HYDROGEOOMIC AND LANDSCAPE INFLUENCES ON DISSOLVED ORGANIC MATTER IN STREAMS AND RIVERS ON THE SOUTH CAROLINA COASTAL PLAIN

Setzen Altan-Ochir1 and Daniel L. Tufford, Ph.D.2
1Cornell College, Mount Vernon, IA; 2University of South Carolina, Columbia, SC, USA

Abstract

Dissolved organic matter (DOM) is recognized as a major component in the global carbon cycle and is an important driver of numerous biogeochemical processes in aquatic ecosystems. We investigated DOM in stream and downstream in estuaries. This study sought to characterize chromophoric DOM (CDOM) in major rivers and their tributaries of the South Carolina Coastal Plain to assess the impact of land use and other factors on water quality. During eight trips from June 11 to July 9 of 2014 throughout the South Carolina Coastal Plain, we visited 54 sites, where we measured field parameters (temperature, dissolved oxygen, pH, and specific conductance), collected water samples for laboratory analysis of dissolved organic carbon (DOC) and dissolved nutrients. Sample sites included headwater wetlands and springs, streams and rivers, and water table monitoring wells. Spectral analysis of the filtered water samples was done from 200-800 nm using a Shimadzu UV-1700 spectrophotometer. We used specific absorption coefficients, and related metrics to facilitate broad characterizations of the nature of the CDOM in the water based on source and other landscape factors. We performed principle components analysis (PCA) to further understand variability in the data from a landscape perspective. Highest concentrations of DOM occurred in black waters and in smaller streams and rivers. There were significant differences in SR, DOC concentration, and pH among the different water types and stream orders, while SUVA254 showed significant variations only for the different water types. PCA allowed us to compare DOM characteristics from different sources and land cover types, and relate them to landscape characteristics. The correlation of DOC concentration is mixed with the PCA eigenvectors. The correlation of DOC concentration is mixed with the PCA eigenvectors. The correlation of DOM with water type and stream order.

Methods

Study sites

A total of 54 sites were sampled in the upper and lower Coastal Plain during eight trips from June 11 to July 9 of 2014. Sites were located in 11 water bodies, e.g. water table wells, (1) water table well, (2) seepage springs, or (2) 2nd, 3rd, or 4th order streams. Stream order was based on existing literature or assessment of digitized USGS topographic maps.

Field sampling

Water samples were collected during baseflow in acid washed 1-liter polyethylene bottles and carried back to lab in coolers. Field parameters were measured in situ using a YSI Sonde.

Sample preparation and analysis

Water samples were filtered within 12 hours of collection using 1 µm glass fiber filters. The filters were stored in a refrigerator at 4°C. Samples for DOC analysis were preserved with HCl.

Spectral analysis of DOM was done from 200-800 nm using a Shimadzu UV-1700 spectrophotometer. Absorbance was recorded at 0.5 nm intervals.

DOC analysis was done using a Shimadzu total organic carbon TOC-V analyzer equipped with an autosampler.

Land cover

The catchment for each sample site was determined using ESRI ArcMap v10.1 and a combination of existing layers of Hydrologic Unit Code (HUC) watersheds and on-screen delineation (for smaller catchments). These catchments were used to clip data from the 2011 National Land Cover Database (NLCD, 2011). The percent composition of each of the following land cover types was calculated for each catchment:

- Forest
- Developed
- Water
- Evergreen forest
- Herbaceous wetland
- Evergreen forest

Statistical analysis

Data was analyzed using SAS v9.4 PROC MEANS, PROC GLM, and PROC PRINCOMP. Significance was determined at p<=0.05.

Results

There were no significant differences in SUVA254 by stream order but there were by water type. There were differences in SR, DOC concentration, and pH by both stream order and water type (Figs. 4 and 5).

Discussion

1) The higher concentrations of CDOM in black water, over brown and clear water, are consistent with other studies of the origins and composition of the waters. Black water originates in floodplain and riparian areas and is characterized by high concentrations of dissolved organic matter. Brown water is more turbid and often quite clear. Although none of our samples were taken on the Piedmont (Fig. 1), three sites were large rivers with watersheds that mostly drain through these. These are the brown water sites.

Figure 2 (left) and 3 (right). Mean absorption coefficients (ι± standard error) from 250-450 nm by water type and stream order.

Conclusions

1) We found higher DOC concentrations in black water on the lower Coastal Plain (LCP) than the upper Coastal Plain. The LCP is the upstream portion of the system and is more impacted by the point and nonpoint sources of DOM. The LCP is more affected by agriculture and urbanization, which are a key component of DOM loading to streams. Loss of wetlands likely will have a negative impact on the quantity of DOC in Coastal Plain streams.

3) Sampling over a broad range of water sources and types provides a greater representation of the diversity of CDOM and the impacts on water quality.

4) Analysis of variance found that not only the concentration of DOC is higher in black water than in brown or clear waters, but also the composition of DOM may be different.

The PCA analysis shows a strong relationship between DOM in brown and black watersheds from June 11 and July 9 of 2014 along with field parameters (temperature, dissolved oxygen, pH, and specific conductance). The PCA analysis shows a strong relationship between DOM in brown and black watersheds from June 11 and July 9 of 2014 along with field parameters (temperature, dissolved oxygen, pH, and specific conductance). This study sought to characterize DOM in major rivers and their tributaries of the South Carolina Coastal Plain to assess the impact of land use and other factors on water quality. During eight trips from June 11 to July 9 of 2014 throughout the South Carolina Coastal Plain, we visited 54 sites, where we measured field parameters (temperature, dissolved oxygen, pH, and specific conductance), collected water samples for laboratory analysis of dissolved organic carbon (DOC) and dissolved nutrients. Sample sites included headwater wetlands and springs, streams and rivers, and water table monitoring wells. Spectral analysis of the filtered water samples was done from 200-800 nm using a Shimadzu UV-1700 spectrophotometer. We used specific absorption coefficients, and related metrics to facilitate broad characterizations of the nature of the CDOM in the water based on source and other landscape factors. We performed principle components analysis (PCA) to further understand variability in the data from a landscape perspective. Highest concentrations of DOM occurred in black waters and in smaller streams and rivers. There were significant differences in SR, DOC concentration, and pH among the different water types and stream orders, while SUVA254 showed significant variations only for the different water types. PCA allowed us to compare DOM characteristics from different sources and land cover types, and relate them to landscape characteristics.

References


For further information: Setzen Altan-Ochir - saltochir78@cornellcollege.edu

Dan Tufford - tufford@ucsc.edu

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