

2017 Nunavut Research Licence Renewal Application: Wayne Pollard

Project Title: An investigation of the sensitivity of high Arctic permafrost to climate change

Principal investigator: Dr. Wayne Pollard, Professor, Department of Geography, McGill University, 805 Sherbrooke St. W. Montreal, Quebec. H3A 0B9

2017 Research Team: Wayne Pollard (PI), Chris Omelon, Dale Andersen, Denis Lacelle, Jeff Moersch, Cameron Roy (M.Sc.), Melissa Ward (Ph.D.) and 4 undergraduate field assistant from McGill – This is a university-based research project.

2017 Fieldwork Schedule: Planned fieldwork July 5- August 30.

2017 Field sites: The Eureka area on the Fosheim Peninsula, Ellesmere Island (80°00'N 85°95'W), and Expedition Fiord area, Axel Heiberg Island (79°25'N; 90°45'W). We will be based at the Eureka Weather Station.

Funding source: Discovery Grant from the Natural Science and Engineering Research Council (NSERC). Logistical support is provided by the Polar Continental Shelf Program

Project Overview:

This is the last year of a long-term project that examines how global warming, in particular warmer summer temperatures, is affecting the stability of high Arctic permafrost conditions, landscapes and infrastructure. There are 4 main aims: (1) to identify and measure changes in different landscapes (e.g. tundra, polar desert, wet lands, shorelines), (2) to assess local climate variability, (3) to evaluate the nature and extent of ground ice in permafrost and its vulnerability to climate change, (4) to determine the amount and rate of landscape change caused by warming and melting permafrost (thermokarst). A secondary aim is to assess the degree to which these changes impact fuel contaminated soils. The significance on this project is reflected in the dramatic increase in melting permafrost observed in 2011 and 2012. The information collected in this study will improve our understanding of how climate and permafrost interact and how resiliency of the permafrost system, both of which will allow for the better prediction of future changes. This research also has a significant training component involving students on several levels.

Progress Report – 2016 Scientific Research Licence #02 023 16R-M (multiyear)

In 2016 fieldwork focussed on sites in the Eureka Sound lowlands on Ellesmere Island and Expedition fiord Axel Heiberg Island. My students and I based our work from the Eureka weather station for a period 15 days (July 14 – July 29) during which we repeated on going measurements of thaw slump retreat and ice wedge subsidence around the Environment Canada weather station, runway and DND base. Fieldwork at Expedition Fiord area of Axel Heiberg Island was from August 7-20. My activities at Eureka included detailed survey and mapping geomorphic in areas of natural thermokarst; work included dGPS, GPR and vegetation surveys. Ice and soil samples were collected to determine carbon and ice content and ground ice origin. Results to date are interesting, we found that Total Soil Carbon (TSC) contents in the active layer for most of the area are extremely low < 1% in most areas. However we found that TSC in wetlands to be up to 2-5%, but keeping in mind that wetlands cover less than 3 % of the land area. The pattern of thawing permafrost was more typical and very comparable with the past 3 years (2013, 2014 and 2015) and much lower than seen in the warm summers of 2011 & 2012. The Eureka area contains extensive massive ground ice deposits (massive ground ice refers to thick (3-10m) layers of nearly pure ice) beneath 1-4 m of marine sediments. The presence of massive ice makes this area extremely vulnerable to thaw subsidence and erosion. My work in the Eureka Sound Lowlands over the past 2 decades has now identified at least 11 “hotspots” where ground ice represents a significant part of the near surface permafrost. Since 2011 we have mapped thaw and changing landscape conditions

related to ground ice almost everywhere below 150m asl. In 2012 we reported an unprecedented level of thermokarst (250+ retrogressive thaw slumps) but in 2016 the pattern was greatly reduced. MSc student M. Templeton completed his research on the impact on ice wedges and found that they comprise up to 3 % of the sediments in the upper 5 m. The monitoring of retrogressive thaw slump retreat is part of the PhD research by M. Ward. In addition to field mapping areas of thermokarst Ward is using satellite imagery to map and monitor landscape scale changes. July fieldwork included ground penetrating radar surveys of ice wedges and massive ice deposits, sampling of ground ice and aerial surveys. Field work on Axel Heiberg was cut short because of heavy snow and planned work on ice wedge mapping will be undertaken in 2017.

2017 Field Program.

This will be the final year of this stage of my research, corresponding to my funding cycle by NSERC. The aim of my 2017 field program is to complete preliminary investigations on how climate change is affecting ice-rich permafrost and in particular rates of thermokarst. My 2017 field program will address 3 topics: (1) the analysis of the stability of ice-rich permafrost in response to changes in the active layer, (2) analysis of changes in ice wedge morphology and (3) analysis of the chemistry of ground ice and active layer ice. The latter includes 1 new student (C. Roy). The measurement of changes occurring in the active layer remains a key focus as well as identifying connections between the atmosphere, active layer and permafrost. Fieldwork is planned for the Expedition Fiord area on Axel Heiberg Island (79°25'N; 90°43'W) and the Eureka area on Ellesmere Island (79°59'N; 85°49'W). Study sites that were selected in 2012 are representative of common ecosystems. These sites were chosen because of their accessibility, availability of baseline data, and existing research facilities. Together this research will assess the sensitivity of key permafrost systems to warming by defining the surface temperature fluxes in the active layer and at the active layer permafrost interface. This study will identify critical thresholds of non-recoverable change known as tipping points, and potential feedbacks. In 2017 we are asking 4 questions: (1): Are current and recent changes in the landscape due to climate change? (2) Does the active layer buffer the permafrost system? (3) Why do ice wedge polygons collapse so rapidly? And (4) is the chemistry of active layer moisture changing due to increased thaw? Activities planned for 2017 include the measurement of changes in the ground surface using a high resolution gps system coupled with ground penetrating radar. These data will be included in a geographic information system and will be used to geo-reference satellite images, (b) monitoring active layer processes and the measurement of temperature and moisture changes in mid-summer. This will involve the collection of sediment and ice samples from the active layer and top of permafrost, and (c) continued aerial surveys of changes throughout the Fosheim Peninsula.

Significance:

My research has made a significant contribution to the understanding of permafrost and ground ice conditions in the high Arctic. It provides new insights into the origin and age of permafrost systems, rates of change and the potential vulnerability of ice cored landforms (see attached manuscript). The magnitude of warming projected for the high Arctic will have significant effects on both the ecology and geomorphology of the region. This work is even more important given the increased level of mineral exploration interests in this area.

Wayne Pollard

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ክምርብ: ጎረቤት ያለፈ ኃረር Dr. Wayne Pollard, ልሳሳት ሰራተኛ ሙያ ምርመራ ሪፖርት
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2017 ንግዳላዊና ምርምር: ያብል፡ ደረጃ Wayne Pollard (PI), ዶክተር ብርሃኑ ሪባሪ Chris Omelon, ርእሰ ልማት Dale Andersen, በጽሁፍ ርዕይ Denis Lacelle, ስነ ግንዛቤ ጆፍ ሞየርስ Jeff Moersch, ህጻናት ምርምር ምርምር Cameron Roy (M.Sc.), ፖለቲካ ምርምር Melissa Ward (Ph.D.) ለዚህ ልማት ምርምር ልማት ምርምር ምርምር - ልማት ምርምር ምርምር ንግዳላዊና ምርምር.

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2017 ለጥናት ያደረጉበት: ልብስ ትኩረት ያደረገው Fosheim Peninsula, የምርጥ Ellesmere Island (80°00'N 85°05'W), ልብስ ትኩረት ያደረገው Expedition Fiord, የምርጥ Axel Heiberg Island (79°25'N; 90°45'W). ልብስ ትኩረት ያደረገው በሰላማዊነት ነበረ.

ፆፃፈኑኤባህር : ዲፖርትሚንት ኃሳሥዊ ወጪጋርገጠሚንት ፆርገሚንት ልሊጋ ልጋሪፎጠጠ ኤፕላኒኖጠጠ ከባሊኒፎጠጠ Natural Science and Engineering Research Council (NSERC). ልፆፆፆፆፆፆፆ ልፆፆፆፆፆፆፆ ልፆፆፆፆፆፆፆ ልፆፆፆፆፆፆፆ Polar Continental Shelf Program

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