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Rapid Landscape Evolution at the Permafrost-Glacier Interface

Permafrost underlies a large portion of Canada's landscape and in some locations, massive amounts of ice have been preserved for thousands of years. However, much of the permafrost in Canada is thawing, resulting in the melt-out of ground ice and dramatic alterations to the landscape and overall terrestrial environment. This is resulting in a step change (a tipping point) in the rate and character of landscape evolution - something seldom taken into account in the climate change impact predictions due to its complexity. It is most obvious in the Arctic where glaciers are rapidly retreating, producing large volumes of melt water impacting the frozen ground and massive buried ice surrounding the glaciers. The result is an environment which is changing in ways we have not witnessed before. Four interrelated projects designed to better understand the changes occurring are:

Remote Sensing innovations for measuring the glaciers and permafrost

Recent advances in Unmanned Aerial Vehicle (UAV) hardware has resulted in UAVs now being effective platforms for carrying small remote sensing sensors. This project will include; a) testing the impact of flight parameters on ultimate data resolution, b) determining the effectiveness of using a combination of optical and thermal imagery to quantify ground surface characteristics, and c) developing an algorithm to quantify the accumulation of sediment on the surface of a glacier as the glacier retreats.

Glacier-permafrost hydrodynamics

This project will measure water storage and flow through an arctic glacier. Specifically, the hydrological processes that are producing large outburst floods, ephemeral fountains emerging from the glacier and outwash plain will be measured. These phenomena are indicators of the rapidly changing system. To be able to predict how the system will react to further changes, we first need to understand how and where these processes are operating.

Ice burial processes, stability and permafrost dynamics

This project will measure fluvial and thermal erosion of permafrost and ground ice. Once permafrost reaches the melting point a step change in the rate of landscape evolution occurs. We will determine how significant of a contributor this step change is in changing the landscape.

Extrapolating processes to system dynamics

Using existing and new satellite data, step changes in landscape evolution will be modeled over the large scale. This kind of data fusion and process up-scaling will result in a more accurate and comprehensive understanding of the changes underway in the broader arctic environment.

The results of this research program will make contributions to our understanding of the arctic environment, how it is currently changing and the impact climate change will have in the near and extended future. Graduate and undergraduate students will be an integral part of this research, resulting in the training of 15 highly qualified personnel.