

IMPACTS OF THERMAL EROSION GULLYING ON CARBON, NUTRIENTS AND SEDIMENTS FLUXES

BYLOT ISLAND, NUNAVUT

K. Rioux^{1,2}, D. Fortier^{1,2}, M. Lafrenière³

¹Geography Department, University of Montreal, Montreal, QC, Canada, ²Centre for northern studies, Laval University, Quebec, QC, Canada. ³Department of Geography and Planning, Queen's University, Kingston, ON, Canada



CONTEXT

Permafrost of Arctic environments is well-known for its important role in the long-term storage of organic carbon. Perturbation of this vulnerable reservoir may have major consequences on the global carbon cycle. Thermal-erosion gullying is one of the most rapid permafrost degradation processes. This is initiated by concentrated infiltration of runoff water into sinkholes, which evolve into tunnels expanding into the permafrost, especially into ice-wedge networks. The gullies are created by the collapse of the roof of these tunnels and induce major changes in landscape morphology. A substantial quantity of material is exported as a gully forms and expands, leading to a significant reorganization of the hydrological network. Nutrients, particulate and dissolved organic matter, and sediments accumulated and stored in permafrost for centuries are suddenly released and their mobilization has a direct influence on the water chemistry of the gully stream.



OBJECTIVES

1. Quantify the temporal and spatial variation in organic carbon, nutrients and suspended sediment fluxes along an active thermal erosion gully.
2. Quantify global carbon fluxes through thermal-erosion degradation processes.

HYPOTHESIS

1. Occurrence of a first pulse of carbon (especially DOC) associated with the snowmelt run-off.
2. Occurrence of subsequent lower DOC fluxes as the gully head retreats and as the active layer of unstabilized gully margins thaws and collapses into the channel.
3. Observation of a delay between the flow peak and the suspended sediment peak as a result of the limited availability of sediments, induced by the presence of persistent snow on the channel bed and by the frozen of gully floor sediments.

STUDY SITE

The active thermal erosion gully (R08) selected for this project is situated within the ice wedges polygone terrace of the Qarlikturvik Valley (or glacier C-79 valley), on Bylot Island, Nunavut. The gully network initiated in 1999 is now about 1.5 km long and it still actively expanding into the ice-rich aeolian sediments that compose the terrace.



EXPERIMENTAL DESIGN

● Monitoring of carbon, nutrient and sediment fluxes from non-eroded contributing area.

● Monitoring of fluxes from thermal-erosion affected area.

● Comparison of lake and gully contributions.

● Outlet : Monitoring of carbon, nutrient and sediment global exports.



OUTLET



MAIN CHANNEL



TRIBUTARY CHANNEL



INLET 4A



INLET 2A



INLET 1

FIELD

- Daily water sampling, associated with water temperature, pH, electrical conductivity (EC) and velocity measurements at 13 sites along the active thermal erosion gully.
- Water sampling three times a day at the gully outlet.
- Filtration of samples with 0.22 µm PVDF filters and 0.43 µm GF/F glass fiber filters.
- Weekly thaw depth measurement at each of the 13 sites.



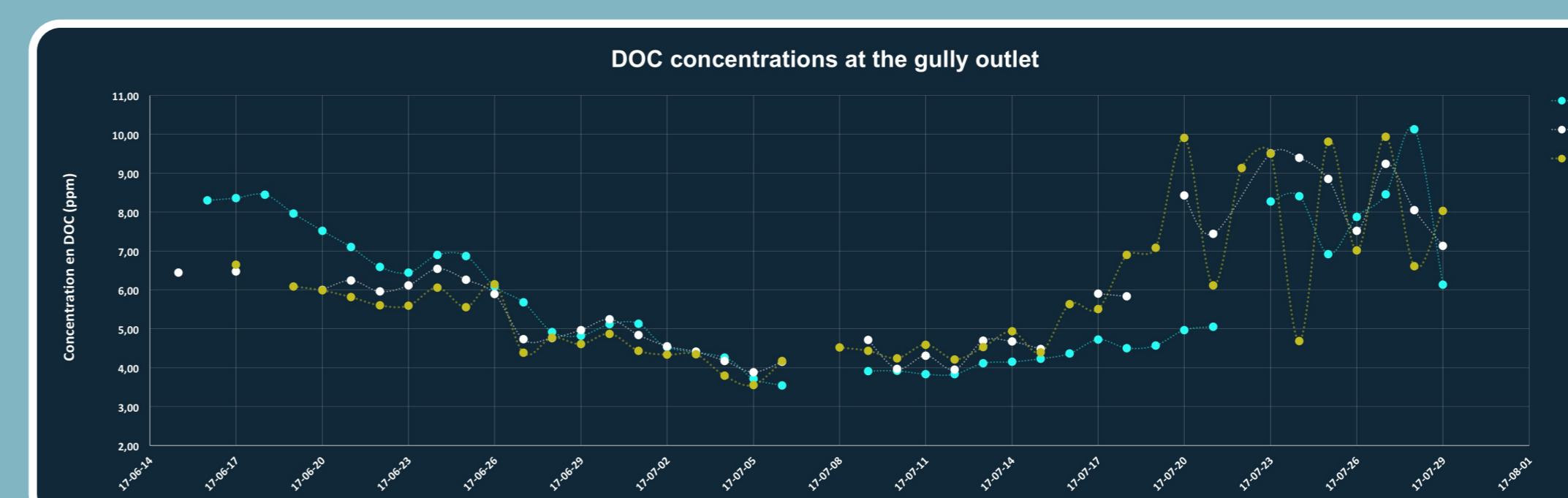
LABORATORY ANALYSIS

- Analysis of dissolved organic carbon (DOC) and total dissolved nitrogen (TDN) by high temperature combustion with a TOC analyzer and its TN module.
- Analysis of anion and cation concentrations (including inorganic N) by liquid ion chromatography.
- Analysis of the isotopic composition by off-axis integrated cavity output spectroscopy (OA-ICOS).
- Characterization of DOM composition by fluorescence spectroscopy.



These analyses will provide a specific and precise characterization of the stream chemistry throughout the flow season.

PRELIMINARY RESULTS



- Progressive decrease of DOC concentrations measured at the gully outlet following the snowmelt run-off.
- Diurnal variation of measured DOC concentrations during the snowmelt.
- Snowmelt run-off and late summer rainfall events lead to similar DOC concentrations.