Permafrost detection using thermal profiling at Nain, Nunatsiavut

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Introduction

Permafrost environments are warming in the face of climate change, with impacts on infrastructure and development in the North (Allard et al., 2023). Permafrost in Nain, Nunatsiavut (Labrador) has been thawing, with ground subsidence and infrastructure damage observed in portions of the community (Way et al., 2021). The community of Nain is in need of improved assessments of permafrost distribution to support climate-resilient development and planning.

Here we present the results of ground temperature measurements in Nain using data collected in Summer 2025. This project is a part of a larger effort to map geocryological hazards across Nain for the Nunatsiavut Government and the Nain Inuit Community Government.

Objectives

1. Determination of cryotic ground presence or absence at 84 locations in Nain using ground temperature gradients measured *in situ*.
2. Evaluation of the influences of ecosystem and landscape variables on cryotic ground distribution in Nain.

Study area

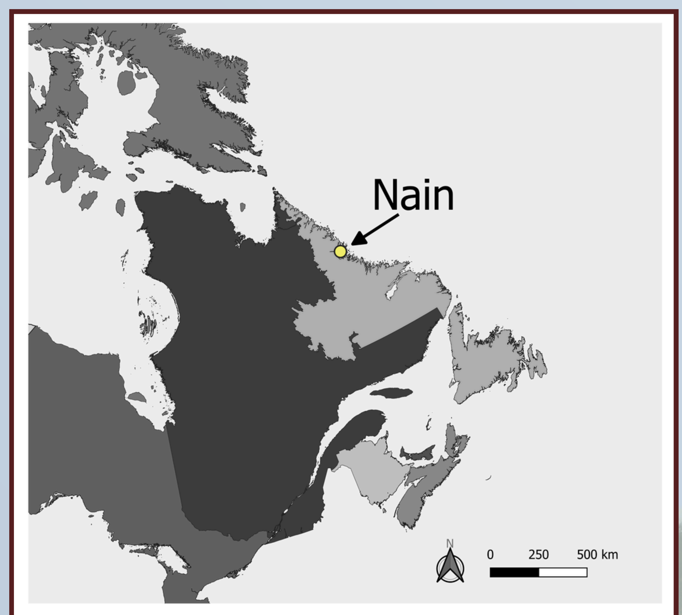

Figure 1: Location of Nain indicated by a yellow point.

Figure 2: Photo of Nain from an airplane (2025).

Nain (56.32°N, 61.42°W) is an Inuit community in Nunatsiavut, NL (Figure 1). Nain is the largest and northernmost community in Nunatsiavut (Figure 2). Nain is located in an east-facing valley surrounded by hills reaching ~275 m a.s.l. and lies in the discontinuous permafrost zone.

Ground temperature measurements

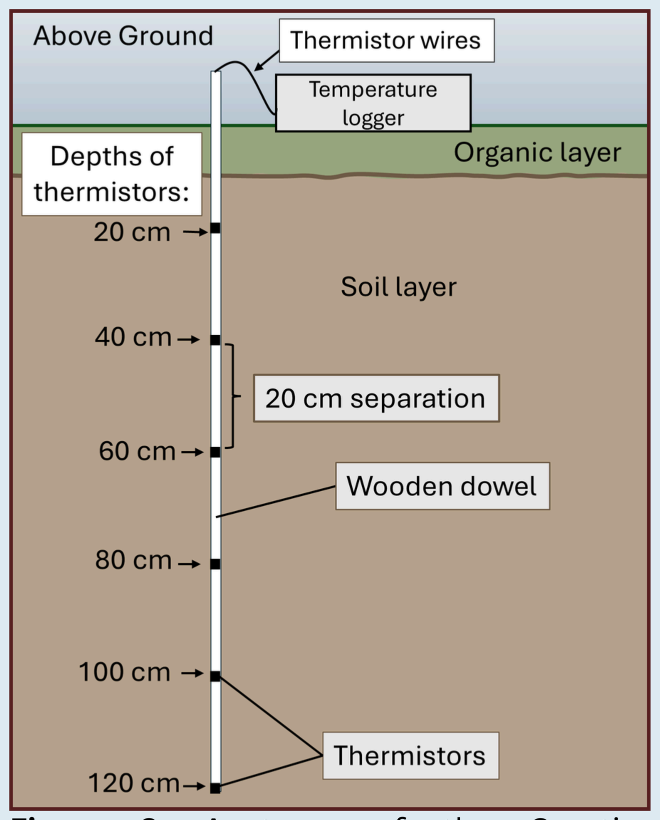

Figure 3: Anatomy of the Cryotic Assessment Temperature probe.

Figure 4: Photo of the Cryotic Assessment Temperature probe in the ground.

Ground temperature gradients spanning 120cm were measured using the Cryotic Assessment Temperature probe (Figure 3 & Figure 4). The measured ground temperatures were extrapolated to predict the depth to 0°C. In total, 40% (33/84) of sites predicted cryotic ground (ground temperatures below 0°C) in the upper 3 m (Figure 5).

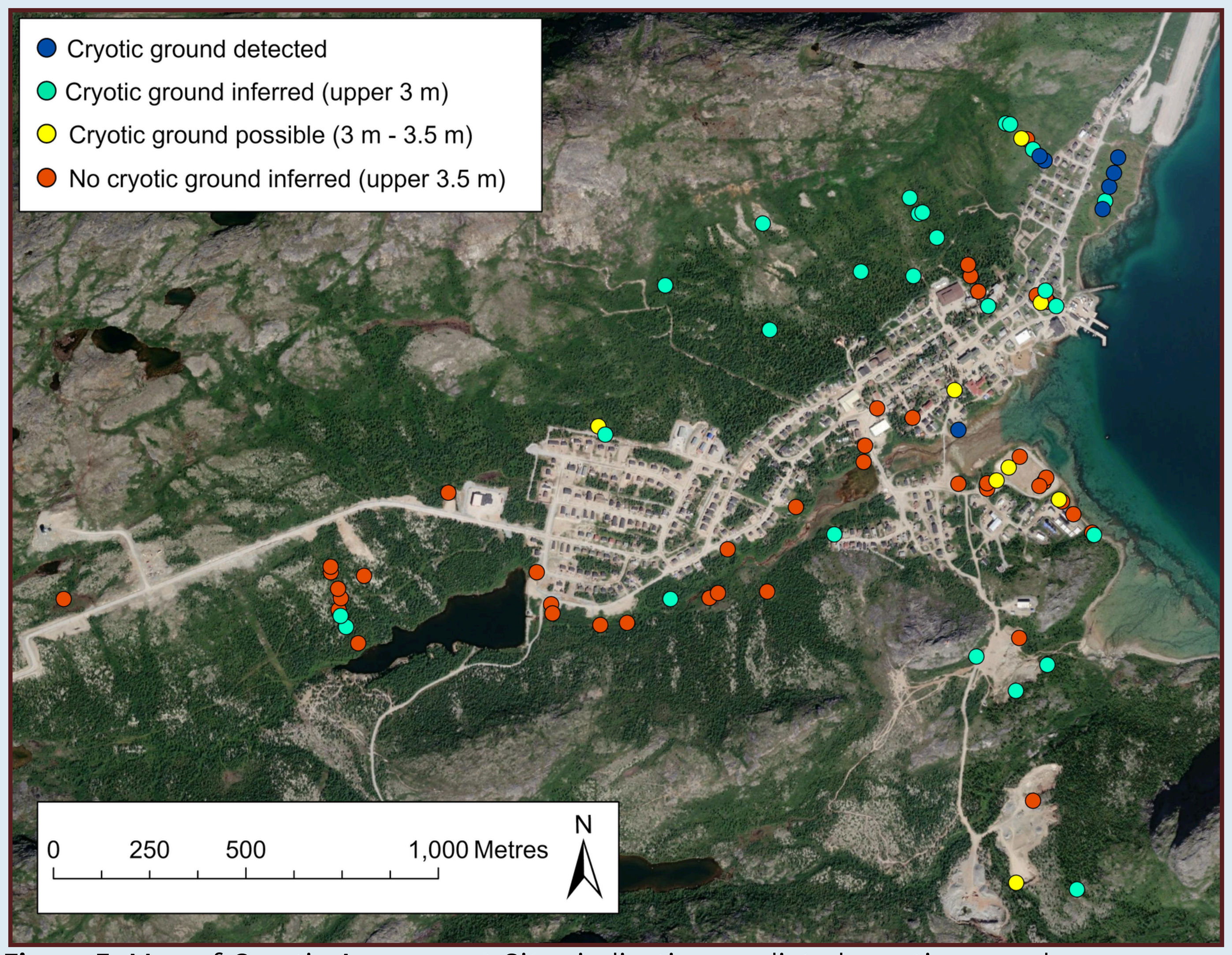

Figure 5: Map of Cryotic Assessment Sites indicating predicted cryotic ground presence or absence.

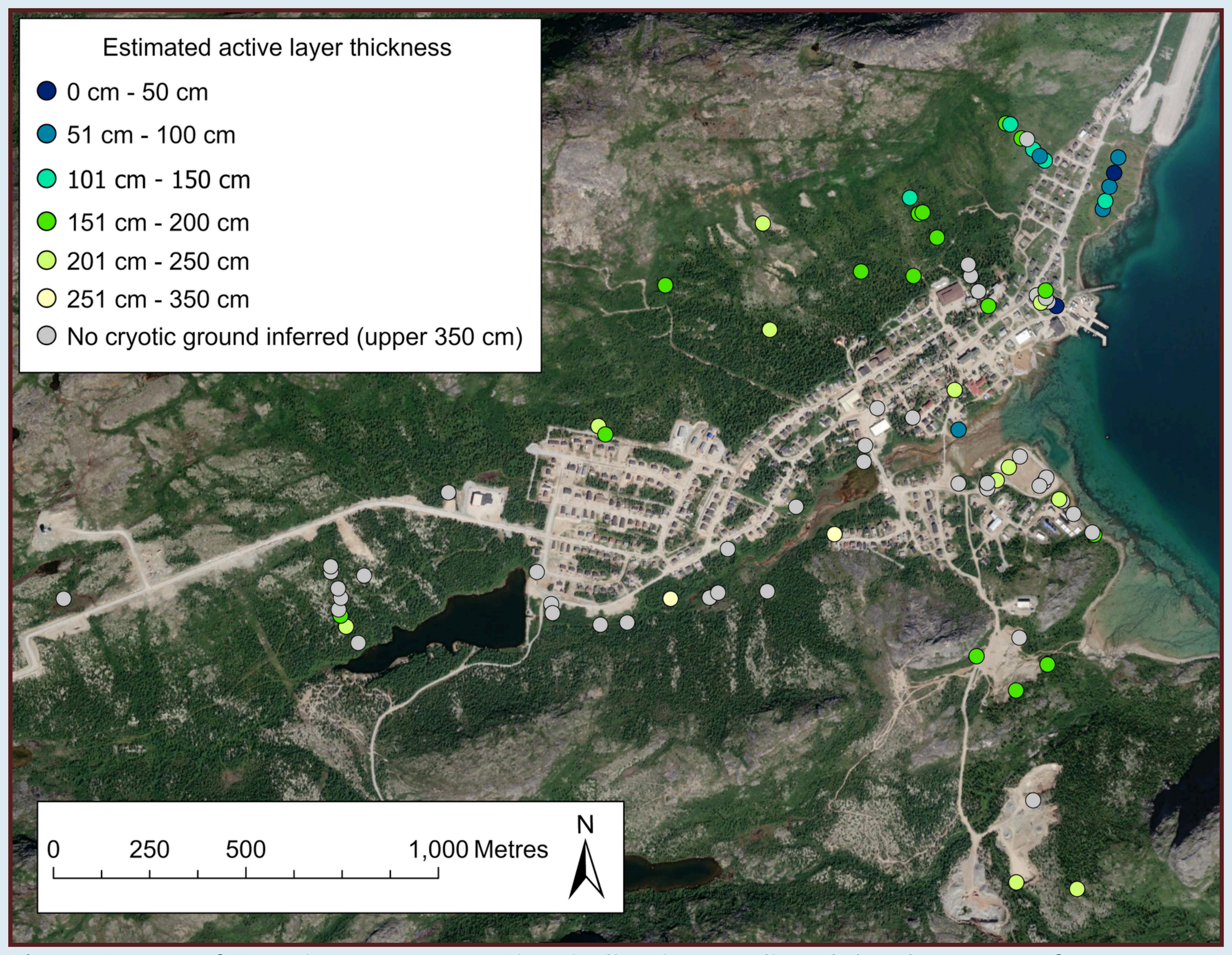

Figure 6: Map of Cryotic Assessment Sites indicating predicted depth to permafrost.

Influence of ecosystem and landscape variables

Environmental variables were also measured at the Cryotic Assessment Sites. A random forest model was used to evaluate the correlation between these variables and inferred cryotic ground presence. Percent cover of vegetation and soil moisture were the most correlated with cryotic ground prediction (Figure 7). Where higher percent cover vegetation and lower soil moisture are associated with cryotic ground.

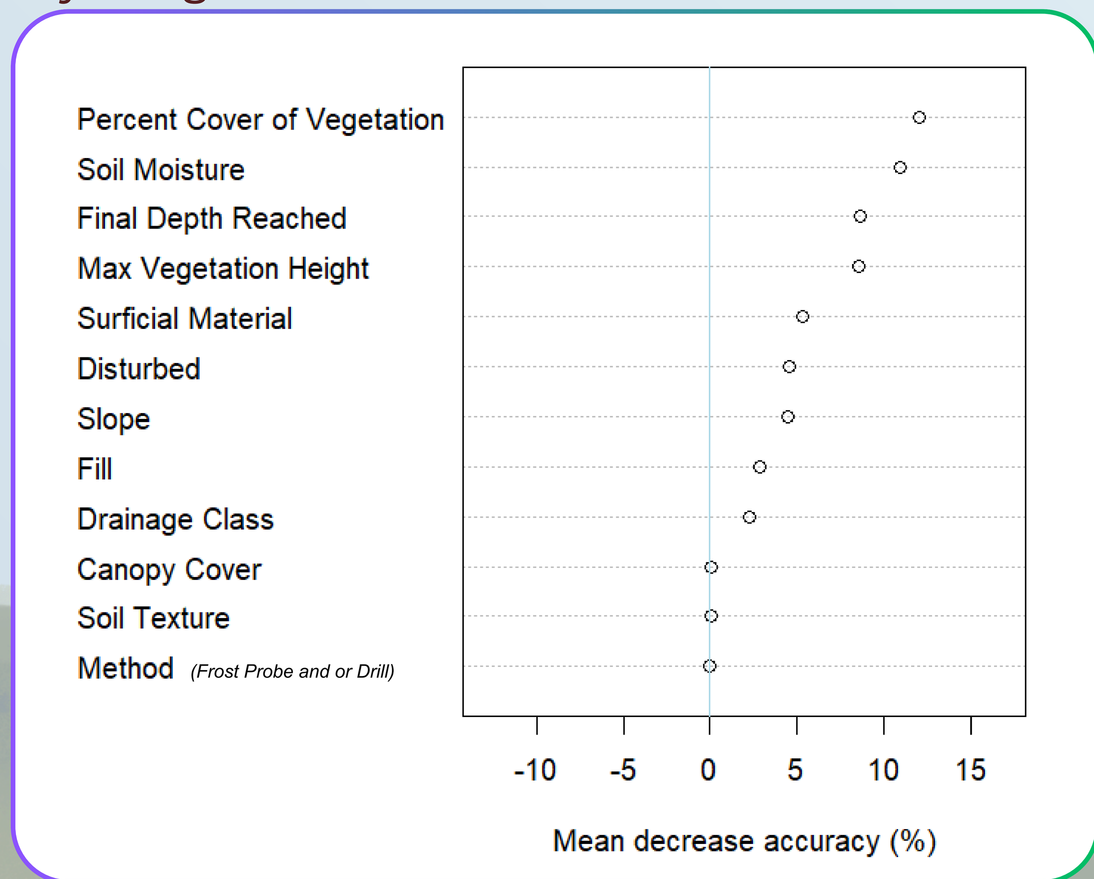

Figure 7: Variable Importance plot between the correlation of predicted cryotic ground presence and collected variables. The larger the increase in *mean decrease accuracy*, the more correlation with predicted cryotic ground a variable has.

Acknowledgments

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References

Allard, et al. (2023). Arctic Science. 9(3): 657-677. https://doi.org/10.1139/as-2022-0024

Way, et al. (2021). Regional Conference on Permafrost 2021 and the 19th International Conference on Cold Regions Engineering,: 11.