Biodegradability of dissolved organic carbon in three tropical watersheds

Introduction

✓In rivers, the microbial loop explains how microbes oxidize DOC to obtain energy making carbon available to higher trophic levels in the river foodweb.

✓DOC biodegradability, however, is variable depending on its source. Its concentrations and quality can be affected by allochthonous sources, but can also be affected by anthropogenic sources such as wastewaters and runoff from urban or agricultural areas. Anthropogenic carbon inputs to rivers can increase the concentration of labile DOC (Balakrishna, 2006).

Hypotheses

Rivers located in the upper forested regions of the watersheds have the highest concentration of labile DOC, which will diminish through the altitudinal gradient. Also, if anthropogenic activity on the watershed increases loads of organic carbon to the river, urbanized watersheds will have higher DOC (potentially labile) and POC levels than forested watersheds.

•The objective of this investigation is to determine the change in the quantity and quality of dissolved organic carbon along altitudinal and land use gradients in three tropical watersheds in Northern Puerto Rico.

Study Site

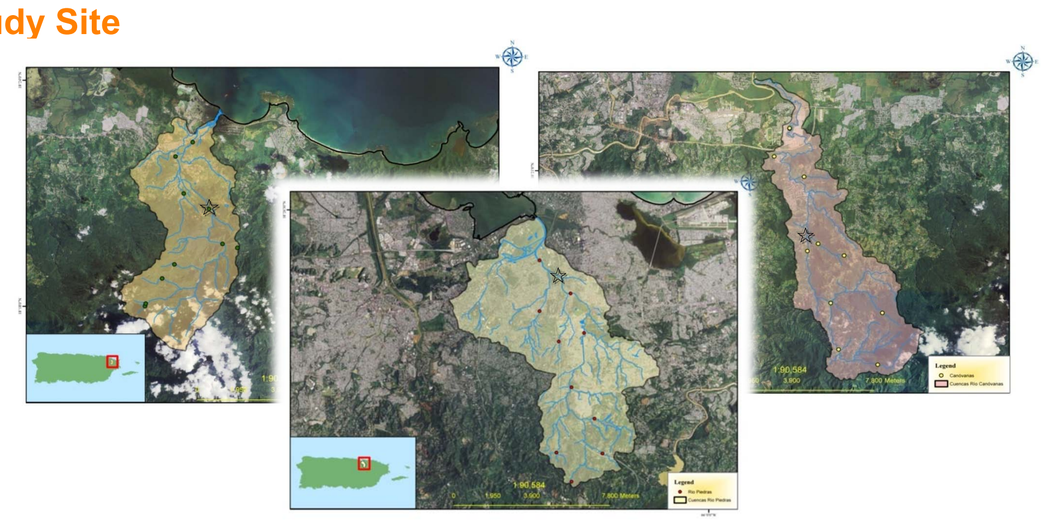

Figure 1. Detailed view of the studied watersheds: Río Mameyes (top left), Río Canóvanas (top right), and Río Piedras (below). Stars illustrate the location of the USGS gaging stations.

Methods

We compared the quality of the DOC along an altitudinal gradient in three different watersheds with different urban cover. We collected water samples in ten sites from each watershed during three sampling campaigns. Regression analysis were applied to explore altitudinal patterns of BOD5 and organic carbon quantity. This poster shows the gathered data and analysis.

To evaluate temporal changes in DOC quality, water samples were collected once during the wet season of 2007 and during the dry season of 2008 and 2009. Table 1 summarizes the sampling dates for each of the watersheds and the flow conditions associated to each sampling event.

Table 1. Flow conditions during the sampling events in each of three watersheds.

River and gauging station	Date	Mean daily flow (m^3/s)	Exceedance probability (%)
Río Canóvanas at Campo Rico 50061800	8/11/07	0.34	53
Río Piedras at Hato Rey 50049100	8/9/07	0.65	50
Río Mameyes NR Sabana 50065500	8/2/07	0.28	99
Río Canóvanas at Campo Rico 50061800	3/25/08	0.24	70
Río Piedras at Hato Rey 50049100	3/24/08	0.37	80
Río Mameyes NR Sabana 50065500	3/27/08	0.71	66
Río Canóvanas at Campo Rico 50061800	4/11/2009	0.37	47
Río Piedras at Hato Rey 50049100	4/24/2009	0.42	77
Río Mameyes NR Sabana 50065500	4/9/2009	0.31	98

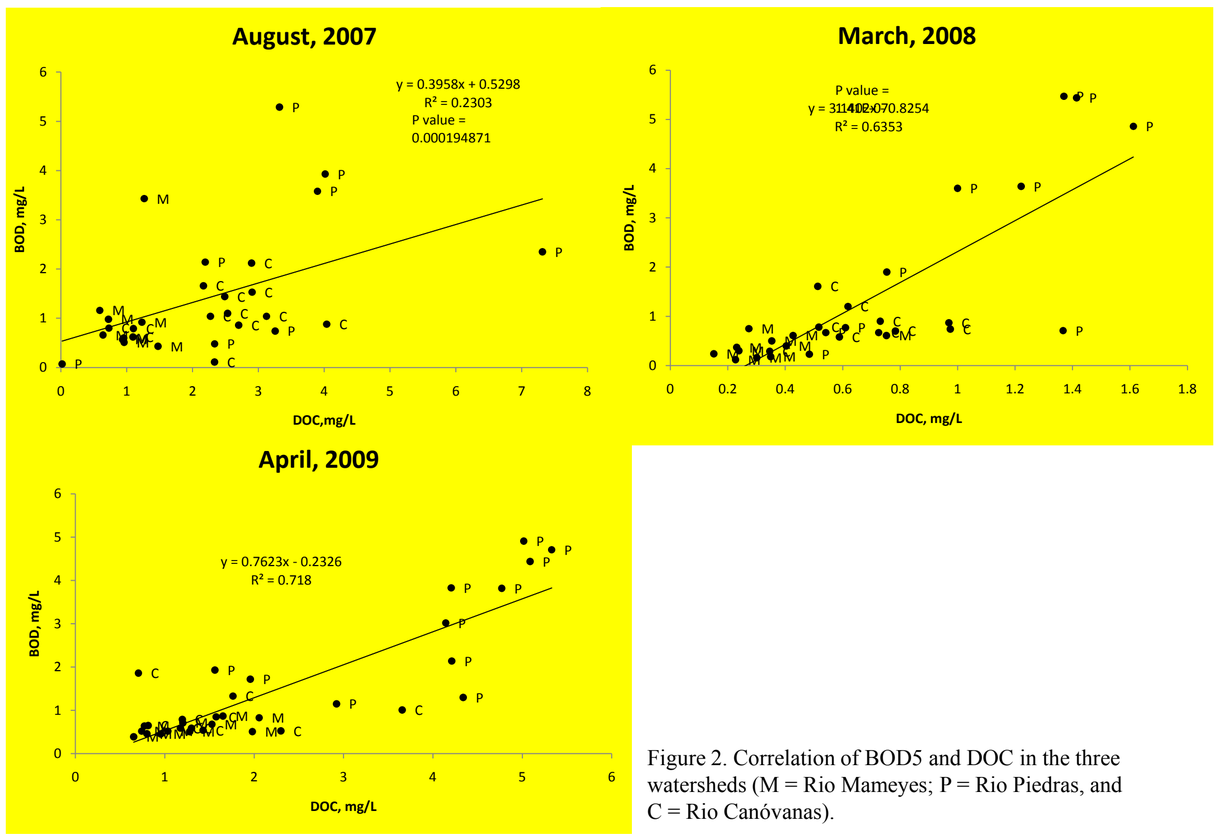

Figure 2. Correlation of BOD5 and DOC in the three watersheds (M = Rio Mameyes; P = Rio Piedras, and C = Rio Canóvanas).

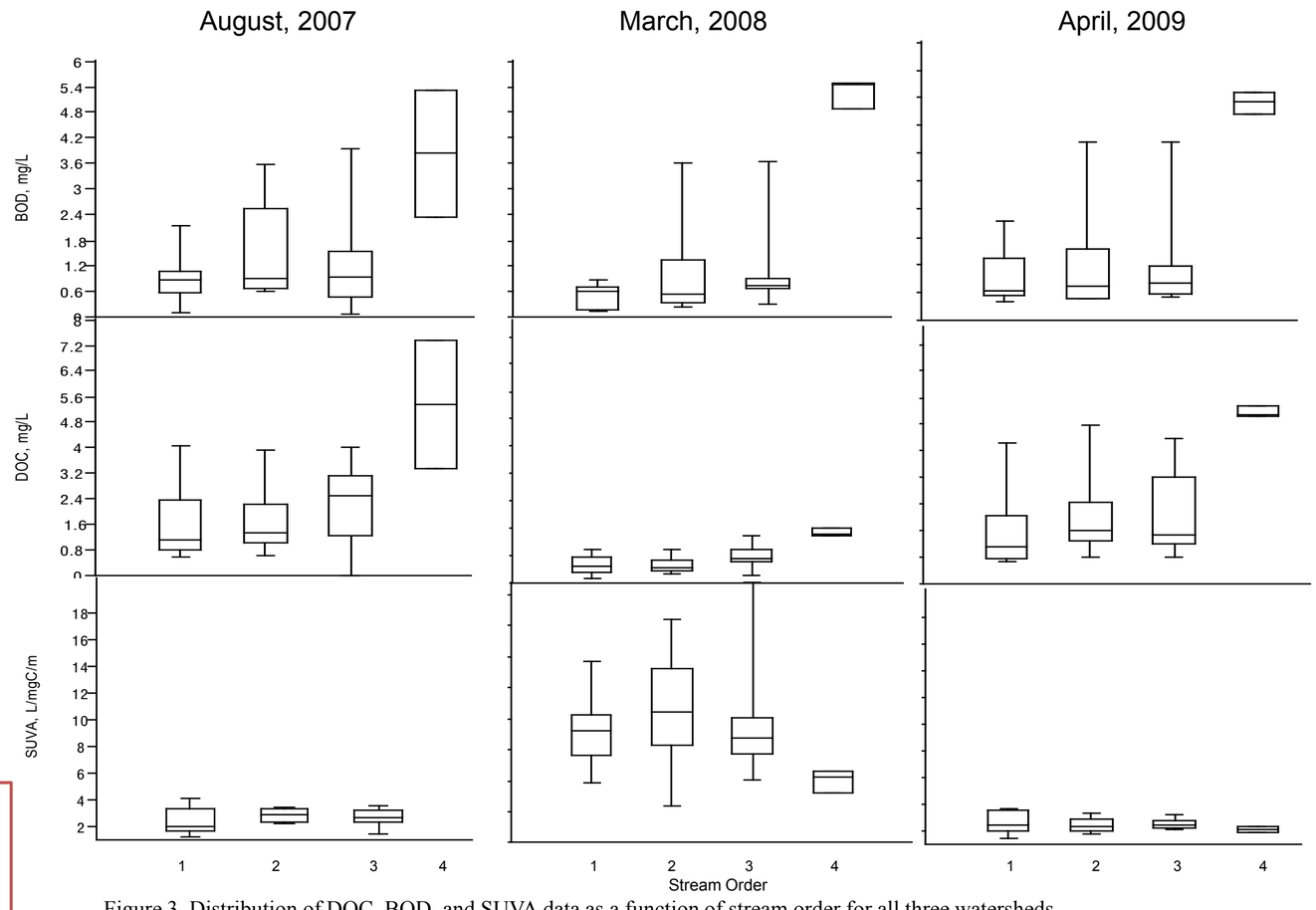

Figure 3. Distribution of DOC, BOD, and SUVA data as a function of stream order for all three watersheds.

Discussion

The regression between the DOC and the BOD5 of the three watersheds (Figure 2) revealed that the quantity of BOD5 increases exponentially as the DOC concentration increases. This correlation can be explained by the level of anthropogenic activity in each watershed. In a forested watershed such as the Río Mameyes, the levels of DOC are lower than in the transitional (Río Canóvanas) and the forested basin (Río Piedras) because there are no anthropogenic inputs of organic matter; only natural inputs.

In Figure 3, we can observe the relationship between BOD5, DOC and the SUVA with stream order. In the SUVA analysis, the sampled rivers did not show any significant differences among stream orders. Large rivers also show significantly high BOD5 values compared to low order sites (Single Factor ANOVA; P = 0.03). Similarly, the high stream order sites showed significantly higher DOC concentrations than low order streams (Single Factor ANOVA; P = 0.004).

Conclusions

Our results suggest that in the studied tropical watersheds, headwater streams show relatively low DOC concentrations of low biodegradability compared to downstream river segments. Human activities, which are concentrated in the coastal plains, are associated to high organic inputs to rivers of high organic content and relatively high lability compared to upstream forested sites. Based on our results, BOD5 concentrations remained fairly similar in both wet and dry seasons suggesting that DOC quality may be insensitive to flows.

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Alexandra S. Marcano Rivas and Jorge R. Ortiz Zayas, Institute for Tropical Ecosystem Studies, University of Puerto Rico

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