Seasonality and landscape factors drive organic matter export in streams of varying land use

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Introduction
Carbon cycling in stream ecosystems is highly driven by watershed land use, morphology, and microbial activity. These processes shape the quantity and quality of dissolved organic matter (DOM) present in streams.

Land use influences the quantity of terrestrial DOM introduced to stream ecosystems, and indirectly defines the in situ production and cycling.

The amount and character of DOM in terrestrial and aquatic ecosystems can vary considerably over time.

Objectives
1. Compare fluxes of nutrients and DOM between agriculture and forested catchments.
2. Report on seasonal variations in the hydrologic phenomena that influence DOM.

Methods
Water samples were collected weekly between Feb and Nov 2018 from two streams flowing through watersheds of contrasting land use: agriculture vs. forested (Fig 1).

Water quality parameters were measured in situ, while additional parameters were analyzed in the laboratory (solids and nutrients). Absorbance and fluorescence spectroscopy was used to characterize DOM.

Results
The differences between the two streams were small, except that the forested stream was more variable and experienced greater peaks and exports of terrestrial and/or microbial DOM (e.g., flashiness) (Fig 2).

DOM composition remained relatively consistent seasonally, however, two periods were distinguished in the DOM properties: spring and summer-autumn (Fig 2a).

Spring exports a DOM pool composed of greater humic and aromatic material, whereas the summer exports a more microbial-like DOM (Fig 3).

Most of the DOM export occurred during heightened hydrological events.

Future Directions
1. Determine the bioavailable fraction of DOM (Fig 4), and relate to DOM composition and to shifts in DOM composition during microbial degradation.
2. Use parallel factor analysis (PARAFAC) modeling to further analyze and characterize the DOM pool.
3. Estimate carbon loads using the FORTRAN Load Estimator (LOADest) program.

Significance
The effects of land use and climate on stream and river DOM character have important implications for global carbon cycling, owing to their potential to control rates of microbial carbon processing in agricultural systems.

1. Anthropogenic land use facilitates environmental conditions that allow DOM to persist in a more reduced state than would be expected in a forested stream.
2. As more land is converted for agricultural or urban use, more microbial-like, labile DOM will be produced or transformed from terrestrial sources.
3. This further stimulates microbial activity, altering stream carbon cycling and changing the quality and quantity of DOM exported to lakes, estuaries, and oceans.

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Fig 1. Agriculture (left) and forested (right) stream sites located in Simcoe County, Ontario.

Fig 2. Time series of β/α (a) and HIX (b) concentrations in forested stream.

Fig 3. Time series of SUVA254 export in agriculture (a) and forested (b) stream.

Fig 4. Time series of bioavailable dissolved organic carbon (BDOC) calculated from biodegradation assays (5 days) utilizing stream water from ASN 34 (agriculture) and ASN 44 (forested).