Real World STEM Connection: Storm Surges

Students may work in groups of 3 to divide up the work for this activity.

Part 1: Book Chapter and Summary of Study

Read through the excerpts below, and highlight the key points that would help you answer the questions:

- How were Indigenous Land-Based Knowledge and Western Science both used to understand the impact of the storm surge?
- How are storm surges and climate change related?
- How can Indigenous Land-Based Knowledge and Western Science be used together in to counteract climate change?

1. Excerpts from Chapter 6: Marine storm surges on inland waters: Different ways of knowing by John Smol (Queen's University)

Traditional Indigenous Knowledge: When an elder dies, a library burns down

"For many years, scientists typically ignored information that was potentially available from the Indigenous peoples who have lived for generations in northern regions. This oversight has been changing and changing fast (Lam et al., 2020). The use of Traditional Indigenous Knowledge, sometimes referred to as Traditional Ecological (or Environmental) Knowledge, or usually simply TEK, has now become commonplace in many investigations, and especially in the North. As summarized by the Arctic Council, TEK includes insights based on evidence acquired through direct and long-term experiences, often including multigenerational observations, lessons and skills, of older members of communities, with a long tradition of living off the land. With typically few written records in Arctic regions these records are invaluable -- "when an elder dies, a library burns down".

"It would seem logical, especially when no or little direct instrumental data are available, that long-term observations made by northerners (as well as those of their ancestors, typically passed down in an oral tradition) would always have been valued. Yet this observational information was largely underutilized for many years, with a frequent excuse being that human memories are flawed and unreliable. Nonetheless, western science has recently begun to more fully appreciate the value of direct observations made by people on the frontlines, witnessing firsthand many of the environmental problems discussed in this book. As many northern peoples still maintain lifestyles that involve extensive hunting, fishing, trapping and gathering, they often have intimate knowledge of how the local environment and biota are changing. For example, if a limnologist has developed a model that indicates fish never existed in a specific lake, but then a local elder recounts that her grandfather used to catch fish in that lake, well then it is probably time to reconsider the model! The blending of western science with TEK is often referred to as "different ways of knowing" or "two-eyed seeing" (e.g. Reid et al. 2021)."

"Given that the area inundated by the 1999 storm surge included some of the traditional hunting grounds of the local Inuvialuit, the logical first line of information about past, pre-instrumental records of flooding would come from the current residents and any information passed down from their ancestors. Kokelj et al. (2012) summarized the results of such interviews with Inuvialuit experts from the Delta region."

"The testimonies of the local hunters unequivocally concluded, at least for the time period that they and their families traveled through and used the affected area for hunting, that the 1999 storm surge was unprecedented. However, to extend the monitoring window back even farther in time, the researchers had to turn to natural archives."

2. Summary of Article

Kokelj, S. V., Lantz, T. C., Solomon, S., Pisaric, M. F. J., Keith, D., Morse, P., Thienpont, J. P., Smol, J. P., and Esagok, D. (2012) Using multiple sources of knowledge to investigate northern environmental change: Regional ecological impacts of a storm surge in the Outer Mackenzie Delta, N.W.T. *Environmental Science Arctic, 65*(3), 257-272.

"Dead vegetation from air" courtesy of Trevor Lantz (University of Victoria). From "Marine Storm Surge Project High - Resolution Images (https://www.queensu.ca/pearl/media/Dead%20Zone%20project/deadzone_pics.php)

These researchers focused on the outer areas of the Mackenzie Delta, which consist of low-lying coastal environments that are sensitive to sea level rise, reductions in sea ice and duration, and variable storm activity (changing storm activity).

In 1999, there was a powerful storm that came from the Gulf of Alaska that created a huge flood in the low-lying areas of the outer Mackenzie Delta. It increased the salt content of the water and it also caused widespread death of vegetation over 130 km^2. The Inuvialuit were aware of these detrimental results years before western science communities took notice or care to the area.

They wanted to determine if a storm surge in 1999, which had extreme duration, wind speed, and intensity, had caused unprecedented (or never seen before) impacts to the area. A storm surge is an unusual coastal flood or rise in sea level from a storm.

This is important research as the Mackenzie Delta is the home and hunting grounds for Inuvialuit and Gwich'in, who both have extensive histories, knowledges, and experiences of the land. In other words, this land has taught them through centuries, and the people here hold a form of Indigenous Land-Based Knowledge pertaining to this place. This place is also significant for bird migration and moose populations.

In the Northwest territories, there are many factors that can all increase the severity of flooding in the coastal areas, such as melting sea ice, warming permafrost, more frequent and intense storms. Inuvialuit hunters shared that they have experienced increases in storms that are accompanied by high winds from the east and northwest directions they have also observed a decrease in summer sea ice.

How were Indigenous Land-Based Knowledge and Western Science used together in coexistence to understand the impact of the storm surge?

Therefore, the researchers set out to determine the depth of the impact of, and implications from the great storm in 1999, by looking at soil chemistry, vegetation, permafrost, and by listening to the Inuvialuit hunters' land-based knowledge.

Firstly, the Inuvialuit Joint Secretariat organized a workshop where several experts came to share their knowledge and experience travelling and hunting in the Outer Mackenzie Delta. People came from Aklavik, Inuvik and Tuktoyatuk, and they were all seated around a map of the Mackenzie Delta and shared their knowledge about the storm surges. A supplementary book chapter by John Smol provided details about this meeting, and where people agreed that the storm surge of 1999 was unprecedented within the known history the communities. The storm directly affected their hunting activities, as they experienced less waterfowl and moose in the area sine 1999. There were hardly any geese anymore, as they now just flew over the land they had previously occupied. A ton of area had then gone unusable hunting grounds. They remembered that the water levels rose about 1.5 m in one area, the winds had even picked up two cabins and moved them 3 km. Saltwater had flooded lands around cabins and immediately froze, trapping salt in the soil, and there was saltwater in unusual places. There was a widespread vegetation die out around the year 2000, and this much vegetation death was not previously experienced with storm surge flooding before.

People from the meeting included Charles Pokiak, David Nasagaloak, Danny C. Gordon, Andrew Archie, Billy Storr, Ned Kayutak, Sam Lennie Sr., and Douglas Esagok.

After hearing these experiences and knowledge, the researchers then set out to gain quantitative data about these impacts they had heard about. Naturally, the data had supported the knowledge shared by the Inuvialuit hunters. The data from the soil salinity tests, vegetation community and permafrost analyses, and Inuvialuit land-based knowledge all presented as solid evidence for the 1999 storm surge's intense ecological damage to the Mackenzie Delta, as the flood caused great oil salination and severe vegetation death across an enigmatic length of land.

It also seems as though previous factors were occurring during the time before the 1999 storm hit, which made its impacts worse than other storms. Indigenous knowledge carried by the hunters helped again to provide clarity and evidence to the phenomenon.

The researchers state that the "the information shared by Inuvialuit knowledge holders regarding environmental change in the outer Mackenzie Delta illustrates the value and relevance of the knowledge that communities possess. Many land users were aware that widespread ecological change had occurred following the 1999 storm and might have identified this as a priority issue as early as 2000" (Kokelj et al., 2012). Therefore, Inuvialuit using their land-based knowledge, already knew that something catastrophic had happened in this area.

How are storm surges and climate change interdependent?

The researchers also suggest that "developing mechanisms to promote knowledge sharing among traditional knowledge holders, scientists, and resource managers, with thematic or regional emphasis, will help focus monitoring and research initiatives and contribute to the more timely detection and reporting of environmental change" (Kokelj et al., 2012).

Lastly, Kokelj et al. (2012) argue that "rising sea levels and a greater extent and duration of the open water season due to climate warming could increase the magnitude and frequency of storm surges and the impacts to Arctic coastal ecosystems." Therefore, the preconditions shared and evidenced by the Inuvialuit, give us a glimpse into the future; as a storm like this, while impacts like this can come again.

How can Indigenous Land-Based Knowledge and Western Science used together in coexistence to counteract climate change?

This study demonstrates how management and monitoring practices for ecosystems require both scientific technology and lived experience from Indigenous land-based knowledge. Listening, honouring, and forming a relationship between Western knowledge and Indigenous land-based knowledge informs all science communities and partnerships about the preparedness and monitoring of the catastrophic weather events that may come with climate crisis. Therefore, sustaining a relationship with different knowledges benefits us all, in learning about the world in which we walk in.

Part 2: Relevant News

After you have read through the excerpt and summary, choose 1 of the following news articles or article summaries and examine how Indigenous Land-Based Knowledge and Western Knowledge have benefitted our understanding of other relevant topics in science. Provide a short summary and explanation in your Jamboard.

- Study 1: Eastern Wolf Population: https://rb.gy/64h4z
- Study 2: Moose Monitoring: https://rb.gy/8lw8e
- Study 3: Fresh Water Mussel Health: https://rb.gy/i4cz6
- Study 4: Canadian Fisheries: https://rb.gy/tpova
- Study 5: Climate Change: https://rb.gy/qwe33

OR

Part 3: How Else are Indigenous Knowledges helping us to understand climate change?
Students will visit the Indigenous Knowledges section of the Climate Atlas of Canada (https://rb.gy/qwcfy) and research a topic of interest. Students will reflect on how these cases contribute to the relationship of Indigenous and Western Knowledges, and how this relationship can help us to understand the climate crisis better. They will then include their findings in the Jamboard.

Part 4: Jamboard
Record your thinking from the 2 readings and from your chosen article on your Jamboard slide. Groups may configure their Jamboard however they would like.

We will discuss what we found in a Talking Circle to share our ideas about the readings, our related experiences to the readings, and our new knowledges from the relevant articles/ case studies that also demonstrate the impact of the relationship between Indigenous Land-Based Knowledge and Western science knowledge. The Jamboard may be kept up on the board as a reference during the discussions with groups.

