Role of fire and landscape position on dissolved organic carbon composition and reactivity in the Yukon-Kuskokwim Delta, Alaska

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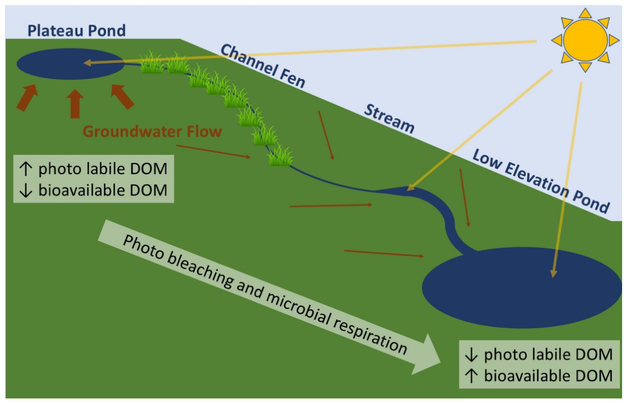
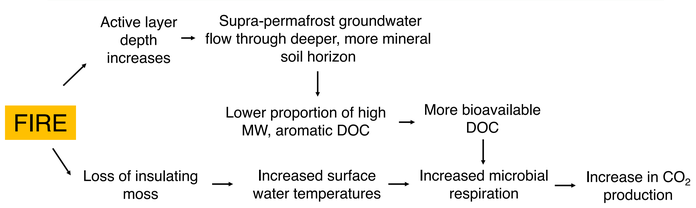
Background

The Yukon-Kuskokwim Delta, located in southwest Alaska, is underlain by discontinuous permafrost, which is vulnerable to thaw induced by climate change. Recent fires in the delta have caused dramatic changes in the landscape, likely changing carbon dynamics, and potentially altering dissolved organic carbon (DOC) concentrations and DOC composition in aquatic ecosystems. These changes likely affect microbial respiration and hydrologic C export from watersheds in the delta. In this study, we investigated how landscape position and fire history drive changes in DOC composition and reactivity in aquatic ecosystems.





Methods

Field Samples

- Sampled pore water, and pond, fen, and stream surface water to measure DOC, TN, nitrate, phosphate, and ammonium concentrations, dissolved CH_4, CO_2, and N_2O concentrations, δ^2H-H_2O and $\delta^{18}O$-H_2O, and CDOM UV absorbance
- pH, conductivity, temperature, and dissolved oxygen measurements taken with a YSI multimeter
- Elevation data extracted from DEM data using GPS coordinates
- Thaw depth measurements taken at sample sites

Water Incubation Experiment

- Water samples were collected from 6 sites, sterile filtered, and put into borosilicate exetainer vials
- Four replicates from each site used for each treatment
  - **Control**: Acidified at start of incubation
  - **Bacterial inoculum**: Covered in foil during SunTest XLS+ irradiation, GF/D filtered common inoculum added
  - **Light treatment**: Irradiated for 16 hours in SunTest XLS+
  - **Light + Inoculum**: Irradiated for 16 hours in SunTest XLS+, GF/D filtered common inoculum added
- After the bacterial inoculum was added, vials were incubated for 5 days, acidified, and analyzed for DOC concentrations and UV absorbance spectra

Results

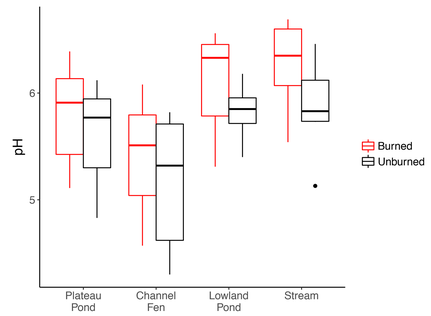


Figure 1. pH of pond, fen, and stream surface waters in burned and unburned catchments.

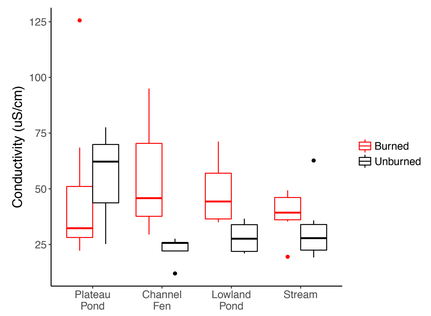


Figure 2. Conductivity of pond, fen, and stream surface waters in burned and unburned catchments.

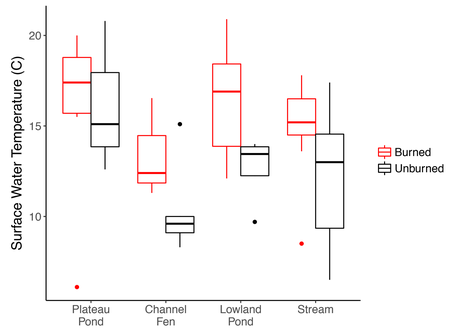


Figure 3. Temperature of pond, fen, and stream surface waters in burned and unburned catchments.

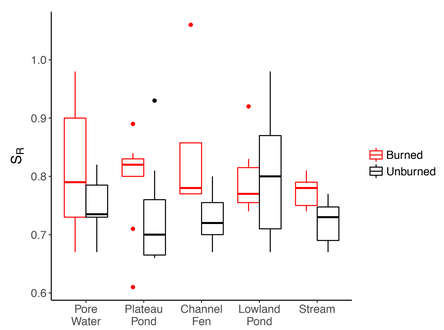


Figure 4. Spectral slope ratio of CDOM absorbance (slope of 275-295nm: slope of 350-400nm) of pore water, pond, fen, and stream surface waters in burned and unburned catchments.

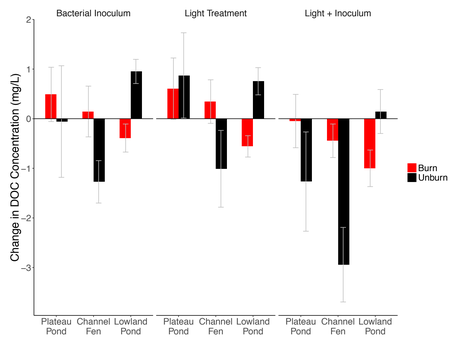


Figure 5. Difference in DOC concentrations between water incubation treatments and control (n=4). Each treatment was performed on water sampled from a plateau pond, channel fen, and lowland pond from both a burned and unburned catchment. Error bars display standard error.

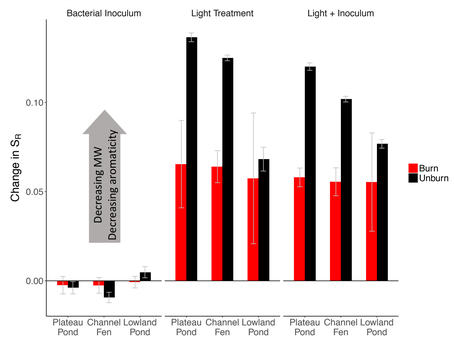


Figure 6. Difference in the spectral slope ratio of CDOM absorbance (slope of 275-295nm: slope of 350-400nm) between treatments and control (n=4). Each treatment was performed on water sampled from a plateau pond, channel fen, and lowland pond from both a burned and unburned catchment. Error bars display standard error.

Discussion

Physical Changes to Burned Catchments

Thaw depth measurements reveal that the active layer is deeper in burned catchments, allowing water to flow through deeper soil horizons. This change in hydrology is indicated by higher pH and higher conductivity in surface waters located in burned catchments lower in the landscape. Additionally, surface waters in burned catchments are warmer, likely due to warmer soil temperatures caused by the loss of insulating moss layers.

DOC Composition

Chromophoric dissolved organic matter (CDOM) spectral slope ratios suggest that DOC in burned catchments has lower molecular weight (MW) and aromaticity than DOC in unburned catchments.

Photochemical Reactivity

DOC from unburned catchments is the most photochemically reactive. Photochemical reactivity appears to decrease from plateau ponds to fens to low elevation ponds, evidence of photo processing as water moves along flowpaths.

Bacterial Respiration

DOC losses, which indicate CO_2 production, were greatest when water was exposed to both UV radiation and the bacterial inoculum. UV radiation may prime DOC for microbial respiration by decreasing MW and aromaticity, thus increasing bioavailability.

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