Beaded Streams: A Case Study in the Blackstone Uplands, Yukon, Canada

Emma Ciric and Dr. Pascale Roy-Léveillée
School of Northern and Community Studies - Geography Program
Laurentian University / Université Laurentienne

Abstract

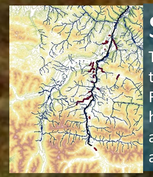
Beaded streams are a type of thermokarst expression resulting from ice wedge degradation found on gently sloping terrain. They have been studied in Arctic ecosystems underlain by continuous permafrost. This research examined beaded streams in the Blackstone Uplands (YT), a sub-arctic tundra landscape of the discontinuous permafrost zone. Analysis of beaded streams on satellite imagery and aerial photography taken in the 1950s indicated that beaded stream development is closely linked to the degradation of ice wedge polygon networks, and results in can result in pronounced changes in vegetation cover as beaded streams mature. In July 2016, a beaded stream from this study area was visited in the field to determine its depth as well as physical observations.

Introduction

Permafrost is rock or soil that remains at a temperature of 0°C or less for two or more consecutive years. The thaw of permafrost can affect the shape of the land surface, as well as the hydrology of Arctic and sub-Arctic ecosystems, and the composition of plant species and the animal habitats they create. Beaded streams are fluvial thermokarstic landforms, i.e. features that result from the thawing of icy permafrost and are associated with the creation of drainage pathways and the flow of water at the land surface. Beaded streams are named for their appearance, as they often look like beads on a necklace and have previously been examined in the continuous permafrost of Arctic tundra environments. The purpose of this research is to examine beaded streams in a sub-arctic environment of the discontinuous permafrost zone.

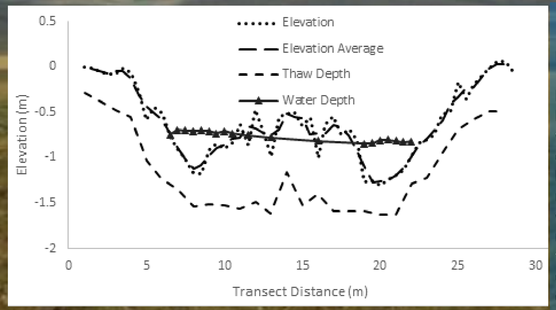
Methods

The attributes of seventeen beaded streams, including length bead width, vegetation width, and the presence of ice wedges, were compared between SPOT satellite imagery from 2010 and aerial photography taken in the 1950s. General characteristics of the stream location were also recorded, including slope gradient, slope aspect, and surficial deposits. One of beaded streams was visited in the field in July and August 2016. Micro topography was surveyed across a 'bead', perpendicular to the water flow.



Study Area

The study area was within the Blackstone Uplands of Central Yukon, Canada, near the Ogilvie Mountains. The area is in the discontinuous permafrost zone, is within the traditional territory of the Tr'ondek Hwech'in and Na-Cho Nyak Dun First Nations, and is traversed by the boundary of Tombstone Territorial Park at 64°04'58"N 138°30'39"W. The Dempster highway traverses the area in a North-South direction. For this study, an area approximately 38.6 km long and 28 km across was determined based on the availability of remotely-sensed images. In this topographic map, beaded streams are highlighted in red.



Results

Beaded streams that are well-established typically had ice wedges were within 100 meters. Young beaded streams were directly adjacent to and surrounded by degrading ice wedges, and the beads were clearly located at the junctions between these ice wedges, such as those reported by Arp et al (2015). The visibility of the degrading ice wedges near young beaded streams was likely enhanced by the absence of tall vegetation nearby. Mature beaded streams, however, were bordered by significant shrub patches that could be over six meters in width. Mature beaded streams clearly connected to other streams or waterways such as the braids of the Blackstone River. Such connections were not as clear for younger beaded streams, which often appeared well defined for only short sections. This cross section shows the approximate active layer depth increases with the presence of a bead compared with the active layer depth of the surrounding discontinuous permafrost.

Discussion and Conclusions

Our results show that beaded streams similar to those reported from the continuous permafrost zone can occur in tundra patches of the sub-arctic where permafrost is discontinuous. Like Arctic beaded streams, they form at the junctions of ice wedges. The presence of extensive ice wedge networks on gentle slopes affected by permafrost degradation appears as a key requirement for beaded stream development. Beaded streams appear to change the vegetation surrounding them as they mature. Large beaded streams in the Blackstone Uplands had shrubs patches well over six meters in width adjacent to them, these shrubs may proliferate because of the improved drainage created by the developing beaded streams. It is likely that more beaded streams will develop under warming climatic conditions, and may further contribute to the increased shrub proliferation and 'greening' of Arctic and subarctic tundra. Continued monitoring via remote-sensing would be beneficial, and field-based studies would improve understanding of the evolution of beaded stream and how they impact surrounding ecosystems.

Acknowledgements

This project was funded by the Northern Scientific Training Program and the Goodman School of Mines. Thank you to the Tr'ondek Hwech'in and Na-Cho Nyak Dun First Nations for allowing us to do field work in their traditional territory. Thank you to Geomatics Yukon for access to satellite imagery. Thank you to Dr. Pascale Roy-Léveillée and Nathan Romahn for their knowledge and support in the field.

Arp, C. D., M. S. Whitman, B. M. Jones, G. Grosse, B. V. Gaglioti, and K. C. Heim. "Distribution and biophysical processes of beaded streams in Arctic permafrost landscapes." Biogeosciences 12.1 (2015): 29-47. Web.

GOODMAN SCHOOL OF MINES / ÉCOLE DES MINES

NSTP Northern Scientific Training Program / PFSN Programme de formation scientifique dans le Nord