Theme 5

Adaptation to Permafrost Thaw

The **principal objective** of Theme 5 is to support northerners in adaptation to permafrost in transition

We are doing this through a series of projects initiated to address specific challenges that have arisen due to thaw of permafrost

Theme 5 Students

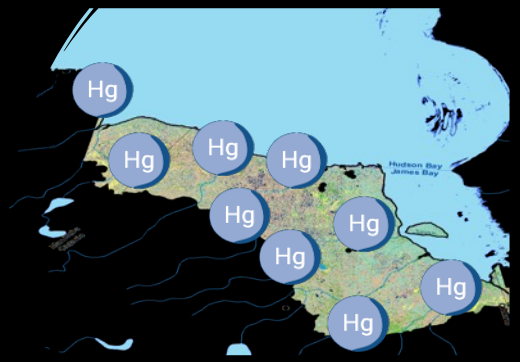
Landscape change and mercury in permafrost zones of the Hudson Bay Lowlands

Adam Kirkwood

Ph.D. Candidate – 3rd year

Supervisors: Drs. Roy-Léveillé & Basiliko

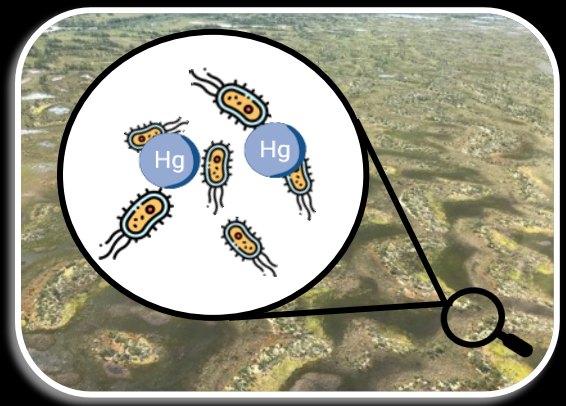
Committee: Drs. Beddoe & Richardson



Objectives:

Evaluate accuracy of estimations of mercury storage in the Hudson Bay Lowlands by calibrating with local field data

Assess the linkages between permafrost degradation and the production of methylmercury, a potent neurotoxin

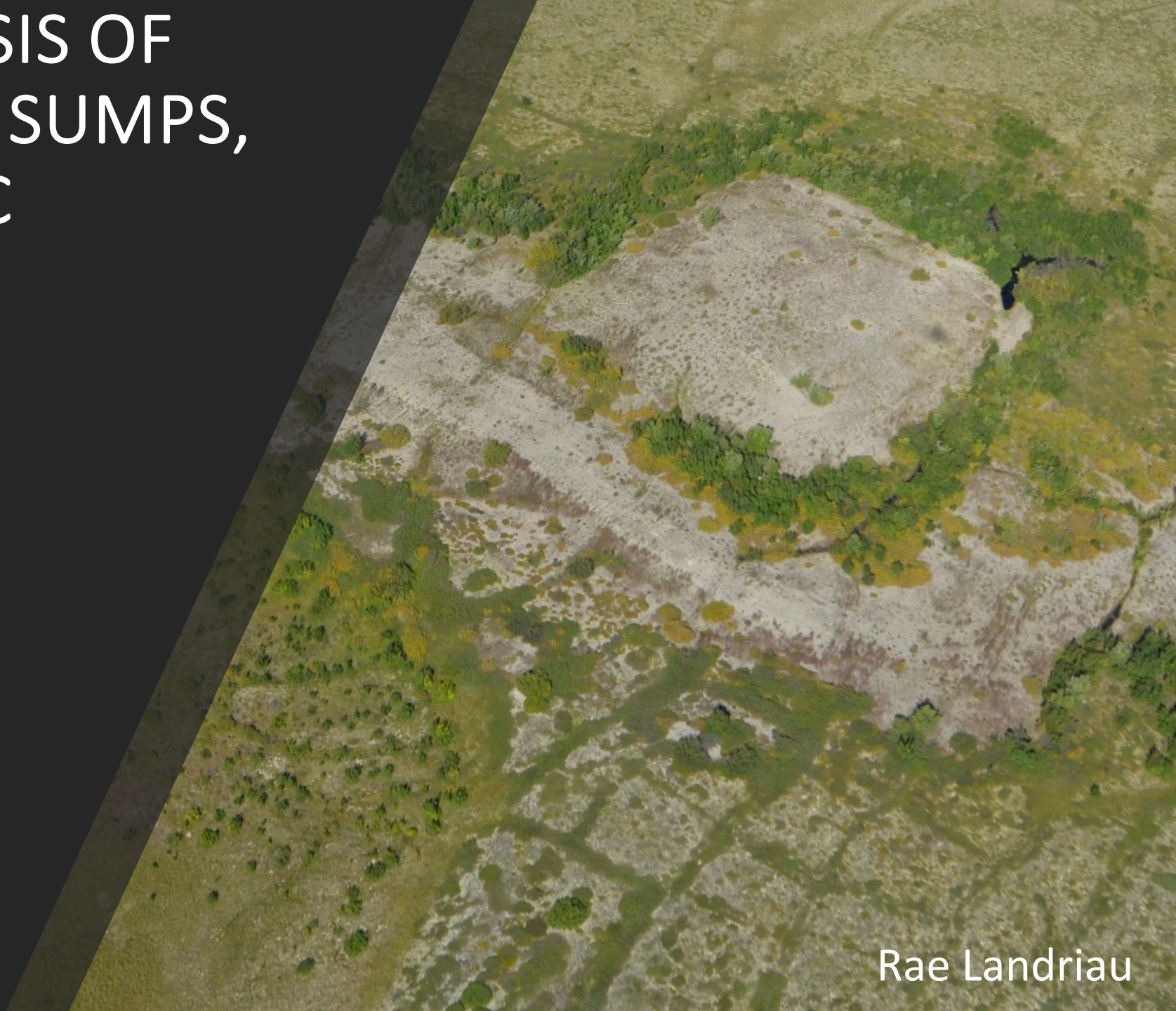


Provide a preliminary description of landslides occurring along the Churchill River and determine their impact on export of Hg to the riverine ecosystem

LaurentianUniversity
UniversitéLaurentienne

STABILITY ANALYSIS OF DRILLING WASTE SUMPS, WESTERN ARCTIC CANADA

Rae Landriau: MSc
Carleton University



Snowbank compaction to improve thermal stability of road embankments built on permafrost

Pat Jardine: MSc

Carleton University

- Snowbanks in central Yukon compacted with snow machines by First Nation of Na-Cho Nyäk Dun
- Test plots in forest and in tundra
- Ground surface temperatures and snow conditions

Completed!

Snowbank compaction to improve thermal stability of road embankments built on permafrost

Snow compaction near Mayo on November 29th, 2020

- Mean surface temperatures 2 - 3 °C lower at compacted plots
- Increase in snow density limited to depth hoar layer in tundra, recorded throughout the snowpack at forest

Paper in development: *Snow compaction beside highways to reduce ground temperatures, central Yukon, Canada*

MSc. Student Astrid Schetselaar

THESIS TITLE: INCREASES IN MAINTENANCE COSTS ASSOCIATED WITH CLIMATE CHANGE IN YUKON

Objectives:

- Quantify the financial impact of climate change on highway infrastructure maintenance in Yukon
- Link changes in maintenance costs to climate conditions and underlying permafrost

Completed!

RESULTS

- Climate-related maintenance costs are increasing by $300,000 per year
- As a proportion of total overall maintenance costs, climate-related costs have increased from 18% to 35% from 1995-2020
- Climate-related maintenance is 5x costlier in sections with >50% permafrost

Journal Article submitted to *Arctic*:
Performance of climate projections for Yukon and adjacent Mackenzie Valley, 1991-2020

ASSESSING A GEOCELL-SUPPORTED RAILWAY EMBANKMENT SUBJECTED TO PERMAFROST DEGRADATION AND PONDING WATER CONDITIONS USING NUMERICAL MODELLING TECHNIQUES

Payam Sharifi

Graduate Student

Supervised by: Dr. Ryley Beddoe

Civil Engineering Department

Royal Military College of Canada

Photo Credit By OmniTRAX Inc

RESULTS

- Optimal placement of geocell in embankment was 0.4 x height of embankment
- When there is ponding water, Geocells could still double the factor of safety of the short-term embankment stability
- Settlement of the railway crest with a geocell embankment was negligible under 20 years of climate warming
- Thesis completed January 2022

In our broader PNET Student Community….

In our broader PNET Student Community….

Most recently - presentations given to Theme 5 by

- Hannah Macdonnell
- Gabriel Karam
- Pia Blake

In our broader “Theme 5” Student Community.…

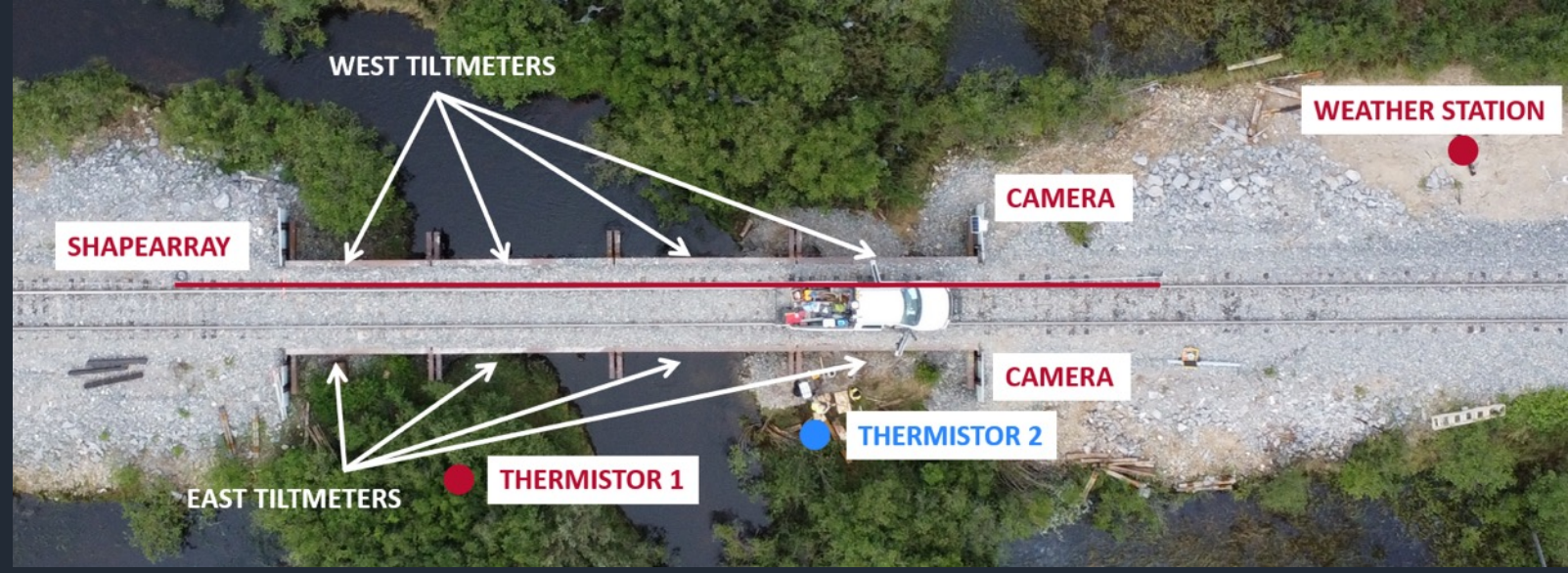
Gale-force topographic winds in Hurricane Alley, north Dempster Highway, Yukon

Trevor Andersen M.Sc. Geography Carleton University

https://www.cbc.ca/news/canada/north/researchers-wind-speeds-dempster-hurricane-alley-1.6598995

Investigating Frost Jacking's Effect on Railway Bridges along the Hudson Bay Railway

Natalie Arpin
Queen's University
Supervisors: Andy Take & Ryley Beddoe



Project Objectives:

- Develop monitoring methods for frost jacking of railway bridges in harsh, remote northern locations
- Complete a case-study of the impact of frost jacking on the bridge at Mile 419.4
- Quantify the system level effects of frost jacking on bridges along the HBR
- Investigate the controlling mechanisms of frost jacking through laboratory experiments

Jon Gallagher
Queen's University
Supervisors: Andy Take & Ryley Beddoe

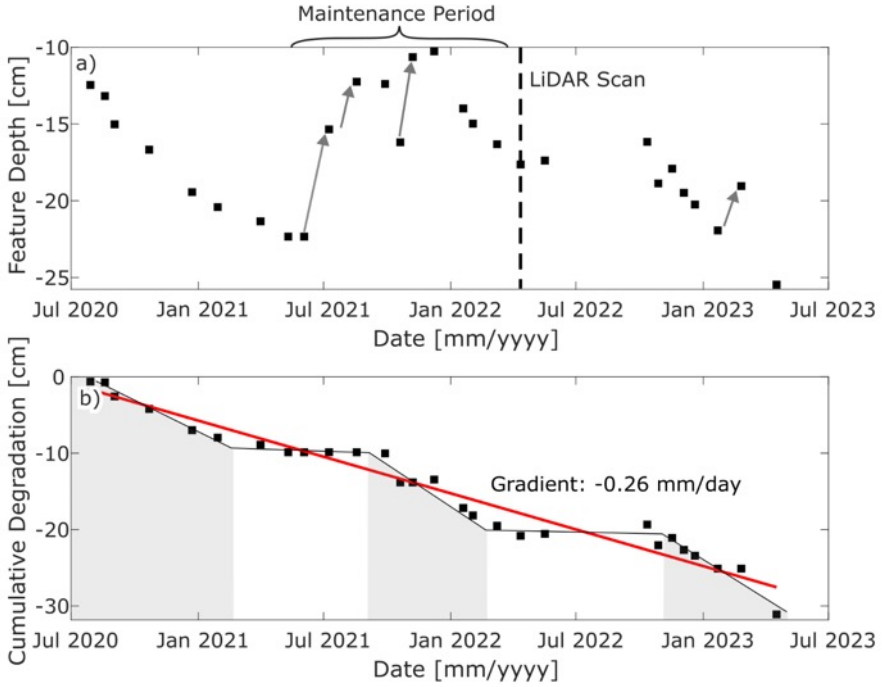
Monitoring climate-induced changes in northern railway infrastructure: an innovative approach using track geometry data

Project Objectives:

- Create a workflow converting track geometry parameters into surface profiles, to monitor the progression of track defects in a northern railway affected by a changing climate.
- Use the railway as a continuous linear sensor to capture climate change effects on the Hudson Bay Lowlands and assess the impacts on infrastructure and degradation rate.

Completed!

(EBA Engineering Consultants Ltd. 1982)



PhD Project

Local- to watershed-scale impacts of permafrost degradation on the natural and built environment in the Stewart River watershed, traditional territory of the First Nation of Na-Cho Nyäk Dun, Yukon

Frederic Brieger

Committee: Shawn Kenny (co-supervisor),

Murray Richardson (co-supervisor),

Christopher Burn

NA-CHO NYAK DUN
BIG RIVER PEOPLE
MAYO, YUKON

NSERC CREATE
UTILI
CRSNG FONCER

PermafrostNet
NSERC | CRSNG

Carleton University

MODELLING THE IMPACT OF PERMAFROST DEGRADATION ON THE ITH - A GUNGHI CREEK ARCH BRIDGE CASE STUDY

Balaussa Kameledenova, MASc Candidate

Supervisors: Dr. Beddoe & Dr. Siemens

Completed!

RMC CMR

Trevor Andersen

Natalie Arpin

Jon Gallagher

Frederic Brieger

Balaussa Kameledenova

Trevor Andersen
Natalie Arpin
Jon Gallagher
Frederic Brieger
Balaussa Kameledenova
Tabatha Rahman
Khatereh Roghangar
Zakieh Mohammadi
Catherine Deslauriers
Anna Pekinasova
Jay Cumming
Emma Stockton
Danika Ouellette
Brett Young
Cameron Ross
Hannah Macdonnell
Pia Blake
Gabriel Karam

PLUS:

Adam Kirkwood
Rae Landriau
Astrid Schetselaar
Pat Jardine
Payam Sharifi

And you?
(let us know!)

The **principal objective** of Theme 5 is to support northerners in adaptation to permafrost in transition

5 Years Later…

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5 Years Later…

Development of people to support adaptation