



**trackingchange...**  
*...in the classroom*

**Science 10:**

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**Global Climate Change &  
Rivers in Different Biomes**

**Indigenous Knowledge Lesson Plan**

Local and Traditional Knowledge in Watershed Governance  
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## Science 10: Global Climate Change and Rivers in Different Biomes

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### SCIENCE 10: ENERGY FLOW IN GLOBAL SYSTEMS (SOCIAL AND ENVIRONMENTAL CONTEXTS EMPHASIS)

#### Purpose

Students will learn about how human activities affect different biomes in various locations, how these activities contribute to climate change, and the actions taken to deal with the impacts of climate change. In this lesson students will be learning about the Amazon, the Mekong, and the Mackenzie rivers/biomes in order to compare and contrast climate change contributors and effects in different river systems.

**Focusing Questions:** Are there relationships between solar energy, global energy transfer processes, climate and biomes? What evidence suggests our climate may be changing more rapidly than living species can adapt? Is human activity causing climate change? How can we reduce our impact on the biosphere and on global climate, while still meeting human needs?

Describe how the relationships among input solar energy, output terrestrial energy and energy flow within the biosphere affect the lives of humans and other species:

- Explain how climate affects the lives of people and other species, and explain the need to investigate climate change (e.g., describe the responses of human and other species to extreme climatic conditions; describe housing designs, animal habitats, clothing and fur in conditions of extreme heat, cold, dryness or humidity, wind)

Relate climate to the characteristics of the world's major biomes, and compare biomes in different regions of the world:

- Identify the potential effects of climate change on environmentally sensitive biomes (e.g., impact of a reduction in the Arctic ice pack on local species and on Aboriginal societies that rely on traditional lifestyles)

Investigate and interpret the role of environmental factors on global energy transfer and climate change:

- Investigate and identify human actions affecting biomes that have a potential to change climate (e.g., emission of greenhouse gases, draining of wetlands, forest fires, deforestation) and critically examine the evidence that these factors play a role in climate change (e.g., global warming, rising sea level(s))
- Describe the limitations of scientific knowledge and technology in making predictions related to climate and weather (e.g., predicting the direct and indirect impacts on Canada's agriculture, forestry and oceans of climate change, or from changes in energy transfer systems, such as ocean currents and global wind patterns)

Students will be encouraged to: Appreciate that scientific understanding evolves from the interaction of ideas involving people with different views and backgrounds (e.g., appreciate Aboriginal clothing and home designs of the past and present that use locally-available materials to adapt to climate; recognize that science and technology develop in response to global concerns, as well as to local needs; consider more than one factor or perspective when making decisions on Science, Technology and Society [STS] issues)

## Teacher Resources

- Amazon River Basin (location and introduction): <http://www.trackingchange.ca/river-basins/amazon/>
- Mekong River Basin (location and introduction): <http://www.trackingchange.ca/river-basins/mekong/>
- Mackenzie River Basin (location and introduction): <http://www.trackingchange.ca/river-basins/mackenzie/>
- This lesson is based on research from Tracking Change: Local and Traditional Knowledge in Watershed Governance: <http://www.trackingchange.ca/>.

## Materials Needed

- Markers, pens, and stick notes for venn diagram activity
- Computer and projector to play Tracking Change NYC Global Meeting video [9:47] <http://www.trackingchange.ca/videos/tracking-change-nyc-documentary/>
- [Optional] Copies of Tracking Change NYC Global Meeting video viewing guide
- Copies of the following handouts (attached):
  - Mekong River Case Study
  - Amazon River Case Study
  - Mackenzie River Case Study
- Presentation Guidelines
- [Optional] Computer/internet access for students to complete additional research
- [Optional] Presentation Assessment Rubric

## INTRODUCTION

Many communities around the world rely on waterways for transportation, agriculture, drinking water, and as a food source. Freshwater is essential. While people around the world have different cultures, ecosystems, and histories, everyone faces the common threat of climate change. This lesson introduces students to ways communities in three different parts of the world contribute to and experience climate impacts on freshwater

environments. Students will explore similarities and differences in climate contributors and threats and apply their knowledge to their own community's experience.

### Key questions for student inquiry:

- How can the experiences of people in various river systems around the world help us better address environmental and climate impacts in our own river system? How does Indigenous knowledge contribute to our understanding of river systems and climate change?

### LESSON PLAN PROPER

- **Location:** Classroom
- **Length of activity:** 90-120 minutes / 2-3 class periods
- **Activating Strategies:**
  - *Introduction.* This lesson focuses on three rivers in different parts of the world: the Amazon River in South America, the Mekong River in Asia, and the Mackenzie River here in northern Canada. All three regions demonstrate (in similar and different ways) how human activities impact not only the environment, social, and cultural life, but they also have significant climate impacts. We will consider human impacts on these river systems, the contributions of these human activities to climate change, and the value of listening to local people in considering how to address these issues. Indigenous people from these regions are able to learn from one another when they gather to discuss issues relevant to the water and communities that rely on it.
  - A project called "Tracking Change" brought together local peoples and collaborators from the Amazon, Mekong, and Mackenzie rivers to share knowledge with one another and bring that knowledge to the United Nations. The aim was to inspire the international community to recognize how climate change links people across the planet and that Indigenous knowledge can help us address climate issues.
  - Show the Tracking Change NYC Global Meeting video [9:47], which demonstrates international links between climate change and issues facing the different rivers in the world, as well as the importance of Indigenous knowledge in dealing with climate change.
  - Provide students with the Tracking Change NYC Global Meeting video viewing guide so they can take notes while watching. Alternatively, provide select questions from the viewing guide to introduce the video. Discuss student responses to the film and introductory questions as a class.



- **Learning Experiences:**

- *Class Activity.* Next, we will dig deeper into the various river systems in these three regions. Distribute case studies on the Amazon (Brazil), Mekong (Thailand), and Mackenzie (Canada) water basins, as well as the "Presentation Guidelines" handout. Give students time to read through the case studies and think about the prompts either individually or in small groups.
- *Group Activity.* Presentation development.
- Review the "Presentation Guidelines" handout with students. Give the groups time to brainstorm responses to their selected prompt and conduct additional web research (if technology allows).
- Encourage students to present their responses to the selected prompt in a creative way that will be engaging for the class and allows group members to draw on their strengths. Students should apply their broader knowledge of biomes and science when creating their presentations and responding to the provided case studies (particularly when accounting for similarities and differences between biomes).

## CONCLUSION

- *Presentations.* Dedicate class time to the students' presentations. Set aside time for the class to ask questions at the end of each presentation. Invite students to consider the links between the ideas in their own presentation and those of others: how are these issues/topics interconnected? Before the presentations begin, remind students about respectful ways to ask questions and discuss strategies for responding to questions students may not be prepared for.
- *Optional:* Use the provided "Presentation Assessment Rubric" to mark students/groups on their presentations. Review the rubric with students before giving them time to work on their presentations.
- *Individual or Group Reflection.* Write and/or discuss:
  - What did you notice about the presentations? Was there anything you were surprised by? Anything you wanted to learn more about? If you wanted to learn more, who in your own community could you ask about this topic?
  - What do you think is the value of research that surveys people in this way?
- *Class Discussion for Moving Forward.* Based on the group discussion, ask students to brainstorm ways community members and leaders can respond to issues of climate change in your community (e.g. share observations about climate change on Facebook groups; present/write to local or national governments to advocate about decisions that affect the climate; set up co-management of the local watershed; involve young people in land-based learning so they learn to recognize signs of change).

**Keywords:** biomes, international

**Themes:** climate change; local and traditional knowledge; community perceptions

# Student Handout: Tracking Change Global Knowledge Symposium Video

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NAME .....

DATE .....

You are about to watch a video about the Tracking Change research project's Global Knowledge Symposium which took place in New York City in Spring 2019. As you watch, write notes about the film and respond to the questions below.

*Tracking Change is a research project based out of the University of Alberta. Local and traditional knowledge research activities in the Mackenzie River basin, as well as the Lower Mekong and Lower Amazon River basins, seeks to strengthen the voices of communities in the governance of freshwater ecosystems. (Cite as: Tracking Change. (2020). About the Project. Retrieved from [trackingchange.ca/about/](https://trackingchange.ca/about/))*

Answer the following on a separate piece of paper:

1. What was the purpose of the Tracking Change NYC Global Meeting?
2. What is the value of bringing together Indigenous peoples and researchers from around the world to discuss issues faced by communities?
3. What other international meeting did the community members attend while they were in New York City? How did Joella Hogan and Ernest Betsina think that meeting went?
4. What does the video say about the importance of youth being involved in managing environmental issues? Do you think youth should be involved? Explain.
5. Why is it important to build relationships and share information about climate change with other communities in our region, or in other parts of the world? Provide an example of communities working together and/or sharing knowledge to address climate change.

# Student Handout: Mekong Basin Case Study

## QUICK ISSUE DESCRIPTION

The Mekong River is a large river that is approximately 4,350 km long, with a drainage area of 795,000 km<sup>2</sup>. It is the twelfth longest river in the world and the seventh longest river in Asia. Originating in the Tibetan Plateau, the Mekong River crosses southern China before passing Myanmar (Burma), Laos, Thailand, Cambodia, and Vietnam, where the Mekong flows into the South China Sea.

The Mekong River Basin is home to a large variety of ethnic groups. Over 60 million people live along the river and in the river basin. They are heavily dependent on Mekong Basin fisheries for food and income. No wonder the Mekong River Basin supports the most important fresh-water fisheries in the world, with an estimated annual fish production in the basin of between 2.3 and 3 million tonnes annually! This freshwater biome supports well over 1000 (around 1200) species of fish, along with 20,000 species of plants, 1200 species of birds, 800 species of reptiles and amphibians, and 430 mammal species, making the Mekong one of the most biodiverse rivers in the world. The river itself is situated in both tropical and subtropical biomes/areas. The seasons of the Mekong River Basin are separated into wet and dry seasons, with the wet season characterized by intense rain and monsoons.



## DID YOU KNOW?

The Mekong Basin is one of the most biodiverse freshwater systems in the world? There are over 1200 recorded fish species!

One of the most famous species of freshwater fish to exist in the Mekong Basin is the Giant Catfish or "Plā duk yaks."

### Thai Translation for Giant Catfish:

ปลาดุกยักษ์

Plā duk yak<sup>s</sup>

### Map of the Mekong Basin

Photo Credit: Ian C. Campbell <https://ars.els-cdn.com/content/image/1-s2.0-S1642359316300428-gr1.jpg>

People in the Mekong River Basin primarily live in rural areas rather than cities. The livelihoods of people living in the basin are connected to fish, other aquatic life, plants, rapids, tributaries, streams, and more. Many local people believe that all natural phenomena are not simply objects to be used but that they each have a spirit. This belief is called “animism,” and it emphasizes the spiritual nature of both land and water.

Despite the importance of the river system to both survival and spirituality, the value of this natural system to people’s livelihoods appears to be frequently underestimated by outsiders.

## ISSUES FACING THE MEKONG RIVER

Over the past 15 years, a series of hydropower dams were constructed in China. Currently, several more are in the planning and construction phases. Hydropower dams pose a significant threat to the river’s ecology and ways of life of communities in the basin. Women are especially impacted, as they are one of the main water use and management stakeholders.

## WOMEN OF THE MEKONG BASIN:

Women from diverse socio-economic statuses have different river knowledge. Wealthier women tend to depend more on land-based and farmed resources and thus know little about the river system. Women (and men) who depend on fish and other aquatic animals for food and income have more in-depth knowledge of the river. These women have been forced to adapt to the environmental devastation caused by hydropower dams to survive and continue providing their household livelihoods.



**Fisherwoman on the Mun River (Baan Kho Tai Village, Thailand)**

Photo Credit: Abby D'Souza



## IMPACTS OF HYDROELECTRIC DEVELOPMENT ON WOMEN

- Women have the most household responsibilities for food collection and income generation for their families, which hydroelectric dams threaten by changing water levels and impacting the surrounding ecosystem.
- Typically, women living just below the Mekong dams experience a reduced quality of life after dam construction due to difficulties accessing fish for food.
- Gender bias favors men, who have an easier time accessing programs that compensate them for the harmful impacts of hydroelectric development.



### THE STORY OF MAE MII SANTAWEESOONG (BAAN DON SUMRAN - THAILAND):

Mae Mii Santaweesoong is a fisherwoman from the village of Baan Kho Thai in Thailand. She spends most days fishing and trapping other aquatic animals, selling her fish, taking care of her family, and creating her own fish traps! However, hydroelectric development has prevented her from relying solely on fishing for her livelihood. Due to this, she also works harvesting rice to make ends meet (D'Souza, 2019).

## IMPACTS OF CLIMATE CHANGE ON THE MEKONG BASIN

The area surrounding the Mekong River is highly vulnerable to the impacts caused by climate change, which affect the people, biodiversity, and natural resources. Climate change can be seen as an “amplifier” of any current environmental threats in the region, threats such as habitat loss, poorly planned infrastructures, unsustainable resource extraction, and so on. An “amplifier” means that climate change intensifies the effects of already existing issues.

These environmental threats weaken the ecosystem's ability to recover from the damage, making it even more vulnerable to climate change. Temperature rises due to climate change result in changing rainfall patterns and the possibility of droughts in the future, creating issues of water scarcity for the people and reduced agricultural production.

The warmer temperatures caused by climate change are intensified by the construction of the hydroelectric dams in the area of the Mekong River. In order to build a dam, the surrounding forest is cut down. As a result, fewer trees are available to absorb the carbon dioxide in the air caused by fossil fuels. Recent studies have also found that the decaying vegetation caused by hydroelectric dams also cause greenhouse gas emissions, further contributing to climate change. The decaying vegetation caused by dams around the world emits roughly a billion tons of greenhouse gases every year. As dams have been used for a long period of human history (over 100 years), dams have collectively produced more methane than rice plantation and biomass burning. Therefore, the damming of the area along the Mekong River further adds to the threats of climate change.

### KEY DEFINITIONS:

**ENVIRONMENTAL HEALTH:** The concept of “environmental health” focuses on the interrelationships between people and their environments. It includes all abiotic and biotic factors that are needed to sustain life. The “environment” part of the term includes both the natural environment and spaces made by humans.

**HYDROELECTRIC DEVELOPMENT:** Hydroelectric engery, or hydroelectric power, is a form of energy that harnesses the power of water in motion - as a hydroelectric dam on a river or a waterfall - to create electricity.

**LIVELIHOOD:** A means of securing the necessities of life. Those who are living along the Mekong River and its surrounding rivers, creeks, and other tributaries, rely on resources from the Mekong River for their livelihoods. An example of these resoureces is fish.

**CLIMATE CHANGE:** Climate change includes both the global warming driven by human emissions of greenhouse gases, and the resulting large-scale shifts in weather patterns.

**BIODIVERSITY:** The variety of life in the world or in a particular habitat or ecosystem.

## TRACKING CHANGE RESEARCH EXAMPLE: DIVERSIFICATION OF LIVELIHOODS IN A REGION IMPACTED BY HYDROELECTRIC DEVELOPMENT, THE MUN AND SEBOK RIVERS (THAILAND)

Research helps us understand the impacts of hydroelectric dams on local communities. This research study by Amabel D'Souza (conducted through the Tracking Change Project) looks how local people living along the Mun and Sebok Rivers (Mekong Basin) are impacted by hydroelectric development.

### Overview:

Local people living along the Mun River and its tributary, the Sebok River, have a deep connection to the ecosystem, as well as longstanding knowledge and practices that are critical to their fishing livelihoods. However, due to rapid hydropower expansion in the Mekong region, communities have had to diversify their livelihoods in an effort to adapt to the associated ecological and socio-economic changes in their regions.

To understand people's experiences with these changes, researchers interviewed twenty-six people in nine different communities in the Isan region of Thailand in an effort to better understand historical fishing practices and adaptations that have taken place over the past two decades. Many of these communities have been impacted by the Pak Mun Dam, a major dam that blocks fish migration and has had other adverse impacts. The villages in this project are Baan Kho Tai, Baan Don Sumran, Baan Hua Hew #11, Baan Hua Hew #4, Baan Na Choom Chon, Baan Thalot, Baan Doom Yai, Baan Huay Mak Tai and Baan Wangsabang Thai.

## DID YOU KNOW?

The word “Baan” means “Home” in Thai. That is why every village has the word “Baan” in front of it.

### Thai Word for “Home”:

บ้าน

Bān

*“Take my story and share it with Canada as a lesson” -Mae Charoen Gong Suk, Baan Hua Hew #11*

**Fisherwoman collecting shellfish on the Mun River**

Photo Credit: Kanokwan Manorom



## Findings from the Interviews:

### *Impacts of the Pak Mun Dam:*

- Local communities were not consulted prior to the construction of the dam, and local people protested for years in attempts to halt construction.
- Households were displaced and entire communities were relocated due to flooding when the dam was built. After completion of the dam, the most notable impact is the blocking of fish migration.
- Other impacts included the loss of rapids/deep pools, high sediment levels in the river, and the loss of riverbanks.

### *Livelihood Diversifications*

- Local people can no longer support themselves on fishing alone.
- These people have coped with the loss of fishing livelihoods by migrating to bigger cities to look for work, switching to manual labor for income, farming fish, purchasing fish from the market for food, and agricultural work.

## DIVERSIFICATION

**Diversification** refers to the process of developing multiple income sources, rather than relying on a single basis for one's livelihood. Diversification is a way of avoiding risk. For instance, if one source of income (such as fishing) is harmed, a person's livelihood is protected because they can turn to an alternative source.



**The Mekong side of the Pak Mun Dam - This Dam blocks fish migration into the Mun River from the Mekong River**

Photo Credit: Abby D'Souza



## Looking Towards the Future:

The research in the Mekong River Basin focuses on involving local people and local researchers in order to investigate how deep knowledge about fish and fish migrations is shared through social networks that extend over space, including across national borders and across generations.

This research is significant because it draws attention to the voices of those people in communities that are directly impacted by the Pak Mun Dam.

These communities came up with several recommendations to address the issues caused by the hydroelectric dam, which are as follows:

- Decommission (shut down) the Pak Mun Dam.
- Should it be impossible to decommission the dam, open the dam during times when fish are migrating in larger numbers, such as from mid-May to mid-July.
- Compensate those living along the Sebok River for the loss of livelihoods. Compensation may be monetary or it may be something else.
- Strengthen the communication between government, academics, community members, and other stakeholders. Better communication between local people and other stakeholders increases the possibility of producing positive results and strengthening relationships.

## Statements from Local People living along the Mun and Sebok Rivers:

*In the future, my grandchildren might not have fish* - Weera Suriach, Baan Doom Yai

*Now very few people get together and share fish - probably because less people are fishing at all.* - Wittaya Tong Noi, Baan Don Sumran

*In the past, no one needed to leave the village. But now they have to because they have no money.* - Mae Tussanee Chiangman, Baan Huay Mak Tai

*I would love if my children were able to live in the village, but they don't have fish careers anymore. Traditional way of live doesn't offer careers anymore.* - Pratim Kamparat, Baan Don Sumran

*Before the dam we could go anywhere to fish, but now there are more people and less fish. When my grandpa was fishing, he fished. He didn't have to sell the fish. He just traded and brought the rice home.* - Mae Tussanee Chingman, Baan Huay Mak Tai

# Student Handout: Amazon Basin Case Study

## QUICK ISSUE DESCRIPTION

The Amazon Basin is the largest hydrographic basin in the world. It is one of the more pristine watersheds in Brazil, with the highest freshwater fish diversity in the world. It also sustains many small-scale fisheries. The Amazon river is over 6600 km long, with a basin area of roughly 5.5 million km<sup>2</sup>. The Amazon region contains an estimated population of 30 million from several different countries, each having jurisdiction over the river. The river is home to 350 ethnic groups, 60 of which remain almost completely isolated.

The Amazon is typically warm all year round with temperatures of 22-43°C and high humidity. Due to the size and variety of habitats, the Amazon basin is the most ecologically diverse place on Earth (WWF, 2019). The Amazon basin "houses at least 10% of the world's known biodiversity, including endemic and endangered flora and fauna, and its river accounts for 15-16% of the world's total river discharge into the oceans" (WWF, 2019). It contains roughly 2200 species of fish - incredible! The Amazonian biome is two times the size of India, and the Amazon river itself has hundreds of tributaries and streams. The Amazon river is a freshwater biome but is a part of the larger Amazon area which is predominantly tropical rainforest, with small portions of vegetations/biome types that are classified as savannas, floodplain forests, grasslands, swamps, bamboos, and palm forests.



## CHECK IT OUT!

From the map to the left, you can see just how huge the Amazon Basin is! The Amazon Rainforest and Basin is the most biodiverse place in the world!

**Map of the Amazon Basin and Amazon Rainforest (The basin is in the Rainforest)**

Photo Credit: WikiTravel/  
Quirky Cruise <https://quirkycruise.com/wp-content/uploads/2019/09/map-of-amazon-jungle-brazil-26.jpg>

## ISSUES FACING THE AMAZON BASIN

Amazonian communities have a mixed economy based mainly on small-scale agriculture, fishing, and livestock. Large tracts of the Amazon remain in good ecological condition. However, local, small-scale fishers face several challenges, partly due to excessive fishing pressure, which decreases the size and abundance of some key fish populations. These changes impact local food security, fisheries sustainability, and conservation of the richest biodiversity in the world.

Forestry and large scale agricultural development also threaten this vital environmental biome. Currently, land clearing (through fire!) is significantly reducing forest canopy which may impact on the quality of water in Amazonian rivers. "The Amazon has lost at least 17% of its forest cover, its connectivity has been increasingly disrupted, and numerous endemic species have been subjected to waves of resource exploitation" (WWF, 2019). One of the main international concerns is deforestation, which along with land conversion causes the Amazon to release up to 0.5 billion metric tons of carbon per year. This does not include emissions from forest fires, which would make the number even higher.

### LAND CONVERSION:

**Land conversion** refers to the process of changing the use of land, typically towards a more "built" state (i.e. for housing, urbanization, commercial agriculture, etc.).

## IMPACTS TO THE CABOCLOS CULTURAL GROUPS

The Caboclos people are of mixed heritage. They are descendants of Indigenous people and Portuguese colonizers, as well as people from African descent. They live along the floodplains of the large Amazonian rivers and have a mixed economy based mainly on small-scale agriculture (cassava, to produce flour), fisheries, and cattle ranching. Such economic activities are closely dependent on the water cycle, marked by a low and high water season. Caboclos fisheries are usually artisanal. In some areas, the main fishing vessels are paddled canoes, while in others low power motorized canoes predominate. Fishers are usually low income people with little political power, and development in the area threatens their livelihoods.

As people who rely mostly on fish as a source of animal protein, the Caboclos are more vulnerable to environmental changes that could affect fish ecology and fish abundance, such as long and unusual periods of drought (climatic changes), dams, mining, and excessive fishing pressure.

## CLIMATE CHANGE IMPACTS

Deforestation and land conversion contributes up to 0.5 billion metric tons of carbon per year in greenhouse gases. The emissions from forest fires are also a climate change issue. Forest fires happen during the dry season (between July and October). While fires are caused naturally by lightning, many forest fires are caused by people. Both farmers and loggers use fire to clear their land for crops or grazing. Warmer temperatures caused

by climate change decrease rainfall and increase the chance of drought, leading to an increase in forest fires. In 2019 it was noted that forest fires produced up to 140 million metric tons of carbon dioxide, which is equivalent to the annual emissions from 30 million cars, according to recent findings.

Current models suggest that by 2050 the Amazon will increase in temperatures by 2–3°C and decrease in rainfall during the dry months, leading to widespread drying of the forest and droughts. Should humans continue on our current path, it would mean the forest would be replaced by fire prone brush and savanna, without sufficient rainfall to sustain the forest.

The Amazon forest helps to regulate temperature and humidity, and it is linked both to regional climate patterns and the global climate. There is an enormous amount of carbon stores in the Amazon forest, roughly 90–140 billion metric tons of carbon. The release of even a small amount of carbon would accelerate global warming significantly.



**Fishermen on the Tapajós River preparing the Pirarucu or Arapaima Fish**  
**This is the biggest freshwater fish in the world!**

Photo Credit: Carolina Freitas

Information can be found from the article "Carbon Dioxide Released by Amazon Fires Could Hasten Climate Change" <https://www.capeandislands.org/post/carbon-dioxide-released-amazon-fires-could-hasten-climate-change#stream/0>

"Climate Change in the Amazon" web page from Panda WWF (World Wide Fund) [https://wwf.panda.org/knowledge\\_hub/where\\_we\\_work/amazon/amazon\\_threats/climate\\_change\\_amazon/](https://wwf.panda.org/knowledge_hub/where_we_work/amazon/amazon_threats/climate_change_amazon/)

"Inside the Amazon" web page from Panda WWF (World Wide Fund) [https://wwf.panda.org/knowledge\\_hub/where\\_we\\_work/amazon/about\\_the\\_amazon/](https://wwf.panda.org/knowledge_hub/where_we_work/amazon/about_the_amazon/)



## TRACKING CHANGE RESEARCH EXAMPLE: RESEARCH ON THE TAPAJÓS RIVER AND THE TOCANTINS RIVER (BRAZIL)

### Overview:

Research studies in the Amazon showcase the rich biodiversity and need for more community engagement in making decisions about the river. One such study through Tracking Change, led by Dr. Renato Silvano, joined together researchers from the Federal University of Rio Grande do Sul in Porto Alegre (Brazil), others from the University of Alberta, and local people from the Tapajós River and the Tocantins River. Both the Tapajós and Tocantins are part of the Amazon River Basin.

Both the Tapajós and Tocantins have clear waters, with little clay sediment. The water of the rivers is nutrient poor and either very transparent or slightly green in colour. The human population around both rivers belongs to either the Riverside or Caboclos cultural groups.

### Objective of the Study:

The main objective of the study was to conduct a detailed comparative analysis of the human ecology of small-scale fishing in two large clearwater rivers of the Brazilian Amazon that differ with respect to the history of environmental impacts.

The studies collected numbers of fish and other biological samples in thirteen different communities (8 in Tapajós and 5 in Tocantins). Researchers conducted a series of activities, including:

- Interviews with fishers about socio-economic issues, fisheries management, and local ecological knowledge about fish;
- Participatory monitoring of the quantity of fish caught and brought to land;
- Standardized sampling of fish communities;
- Mapping of important areas for fishing, spawning, and fish migration; and
- Analysis of stable isotopes analysis and mercury contamination in fish.

### STABLE ISOTOPES

"**Stable isotope** analysis of elements such as carbon, nitrogen, and sulphur, is used in ecology to trace the flow of nutrients through food webs and assess trophic levels" (Springer Nature Publishing AG. 2019:1). In other words, stable isotope analysis helps scientists understand aquatic food webs and ecosystem stressors!

FINDINGS OF THE STUDY	
Tapajós River	Tocantins River
<ul style="list-style-type: none"><li>• Presents conservation units and Indigenous areas along its course</li><li>• No dams yet, however, upcoming plans for dams will likely add another ecological stressor to local communities and species living along/near the river</li><li>• Major impacts due to mining in upper reaches of the river, with possible mercury contamination in piscivorous fish and riverside communities</li></ul>	<ul style="list-style-type: none"><li>• Has fewer conservation units</li><li>• Several municipalities and communities are located on its margins, resulting in greater changes in the forest and greater fishing pressure</li><li>• Has at least three dams along its course, creating stress for the communities and species living along the river</li></ul>



KEY DEFINITIONS

**CONSERVATION UNITS:** are groupings of organisms that have insufficient biodiversity necessary in order to generate new species, to ensure species survive following environmental change, and to continue local adaptation.

**PISCIVOROUS:** refers to carnivorous animals that eat primarily fish

The Amazon Basin is full of Piscivorous and Carnivorous Fish!  
Including the Piranha!  
Photo Credit: Anton Darius

## Looking Towards the Future:

In the last decades, several locally based and bottom-up co-management systems emerged in the Brazilian Amazon. In co-management, local communities manage fishing territories (usually floodplain lakes) by excluding outsiders from the area that do not follow management rules. Co-management is one way to address the issues facing communities that rely on small-scale fisheries by improving fishing yields and increasing fish abundance in the more productive floodplains.

However, the success of local co-management initiatives to promote biodiversity conservation or sustainable use of natural resources is largely unknown for most of the Brazilian Amazon. It is also unclear how much authority the co-management boards have to exclude outsiders from entry. Ongoing research continues to investigate how local Indigenous knowledge informs understanding of the issues. Researchers also seek to communicate findings in ways that help communities and governments better understand how to address the problems facing the Amazon.



**Local Fisherwoman on the Amazon River in Brazil**

Photo Credit: Stephanie Morcinek

## LET'S LEARN PORTUGUESE



Local people in the Amazon speak different local dialects, but most can understand and speak Portuguese! Let's learn a few words together!

Fish = Peixe

Boat = Barco

Fisherman = Pescadore

River = Rio

Place = Lugar

Arapaima = Pirarucu

## Student Handout: Mackenzie Basin Case Study

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The Mackenzie River is the longest river system in Canada and the second largest drainage basin in North America (after the Mississippi). With an area of 1,805,200 km<sup>2</sup>, the river basin is about one-fifth of the entire area of Canada! The river is known by many names to local communities (e.g., Dehcho in Slavey, Nagwichoonjik in Gwich'in, and Kuukpak in Inuvialuktun), and it has been key to the survival of Indigenous Peoples in the North for thousands of years. The river basin stretches across large parts of western Canada and is home to more than 400,000 people (as of 2001), 10% of whom are First Nations, Métis, and Inuvialuit (MRBB 2003; GNWT 2010). The river falls under multiple jurisdictions:

- BC, Alberta, Saskatchewan, Yukon, and the Northwest Territories;
- Treaties 6, 8, and 10; and
- Multiple First Nation Reserves and several Metis settlements.

This freshwater biome is surrounded by boreal forests, wetlands, sparse vegetation, foothills, and some prairie, and is situated in both the taiga (boreal) forest and tundra biome area. The Mackenzie River Basin has a large fish ecology as noted by the Elders in the area, notably the Inuvialuit. The subsistence fishery of the Mackenzie features numerous species including broad whitefish (*Coregonus nasus*) and loche (*Lota lota*).

### ISSUES FACING THE MACKENZIE:

The Mackenzie River is vulnerable to multiple stressors such as climate change, commercial fish harvesting, and resource development activities. Primary development in the area is associated with oil extraction and deforestation. Pipelines and associated spills, forestry, and mining activities have changed the quality and flow of water in the region. The socio-ecological impacts from these activities also affect fishing livelihoods, which is a significant component of traditional food systems for many of the people relying on the river.

### SOCIO-ECOLOGICAL IMPACTS IN THE INUVIALUIT REGION:

Fishing activities are considered very important. Fishing contributes to the traditional food system, and it represents an essential part of traditions, including traditional knowledge. A study done in the Inuvialuit region to assess the importance of fishing livelihoods identify socio-ecological change in the fish using Indigenous Knowledge, and understand critical impact of the socio-ecological changes in fishing livelihoods. The study found that fishing for subsistence is particularly significant, with the majority of research participants declaring more than half of their food consumption comes from harvesting, but there are several areas of concern affecting fish harvesting. Table 1 below summarizes recurrent socio-ecological changes related to fish quality, but these changes vary from year to year.



Theme	Indicator	Observation	Livelihoods impacts
Fish quality	Flesh texture	Softer flesh, particularly in whitefish during the summertime	Preference for fish from the ocean during the summertime
	Fish appearance	Smaller and skinnier burbot (loche) Increase of scars and lumps, particularly in inconnu (coney)	N/A Not edible
	Livers	Discoloured or black spots in livers, particularly in burbot (loche)	Not edible
	Parasites & worms	More fish with higher parasite loads, particularly in inconnu (coney)	Not edible
Fish population	New species	New observations of chum salmon in the Delta, but fewer whitefish	Additional species for consumption
	Less fish	Fewer burbot (loche)	Change of fishing practices or locations

Table 1: Inuvialuit Knowledge indicators of change in fisheries

Inuvialuit fishing livelihoods are complex, dynamic, and ever-changing systems that are essential contributors to the Inuvialuit food system as well as to cultural practices around harvesting. The different changes the Inuvialuit face have caused them to adapt their fishing practices and livelihood strategies. Inuvialuit knowledge plays a key role in both understanding these challenges and building adaptive capacities.



Harvest from a Déliné Fish Camp  
Photo Credit: Chelsea Martin

## ADAPTIVE CAPACITY

**"Adaptive capacity"** relates to the ability of humans and other organisms to adjust in response to potential damage or change, and to take advantage of opportunities.

### CLIMATE CHANGE IMPACTS:

The Mackenzie River Basin may be one of the world's river basins most threatened by climate change. The Mackenzie is a cold-water basin that is full of permafrost. Rising temperatures cause permafrost to melt, resulting in ground slumping, collapse of spruce tree forests, and changes in flooding patterns. Communities who rely on the river are consistently seeing changes in water quantity and quality, drying conditions, warmer weather temperatures, and impacts on fish that people rely on for food. They also notice changes to the ice, including thinner ice in the winter, earlier spring thaw, and later freeze ups in the fall. The warmer weather caused by climate change leads to warmer water temperatures overall, which in turn leads to fish spawning at unusual times compared to the past, and an increase in new fish species to the areas (such as chum salmon in the high Arctic).

The increase in temperature is a problem for the Indigenous people who rely on the river for their livelihoods. Much of the diet of the Indigenous people living in and around the Mackenzie river consists of traditional foods, but climate change is having serious impacts on that diet. Climate change not only affects the health and habitat of the fish, but it also has major implications on how the Indigenous peoples access their traditional harvesting areas. Landslides and/or bank erosions are being seen in the area with more frequency, creeks are drying up, water levels are decreasing in many areas, and precipitation has been decreasing. The shorter ice coverage season and the decrease in water levels are major travel concerns. A shorter ice season means that traditional traplines are altered, and spring and fall hunting seasons are shortened. Lower water levels impact the river flow and causes reefs and sandbars to rise, making travelling more dangerous. In previous years, the ice used to be thick and solid, but warming temperatures has resulted in thinner ice with air pockets that makes the ice less stable.



**Déliné Fish Camp**

Photo Credit: Chelsea Martin

## TRACKING CHANGE RESEARCH EXAMPLE: RESEARCH IN THE SAHTU REGION (NORTHWEST TERRITORIES)

### Overview:

Research in the Sahtu region investigates how the livelihoods of fishers are impacted, including how these people are adapting to climate related changes. This research was conducted by Chelsea Martin. The objectives of this research include:

- Learning about the environmental variability and change in the Great Bear Lake area using local and traditional knowledge;
- Determining how these changes affect peoples' fishing livelihoods; and
- Considering the means by which knowledge is shared, interpreted, and/or transformed between generations.

### Research Structure:

Researchers interviewed Sahtú Got'ine Elders, fishers, and youth. Elders were crucial for this research because their lifetime knowledge helped to identify a 'baseline' environmental norm. The oral histories shared contemporary observations of variability and change in Great Bear Lake, Mackenzie River, and surrounding region. Expert fishers who interact with the environment on a regular basis identified which changes are having the greatest impact on their livelihoods.

### Research Findings:

There are many observable changes in the Great Bear Lake region:

- Most significantly, fish flesh is softening.
- An increasing number of cysts on the fish is attributed to warming water temperatures.
- Declining fish harvest generates an increase in consumption of store-bought food rather than traditional foods, causing monetary and physical stresses.
- Délne community members' understanding of climate change is strongly influenced by the prophecies foretold by Prophet Ayah.
- They understood that changes were going to come, and their conversations and definitions on the topic demonstrates their view of the world. Their resiliency to change is grounded in their worldview.



## Looking Towards the Future:

In the Mackenzie Basin, Tracking Changes research projects span five provinces and territories, and include 11 Indigenous organizations representing over 40 Indigenous communities. The projects draw on local and traditional knowledge to investigate water quality and quantity changes, fish health and migration, and fishing livelihoods across five major subwatersheds.

The research in the Mackenzie River Basin focuses on projects led by local community researchers, Elders, and land users. Communities and Indigenous organizations design and carry out their own investigations to gather Indigenous and local knowledge about water quality, fish and fish migrations, and the impacts of development. This information is shared through social networks that extend over space and cross provincial and territorial borders. These community projects are supported by graduate students and academic researchers who provide additional knowledge and expertise when requested or required by the community.

### Example:

Community-based environmental monitoring programs have the potential to foster an environment for learning. Importantly, they place value on Indigenous knowledge. The Kátł'odeeche First Nation is currently developing a community-based environmental monitoring program that is driven by Indigenous knowledge and built around seasonal traditional harvesting activities. The research done with the Kátł'odeeche First Nation and Tracking Change will help contribute to establishing a baseline of environmental information.



**Cover Photo: Drying Fish, Déliné First Nation, Sahtu Region**

Photo Credit: Chelsea Martin



## Student Handout: Presentation Guidelines

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Your group is tasked with creating a presentation that responds to a prompt you select as a team. Use information from the case study handouts, your existing knowledge of biomes/science, and web research to create the content for your presentation.

**Prompt 1** - Climate Change and River Systems: How do changes to freshwater ecosystems around the world contribute to climate change? What role do human actions play in these changes to freshwater ecosystems? How does this affect local communities (e.g. food, cultural traditions, mobility, etc.), and how do these communities respond? How does this compare to the way climate change is related to your local freshwater ecosystem?

**Prompt 2** - Responding to Impacts on Freshwater Systems: What are some of the actions taken to deal with the impact of climate change in the Amazon and Mekong river basins and the people that live nearby? Are there similarities or differences? How does peoples' knowledge of the freshwater ecosystems direct their actions? How might "lessons learned" from the Amazon or Mekong be useful for your own community when adapting to climate change?

**Prompt 3** - Multifaceted Understanding of Climate Change: Science and technology are helpful in understanding changes to climate and weather. How can community-based knowledge work with science and technology to more fully understand climate change? How do the perspectives of various community members in these cases help us more fully understand climate change and how to respond?

The following are some suggestions to help you create your presentation. Feel free to discuss alternative ideas and presentation requirements with your teacher. The best presentations are those that are informative and engaging for the audience- be creative and have fun!

- The first step in a presentation is always to think about "what's the point"? Decide on 2-3 takeaways for the audience and then present content that will help you get your message across
- Give your presentation a clear structure. Begin by stating the purpose of your talk and what you want the audience to take away. Then include content that helps address the topic you introduced at the beginning. Finish off with a strong conclusion and "takeaway" message.
- Find a way to engage with your audience. What questions can you ask your audience that will get them "hooked" at the beginning of your presentation? Can you do a short in-class, "hands up" survey to poll your audience's perspective on the issue? Think about times that you have been interested in a presentation and what tools the speaker used to keep your attention.

- Use software like Microsoft PowerPoint, GoogleSlides, or Prezi to guide your presentation. These tools allow you to display key points, facts, and images to help you respond to the prompt. If you do not have access to a computer, or would prefer to do a tech-free presentation, consider printing out images, writing/drawing on the board, playing a game, or distributing handouts.
- Keep in mind these general presentation tips:
- Be prepared with speaking notes, but do not read off a script.
- Use hand gestures to emphasize your points.

Look your audience in the eye - it helps keep people engaged.

# Student Handout: Presentation Rubric

NAME -----

DATE -----

	4- Excellent	3- Good	2- Fair	1- Needs Improvement
<b>Content</b> x2	Clear, detailed, and effective explanation of how climate affects the lives of people and other species; the potential effects of climate change on environmentally sensitive biomes; how human actions have a potential to change climate; and the limitations of scientific knowledge and technology in making predictions related to climate.	Good explanation of how climate affects the lives of people and other species; the potential effects of climate change on environmentally sensitive biomes; how human actions have a potential to change climate; and the limitations of scientific knowledge and technology in making predictions related to climate.	Limited explanation of how climate affects the lives of people and other species; the potential effects of climate change on environmentally sensitive biomes; how human actions have a potential to change climate; and the limitations of scientific knowledge and technology in making predictions related to climate.	Does not address the key content outcomes.
<b>Organization</b>	Addresses selected prompt with depth and creativity; provides clear purpose; includes important examples, facts, and evidence; demonstrates knowledge by answering all questions with strong explanations	Addresses selected prompt well; somewhat clear purpose; some supportive examples, facts, and evidence; is at ease with answers to expected questions, without explanations	Somewhat addresses prompt; attempts to define a purpose; provides weak examples, facts, and evidence; uncomfortable with information and answering questions	Does not address prompt; does not define a purpose; weak or no supportive evidence of subject; does not have grasp of information and unable to answer questions
<b>Enthusiasm/ Audience Awareness</b>	Demonstrates strong enthusiasm during entire presentation; increases audience understanding; holds audience attention; seldom uses notes; vocal variety in tone and volume; excellent eye contact; emphasizes key points	Shows some enthusiasm for topic; raises audience understanding about most points; consistent use of eye contact; speaks with satisfactory vocal variety in tone and volume	Shows little or mixed enthusiasm for topic; displays minimal eye contact and mostly reads from notes; speaks with little vocal variety; somewhat raises audience understanding on some points	Shows no interest in topic presented; fails to increase audience understanding; no eye contact and entirely reads from script; speaks with no vocal variety which causes audience to disengage
<b>Visuals (slide show, handouts, movie, etc.)</b>	Excellent and creative visuals engage the audience, enhance the presentation, and emphasize key takeaways	Visuals are appealing; visuals complement the presentation and emphasize key takeaways	Visuals are somewhat appealing/colorful; visuals are somewhat connected to the key takeaways	Little to no attempt to engage the audience with visuals
<b>Comments</b>				