Drivers of permafrost degradation along the Inuvik to Tuktoyaktuk Highway

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Study Area

Inuvik to Tuktoyaktuk Highway (ITH), Northwest Territories, Canada.

The construction started in 2014 and the opening was in 2017.
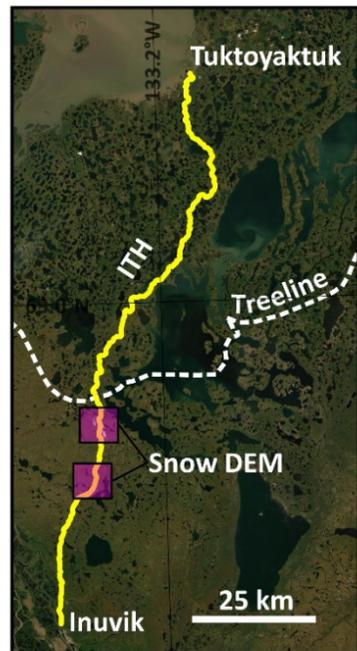
*Side-view of road embankment.*   3D view ITH

Snow Accumulation

Enhanced snow accumulation within 47 m from the road.

Average snow depths of > 1 m next to the road.

Increased snow cover will increase the **thermal insulation** as well as produce **more melt water** and likely promote permafrost degradation.

Mean snow depth derived from 500 m long transects (n=3185) of ITH close to Trail Valley Creek from snow-free (August 2018) and snow-covered (April 2019) Digital Elevation Models.
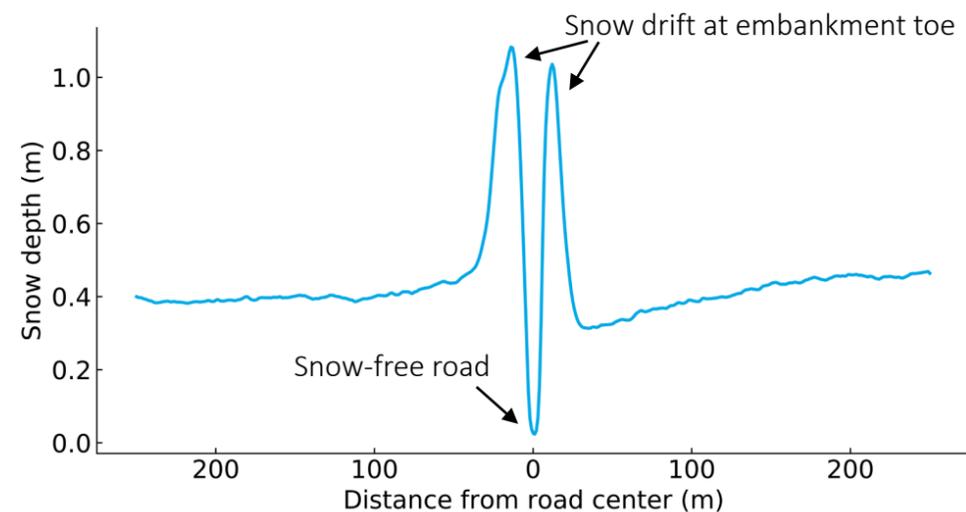
Water Ponding

The difference between upstream and downstream from the road increases every year. NDWI generally increases.

Normalized Difference Water Index (NDWI) derived 50 m around every culvert from Sentinel-2 imagery (10 m resolution).

Increased wetting of the embankment toe **delays the freezeback** of the soil due to latent heat.
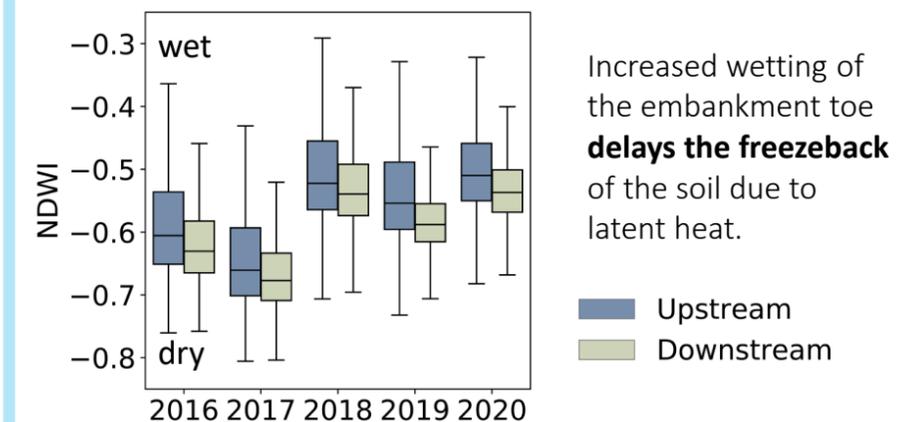
Summary

Gravel highways built on embankments favor snow accumulation and produce dust, which can enhance **permafrost degradation.**

Additionally, even with culverts, embankments can hinder water movement and lead to wetting at the embankment.

Remote sensing has the benefit of large spatial and temporal coverage.

The objective of this study was to use satellite and repeat airborne laser scanner observations to explore the physical parameters which drive permafrost degradation in the regions adjacent to the ITH.

Snow Melt

Areas next to the road become snow free **earlier** in spring than the areas further away.

Effects up to 400 m from the road edge.

May trigger **ecological feedbacks** such as **early greening** and **warming** of the regions adjacent to the road.

Example of partly snow covered true color Landsat 8 image from 2018-05-30.
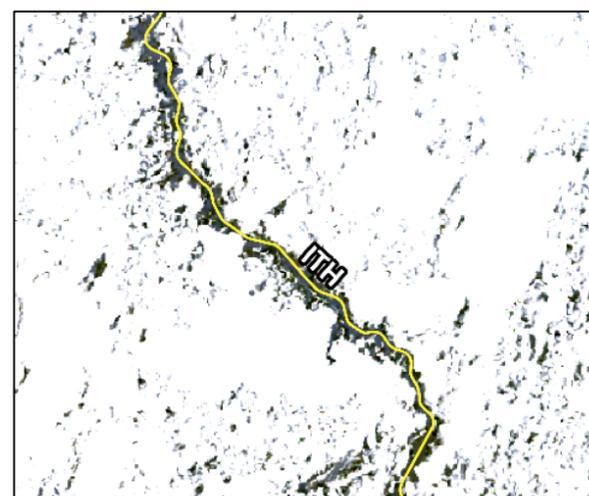
Snow-cover derived from Normalized Difference Snow Index using Landsat 8 images (30 m resolution).