Annual Summary Report

Permafrost Dynamics in Response to Climate Change on Victoria Island, Nunavut

In this project, we are looking at how permafrost landscapes in western Nunavut are changing in a context of climate change. The overall objective is to study and monitor changes in the permafrost environment, with a focus on the community of Cambridge Bay. In 2023, our fieldwork activities were conducted between July 22–August 31 in Cambridge Bay. In 2023, our field campaign focused on three areas: (1) Augustus hills (about 20 km west of Ikaluktutiak); (2) "*Long Point*" and (3) a group of lakes near *Kitigaq Lake* (about 40 km west of Ikaluktutiak). This year, this project on the evolution of permafrost environments on southern Victoria Island has been divided into four smaller projects: (1) Monitoring of permafrost temperatures; (2) Characterization and evolution of Arctic lakes; (3) Permafrost coastal changes and (4) Carbon release from permafrost coastal erosion.

Research team in 2023

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Jasmine Tiktalek, Shannon Evetalegak & Aili Pedersen (field technicians, Polar Knowledge Canada)

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Joseph Evetalegak Jr. (local guide, Ekaluktutiak HTO)

Field activities in 2023

1. *Monitoring of permafrost temperatures*

   In 2023, we collected soil temperature data from five monitoring stations installed between 2019 and 2021. No additional stations were installed this year.

2. *Evolution of lakes on southern Victoria Island*

   This subproject started in 2023 and field data collected this year will be central to prepare the 2024 field sampling operations in the same area. Field data collection includes (1) radiometric and soil moisture measurements on soil surfaces to calibrate remote sensing analyses and (2) bathymetric data (depth of water) and water samples from several lakes to characterize their physical and chemical properties. We also conducted drone mapping surveys to construct a 3D high-resolution elevation model of the landscape. Our preliminary results suggest that there are two different types of lakes in this region: one formed by the thawing of permafrost, with flat bottom as well as turbid and shallow waters; and another

potentially formed by the melting of buried massive ice, with deeper and clearer waters and a complex bathymetry.

3. *Permafrost coastal changes*

   Our team was in the field to collect data related to local processes of coastal permafrost erosion near Augustus Hill. Several were placed onsite to measure ocean waves, currents, water levels and tidal range. These data were complemented by soil temperature sensors to measure temperature gradients in bluff and beach, and a camera station to track changes along the coast and processes that drive these changes. We also collected permafrost samples from the exposed coastal bluff to characterize the permafrost conditions, including its ice content. As in previous years, drone surveys were conducted to collect images of the study area and detect changes in the landscape over time. The data collected in the field will be used to inform a physical modelling campaign of coastal permafrost erosion to capture the processes in high-resolution. Our preliminary results show that our study area is strongly impacted by gullying and shoreline retreat. Between September 2021 and July 2023, the coastline retreated an average of 5.1 ± 4.1 m, and a maximum of 17.7 m. Moreover, a small-scale model of the coastline at Augustus Hill is currently being reproduced in the small wave canal at INRS. Preliminary wave tests are being performed to calibrate the model, and initial tests have been done to develop an artificial permafrost sample. The next steps will be to finalize the testing protocol and begin wave tests with the permafrost sample.

4. *Carbon release from permafrost coastal erosion*

   In summer 2023, our team explored three coastal sites (Augustus Hill, Long Point River and Long Point) where we collected over 50 water samples including meltwater, active layer water, intertidal pore(ground)water, and nearshore seawater. Several chemical parameters were analyzed that includes the salinity, temperature, dissolved organic and inorganic carbon, dissolved organic matter, pH, total and non-inorganic alkalinity, nutrients, and trace metals. Several of these analyses were done in the laboratory at CHARS and others are still in progress. We also successfully tested the use of radium isotopes as a tracer of meltwater input into the nearshore seawater. Our preliminary results confirm the stochastic nature of permafrost-derived dissolved carbon with very highly variable concentrations of organic carbon and nitrogen.

Community meetings and research outputs

Before our field campaign, we met with the local HTO to share updates about the project and plans for the coming months as well as preliminary results about the erosion near the community and on ‘graveyard island’. In January 2024, we will also present the project and results to the Victoria Island Waterways Safety Committee Meeting, which includes government departments (Transport Canada, Coast Guard, ECCC), KIA, NTI, KRWB, CCG Auxiliary, the EHTO, and local hunters and Elders. In July 2023, our team participated at a knowledge mobilization and northern community engagement event held at the Canadian High Arctic Research Station (CHARS; "POLAR Speaker Series"), during which key research findings were shared with the community of Cambridge Bay. Finally, we will present this project at the next International Conference on Permafrost, which will be held in Whitehorse (June 2024).