Spotlight on Student Research

The influence of taliks on permafrost thaw in the Northwest Territories, Canada

CCRN
Changing Cold Regions Network

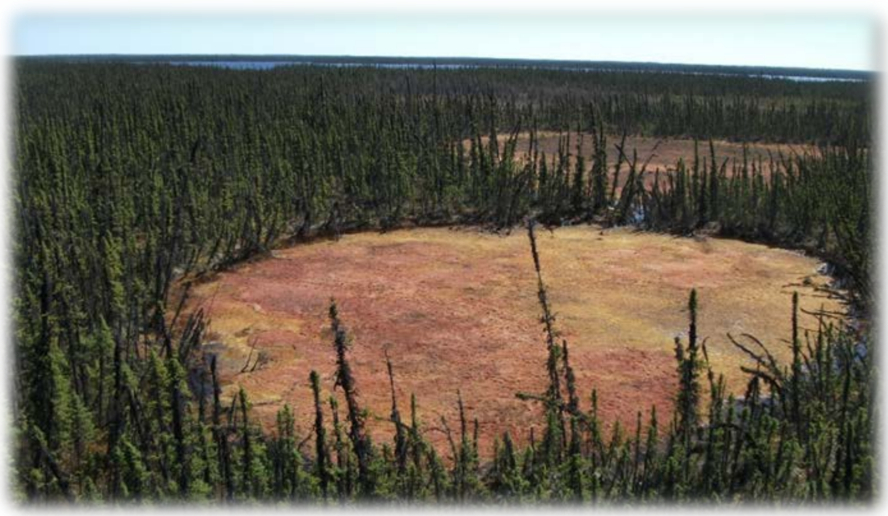
Changing Cold Regions Network (CCRN)

CCRN is a Canadian research network that aims to understand, diagnose, and predict the rapid environmental change occurring in the interior of western Canada. The Network is funded over five years (2013–2018) by the Natural Sciences and Engineering Research Council of Canada (NSERC) through its Climate Change and Atmospheric Research Initiative.

Ryan Connon, PhD Candidate

Ryan fast-tracked his MSc work directly into the PhD program where he has been awarded the W. Garfield Weston Award for Northern Research, an NSERC Doctoral PGS award, an Ontario Graduate Scholarship and has received funding from the Northern Scientific Training Program. Last year he also won the Don Gray award for best student paper and presentation in hydrology at the Canadian Geophysical Union annual conference.

Canada's North is host to one of the most rapidly warming regions on Earth. Since 1950, the region has experienced a 2 °C rise in average annual temperatures, with the highest warming occurring in winter (up to 6.5 °C). This warming is causing permafrost to rapidly thaw across the region and, in turn, is changing the ways in which water can travel through the landscape. Understanding the mechanisms that contribute to permafrost thaw and how it impacts runoff patterns is the focus of Ryan Connon's PhD research with the Cold Regions Research Centre (CRRC) at Wilfrid Laurier University. He is working under Dr. Bill Quinton, Canada Research Chair in Cold Regions Hydrology and co-investigator for the Changing Cold Regions Network (CCRN).



Bog in Scotty Creek Research Basin, NWT

Ryan is conducting his research at the Scotty Creek Research Basin (SCRB; https://www.scottycreek.com/), located 50 km south of Fort Simpson, and has spent over 400 days on site focusing on the headwater regions of the basin, where permafrost is preserved under thermally insulative peat. In this region, permafrost exists solely under forested peat plateaus, which are interspersed by a network of wetlands – channel fens and flat bogs. As the permafrost thaws, the peat plateau forests are converted to wetlands and the biophysical terrain of the basin is altered.

Ryan's recent research focus is looking at tipping points for permafrost thaw. In 8 of the last 11 years, the net annual ground heat flux on permafrost plateaus has been positive, meaning that the ground is gaining more energy each year than it is losing. This means that the permafrost on these plateaus is unstable and is not in balance with the current climate. In some areas, the ground above the permafrost that thaws in the summer does not entirely re-freeze in winter, forming thin taliks between the frozen active layer above and the permafrost below. Currently, it is typically assumed that this entire thickness of ground above permafrost re-freezes in winter, but in areas of discontinuous or sporadic permafrost – like Scotty Creek – this is not always the case.

Ryan measuring streamflow from a flume box in SCRB, NWT.

Ryan's work shows that in areas where taliks are present, vertical permafrost thaw is 5x greater than areas without taliks. This is because taliks prevent over-winter energy loss from the permafrost, which causes it to thaw much faster. In addition, Ryan's work has shown that the proportional coverage of areas with taliks is increasing in the SCRB. From 2011 to 2016, the percentage of points on the interior of a peat plateaus that had a talik soared from 6% to 28%. Ryan suggests that wide-spread talik development was likely caused by a very warm and wet summer in 2012 which amplified permafrost thawing, followed by a year with very high snow cover that insulated the ground and prevented the ground to cool over winter.

As talik development becomes more wide-spread and thaw rates at locations with taliks are much greater, permafrost thaw may exhibit a non-linear response to warming air temperatures. If this happens, the rate of permafrost thaw will increase faster than the rate of warming. Earlier research conducted by Ryan has examined how thawing permafrost changes the water cycling within the SCRB. He found that at Scotty Creek (and other adjacent basins), recent increases in streamflow are linked to the thawing of permafrost. Water that was once stored in the wetlands is now contributing to streamflow as a result of the thawing of the relatively impermeable permafrost that once acted to hold the water back. Understanding the processes and mechanisms that contribute to permafrost thaw are vital to predicting future water resource availability in the region.

For more information, please visit our website at: www.ccrnetwork.ca

What is permafrost?

Permafrost is ground that remains at or below 0 °C for two or more years and is found in high latitudinal regions, like Northern Canada. It consists of soil, rock and sand usually bound together by ice. It is estimated that permafrost accounts for 0.22% of the total water on earth. As the climate warms and permafrost thaws, the stability of the ground can be weakened due to the loss of ice that once bound the soil together. This can result in trees to topple, buildings to collapse and hillslopes to fail.

What is a talik?

A talik is a layer of year-round unfrozen ground that lies in permafrost areas.

Ryan conducting snow surveys in SCRB, NWT.

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