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Factors Influencing the Spatial and Temporal Occurrence of Retrogressive Thaw Slumps along the Yukon Coast, Canada.

Introduction

The mechanism of carbon dioxide and methane release to the atmosphere in permafrost regions is not solely restricted to the progressive thawing of the upper part of the ground by warmer air temperatures. Organic carbon and nutrients are released to streams, rivers or coasts by abrupt processes such as thermokarst, thermal erosion and simply river bank or coastal erosion.

Thermo-erosion, as a mechanism of rapid permafrost thaw, reshapes Arctic coasts and has a clear impact on the mobilization and distribution of carbon and nitrogen in permafrost terrains. **Retrogressive thaw slumps** are one specific and highly dynamic landform, which results from thermo-erosion of ice-rich permafrost and leads to the displacement of large volumes of sediments. Studies reporting on the occurrence and evolution of retrogressive thaw slumps over the Arctic show that in varied Arctic areas, slumps have increased over the last decades. While the processes responsible for the initiation of retrogressive thaw slumps (RTS) are well defined, little research has been done on a regional scale to define the terrains on which they occur, and to measure the volumes of sediments eroded through their development.

The overall goal of the study is to later provide estimates of the contribution of these permafrost degradation landforms to the nearshore carbon budget in order to account these features in the carbon models.

The main goal of this study is to highlight the dynamics of retrogressive thaw slumps on a coastal plain in the eastern part of the Beaufort Sea . The objectives are:
1) to measure their evolution on a ca. 150 km coastline along the Yukon Coast over the last 60 years (1952-2011)
2) to determine the prevailing factors accounting for their distribution and driving their expansion

Figure 1: Study Site

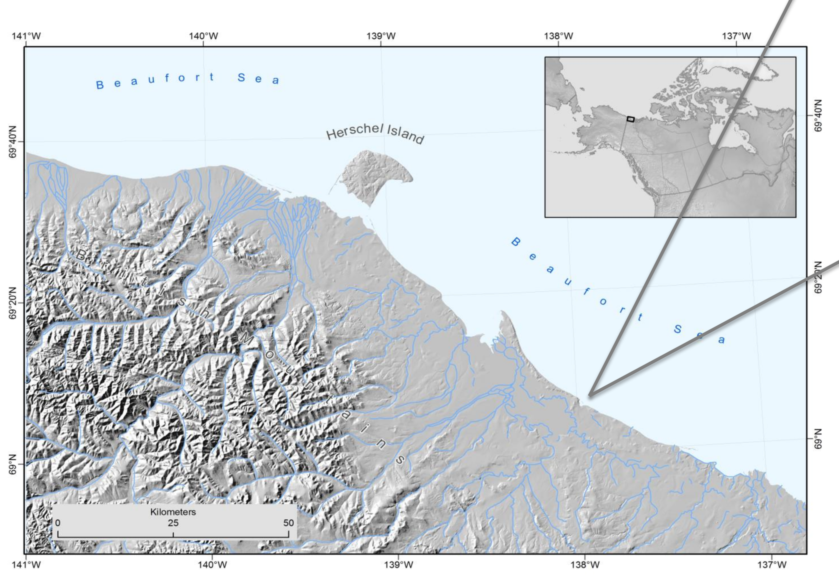
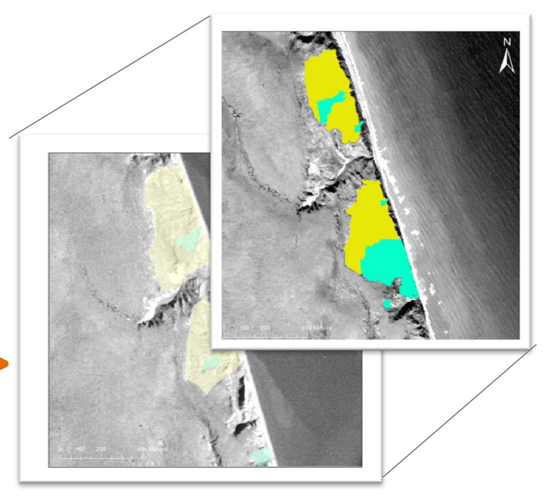


Figure 2: Active Retrogressive Thaw Slump along the Yukon Coast

The **Yukon coastal plain** is characterized by a flat and gently sloping erosional surface, north of the British, Barn, and Richardson mountains. It is underlain by thick (> 60 m) unconsolidated glacial and glacial-marine deposits (Rampton, 1982), which accumulated during Pleistocene and Holocene. The coast is located at the margin of the past glaciated area and the easternmost part of Beringia (non-glaciated area) to the west.

Methods

<u>Landform detection</u>
Mapping based on high resolution satellite imagery: GeoEye-1, WorldView-2 and historical aerial photographs



<u>Spatial analyses and landform classification</u>
Based on field observations and spatial analyses

<u>Statistical analyses</u>
Principal Component analysis

Key Findings

1. Retrogressive thaw slumps mostly occur on morainic deposits, where excess ice is high.

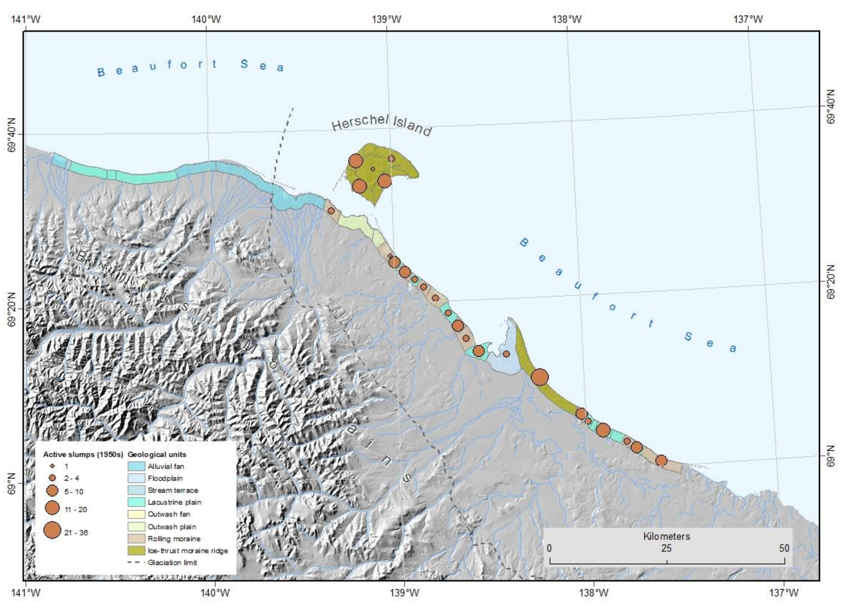
2. Retrogressive thaw slumps have increased in number (41%) but their total surface has decreased in most of the units (-43%).

3. The highest change in number of active RTS is related to coastal topography.

Preliminary Results

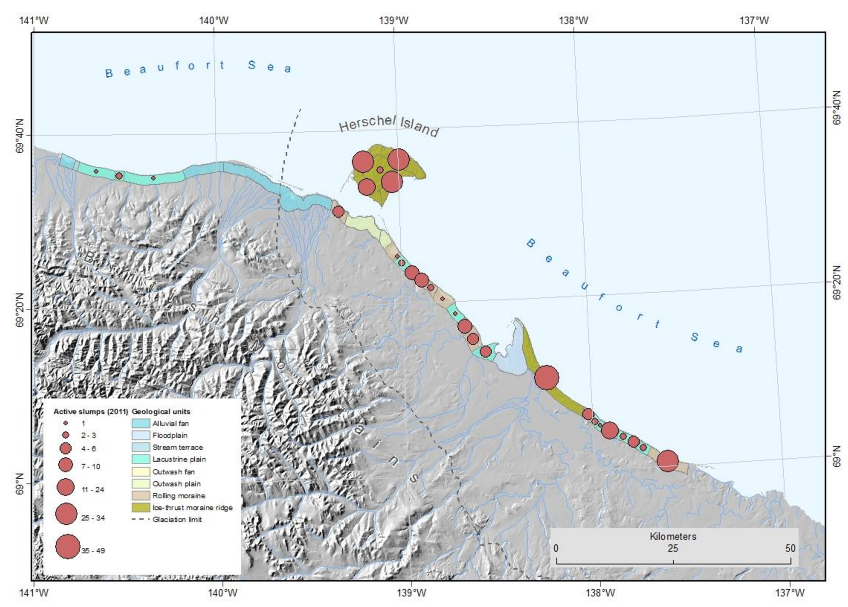
Slump distribution

Location of Active Slumps in 1950s



- 52.2% of the RTS are found on the ice thrush morainic deposits (Mr)
- 23.3% on the rolling moraines (Mm)
- 24.4% in lacustrine deposits (L).

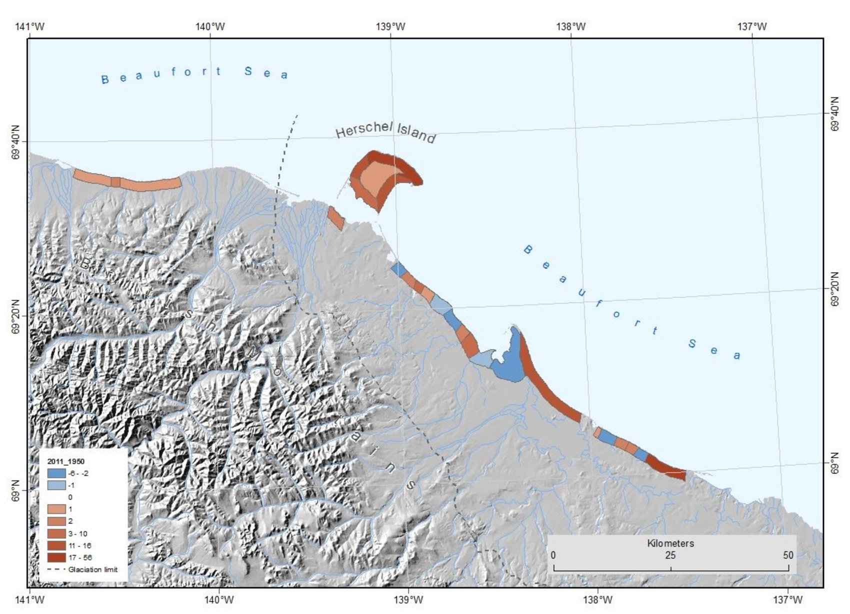
Location of Active Slumps in 2011

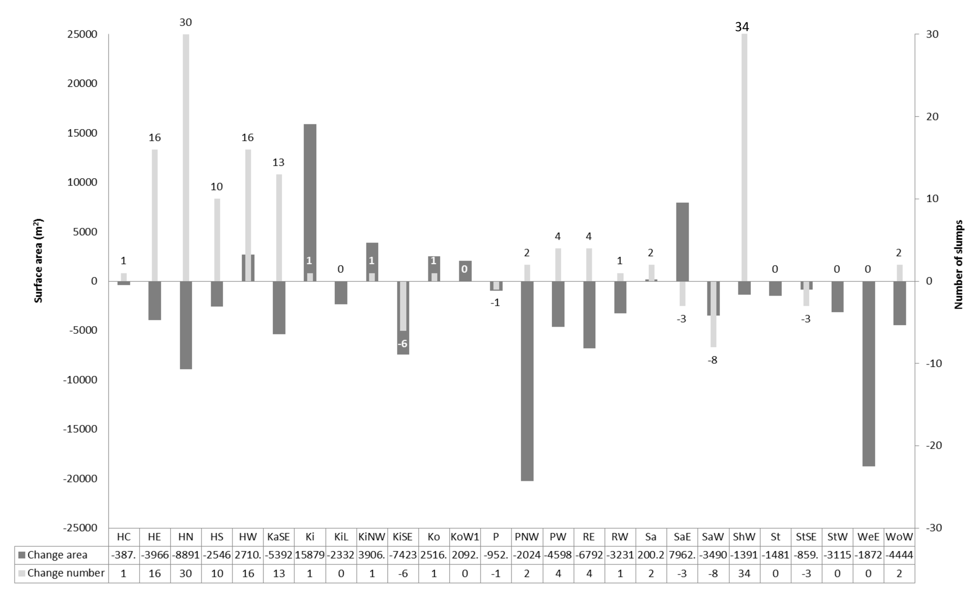


- 56.7% of the RTS are found on the ice thrush morainic deposits (Mr)
- 30.5% on the rolling moraines (Mm)
- 12.8% in lacustrine deposits (L).

Slump evolution

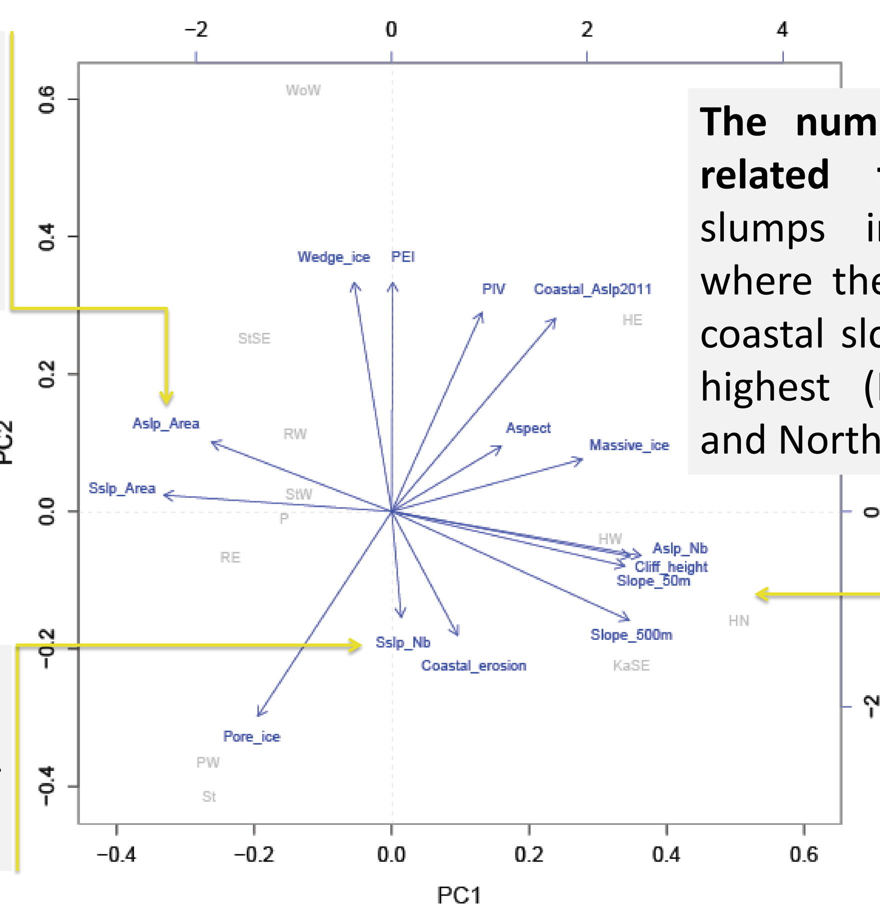
Evolution of Active Slumps Between 1950s and 2011





In most of the units, the number of active RTS has increased but RTS appear to be smaller; the overall surface area occupied by RTS decreased. This might be the consequence of RTS reactivation due to changes in the slope gradient related to costal erosion.

None of the environmental factors included in this study can explain the increase in RTS areas.



The number of active RTS is related to the topography: slumps increased in number where the cliff height and the coastal slope over 50 m are the highest (Herschel Island West and North and Kay Point SE).

In the units where coastal erosion is low, there is stabilization of RTS.

FURTHER STEPS:
1. Define the factors responsible for increasing RTS areas
2. Measure eroded volumes of sediments from RTS
3. Estimate the amounts of carbon mobilized through RTS development

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