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Effects of Hillslope Geomorphology on Water Track Pattern Formation

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Hillslopes in the Canadian High Arctic can express curious features called water tracks, where stone and soil domains self-organize into quasi-linear patterns. Though they physically resemble rills, they are not characterized by sustained surface flows following rainfall or snowmelt; hence, no obvious evidence of active particle transport downslope is observed. This motivates several questions which at present are little explored. First, how does hillslope geomorphology affect the cross- and down-slope topographic patterns that we see? Second, by what mechanism(s) (e.g., freeze-thaw, granular, fluid-flow-driven) do water track patterns develop? Answers to these questions have broad implications for periglacial geomorphology because water tracks are thought to play an important role in the development of channel networks and are particularly important in water-limited polar desert environments. Deepening of the active layer in response to climate change will increase the potential for further incision and expansion of water tracks.

Our goal is to begin to address these knowledge gaps through a multi-disciplinary approach combining field and modelling techniques. We created a digital elevation model (DEM) of a field site on Devon Island, Nunavut using topographic LiDAR data to assess the connections between hillslope geomorphology and water track shape. Spectral analysis shows a finite range of wavelengths between 1-2 meters, rather than one dominant feature wavelength, characterizing the highest spectral powers. We find no correlation between hillslope gradient and feature wavelength distribution. Last, using the hillslope DEM, we map the water track network to determine the dominant length scales and their correlation to topographic metrics of the hillslope.

The diversity of water track wavelength and length scales, along with the varying relationships identified between the features and the hillslope, suggests the study site is in an early stage of response to the ongoing amplified Arctic climate change. Therefore, we anticipate continued development into the foreseeable future, with implications for expansion of the existing local drainage network as the warming climate deepens the active layer through which hydrologic processes occur.

Keyword-1

Climate Change

Keyword-2

Patterned Ground

Keyword-3

Periglacial Geomorphology

Author: JOHNSON, Grace (Department of Physics, Simon Fraser University)

Co-authors: Dr ANDERSON, Sam (School of Environmental Science, Simon Fraser University); Dr CHARTRAND, Shawn (School of Environmental Science, Simon Fraser University)

Presenter: JOHNSON, Grace (Department of Physics, Simon Fraser University)

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