Based on the rate of change and the remaining ice, ask students to calculate how many years it will take for the Athabasca Glacier to melt entirely (*assuming a constant rate of change*).

8. Lead a discussion about the students' results. Did your results differ from the class average? How could you improve the accuracy of your map? Is this an accurate method for determining glacier cover?

9. In this activity, students are only asked to consider the surface area of the glacier. Ask students to think about the volume of the glacier. Depth of the glacier is arguably a more important variable to consider than surface area. How could we measure the depth of a glacier? Students can research some of the different ways that glaciologists are studying glaciers.

10. *Extension: Have students visually investigate how other glaciers in their area have changed over time. The Mountain Legacy Project Explorer (explore.mountainlegacy.ca) contrasts historical photos against modern day photos. Use the satellite view in the Google base map to identify which photos might show glaciers. How might the season or year that the photo was taken impact your observations? Have any glaciers disappeared entirely?*

In the past 125 years, the Athabasca Glacier has lost half of its volume and retreated more than 1.5 kilometres.

This activity has been adapted from "Glacial Retreat: Quantifying Changes in Glacier Cover over Time" from the NASA Landsat Education Team. View the original lesson plan at mynasadata.larc.nasa.gov/sites/default/files/2018-06/Day%207_Glacial%20Retreat.pdf.

BACKGROUND ESSAY

The earth's climate is a complex, interconnected system that exists in a delicate balance. It is comprised of many moving parts that respond to one another. The earth's climate is regulated by something called **climate feedback loops**. In these loops, a change in X will lead to a change in Y. The change in Y will lead back to a change in X. Another way of thinking about feedback is as a cause-and-effect loop that make the impact of key climate factors stronger or weaker, starting chain reactions that repeat again and again. What this means is our basic understanding of how the enhanced greenhouse effect is affecting glaciers becomes a whole lot more complicated.

There are both negative and positive feedback loops. A positive feedback loop will amplify the impact of the original change, potentially leading to large-scale, lasting system changes. Positive climate feedback loops can create vicious cycles that lead to accelerated or runaway rates of warming. The melting of glaciers is an example of a positive feedback loop. When ice melts, open water or land is left in its place. Both land and water are less reflective than ice, so they absorb solar radiation which in turn increases surface temperatures even more. This leads to additional melting and the cycle repeats itself.

Negative feedback loops on the other hand maintain balance within a system. Some of the best understood negative feedback loops are predator-prey relationships. For example when snowshoe hare populations increase, there is more food for lynx whose populations subsequently also increase. With increased predation from lynx, hare populations will decline thus leading to a decline in lynx populations, and so on.

A negative feedback loop with respect to climate change would be an impact that reverses the increased concentrations of CO_2 in the atmosphere that are a main driver of climate change. For example, it is possible that warming will allow trees to grow at higher latitudes where it has previously been too cold for them to survive. The growth of new trees captures CO_2, removing it from the atmosphere and potentially mitigating the greenhouse effect. Positive climate feedback loops are a big concern that could lead to a tipping point, whereas negative feedback loops are not expected to alter our current climate change trajectory.

ACTIVITY – COMPLETING THE LOOP

Students will brainstorm and visualize the feedback loops that are predicted to ensue from different climate change effects by creating systems diagrams. This can be a very challenging activity for some students and it may be beneficial to work through one or several examples as a class to demonstrate how to approach the activity.

DURATION 30+ minutes

MATERIALS

- Internet access
- Chart paper
- Markers

1. Assign the following climate feedback mechanisms to individual or groups of students and ask them to predict how they will increase (positive feedback) or decrease (negative feedback) the effects of climate change and/or global warming. As they work through their feedback mechanism, ask the students to consider how the predicted changes could ultimately effect glaciers.

Explain to students that there are many possible outcomes for the same mechanism.

- Increased forest fire activity
- Melting glaciers
- Permafrost melting
- Melting sea ice
- Forest loss
- Increased productivity in forests
- Increased storm activity
- Increased evaporation

2. Ask students to start by brainstorming the consequences of their assigned feedback mechanism. For example, forest fires produce smoke and ash, release carbon dioxide and change the species composition of the forest. Which – if any – of the consequences could contribute to further climate change? Which consequences are not expected to intensify climate change?

3. Encourage students to create as many steps in their feedback loops as possible. They may find that there are multiple loops that spin-off from the original mechanism. Ultimately they should aim to arrive back at a change in temperature and/or greenhouse gases with at least one of these loops. *Students may need to do additional online research into their feedback mechanism to understand how it will ultimately intensify climate change.*

4. Create a systems diagram, using boxes and arrows to show cause and effect within the system. Refer to Figure 1 for an example of a systems diagram describing climate feedback loops.

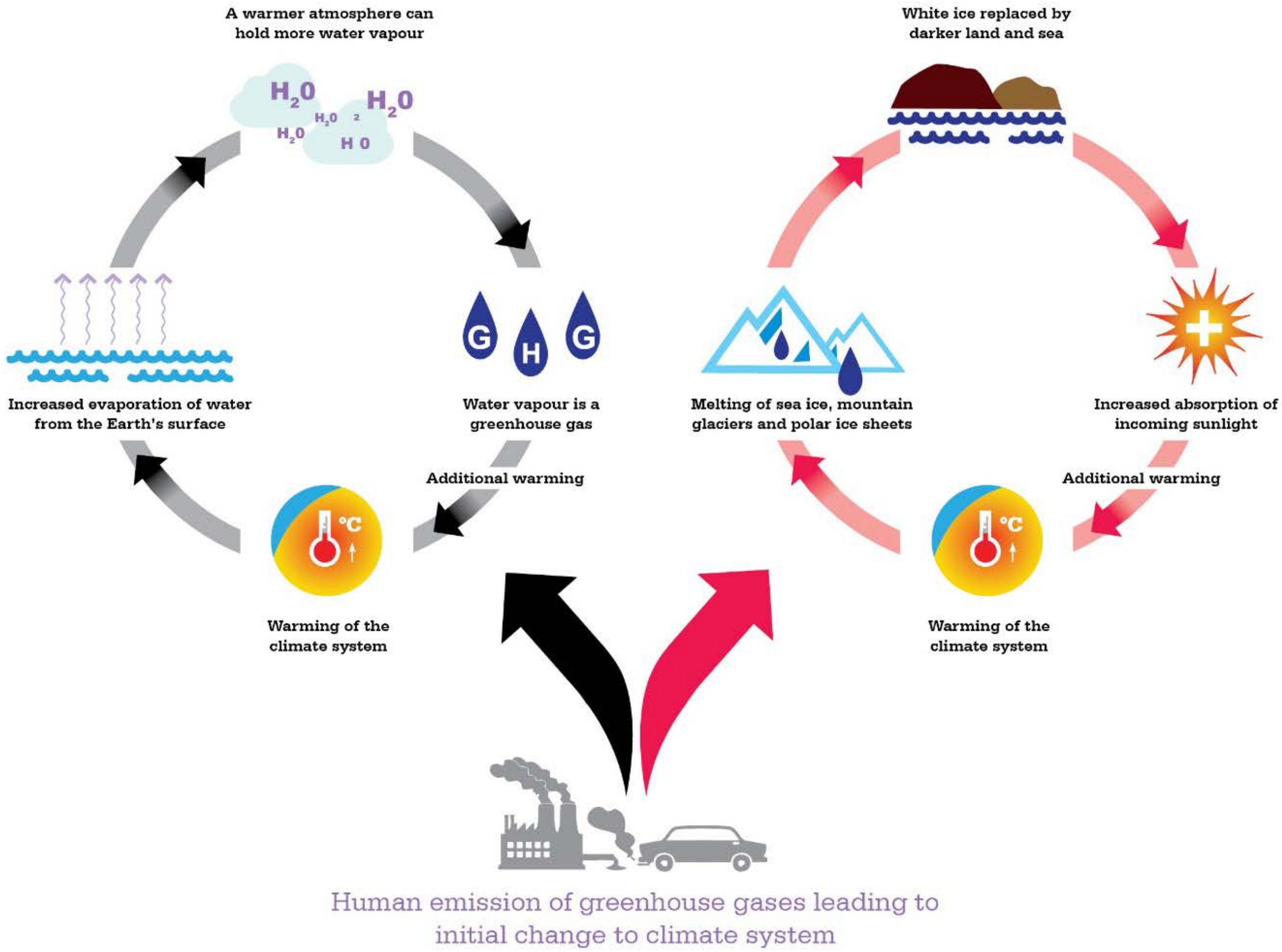
5. *Extension: SageModeler (www.sagemodeler.concord.org) is a free, web-based modeling software. It is a useful tool for getting students to think about systems and feedback loops. Students can start by browsing examples, then research and create their own climate change feedback loops.*

REFERENCES

Climate Reality Project. (2020, January 07). *How feedback loops are making the climate crisis worse.* Accessed 31 March 2020. climaterealityproject.org/blog/how-feedback-loops-are-making-climate-crisis-worse

National Snow & Ice Data Center. (2020). *All About Glaciers.* Accessed 28 March 2020. nsidc.org/cryosphere/glaciers.

Figure 1: Examples of climate change induced positive feedback loops (*Source: Climate Council, 2020*)



MEASURING GLACIAL RETREAT STUDENT ACTIVITY SHEET

PART 1: Results

What is the glacier cover of the Athabasca glacier in 1870? = _______ grid squares (a)

What is the glacier cover of the Athabasca glacier in 2019? = _______ grid squares (b)

What is the difference in glacier cover from 1870 – 2019? = a – b = _______ grid squares (c)

PART 2: Calculating the percentage cover change in the Athabasca Glacier

You can calculate the cover change of the Athabasca Glacier as a percent (x) of the original size (a). This can represented mathematically as $^{x}/_{100}$. The formula for this is:

$$\frac{x}{100} = \frac{c}{a}$$

Plug in your values for (a) and (c) and solve for (x) below (show your work):

PART 3: Calculating the rate of change in glacier cover

Number of years from 1870 – 2019 = _________ years

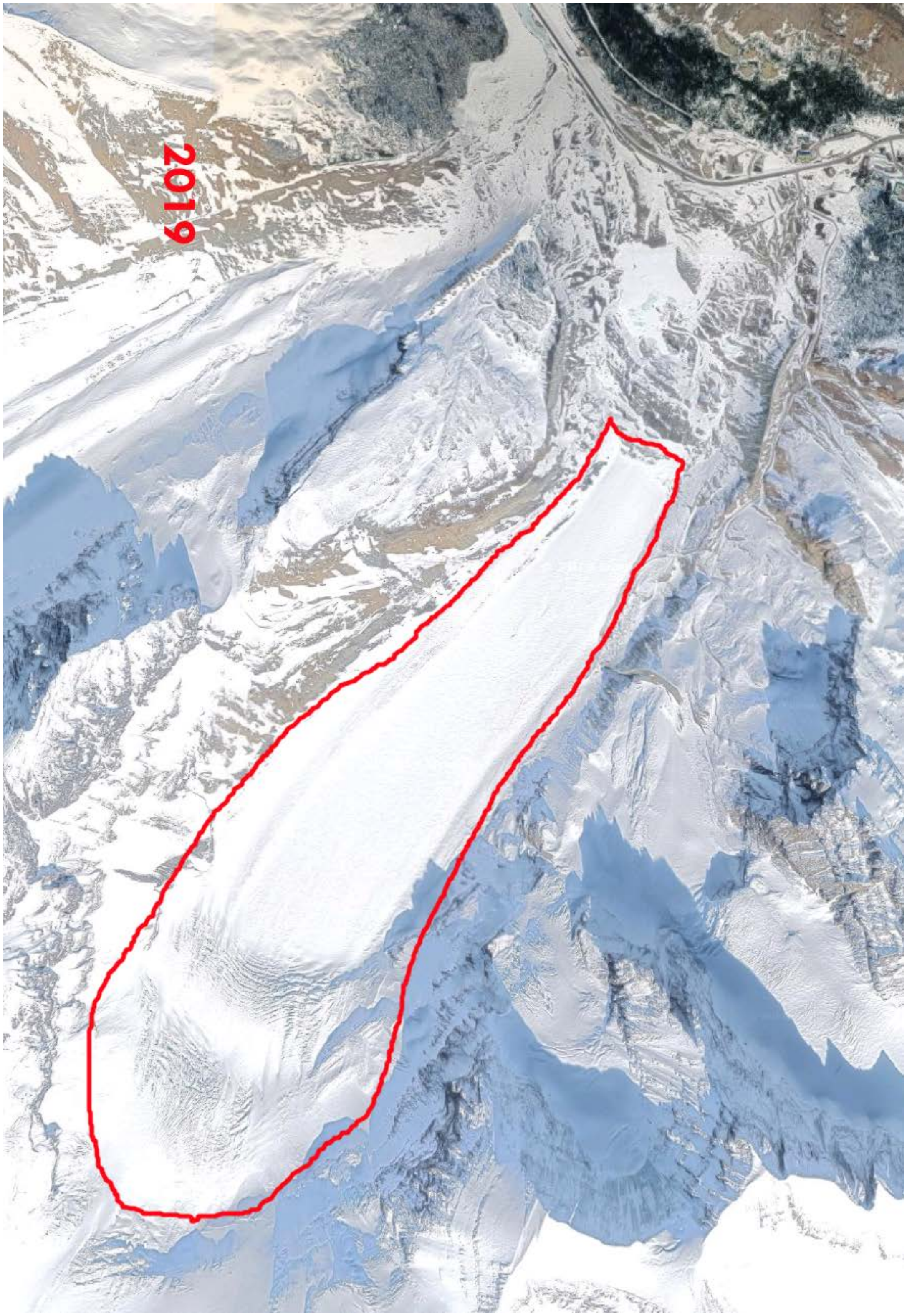
Rate of change = $\frac{\text{change in glacier cover (grid squares)}}{\text{\# of years}} = \frac{c}{\text{\# of years}}$ = __________ grid squares/year

PART 4: Estimating time before Athabasca Glacier disappearance

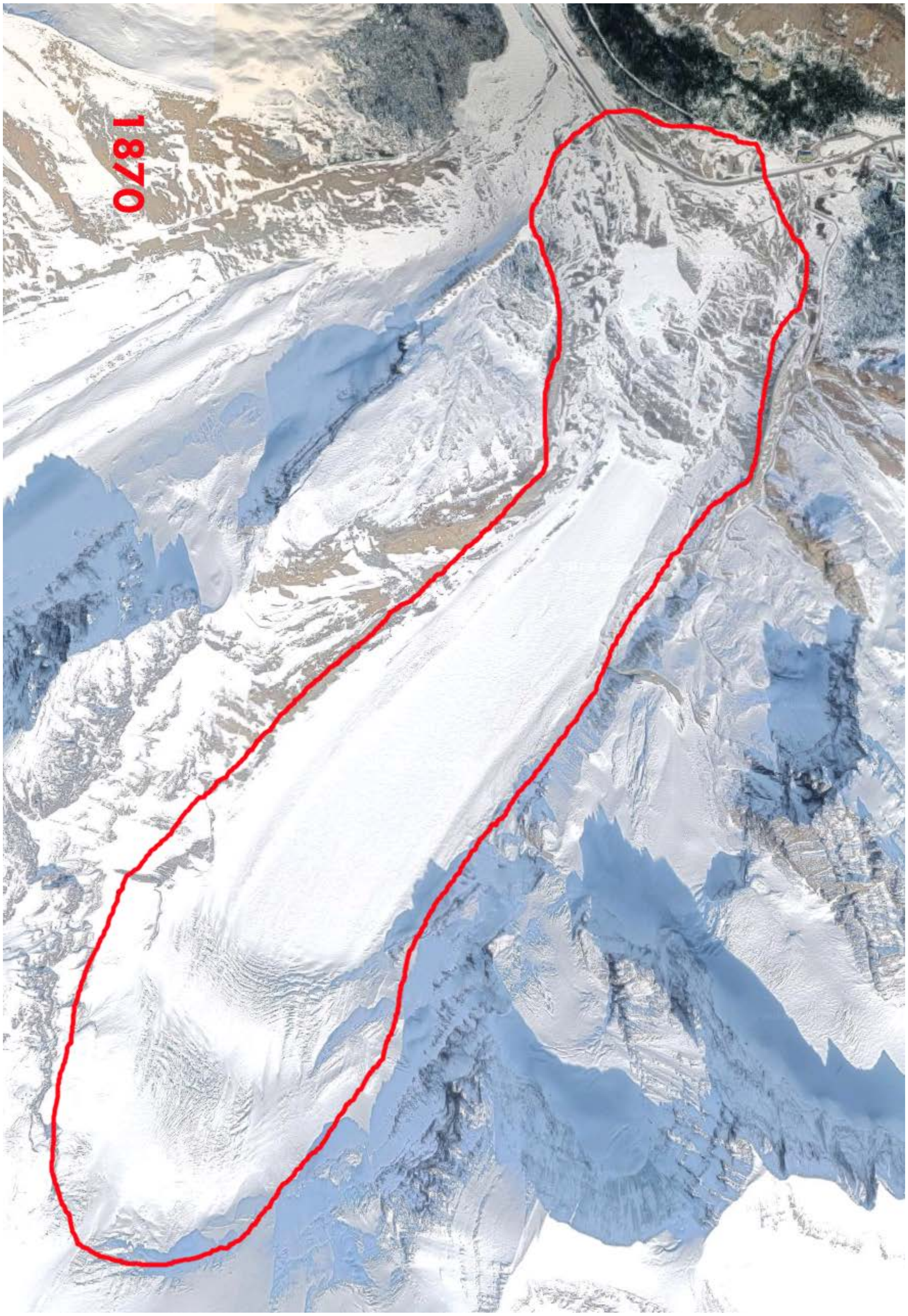
By multiplying the rate of change that you calculated in Part 3 by the current glacier cover (b), we can estimate how much longer it will be before the Athabasca Glacier disappears

Rate of change _______ (grid squares/year) × 2019 glacier cover _______ (grid squares) = ____________ years

ATHABASCA GLACIER (2019)



ATHABASCA GLACIER (1870)



GLACIERS AND FEEDBACK (Part III)

GRADE Grade 8

PART 3 of 3

TOPICS Climate change, glaciers, water cycle, feedback loops, greenhouse effect

CURRICULAR CONNECTIONS

Grade 8 Science

Unit E – Freshwater and Saltwater Systems

2. Investigate and interpret linkages among landforms, water and climate
   - Identify evidence of glacial action, and analyze factors affecting the growth and attrition of glaciers and polar ice caps
4. Analyze human impacts on aquatic systems; and identify the roles of science and technology in addressing related questions, problems and issues
   - Illustrate the role of scientific research in monitoring environments and supporting development of appropriate environmental technologies
   - Provide examples of problems that cannot be solved using scientific and technological knowledge alone

OVERVIEW

In Part I and Part II of this lesson, we explored how glaciers form and the impact that climate change is having on alpine glaciers. In this final part, we turn out attention towards better understanding how people can adapt to and mitigate the effects of climate change on glaciers. The activities that follow help students better understand how human values shape our responses to scientific information and how we can craft messages to convey the importance of responding to the threats posed by climate change.

OBJECTIVES

- Students will learn to distinguish between the root causes and symptoms of a problem
- Students will understand the difference between actions that are mitigations for climate change and those that are adaptations
- Students will understand the importance of a well-crafted message when communicating the science and impacts of climate change

KEY TERMS

- **Adaptation** – the process of changing to suit different conditions
- **Mitigation** – the action of reducing the severity or seriousness of something
- **Net-zero building** – a building with zero net energy consumption, meaning that the total amount of energy used by the building in a year is equal to the amount of renewable energy created on site
- **Root cause** – the main underlying reason for a problem
- **Symptom** – the reaction to a problem

GUIDING QUESTIONS

- Is your individual energy better spent addressing the symptoms of climate change or the root causes? Why?
- What are strategies that we can use to communicate the science of climate change to diverse audiences?

BACKGROUND ESSAY

When we think about tackling the challenges posed by climate change, it is important to make the distinction between **adaptations** and **mitigations**. Mitigations are actions that are taken to address the **root cause** of climates change by reducing greenhouse gas emissions. Adaptations on the other hand seek to address the symptoms or impacts of climate change and reduce our vulnerability to its effects. By understanding the predicted impacts of climate change we can make changes to be better prepared. Both mitigations and adaptations are important considerations for our communities to address the threats posed by climate change.

GO BEYOND

Hot Planet, Cool Athletes is a not-for-profit, charitable organization dedicated to educating and inspiring the next generation of climate champions. The goal of the program is to inspire high school students to be climate leaders in their schools, communities and beyond. You can book a program in your school by visiting www.hotplanetcoolathletes.ca.

DURATION 20-30+ minutes

MATERIALS

- Agreement signs (optional)
- Tape
- "Take a Stand" prompts

In Part I we learned that glaciers are an important freshwater resource, especially for irrigation. By improving water infrastructure and water use efficiency in agriculture, farmers can increase their resiliency to dry periods that are expected to become more common in the future. In areas that rely on glacier meltwater for hydropower, communities can explore alternative forms of energy production such as biomass generation or wind power. And finally glaciated areas that rely heavily on tourism can look into expanded forms of tourism. Adaptation is an important piece of the puzzle, especially given the uncertainty surrounding climate change timelines and feedback loops.

There are many actions that individuals can take to mitigate climate change with the goal of slowing down the worst predicted impacts. The actions that are the most realistic and the most impactful will differ from person to person. What matters most is that we all do what we can to create the largest impact. Some actions that address the root causes of climate charge – greenhouse gas emissions – include:

- Eating less meat
- Choosing alternative transportation wherever possible, such as carpooling, walking or biking instead of driving alone or flying
- Buying only what you need and reusing whenever possible
- Considering who you can influence and what is the best way to do so, such as friends, family and lawmakers

ACTIVITY – TAKE A STAND

This activity asks students to respond to a number of provocative statements on climate change. It will challenge students to explore their attitudes and opinions and those of their classmates on complex environmental and social challenges.

1. Identify an area in the programming space where students can stand along a line, a U-shape or in designated areas. Place *"Strongly Agree"* and *"Strongly Disagree"* signs at opposite ends of this line or designated areas.

2. Before beginning, outline to students the important of showing respect to classmates and others who hold opinions that differ from their own. Ask students to offer their opinions or stance using *"I"* language, rather than the more accusatory *"you."*

3. Explain to students that you are going to read a statement. You will give the students a few seconds to reflect on the statement and then they will move to a spot along the line that represents their opinion on the statement. Tell them that if they stand at the far end, they are indicating that they firmly agree or disagree. They may stand anywhere between the two extremes, depending on how much they do or do not agree with the statement. *You may wish to begin with one or two statements*

that are simple in order to ensure that students understand the activity, for example "cats are better than dogs."

4. Invite students to explain why they have chosen to stand where they have and encourage the students to refer to examples and evidence when they explain their position. Emphasize that there is no wrong or right position.

5. After several viewpoints have been shared, ask the students if anyone would like to move. Encourage students to keep an open mind; they are allowed to move if someone else presents an argument that alters where on the line they want to stand. Ask students to respond to statements made by their peers.

CASE STUDY

How do the opinions of your students compare to those of adults across Canada? The Yale Program on Climate Change Communication created the Canadian Climate Opinion Maps, which estimates and visualizes differences in perceptions, attitudes and support for climate policy across the country, riding by riding. View the map at bit.ly/3aA1cU1.

Extension Activities

6. Lead a discussion about the clash of opinions that resulted from sharing different perspectives on issues related to climate change.
   a. What are some of the underlying values that might inform people's opinions? Brainstorm strategies for overcoming these differences of opinion.
   b. Ask students about what would happen if you took a vote on the statement in question. Ask the students who lost how they feel about the outcome.
   c. Challenge students to modify the statement in a way that everyone in the group can agree on the statement. Students should recognize strategies to help them find common ground on the issue.

7. Have students pair up with someone who had a different opinion than their own. Invite students to find out why their partner stood where they did and to understand their perspective.

8. This activity can be used to set up a class debate on an issue. Choose a statement that has created a clear divide among the group. Have each side formulate their arguments, which they can then present to the other side using a debate format. ***Note: Avoid debating whether climate change is human-caused, as this may lead to students developing conclusions that are rooted in bad science or misinformation. Facilitate a discussion about developing persuasive arguments and citing reliable sources and facts prior to conducting research for this debate.***

"Take a Stand" prompts

- Climate change is the most pressing challenge facing the world today.
- Earth's climate has changed in the past and therefore we don't need to be too concerned with climate change.

- Humans can solve climate change using technology alone.
- Humans can solve climate change without compromising their quality of life.
- Humans have a moral responsibility to solve climate change.
- Drought and extreme weather conditions attributed to global warming are really just part of the natural fluctuations of the global climate system.
- Canada should immediately cease all oil and gas extraction.
- When it comes down to it, protecting jobs in the short run is more important than protecting the environment for future generations.
- Automobile manufacturers should be required by law to produce only electric vehicles, even if it costs the consumer more.
- People should be required by law to recycle and compost their waste.
- Wealthy countries who emit more CO_2 should be required to pay developing nations that are more impacted by climate change so that they can adapt.
- Canada should increase taxes on carbon-based fuels in order to offset emissions.
- All new buildings should be built to **net-zero standards**

BACKGROUND ESSAY

While 97% of scientists agree that the earth's climate is changing and that these changes are caused by human activities, only 70% of Albertans believe that the climate is getting warmer. That is 13% below the Canadian average, according to a 2018 Canadian Climate Opinion Map created by the Yale Program on Climate Change Communication. Being able to communicate the science of climate change to our peers, neighbours and society at large is a vital skill.

Furthermore public opinion on climate change is an incredibly important input for the development of climate change mitigation and adaptation policies. Without public support, governments will face much more pushback for introducing measures like carbon taxes that are meant to offset carbon emissions and will therefore be less likely to take the decisive action necessary to curb emissions.

While communicating accurate scientific information is incredibly important, we should also consider the language that we are using and the way that we are framing the conversation. If people are confronted with scientific evidence that appears to attack their values, they are much more likely to become defensive. In turn, they may consider the evidence they are receiving to be flawed, thus strengthening conviction in their prior beliefs.

Consider this: we have learned that glaciers are melting at an unprecedented rate due to the enhanced greenhouse effect. This is already contributing to more severe droughts, increased forest fires,

KEEP READING

The Alberta Narratives Project (ANP) is a community-based initiative that aims to uncover language and narratives that reflect the values and identities of Albertans, and to find ways of talking about our energy-climate future that build bridges to better community conversations. The ANP produced two reports that are intended to provide practical guidelines for climate and energy communicators about what language works well and what language might pose an obstacle for communicating with any specific group. Learn more by visiting www.albertanarrativesproject.ca.

and changing access for recreation. Rather than talking about the science of climate change to your audience, present information in a way that takes their values into account. Communicating with a farmer? Talk about changes in access to water or the consequences of warmer winters. Communicating with a backcountry skier? Discuss changing access to sought-after routes or traverses and heightened danger due to new crevasses. In order to teach, inform and connect with people, we need to be effective storytellers.

DURATION 60+ minutes

MATERIALS

- Internet access

ACTIVITY – COMMUNICATING THE SCIENCE OF CLIMATE CHANGE

In this activity, students will assume the role of a climate scientist trying to address misconceptions about climate change. Students can identify their own misconceptions or choose from a list.

1. Students will choose (or be assigned one) from the following list of misconceptions about climate change, or identify their own.
    - The Earth's climate has always changed, this is no different
    - Plants need carbon dioxide and more is better
    - Global warming can't be real because it is still cold in the winter
    - Climate change is a problem that is in the future
    - Renewable energy can only work when it is windy or sunny
    - Animals will adapt to climate change
    - China emits more carbon dioxide than Canada, so why should Canada be responsible for dealing with climate change
    - Climate change is due to sunspots

2. Ask students to research and write a letter refuting the misconception that they have chosen. Students should try to understand the underlying assumptions and values that have led to people adhering to this misconception. What is the evidence or reasoning behind the misconception and how will you refute it using scientific reasoning? Alternatively, students can present their arguments in any number of ways such as a class presentation, a letter-to-the-editor, or an opinion piece for the local newspaper.

3. *Extension: Explore creative ways to have the students share what they have learned with the school or the community.*

REFERENCES

Climate Reality Project. (2017, November 09). *Communicating climate change: focus on the framing, not just the facts.* Accessed 1 April 2020. www.climaterealityproject.org/blog/communicating-climate-change-focus-framing-not-just-facts

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