Towards characterizing the response of water quality to regional variability in permafrost thaw

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The water quality response of Arctic rivers to permafrost thaw depends on landscape features, permafrost conditions, and hydrological processes, all of which are highly variable across the Canadian Arctic. This study aimed to improve understanding of how fluvial systems respond to climatic variability and permafrost thaw in different geographical contexts. This research will enable land managers to anticipate changes, focus on parameters of concern, and in turn, develop meaningful water quality monitoring programs and water resource management plans.

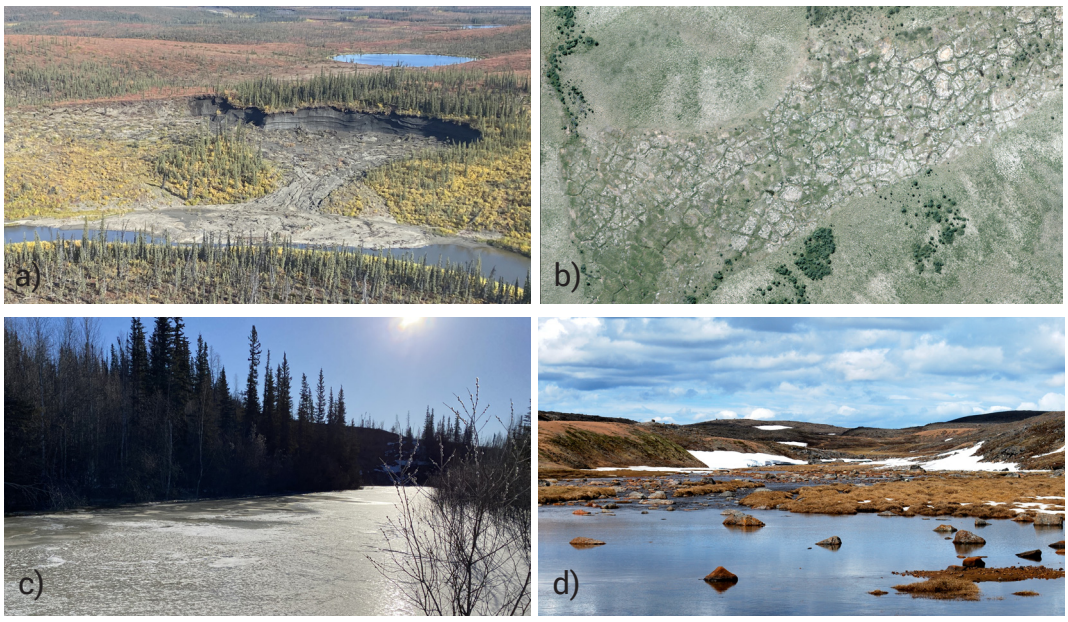

Figure 1. Examples of how permafrost thaw is influencing the focal watersheds: a) a thaw slump on the main channel of Miner River (NT); b) an example of polygonal peatland terrain in the Beaufort Delta Region (NT); c) the emergence of winter discharge at Caribou Creek and Rengleng River (NT); d) absence of physical disturbances to the permafrost in the Niaqunguk River watershed (Baffin Island, NU).

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Research summary

We characterized the water quality of fluvial systems in four contrasting permafrost landscapes:

i. **Miner River:** Situated in a region of ice-rich, continuous permafrost, water quality is influenced by thaw slumping (Figure 1a) and organic-rich peatland streams (Figure 1b).

ii. **Rengleng River and Caribou Creek:** Situated below treeline and without evidence of physical disturbances to the permafrost (Figure 1c). Recently, both rivers started flowing in winter, indicating increases in the connection of groundwater flow pathways.

iii. **Niaqunguk River (Apex river):** Vegetation and organic material are sparse in the Niaqunguk River watershed. The surficial material is predominantly comprised of glacial till, regolith, and bedrock. There are no obvious physical disturbances to the permafrost (Figure 1d).

In each watershed, water sampling surveys were conducted and terrain characterizations were developed for linking the landscape to the rivers.

Spring snowmelt and rainfall mobilize organic and mineral material from the land. For the Niaqunguk River, they also drove trace metal concentrations.

Active layer thaw is important, controlling seasonal dissolved organic carbon (DOC) and mineral ion concentrations. In the Rengleng River, winter discharge was a source of aged DOC, indicating subsurface flow through recently thawed regions deep in the soil profile. There was no evidence of aged DOC in winter flow through Caribou Creek.

Thaw slumping mobilizes mineral sediment and particulate trace metals into the Miner River. Increases in river discharge, projected for most Arctic regions, will likely increase the transport of sediment, particulate metals, and mineral ions through the Miner River.

Organic rich peatland streams are an important source of DOC to the Miner River. We also found that DOC may not adsorb to mineral material as readily here as in other watersheds.

Taking action

The effects of permafrost thaw on water quality varies across permafrost landscapes. The next step is to develop a conceptual framework for characterizing the water quality response of Arctic streams and rivers to permafrost degradation that can be used by land managers and decision makers.

Connections to other projects

4 5 This project is part of Theme 4 - *Hazards and impacts associated with permafrost thaw* and links to Theme 5 - *Adaptation to permafrost thaw*. It is related to other network projects investigating the impact of thawing permafrost on water quality such as *Mercury storage and cycling in permafrost peatlands of the Hudson Bay Lowlands* by Adam Kirkwood and Nicole Corbiere's project Catastrophic thaw l*ake drainages and the mercury cycle*.

Partners, team members and support

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