**Lesson in a Backpack**

Includes:

Final Report, Classroom Teaching Material, Human Impact Assessment Activity, Georgian Bay Climate Change Worksheet

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Completed for: Georgian Bay Biosphere

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# Lesson in a Backpack: Climate Change

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ERST 4830: Project 5102

06/04/2023

# Final Report

The purpose of this project was to develop a "lesson-in-a-backpack" (LIAB) for Grade 8 students centered around the health of Georgian Bay, specifically pertaining to climate change. Georgian Bay Biosphere (GBB), a UNESCO biosphere reserve and the host organization for this project, provides free resources for local teachers to educate their students about the local environment. One service they provide are "lessons-in-a-backpack", which are various lesson plans for teachers to deliver in accordance with Ontario curriculum guidelines. Climate change is a topic these students have heard of before but is not something that they learn about in depth at this point in their education. Initially, as indicated in the progress report, a focus of this project was meant to be about invasive species, but that subject is already covered by other LIABs and is a concept students this age are already relatively familiar with. Additionally, climate change is more compatible with Ontario curriculum expectations, which necessitates an understanding of water science in the context of the changing world. Climate change is a much more broad and less physically tangible subject, making it a more challenging concept for students this age to grasp. Many steps were taken throughout the development of this LIAB to ensure that students would be able to easily understand such an extensive and complicated subject, mostly through easy-to-understand language and a focus on framing issues as tangible instead of conceptual. The vast majority of research was done using the GBBs own resources. Every five years, they release an extensive report detailing the health of Georgian Bay. The 2018 report was central to this project, as was the upcoming 2023 report.

The lesson (Appendix A) centers primarily on a presentation, the first half of which covers the technical processes of climate change and what general impacts are occurring and will occur on a global level. Halfway through, students are given copies of the 2018 GBB magazine

and are tasked with reading a four-page section which details the impacts climate change has been having and will have on Georgian Bay. They are then tasked with completing a worksheet developed for this project which centers around what they just read. Afterwards, the presentation continues, focusing on a local framework. It finishes on looking at solutions for both global and local contexts, while also addressing climate grief. Throughout this presentation, students are asked to deliberate in breakout groups in order to facilitate discussion, bolster engagement and prevent boredom. The second activity is a Kahoot quiz which is meant to test the knowledge of students on this subject in a fun and competitive way and is meant to be done right after the presentation. The third activity is a human impact assessment (Appendix B), wherein students in their breakout groups go outside and assess the environment around them themselves. Each group is given a worksheet and are tasked with assessing human-caused environmental issues such as waste, transportation, energy, soil issues, water issues and biodiversity issues. They must write down what they notice about each concept listed. Each section has a few questions which asks students to ground their thinking and connect each issue to the other, and ultimately connect them to climate change. The purpose of this activity is to get students outside and moving in order to have them engage deeply with the environment, and so they can very palpably understand broad environmental issues. Two extension activities were developed as well, one which directly connects to the human assessment impact activity, being a community clean up. In this extension activity students are tasked with collecting whatever garbage/recycling they find outside while already outside looking for litter. The second extension activity is climate change dodgeball, which is meant to be a fun and exciting game for the students to play that displays the mechanics of the greenhouse effect. The game has some students forming an inner circle representing the earth, some students forming an outer circle representing greenhouse

gasses, and one student running around who represents the sun. The ladder student throws dodgeballs/hacky sacks into the inner circle, who then tries to throw them back out into space. The outer circle of students try to prevent them from doing this. In the following rounds, more students are made to fill the outer circle in order to make it more difficult for the inner circle to complete their task. Also included in the LIAB is comprehensive background information for educators delivering it, as well as extra resources.

In early March, the presentation was piloted in-class at a local school in Parry Sound. The students were very receptive to the material and were, for the most part, consistently engaged due to the subject matter and the deliberation they had in their breakout groups. The teacher noted that separating the presentation into general global concepts before moving on to more tangible local impacts was a great idea that really helped to compartmentalize the subject matter. The biggest takeaway from the piloting was that because the students were not well versed in the mechanics and processes of climate change, they seemed to be deeply mired in climate grief. A section detailing climate grief was later added to the presentation in order to address the fear that many youth feel, noting that paralyzing fear is not productive and that there is hope for the future. All in all, this project was a success. Educators local to Parry Sound now have additional resources to teach their Grade 8 students about a difficult and relevant subject in dynamic and comprehensible ways, and students should feel educated and relieved to be taught this LIAB.

As the researcher, I would like to extend my thanks and gratitude to the GBB for hosting this project. It was a great experience I learned a lot from, and one which I felt helped prepare me for employment prospects down the line. The GBB staff who worked with us, Aliena Hoskins and Katrina Krievins, were helpful and proactive and overall, I really enjoyed my time developing this LIAB with them and I hope that it gets put to good use. I would also like to thank

Professor Stephen Hill and Matthew Walmsley for their advice, guidance and supervision over this project, as well as Professor Brendan Hickie for leading the class. Finally, I would also like to thank fellow researcher Sophia Ramirez-Hennessey, who also developed a LIAB with the GBB, for being a great partner for this project.

Below, the LIAB in question (Appendix A), followed by the human impact assessment activity (Appendix B), and then the climate change worksheet (Appendix C) can be found. The presentation slides are attached separately.

Appendix A: Classroom Teaching Material

Lessons in a Backpack

United Nations Educational, Scientific and Cultural Organization

GEORGIAN BAY BIOSPHERE MNIDOO GAMI Spirit of the Wate

# LIAB: Climate Change

## At a Glance

**Grade Level: 8**

**Learning Environment:**
Indoor Classroom
Schoolyard

**Prep Time:**
5-15 minutes

**Length of Lesson:** 1 hour – 1.5 hours

**Key Vocabulary**: Anthropogenic, Feedback Loops, Greenhouse Gasses

**Staffing: 1 - 2**

**Materials:**
1. Microsoft PowerPoint/Google Slides
2. Copies of the 2018 Ecosystem Health Report
3. Kahoot and Relevant Devices
4. Activity Sheets (Provided Here)
5. Pens/Pencils, Clipboards
6. Protective Gloves & Garbage Bags

**Groupings:** Breakout Groups of two to Four

**Teaching/Learning Strategies:** Involved lecture, discussions of thoughts

## Description of Lesson

In this lesson, students will learn about the concepts, mechanisms and effects of anthropogenic climate change on a global and local level. They will learn what it will mean for their lives, as well as what they can do to help mitigate it.

## Connect with the Georgian Bay Biosphere

**www.gbbr.ca**
**(705) 774-0978**
**education@gbbr.ca**



GEORGIAN BAY BIOSPHERE MNIDOO GAMII Spirit of the Water

# Lesson Outline

| TIME | ACTIVITY | LOCATION | MATERIALS |
|---|---|---|---|
| 30-40 mins | PowerPoint Presentation and Worksheet | Classroom | Microsoft PowerPoint/Google Slides, Copies of the 2018 Ecosystem Health Report, Copies of Worksheet |
| 10-15 mins | Kahoot Quiz | Classroom | Kahoot and Relevant Devices |
| 30-60 mins | Human Impact Assessment | Schoolyard | Provided Activity Sheets, Clipboards, Pens/Pencils |
| 15-30 mins | Climate Change Dodgeball | Outside/Gym | Dodgeballs/Beanbags/Hacky Sacks, Bandanas or Bibs of Various Colours |
| | | | |

# Curriculum Expectations
# Grade Level and Subject Area

**UNIT**

*Overall Expectations*

D1. Relating Science and Technology to Our Changing World

E1. Relating Science and Technology to Our Changing World

E2. Exploring and Understanding Concepts

Specific Expectations

D1.2 assess the impact on individuals, society, and the environment of alternative ways of meeting needs that are currently met by existing systems, taking different points of view into consideration

E1.1 assess the social and environmental impact of the scarcity of fresh water, and propose a plan of action to help address fresh water sustainability issues

E2.3 explain how human activity and natural phenomena cause changes in the water table

E2.4 identify factors, including climate change, that have contributed to the melting of glaciers and polar ice-caps, and describe the effects of this phenomenon on local and global water systems

# Background

Over the last few years in particular, climate change has become an issue of grave concern. Its long lasting and worsening impacts are of particular concern to young people, making this a sensitive issue for many Grade 8 students. Climate change is the process by which the average atmospheric temperature is increasing due to human activity. As $CO_2$, methane gas, and other greenhouse gasses are released into the atmosphere due to industrial and agricultural activity, more heat is trapped within the atmosphere due to the greenhouse effect. When the sun's rays hit Earth, some of it is absorbed and some is reflected back into space. Greenhouse gasses have the capacity to absorb reflected and released heat, storing it for centuries - thus the name 'greenhouse effect'. As more and more greenhouse gasses are released into the atmosphere, the atmosphere's capacity to store heat increases accordingly. Climate change is indeed human-caused, or 'anthropogenic'. During the last 150 years since the industrial revolution, $CO_2$ levels have gone from 280 parts per million to 400 parts per million.

The heating of the planet has already had detrimental effects on the environment: atmospheric heating has increased the amount and intensity of natural disasters, floods, droughts, and fires across the globe. The melting of glaciers and the ice caps is contributing to rising sea levels, as well as the desalination of ocean waters. Additionally, climate change exacerbates already existing environmental issues, culminating in species extinction and soil infertility. Such environmental effects have severe consequences for humans: agricultural activities will become much more difficult as wells dry up and soil degrades, and areas close to the equator may become uninhabitable.

Global temperatures are increasing exponentially due to a phenomenon known as positive feedback loops. An example of this would be that, as global temperatures rise, ice melts and more ocean is exposed. Since ice reflects the sun's rays and water absorbs it, more heat is absorbed, which melts the ice even faster. Should the global temperature rise by 2°C, the ice caps and glaciers will melt at unprecedented rates and will result in sea levels rising substantially, most significantly affecting coastal areas.

While climate change has a large scope, its impacts are most discernible on a local level. The Canadian Ice Service has taken weekly measurements of the ice cover and water temperature of Georgian Bay since 1973. Additionally, the Great Lakes are frequently monitored using weather stations, research laboratories, and buoy monitoring which helps measure the impacts of climate change. To track ice cover, a variety of methodology is used, including real-time satellite imagery, the measurement of lake levels and water movement patterns, the measurement of maximum and average ice thickness, and the tracking of the duration of ice cover. Additionally, ice on/off dates - the periods of the year in which ice forms and melts - also help define climate trends. While there is considerable variation year to year, the overall linear trend for maximum ice cover of Lake Huron has decreased steadily and significantly since 1973.

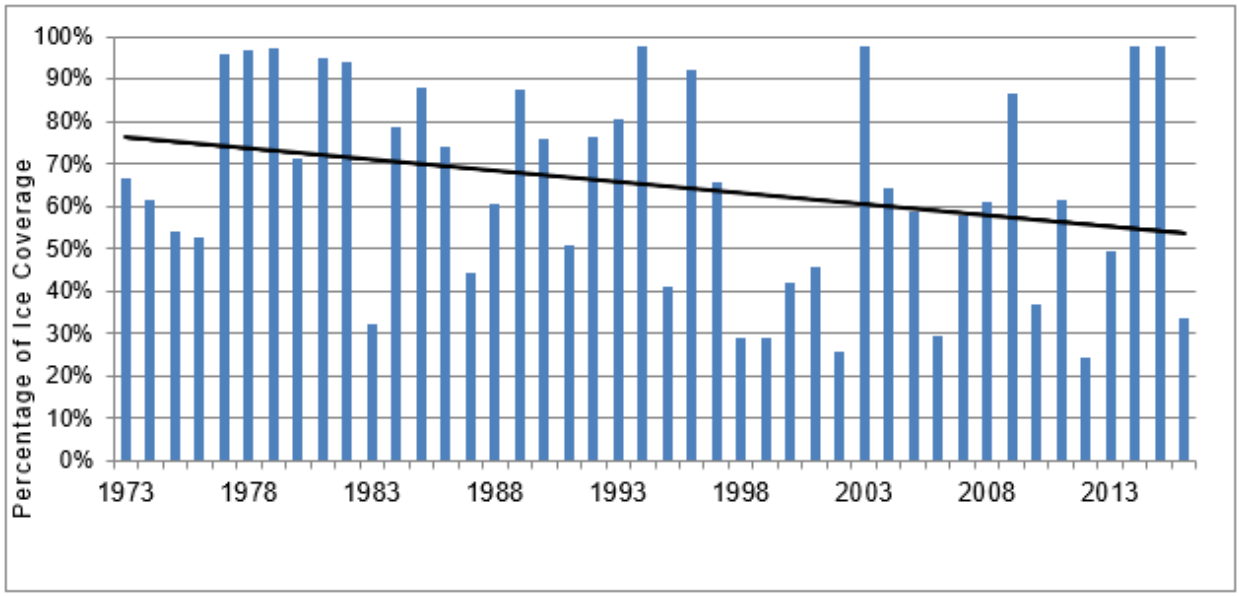


Fig. 1: The maximum annual ice coverage for Lake Huron, 1973 to 2016 (Canadian Ice Service). Blue bars indicate percentage of ice cover, and the black line represents the linear trend for maximum ice cover over 43 years. Learn more at ec.gc.ca/glaces-ice

Water temperature has experienced a similarly alarming trend, with Lake Huron's average summer surface water temperature increasing at a rate of approximately 0.9°C per decade from 1980 to 2014, with average autumn water surface temperature having increased by an average of 4.1°C since 1970. While these changes in temperature do not seem significant at a glance, over the course of a century, such changes become significant enough to alter entire ecosystems. Even small average temperature changes can prove environmentally significant to increasingly fragile and vulnerable habitats. Shallower bodies of water, like Lake Erie, are even more adversely affected.

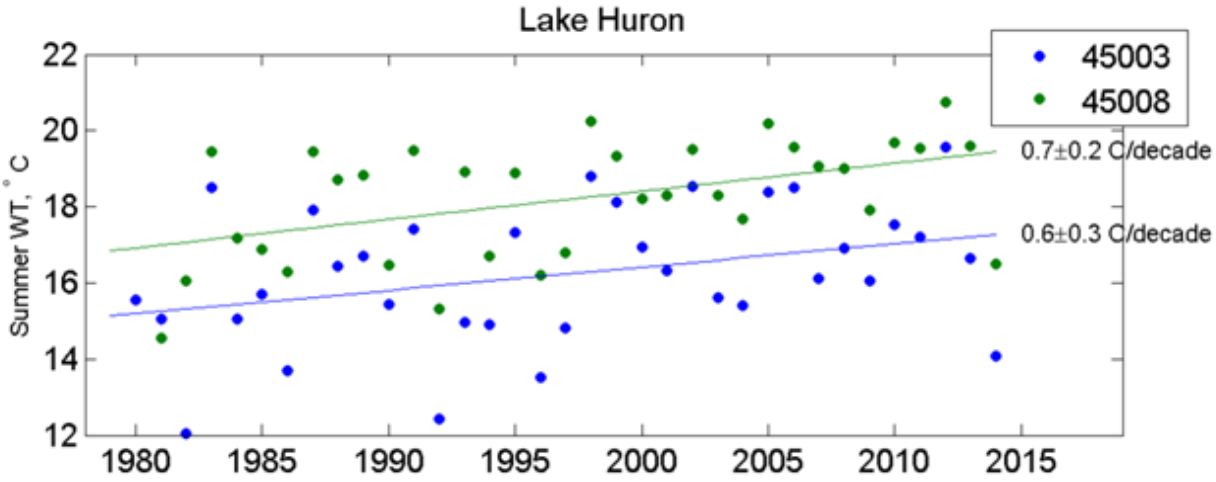


Fig. 2: Summer (July-September) surface water temperature trends for Lake Huron (buoys 45003 and 45008 are located in the main basin of Lake Huron).

It must also be further emphasized that warming trends are exponential. Six of the warmest water temperatures ever recorded in Severn Sound are from the past seven years. While much more research needs to be done, it is an unfortunate truth that warming trends will continue to worsen. Of course, it is not just water that is warming up: air temperature in Severn Sound has increased by an average of 1.9°C since 1974.

Like most ecosystems, Georgian Bay has already been tangibly impacted by climate change, as climate plays a vital role in freshwater ecosystems. In 2017, the spring storms in Quebec and eastern Ontario saw a record 155 mm of rain drop in less than 24 hours. The subsequent flooding caused an estimated $226 million in insured damages alone. Georgian Bay is currently seeing the gradual collapse of its food web due to warming waters and invasive species (which become emboldened as the temperature rises).

Climate change is putting our future into question. Many of the world's most powerful computers are being used to generate climate models which show what the climate was like in the distant past, helping scientists to understand and determine what the climate may be like in the distant future. The climate atlas is a tool in Canada used to determine future climate scenarios for specific places regarding temperature, precipitation, frost dates, etc., which is useful in predicting areas of drought and flooding across the nation. The worst case scenario for warming is an RCP of 8.5, or an increase in warming by about 4.3°C from pre-industrial levels by 2100. This scenario will see Parry Sound is experience 55.8 icing days in the immediate future, and fewer than 40 by 2050. The amount of very hot days in Parry Sound are set to increase by a large amount, from 1-2 per year throughout 1976 to 2005 to over 10 per year come 2050. Warmer winters and hotter summers have deep environmental implications, as they alter the hibernation and breeding processes for native species, permit diseases to spread more rapidly as insect egg cycles are disturbed, allow invasive species to run more rampant, cause groundwater shortages and more. These consequences directly impact humans, as they make agriculture more difficult and excessively hot days are dangerous to the young and the elderly.

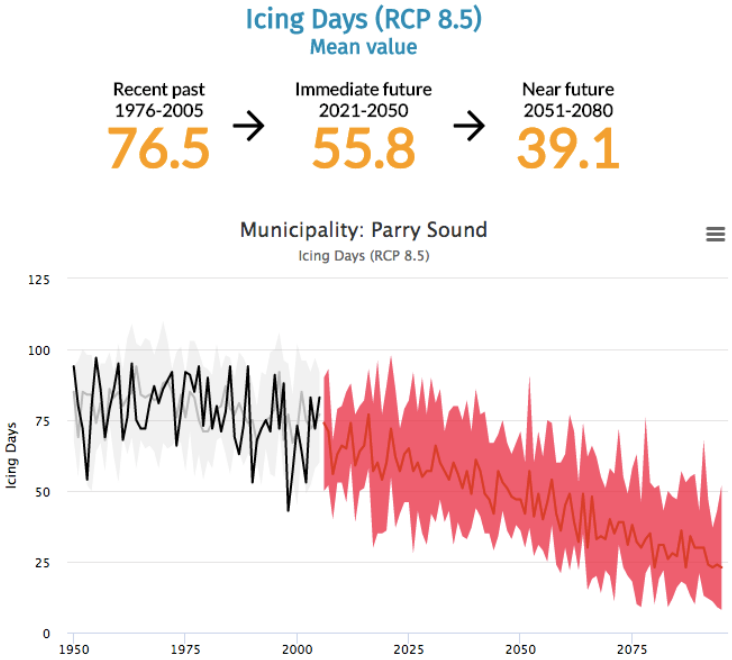


Fig. 3: Average number of icing days (<0°C) for Parry Sound (Climate Atlas of Canada, 2018).

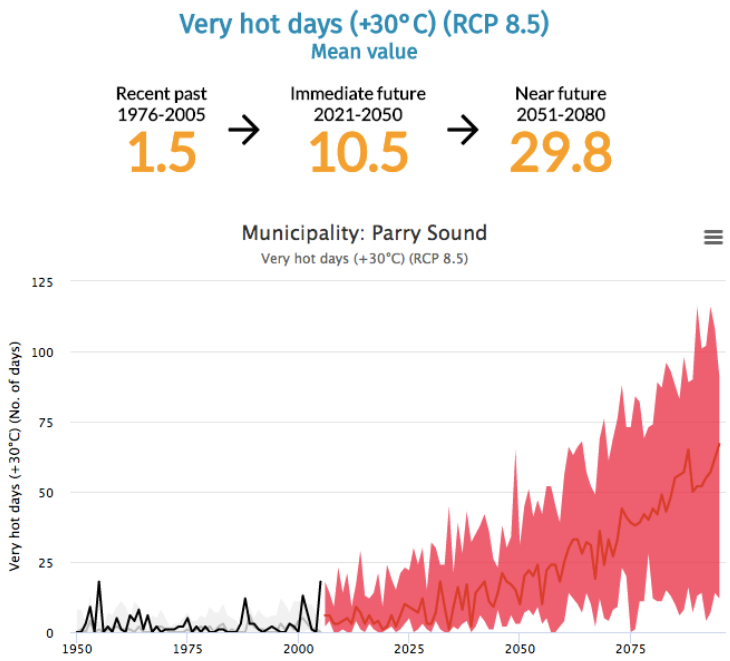


Fig. 4: Average number of very hot days (+30°C) in Parry Sound (Climate Atlas of Canada, 2018).

The reason why it is important to understand the worst case scenario is because it shows that there are varying outcomes. While it is increasingly unlikely that humans will be unable to stop heating from exceeding 1.5°C by 2100, it shows my it is important to limit heating as much as possible. Climate grief is a common feeling among today's youth, who believe that their futures have little hope in regards to the environment. This feeling contributes to apathy and a lack of action and/or accountability when in reality, any kind of reduction of potential heating is significant. It is important to understand this, as solving climate change is no easy task. As a collective action problem, it requires not only cooperation between countries, but between people, governments and corporations. One thing is certain: there is a scientific consensus that anthropogenic climate change is real, it is severely threatening to the ecosphere, and therefore threatening to the capacity for humans to live comfortably - particularly the world's poorest. Adapting to the effects of climate change will be no easy feat, even for the world's wealthiest nations. Sufficient scientific knowledge is paramount to this, as is an understanding and caring government and populace. Mitigating climate change sufficiently will require not only government action, but action on the part of everyone: as it stands, environmentally oriented behavior should be encouraged, such as using less energy, eating locally, taking public transportation, reducing waste, consuming less commodities, and getting involved in the community and in politics.

**Due to increasing average air and water temperatures as a consequence of climate change, ice cover has become weaker: it melts faster in the spring and grows more slowly in the winter. This interrupts many things including the breeding patterns of aquatic invertebrates, the life cycles of aquatic plants, the protection of certain fish eggs, as well as the ability for people to engage in relevant recreational activities.**

# Teaching and Learning

## Part A. Climate Change PowerPoint

- It is encouraged for you to read through the speaker notes of this presentation thoroughly beforehand.
- Throughout this presentation, there are several questions that may be posed to the class. Have students discuss their thoughts in breakout groups of two or three and then have them groups report their thoughts to the rest of the class.
- There is also a portion for individual work, which includes the discussion of answers within their breakout groups.

The PowerPoint is attached to a different document. The speaker notes go as follows:

**Slide #1: Title**

**Slide #2: Class Question: What is climate change?**

1. Students should be broken up into pairs or groups of three, which they will be a part of for the entirety of this presentation. After forming groups, give them some time (and materials to write with if they wish) to come up with some short answers or thoughts which they can share with the rest of the class.

2. This would be a good opportunity to ask students about how climate change makes them feel as well.

**Slide #3: The Greenhouse Effect**

1. Elaborate on what was discussed in the question period.

2. The sun's rays are either absorbed by the planet or reflected back into space.

3. Much more heat is absorbed than reflected, as water is a key absorber of heat and our oceans cover most of the Earth's surface.

4. Certain gasses have the capacity to absorb and trap excess heat in the atmosphere that otherwise would have been reflected or released into space, with $CO_2$ being the prime example.
    4.1. Other gasses, such as $CH_4$ (methane), are significant as well.

5. This warming is exponential: the warmer the planet gets, the more ice melts.
    5.1. When ice, being the primary reflector of the sun's heat, is melted, more ocean is exposed. The oceans are a primary absorber of heat, meaning that as more of it becomes exposed and more heat is absorbed, the planet warms faster, melting the ice at an even faster rate. This is a process known as a feedback loop, whereby environmental degradation is accelerated as a result of an intricate balance being disrupted.
    5.2. A feedback loop can be described as the process of warming being accelerated due to changes induced by warming.

**Slide #4: A Changing Climate**

1. Humans have been releasing more and more $CO_2$ into the atmosphere every year, systematically warming the planet.

2. Greenhouse gas emissions are rising in virtually every country every passing year.

3. According to most sources [including Reuters], the average global temperature has risen by 1.3°C, and that we may cross 1.5°C by the end of the decade.

4. While it is true that the climate has changed before, it must be noted that at no point in verifiable history has it undergone a change so rapidly.

    4.1. With feedback loops and a continual rise in fossil fuel use, warming has gone from a rise in 0.08°C per decade in 1880 to 0.18°C per decade since 1981 according to the NOAA - a number that is steadily increasing.

5. There is a scientific consensus that climate change is caused by human activities - making it an 'anthropogenic' phenomenon.

    5.1. Greenhouse gasses, however, have always existed in the atmosphere, meaning it should be emphasized that the greenhouse effect is not inherently anthropogenic, but that it is a process significantly exacerbated by anthropogenically released greenhouse gasses.

**Slide #5: Class Question: What sources of emissions are there?**

1. Continuing in their established pairs/groups, students should be discussing where such high volumes of $CO_2$ and other GHGs (greenhouse gasses) are coming from in regards to human activity, and share their thoughts with the class. As students share such thoughts, a list can be made on the board, with more frequent answers being emphasized.

**Slide #6: Sources of Emissions**

1. An array of pictures demonstrating the biggest sources of emissions: industry, energy, shipping, transportation, agriculture and waste.

2. Any answer not discussed in the question period should be emphasized here.

3. Although it will be discussed later on, this would be a good point to ask students their thoughts on sources of emissions, and what could be done to curb such emissions.

**Slide #7: Emissions in the Biosphere**

1. This infographic covers specific emissions data in Parry Sound.

2. 98% of Parry Sound emissions come from the community, not corporations - a stark contrast from most other places in the province.

3. The vast majority of these emissions are transportation related, including on-road transportation (cars), waterborne transportation (personal boats), and off-road transportation (ATVs, snowmobiles, dirtbikes, etc).

4. Corporate emissions include fleet, facility use, and wastewater.

5. Local emissions can mostly be boiled down into buildings (yellow), transportation (red) and waste (green).

**Slide #8: Environmental Impacts**

1. Knowledge about climate change is constantly being expanded.

    1.1. A lot about it is not yet fully understood, as it is very complicated. It must be emphasized, however, that there are aspects that are overwhelmingly clear, such as that it is indeed anthropogenic, that it is an increasing threat to delicate ecosystems, and that it will have a tangible impact on humankind.

2. As the planet warms, glaciers and the ice caps are melting, causing sea levels to rise. This poses an existential threat to those living in communities next to the shore.

3. Floods and droughts are becoming more common and more severe due to fluctuations in temperature affecting precipitation. Droughts are often worsened by human consumption of water.

4. Changes in atmospheric temperatures cause weather events to become more frequent and more severe, particularly hurricanes and other storms, as well as fires, which have the capability of being very destructive.

5. A warming atmosphere means milder winters and hotter summers, interrupting breeding patterns, migration patterns, and life cycles, damaging entire ecosystems.

**Slide #9: Climate Over Time Activity**

Climate Change Time Machine: https://climate.nasa.gov/interactives/climate-time-machine/

1. This activity can be done in breakout groups or with the whole class depending on whether or not students have access to computers.

2. In breakout groups, students can play around with the website, which will show them the long-term global trends of climate change.

3. As a class, go through each of the four sections of the time machine and explain to students that emissions and average temperatures are higher than ever.

**Slide #10: Activity Time!**

1. Each student should be given a copy of the 2018 Ecosystem Health Report. They should individually read pages 30 - 33.

2. As they are reading, they will have a worksheet to fill out, attached to a different document.

3. The worksheet has discussion questions (which are also on the following slide) they should discuss in their breakout groups upon completion of the worksheet.

**Slide #11: Activity Questions**

1. After students have had time to discuss these in their groups, they may present their thoughts with the rest of the class.

**Slide #12: Georgian Bay - Effects**

1. Georgian Bay is a perfect case study of climate change on a small level, where impacts are most tangible.

2. The Bay, as well as the Great Lakes as a whole, are seeing excessive fluctuations in their water levels when compared to past decades. This is a result of warming, which directly affects precipitation and evaporation.

3. There has been a rise in air and water temperature, which directly impacts the breeding patterns, migration patterns, and life cycles of ecologically significant native species.

4. Such warming exacerbates existing issues, such as invasive species survivability.
    4.1. As an ecosystem degrades (in this case, due to rising temperatures), invasive species may take advantage of the situation by preying on affected native species, further worsening the health of a given ecosystem.

5. Additionally, fluctuating water levels exacerbates erosion, degrading shorelines.

6. As more warming occurs, environmental monitoring becomes a more difficult and tedious process as more aspects of an ecosystem need to be monitored, and such monitoring must become more frequent.

**Slide #13: Georgian Bay - Impacts**

1. As previously mentioned, breeding patterns, migration patterns, and life cycles are severely interrupted by rising temperatures.
    1.1. Many animals' life cycles are tied to temperature and seasonal change, which is being strongly affected by warming temperatures. There exists an intricate balance that is being disrupted, and animals are not coexisting in tandem as much as they previously were, leading to ecosystem changes.

2. This is seen most severely in macroinvertebrate populations.
    2.1 They breed quickly and are essential to the food web. They are extraordinarily susceptible to changes in temperature. This has strongly impacted freshwater ecosystems because species that depend on them as prey have difficulty adjusting to their rapidly changing breeding patterns.

3. Changes in breeding patterns has allowed for the more rapid spread of disease throughout environments: ticks, for example, are more increasingly out of cycle with the species that prey on them, letting them breed at unprecedented rates, allowing them to spread diseases much more rapidly.

4. All of this is severely detrimental to the food web which is very delicate and important to healthy ecosystems.

5. A changing climate makes it more difficult for Indigenous communities to practice their cultures, especially if they directly rely on ecosystem services such as fish, edible wild plants and animals for hunting.

**Slide #14: Ice in Georgian Bay**

1. Average annual ice cover in Georgian Bay is decreasing as winters become more and more mild.

2. Ice cover protects shorelines from erosion and is essential to the life cycles of many native fish as it protects their eggs.

3. It also limits sunlight from reaching the bottom of the bay; a process essential to underwater plant life which have evolved to grow in the spring when sunlight is able to reach further down, putting their life cycles in disarray.

4. There has been a slow, long term, worsening decline in annual maximum ice coverage on the bay, impacting economical and recreation activities as less stable ice is much less safe.

**Slide #15: Ice in Georgian Bay – Infographic**

1. An infographic which displays the decreasing peak ice cover of Lake Huron from the past five decades.

2. We can see that, while there are some massive fluctuations year to year, there is overall an alarming downward trend for ice cover in Georgian bay.

3. Lake Superior may become ice free by 2055.

4. The information displayed on the last slide can be discussed here as well.

**Slide #16: Warming Waters**

1. This slide emphasizes already discussed themes, so it can be kept brief.

2. The average rise in water temperatures causes species to breed out of tandem, stressing the food web and altering the balance of the ecosystem, which is advantageous to invasive species.

3. Plankton breed faster and are more fragile, meaning they are excessively affected by temperature changes. Since they are essential to the food web, this poses huge challenges for the species which depend on them, causing massive ripple effects for the entire food web.

**Slide #17: Ticks**

1. Rising temperatures allows for ticks to breed faster, putting their breeding cycle out of tandem with the species that prey on them (such as birds), allowing for an increase in population.

2. Like mosquitos, they are essential to our ecosystems, but it's bad when there are far too many.

3. The formerly colder north is now becoming hospitable to ticks, who lack as many predators and can breed extraordinarily quickly.

4. Deforestation creates fields where ticks thrive even further.

5. The population boom allows for them to spread diseases very easily.

6. Everyone should be encouraged to wear closed toed shoes and long pants when in woody or long-grassed areas.

**Slide #18: Class Question: What can YOU do?**

1. In their groups, students should discuss what they can personally do to do their part. At the front of the class could be a chart paper which the students (or the presenter) can fill out accordingly, which could be left for the class.

2. They have read some relevant answers in their reading, which includes consuming less, eating local, using less hot water, less reliance on a car, eating less meat, and preserving heat in the home.

**Slide #19: What You Can Do**

> A redux of the previous slide

1. Reducing, reusing, recycling, and rethinking are essential.

2. Becoming active in the community, joining action groups, and having discussions with adults goes a long way in changing attitudes and fostering an optimistic environment.

3. Unfortunately, the reality is that climate change is a global action problem, and ultimately cannot be solved on an individual basis.
    3.1. Individual actions do make a difference, but the government and massive corporations will need to pioneer drastic changes on a bigger level, and it is necessary to pressure them to do so.

**Slide #20: Climate Action**

1. There are differences between mitigation and adaptation.

2. Mitigation: Actions to reduce emissions that cause climate change.
    2.1. Measures include sustainable and public transportation, renewable energy, and energy efficiency.

3. Adaptation: Action to manage the risks and impacts of climate change impacts.
    3.1 Examples include infrastructure upgrades and modernization, flood protection and disaster management.

4. Some measures that include both streams include education, conservation of water and environment and developing new energy systems.

5. Both mitigation and adaptation measures are necessary to combat climate change. Both can be very expensive, but are much more expensive to do when it's too late.

**Slide #21: Overcoming Climate Grief**

1. The scope of climate change is overwhelming, and it is easy and understandable to feel helpless and hopeless.

2. While a certain amount of climate change is unavoidable, giving up is not an option. We still have the time and capacity to stop heating from exceeding above catastrophic levels, and it is imperative that we do so. The task of transitioning is complex and multidimensional, but that does not mean it cannot happen.

3. it is important to understand that there are varying possibilities for the future. A rise of 1.5°C is much different from a rise of 2°C, which is much different from the worst case scenario (4.3°C). Damage control makes an enormous difference.

4. There is hope for a better future if you are willing to fight for it.

**Slide #22: End Card**

Reuters Link: https://www.reuters.com/business/cop/how-close-are-we-passing-15-degrees-celsius-global-warming-2022-11-14/#:~:text=SHARM%20EL%2DSHEIKH%2C%20Egypt%2C,degrees%20Fahrenheit)%2C%20scientists%20say.

NOAA Link:
https://www.climate.gov/news-features/understanding-climate/climate-change-global-temperature#:~:text=Earth's%20temperature%20has%20risen%20by,0.18%C2%B0%20C)%20per%20decade.

## Part B. Kahoot

## Follow the link to the Kahoot here:

https://create.kahoot.it/share/lessons-in-a-backpack-climate-change/d8ca0490-c703-4006-b7bd-924ea9ffa417

The Kahoot will serve as a test of knowledge for students.

## Part C. Human Impact Assessment

Take students out on a walk, either within the neighbourhood or on school property in order to conduct a "human impact assessment". The purpose of this activity is to reduce the immense scope of climate change and other broad environmental issues into one that is more tangible by framing it in a local context. In conducting this assessment, students will come to better understand the intertwined nature of environmental issues. On this walk, students should be given the attached worksheet in groups of two to four, along with clipboards and writing supplies. The worksheet is divided into four sections: waste, transportation, energy, and soil & water. Students should read the worksheet before going on the walk. Each section contains questions for students to ask themselves while in their groups, and they should be made to present their ideas with other groups or the rest of the class after coming back from the walk.
Additionally, as students assess litter within their community, they may also be made to clean up anything they find - see extension activities for more details.
The activity sheet is attached to a separate document.

- The waste section will ask students to record any waste they see, and what kind of waste it is. They will further be asked why they think waste is present, and what it may mean for the environment.
- The transportation section will ask students to observe 5-10 vehicles that pass by, taking note of the type of the vehicle and how many people are inside of it. It will also ask students to take note of any walking pedestrians and cyclists going by as well, as well as if they think infrastructure is suitable for non-car transportation.
- The energy section will ask students to take note of any power-related items (e.g. electrical outlets, street lamps, and power lines) and will have them note if they are green. It will challenge the students to think of how renewable energy could be more widely used within the community. It will also ask students to observe any gaps, cracks or damage on the school exterior which permits cold/hot air to inadvertently enter, which necessitates energy intensive air conditioning/heating.
- The soil and water section will ask students about soil health in relation to water permeability, as well as what unhealthy soil might mean for the environment.

After the outdoor portion of the activity is complete, students should share their answers with other groups, or with the rest of the class, in order to facilitate an understanding of the connections of different environmental impacts and the wide scope of human impact.

Answer Keys

*Waste*

How did the waste get here?
Largely, people litter because they do not care, usually due to ignorance or apathy. It should also be noted that these products exist in the first place to satiate the desire for consumer convenience, and that it is worth considering alternative ways of consumption.

How long will it take for this waste to decompose?
It may take several hundred years for plastics, metals and glass to decompose.

What does its presence mean for the health of the environment?
High concentrations of physical pollution can be devastating. Metal and glass contaminants can influence mineral contaminants in soil and water, while plastics break down into microplastics which accumulates in living beings on a molecular level.

*Transportation*

How many people drive alone in their cars, and is that an issue?
This question is straightforward, and the answer will be directly deduced from student observation.

Do different vehicles emit varying levels of pollution?
Yes - bigger vehicles emit more pollution. However, a bus, for example, can have dozens of people on it. Some personal vehicles, however, are very large.

Is the infrastructure in my neighbourhood friendly to cyclists and pedestrians?
This question is also straightforward and can be directly deduced from student observation.

*Energy*

How can renewable energy be more widely used?
Renewable sources, like solar, wind, hydro and geothermal sources, emit much less or almost no carbon emissions. Much of our energy still comes from non-renewable sources, such as natural gas and oil. Making renewable sources more widely used means building infrastructure like solar or wind farms, or hydroelectric dams. In some circumstances, this can be done on an individual scale (such as with personal solar panels).

How can we conserve more energy?
Heating and air conditioning are very energy intensive. If a building has unintentional exit/entry points for heat, more energy is needed to keep that building at the desired temperature. Wearing a sweater when it is cold instead of turning up the heat is a great way of circumventing this, as is making sure buildings are up to code. Furthermore, doing things like hanging up the clothes instead of using the dryer, as well as making sure your energy is coming from renewable sources, helps to minimise environmental impact.

*Water and Soil*

How permeable is it?
This answer is entirely observational and may be different depending on the time of year.

Do you notice any runoff or drainage?
This answer is also entirely observational. Due to melting snow, early springtime typically has more runoff.

Is there a difference between bare soil and soil with plant cover?
Often, a lack of plant life leaves soil exposed to the elements, which can very easily dry it out. Dry soil is more hydrophobic, meaning that barren soil often worsens floods. Soil covered in plant life is often more nutrient rich and has the capacity to absorb much more water. As students observe the difference, they will likely notice that exposed soil is indeed drier.

What does unhealthy soil mean for the environment?
Plants have difficulty growing in unhealthy soil, thereby increasing the amount of unhealthy soil as plants help cycle nutrients and prevent erosion - this is an example of a feedback loop. Unhealthy soil has difficulty absorbing water, making areas with poor soil health more susceptible to flooding.

*Biodiversity*

Are there a wide variety of plant and animal species within my community? Do they appear to be healthy?
This answer is observational and somewhat subjective. If the students neither see nor hear any animals, they should record such. Plant health is usually visibly noticeable: unhealthy plant life will usually have wilted/dead sections or may have exposed sores.

What could be contributing to a lack of biodiversity/habitat in my community?
This answer is a bit open-ended. Students should link the themes throughout this worksheet together, and answers should include things like development, waste, unhealthy soil, etc.

*Questions to Consider*

How are these impacts related to climate change?
Transportation, waste and energy are some of the biggest sources of anthropogenic greenhouse gasses which are changing the climate. Rising temperatures has a direct impact on soil health and biodiversity, as excess heat dries out soil and makes it harder for many species to live healthily.

How do different environmental impacts affect one another?
One good example is that as soil dries out due to rising temperatures, and in some areas also due to lack of water, it becomes increasingly unable to host healthy native plant life. As a result, it negatively affects biodiversity. Additionally, dry, barren soil is more hydrophobic than healthy soil, making floods much more serious.

Does my community represent what is going on in the rest of the country or world?
Parry Sound does not necessarily represent what going on everywhere. For example, in Canada, cities on coastlines will experience much worse climate change impacts as sea levels rise. Across the world, other countries are having a much harder time dealing with impacts, as many lack the resources Canada has and many sit near the equator where heat waves and droughts are most severe.

**Making a Cultural Connection**

To be updated upon the release of the 2023 State of the Bay Report

# Extension Activities

## Extension Activity 1: Community Cleanup

In conducting their human impact assessment, students can be asked to clean up whatever litter they find. Alternatively, this can be done as a separate activity entirely.

Materials Needed: Long Pants and Closed-Toed Shoes, Protective Gloves, Garbage Bags

While it is preferable to reduce, reuse and recycle whenever possible, sometimes something must be thrown away. Litter is very damaging to the environment, especially plastics, which pollute on a molecular level and take decades to hundreds of years to break down. It is important to teach students that if you do have to throw something away, to put it in the garbage or recycling. Not doing so is more environmentally destructive. The purpose of this activity is to collect litter on and around school property in order to show students that even in Parry Sound, there is often an unforgivable amount of litter which serves to damage the environment and ultimately worsens climate change. Every student should have a pair of protective gloves when handling litter, as rusty metals and old glass are potentially dangerous to pick up with bare hands, and wet plastics are gross to touch. Students may break out into groups (each group having one garbage bag) and work together. Additionally, this activity could be made into a competition - whichever group collects the most garbage wins (perhaps a prize)!

## Extension Activity 2: Climate Change Dodgeball

This activity is a great way to demonstrate the mechanics of the greenhouse effect in an active environment and can be a segway into a larger discussion about climate change!

Materials Needed: A set of beanbags or dodgeballs, bibs/bandannas of 3 different colours, and a pre-existing circular marking on the ground, or if outside, a circle in chalk

1. Divide the students into two groups, with about twice as many placed inside the circle as the forming an outer circle around them.
2. The students inside the circle represent the earth, and should all be wearing bibs of the same colour. Those forming the outer circle represent greenhouse gases in the atmosphere and should have differently coloured bibs.
3. One individual is the sun who is outside of the circles, and throws “rays” (dodgeballs/beanbags) at the earth (inner circle).
4. The inner circle will attempt to repel the rays by throwing them back out of the circle, representing heat being reflected from the Earth’s surface.
5. The outer circle will try to catch or block the rays from leaving the circle and throw them back at the Earth.
6. The round ends when all the rays are outside the circle. Since most of the children are inside the circle it should end quickly.
7. In subsequent rounds, increase the number of students representing greenhouse gases in the outset circle by pulling them from the earth group inside the circle, explaining that there are more in the atmosphere due to human actions; it is then harder for the heat to escape the Earth’s atmosphere.
8. The final round should consist of one student in the centre and everyone else as greenhouse gases! Additionally, the student playing the sun may switch every turn.

After the game, ask students:

- What does this game demonstrate?
- Did it seem like earth was suffering towards the end?
- What can we do to help stop this?

# Additional Resources

Additional resources can be found on the Georgian Bay Biosphere Website. Some useful links are attached below:

- https://www.stateofthebay.ca/on-thin-ice-trends-and-implications-for-great-lakes-ice-cover/
- https://www.stateofthebay.ca/spring-signals-spawning-season/
- https://www.stateofthebay.ca/tick-check/
- https://www.stateofthebay.ca/indigenous-fire-shkode-keeping-and-land-management/
- https://www.stateofthebay.ca/climate-change-impacts-on-our-economy-and-our-health/
- https://www.stateofthebay.ca/the-ripple-effects-of-climate-change/
- https://www.stateofthebay.ca/wp-content/uploads/2018/07/GBBR_State-of-the-Bay_2018_Magazine.pdf

# Appendix B:

## Human Impact Assessment Activity

Climate change is just one of the ways humans have impacted the environment. Deforestation and littering are two more examples of our negative impacts on the ecosystem which we depend on. In this activity, you will go outside and assess these impacts within your community! It is important to assess the health of the environment to understand what changes we need to make to protect it. Consider the questions carefully and write some thoughts down - you will be discussing them later.

### Waste

In the space below, take note of any litter you see. Record if it is plastic, metal, glass, etc. Collect any garbage/recycling you find so it can be disposed of properly!

**How did the waste get here? How long might it take for this waste to decompose? What does its presence mean for the health of the environment?**

### Transportation

Observe 5 to 10 passing vehicles. In the space below, record what kind of vehicles you see and how many people are in them. Also take note of any walking pedestrians and cyclists.

**How many people drive alone in their cars? Do different vehicles emit varying levels of pollution? Is my neighbourhood friendly to cyclists and pedestrians?**

### Energy

In the space below, record anything you see that runs on electricity (like streetlights), and note if you know whether or not they come from **renewable** sources of energy.

Also record any exterior gaps, cracks or damage on your school which would allow outside air to enter - making energy-intensive air conditioning/heating more necessary.

**How can renewable energy be more widely used? How can we conserve more energy?**

## Water and Soil

In the space below, take note of the soil in the area you are conducting this assessment in. How **permeable** is it (how easy is it for water to pass through)? **Do you notice any runoff or drainage? Is there a difference between bare soil and soil with plant cover? What does poor soil quality mean for the environment?**

## Biodiversity

Biodiversity refers to the variety of living things within an area. In the space below, take note of the plants and animals you see (or hear) while outside. **Are there a wide variety of plant and animal species within my community? Do they appear to be healthy? What could be contributing to a lack of biodiversity/habitat in my community?**

## Other Questions to Consider

How are these impacts related to climate change?
How do different environmental impacts affect one another?
Does my community represent what is going on in the rest of the Country or the world?

# Appendix C:

## Georgian Bay Biosphere Climate Change Worksheet

**True or False**

Human activity is responsible for climate change
**True** ☐ **False** ☐

Because of climate change, it is a certainty that next year will have decreased ice cover
**True** ☐ **False** ☐

We rely upon the ecosystem for most aspects of our lives
**True** ☐ **False** ☐

**Short Answers**

How many parts per million of CO2 exist in our atmosphere today?

_____

How many icing days is Parry Sound projected to have after 2050?

_____

How much has the average air temperature increased in Severn Sound since 1970?

_____

How much has the average water temperature increased each decade in Lake Huron?

_____

What is a trend?

_____

_____

What is a climate model?

_____

_____

**Long Answers**

Why are hot summers dangerous?

_____

_____

_____

What is an example of a feedback loop? Why are they significant?

_____

_____

_____

What can you do to help combat climate change?

_____

_____

_____

Why is conservation so important in dealing with climate change?

_____

_____

_____

**Discussion Questions**

What are some examples of climate change impacts in Georgian Bay?

What could the future look like because of these impacts?

# Georgian Bay Biosphere Climate Change Worksheet - Answer Keys

## True or False

Human activity is responsible for climate change
**True ✓** **False ☐**

Because of climate change, it is a certainty that next year will have decreased ice cover
**True ☐** **False ✓**

We rely upon the ecosystem for most aspects of our lives
**True ✓** **False ☐**

## Short Answers

1. **How many parts per million of $CO_2$ exist in our atmosphere today?**

**Answer**: 400 parts per million (page 30).

2. **How many icing days is Parry Sound projected to have after 2050?**

**Answer**: Fewer than 40 (page 33).

3. **How much has the average air temperature increased in Severn Sound since the 1970s?**

**Answer**: It has warmed an average of 1.9°C (page 31).

4. **How much has the average water temperature increased each decade in Lake Huron?**

**Answer**: By approximately 0.9°C each decade (page 31).

5. **What is a trend?**

**Answer**: The state of something (in this case, ice on/off dates) when data is recorded over decades. The overall trend is much more important than year-to-year variation (page 31).

6. **What is a climate model?**

**Answer**: The results of the most powerful computers on earth reconstructing climates of the distant and recent past, as well as envisioning future possibilities (page 32).

## Long Answers

1. **Why are hot summers dangerous?**

**Answer**: Due to heart waves and high temperatures, there are implications for human health,

especially for seniors and children. Hot temperatures also cause droughts, groundwater shortages, crop failure, increased food costs, pest outbreaks and forest fires (page 33).

2. **What is an example of a feedback loop? Why are they significant?**

**Answer**: As global temperatures rise, ice melts, shrinking white reflective areas and expanding dark surface areas of water that absorb the sun's rays. They are significant because it means warming is exponential, with every decade warming faster than the previous one (page 30).

3. **What can you do to help combat climate change?**

**Answer**: Be energy efficient at home and work/school, choose green power, use less hot water, Consider alternative transportation, eat locally, reduce your waste and buy less, and get involved and informed (page 32).

4. **Why is conservation so important in dealing with climate change?**

**Answer**: They buffer the effects of extreme weather events and are important for species migration (page 31).

## Discussion Questions

When students are finished with this sheet, discuss what they have written in their breakout groups, as well as the questions below. The following questions are also displayed in the presentation.

**What are some examples of climate change impacts in Georgian Bay?**
Answers may include:

- Shortening icing periods
- Hotter summers
- Interrupted spawning seasons for fish
- Interrupted migrations for birds
- Difficulty for plankton to breed properly
- Difficulty for native species to compete with invasive species
- Collapsing food web
- Diminished capacity for wetlands to function
- Worse erosion

**What could the future look like because of these impacts?**
Answers may include:

- More frequent and extreme weather events will cause damage to us and the environment
- More frequent and extreme droughts will increase water insecurity
- More frequent and extreme floods will cause prolonged damage
- Harsher summers will make it more difficult to grow crops