The Age and Lability of Organic Carbon in Headwater Catchments With Varying Land Use

by Dempsey, Christopher.1, Morris, Donald.1, Pazzaglia, Frank.1, Raymond, Peter.1, and Peters, Stephen.1
1Lehigh University Earth and Environmental Science Department; 2Yale School of Forestry and Environmental Studies

Project Goals and Outline

Recent studies have shown that the age of dissolved organic carbon (DOC) and particulate organic carbon (POC) being transported by large river systems on the east coast of the United States can be several thousand years old and recalcitrant in nature. Carbon age in large river systems may be obscured by factors such as carbon production, large-scale land use, and sewage treatment plants. We are studying three headwater catchments with varying land uses to better understand organic carbon age, lability, and the processes that control the export of this material to larger river systems. We hypothesize that land use plays a critical role in controlling the watershed hydrology and organic carbon dynamics of these catchments. For the past year, we have captured two storm events and sampled soil horizons along a catena within each watershed. In most locations we combined the O/A-horizons and sampled the B-horizon separately. One site contained an once logged forest, and agricultural area.

The streams were sampled in late summer and spring to assess seasonal changes in DOC composition and quality. Soil horizons were restricted to the upper 30 cm and were sampled during the summer. In most locations we combined the O/A-horizons and sampled the B-horizon separately. One site contained an once logged forest, and agricultural area. DOC and POC samples from baseflow and peak DOC concentration in both streams were radiocarbon dated. DOC and POC leached from specific soil horizons were also radiocarbon dated. We assessed DOC lability throughout the course of the storm events and for each soil horizon. As the bulk of organic matter is exported from watersheds during storm events, we hope to clarify the age and lability of the organic matter within our study catchments, with the intent of showing how this may influence larger river systems.

Sampling Locations/ Methods

Storm Sampling

The use of automated DOC samplers allowed us to sample continuously through 24-hour storm events. We used paired level loggers, a rain gauge, and soil moisture meter to monitor snow accumulation and to record stream discharge (storms) at each of our stream locations.

Soil Sampling

Sample pits were dug along a catena within each watershed (high, middle, and low). About 10 grams of soil from specific horizons were extracted into 50 mL glass flasks. Extractable organic carbon was isolated by quartz fiber filtration after 24 hours of baking with ultra pure DI water.

Biolability

DOC biolability was measured over a 20-day period using 0-90% (Figure 7) livability of soils by land use type, catena elevation, and soil horizon.

Conclusions

1. The data indicate that a young, rapidly recycling pool of DOC exists in all of the watersheds. Small portions of older DOC can be found in the forested catchments.

2. The recruitment of POC in the streams is likely the result of bank erosion. We observed younger POC age with increasing discharge which suggests a surface input (younger carbon).

3. Land use controls the export of POC. We observed the oldest POC export from the AG site (Storm 1). The older ages observed in this storm may be the result of hydrologic "loading."

4. Biolability in the streams and soils was variable in nature. The OGF contained recalcitrant DOC as we observed lower lability values in the soil DOC. There was no correlation between elevation and biolability in the AG horizon. The lack of vegetation in the AG area suggests that there was available carbon on the forest floor that allowed stream communities to increase the amount of organic carbon utilized during respiration.

5. We observed lower biolability values in the soil DOC. There was no correlation between elevation and biolability. The lack of vegetation in the AG area suggests that there was available carbon on the forest floor that allowed stream communities to increase the amount of organic carbon utilized during respiration.

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Figure 1. Watershed Characteristics

Figure 2. Soil Sampling

Figure 3. Madden Discharge Hydrographs

Figure 4. DOC and POC ages of stream samples for Storms 1 and 3. Samples were divided into "baseflow" and "peak" discharge. Replicate samples are shown in the second column of data for each parameter. Ages are reported to calibrated years BP with a 2 sigma error. There were clear differences in organic carbon recruitment between Storms 1 and 3.

Figure 5. DOC biolability by soil horizon and elevation within each watershed.

Figure 6. Range of stream DOC biolability values within each watershed.