The spatial distribution of ice-wedge polygons in Nunavik

A. Chiasson[1,2], M. Allard[1,2] & E. L'Hérault[2]

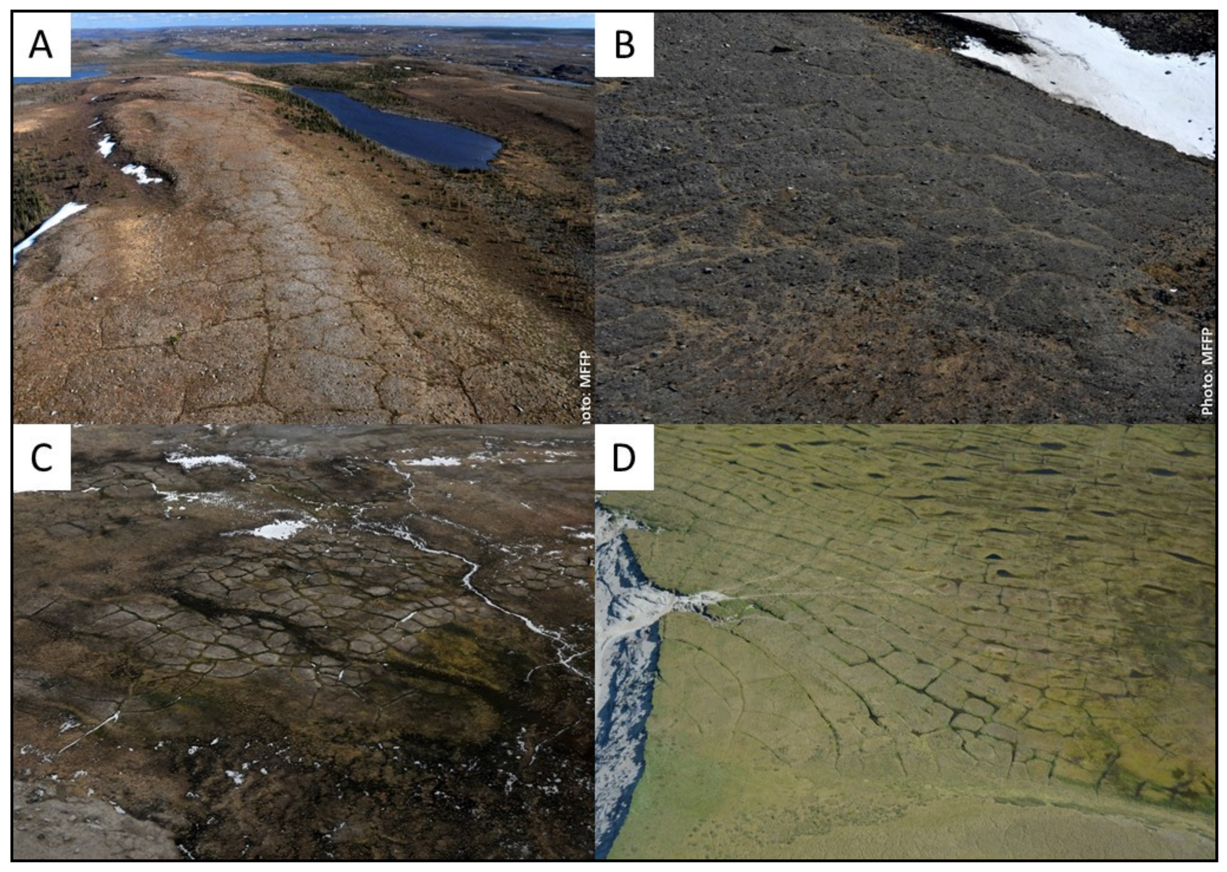
1. Université Laval, 2. Centre d'études nordiques

CENTRE D'ÉTUDES NORDIQUES
CEN Centre for Northern Studies

UNIVERSITÉ LAVAL

INTRODUCTION

Ice wedges in polygonal terrain are one of the dominant features of permafrost that are affected by the deepening of the active layer and the thawing of permafrost provoked by climate warming. Despite abundant research in Nunavik on permafrost, ice-wedge polygons and on soil thermal cracking, no analysis of the spatial distribution of tundra polygons has ever been done. Furthermore, there is absolutely no knowledge of the spatial distribution of active ice wedges (i.e. actually cracking). According to several studies, the southern limit of active ice -wedge polygons is already migrating northward due to global warming.



A: Ice-wedge polygons formed on a drumlin near Kuujjuaq. B: Ice-wedge polygons formed in a till deposit near Salluit. C: Ice-wedge polygons formed in a raised beach deposits near Ivujivik. D: Ice-wedge polygons formed in a thin deposit of organic matter and silt/sand sediments near Sugluk inlet (Salluit).

OBJECTIVE

The objective of this project is to assess the activity of frost-cracking, ice-wedge polygons and tundra polygons across the bioclimatic zones of Nunavik.

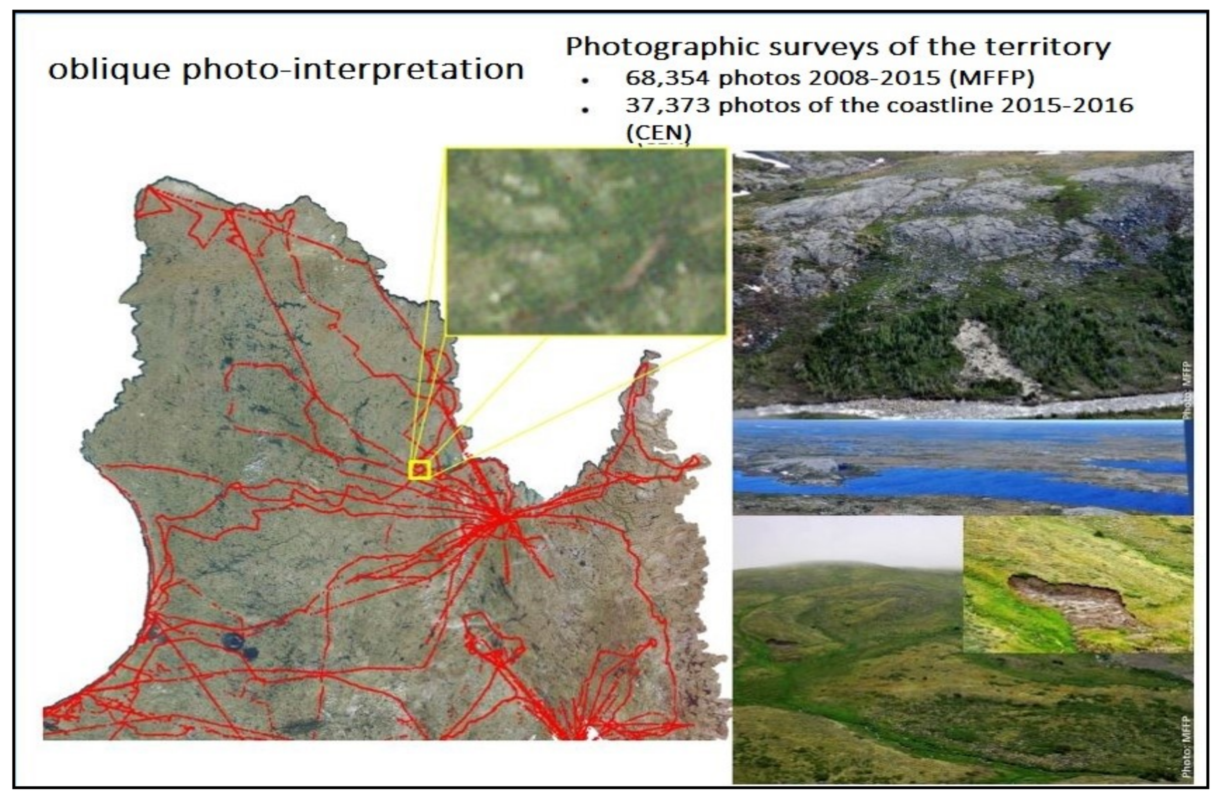
Since frost-cracking is a temperature-controlled process affecting materials with different rheological properties, it is assumed that activity is related to surface climatic conditions, soil materials, vegetation type and snow cover.

This assumption also implies that ice wedges and polygons that are either dormant or fossil in the landscape were formed and have evolved under colder past climates.

METHODS

- In the summer of 2017, in Salluit, we dug dozens of soil pits to find out the degree of frost-cracking of the ice-wedge polygons under current climate conditions and ground temperatures.
- We analyzed thousands of georeferenced aerial photographs (MFFP: 68 354/ CEN: 37 371) for tundra polygon location; then we built a database and mapped our findings.
- We assigned basic parameters to each observed site, i.e. the probable type of ice wedge, the form of the polygons (e.g, open, closed, flat, high-center, low-center), the surficial geological material and the vegetation type.

Procedure used (digging) to determine the degree of cracking of ice-wedge polygons. See also Samuel Gagnon's presentation (this conference).



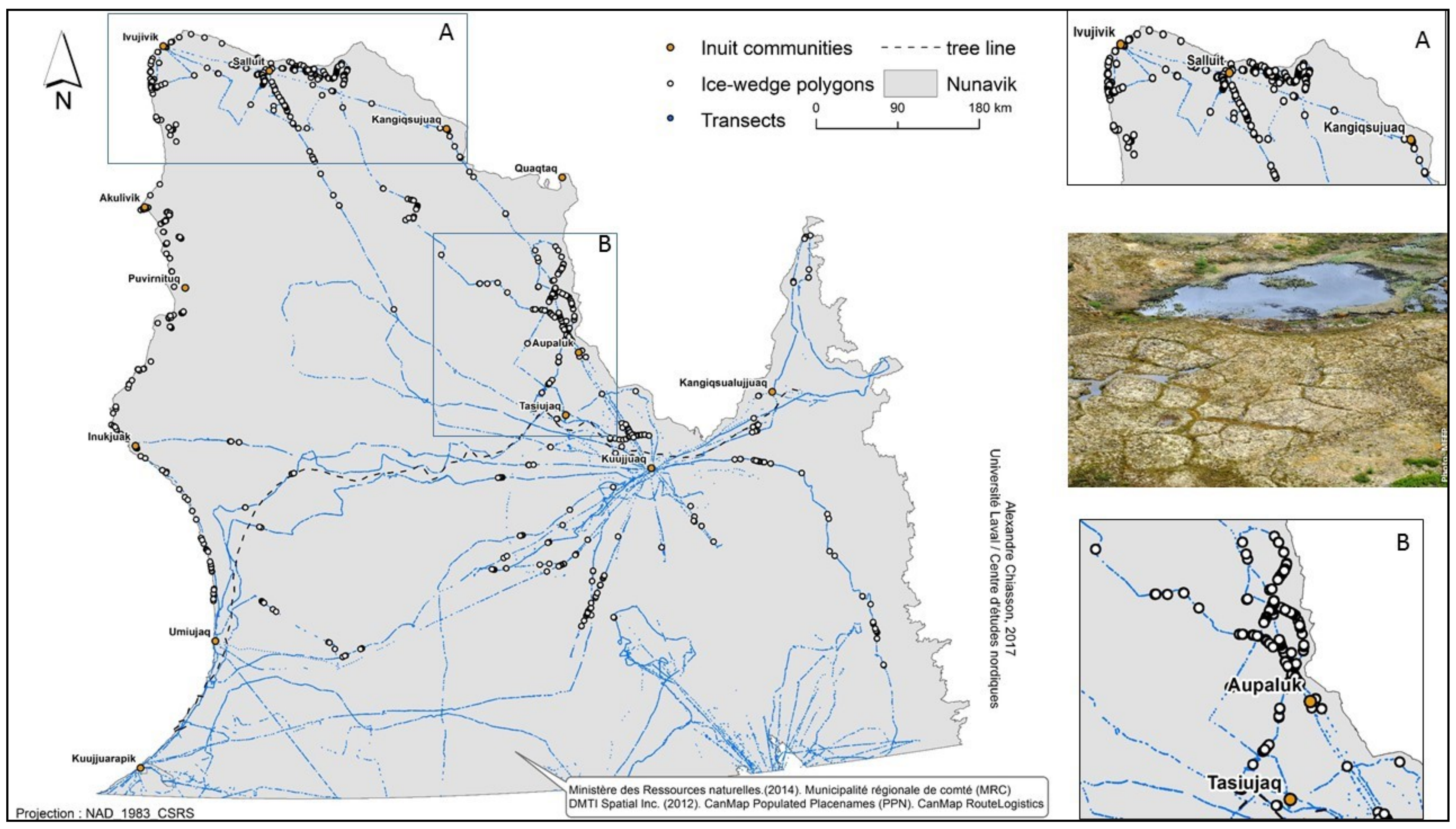
Location of transects made by the MFFP between 2008-2015. Each point (68,354) represents an aerial photograph. CEN'survey lines followed the coastline.

PRELIMINARY RESULTS

- Our results show that ice-wedge polygons in Nunavik are relatively recent because of their settings (Holocene).
- They formed in current and raised beach deposits and on glaciogenic terrain land forms (eskers, drumlins). These deposits were put in place during or after deglaciation.
- In Salluit, the majority of sites with ice-wedge polygon networks were active in 2017. The ground had cracked during the previous winter (Image below).
- Twenty percent of the located polygon sites in Nunavik are below the tree line. These ice-wedge polygons seem inactive due to the presence a dense vegetation/snow cover.

Ice-wedge polygons formed in glaciofluvial deposits near the Raglan Mine.

The ground has cracked during the winter 2017 (Foucault River).

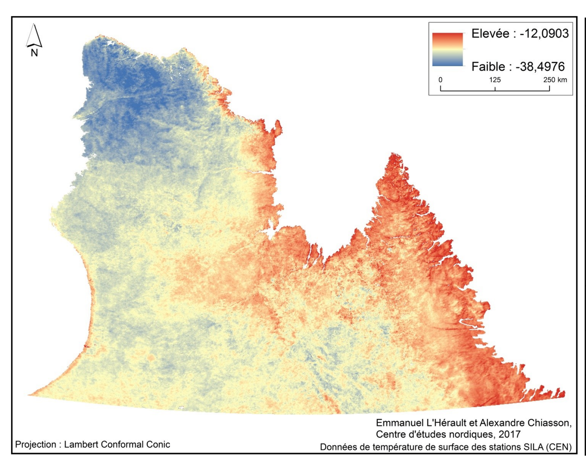


The spatial distribution of identified ice-wedge polygons in Nunavik (preliminary results).

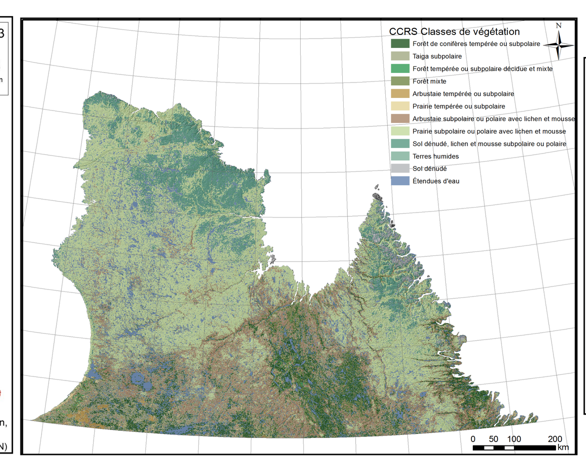
NEXT STEPS

We will apply the TTOP model to estimate and map the mean and minimum ground temperatures at the top of permafrost for the months of January and February 2015-2017 to identify areas that are affected by thermal regimes likely to induce cracking. The buffer layer effect of the snow cover that may impede frost cracking will be calculated with an existing model of canopy cover, a model of snow cover and a surficial geology map at a resolution of 250 m. The ice-wedge polygons will be classified into four categories according to the degree of activity of the ice wedges: (1) active ice-wedge polygons, (2) sporadically active ice-wedge polygons, (3) inactive ice-wedge polygons and (4) fossil ice-wedges polygons

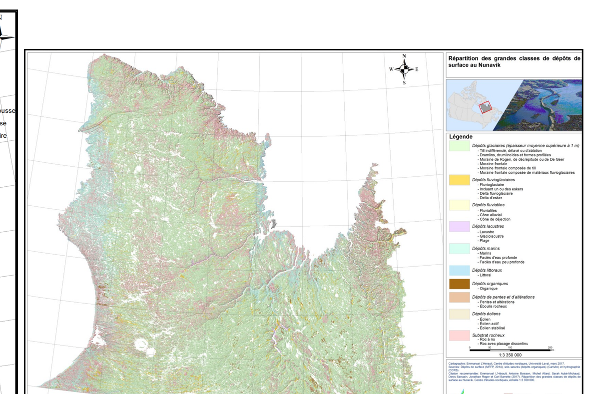
In the summer of 2018, in Akulivik, we will also dig dozens of pits to examine whether ice-wedge polygons are still active at a more southern latitude.



Temperature (° C) at the top of permafrost (February 2012)



Map of vegetation cover



Map of surface deposits

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