Downstream persistence of particulate organic carbon released from thaw slumps on the Peel Plateau, NT, Canada

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Underlain by ice-rich permafrost, the Peel Plateau in western Canada is highly susceptible to rapid permafrost degradation in the form of retrogressive thaw slumps and has experienced a non-linear intensification in the area, volume, and thickness of permafrost thawed since 2002. These slumps tend to occur along stream networks, which flow directly into the Peel River, through the Mackenzie Delta, and into the Beaufort Sea. Thus, lateral transport of previously sequestered organic carbon from these features has the potential to propagate far downstream. Upstream-downstream comparisons have shown that thaw slumps mobilize material to stream systems primarily in the form of particulate organic carbon (POC), increasing organic carbon yields by orders of magnitude, and switching stream networks to particle-dominated systems. Furthermore, the bulk POC released from slumps can be upwards of 10,000 $^{14}$C years old, and base-extracted fluorescence measurements suggest material is more reworked since terrestrial production compared to upstream material.

To determine how far this effect propagates downstream we measured particulate and dissolved organic carbon (DOC) fluxes across stream transects extending 0.4 to 1 km downstream of thaw slumps in 1st to 2nd order streams and found no consistent decrease in TSS or POC fluxes with transit downstream. In addition, we measured the composition (%POC, C:N, fluorescence, $D^{14}$C) and flux of DOC and POC within the ~1100 km$^2$ Stony Creek watershed, examining tributary streams representing different vegetative, slump-density, and geological units in addition to the Stony Creek mainstem, to determine contributions to downstream flux. We found organic carbon fluxes were dominated by slump-mobilized POC at all points downstream of disturbance, and that these organic carbon fluxes were greater than any non-disturbed tributary stream. The $^{14}$C age of POC along the Stony Creek mainstem increased by thousands of years with the introduction of slump inputs and remained similarly depleted in $^{14}$C at the watershed outlet. Using historical suspended sediment, POC, and discharge data for the 75,000 km$^2$ Peel River drainage basin containing the Stony Creek watershed, we will examine whether there have been increases in instantaneous sediment and POC fluxes during the thaw season to track the trends of intensifying slump activity that have been documented on the Peel Plateau. Constraining the downstream effect of these abrupt, localized disturbances may improve detection and prediction of change
that will likely cascade through the region over the coming decades.