Determination of Bulk Dissolved Organic Carbon Content in the Verde River-Reservoir System

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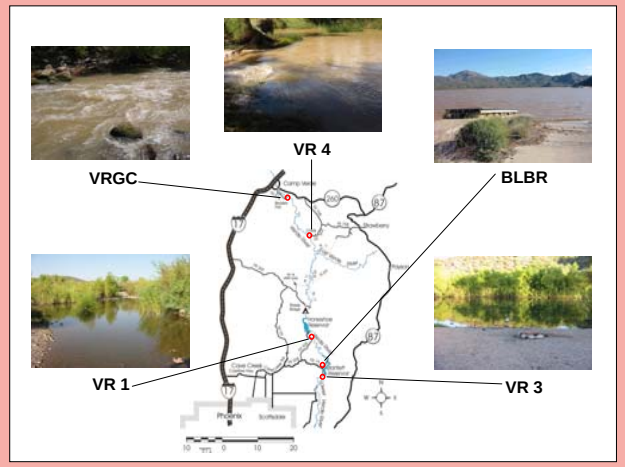
Abstract

The biogeochemical processes that alter dissolved organic carbon (DOC) in rivers may be different in pristine and human-influenced river reaches. Five sites along the Verde River system have been sampled monthly from Aug. 2004 to Dec. 2005. The sampling sites consist of two upstream sites (pristine sites) and three downstream sites where the river is influenced by man, (i.e. lakes and dams). We made measurements of bulk DOC, conductivity, pH, dissolved oxygen, and temperature. Carbon concentrations are generally highest at the downstream sites. Carbon concentrations are lower, but more variable in the upstream, pristine sites. Conductivity decreased from upstream to downstream suggesting freshwater inputs from tributaries; there is an inverse correlation between conductivity and DOC. The increase in DOC over the same reaches suggests a source of DOC within the river, perhaps production by phytoplankton. Processes that remove DOC from the river have been examined through laboratory experiments. Approximately 20 % of the riverine DOC could be degraded or removed via photooxidation after 6 hours of exposure to direct sunlight. These results suggest that there is a complex set of processes that produce and remove DOC in the river. This study provides a better understanding the biogeochemical processes that are controlling the DOC content in the Verde River which is a major source of water and drinking water for the Phoenix area.

Introduction

There are three main reasons why studying carbon cycling in the Verde River is relevant:
- The Verde River/Bartlett Lake system is one of the Phoenix metropolitan area's main water sources, and dissolved organic carbon (DOC) can be a contaminant in drinking water (leading to problems with drinking water's tasted and odor).
- DOC can be a food source for bacteria and algae and thus contribute to eutrophication (accelerated plant growth).
- River systems in arid regions are poorly understood from a biogeochemical perspective.

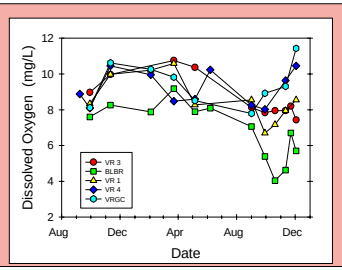


Site Description

- VRGC and VR 4 are considered our upstream, pristine sites
  - VRGC is located approximately 8 miles downstream of Camp Verde, AZ.
  - VR4 is located approximately 0.5 miles downstream of Childs, AZ
- VR 1, BLBR, and VR 3 are considered our human influenced sites.
  - VR 1 is located approximately 1.5 miles downstream of Horseshoe Reservoir.
  - The BLBR site is sampled from the boat ramp of Bartlett Reservoir.
  - VR 3 is located approximately 0.8 miles downstream of Bartlett Reservoir.

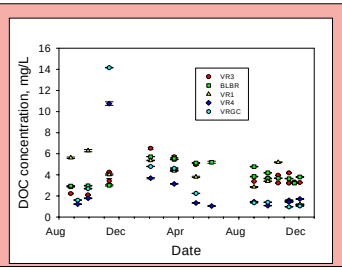
Methods of analysis

- Bulk DOC was analyzed by high-temperature combustion using a Shimadzu TOC-V analyzer. This analysis provides concentrations of DOC in each sample.
- Conductivity, pH, DO, and temperature measurements were made using handheld meters.



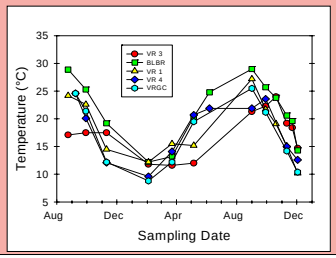
Trends in Dissolved Oxygen

- Upstream sites usually have higher DO other than downstream sites.
- DO decreases in late summer, which can be attributed to higher water temperatures, which hold less DO.



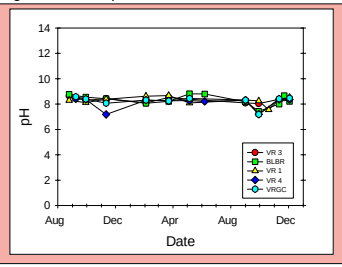
Seasonal DOC Trends

- Increase in DOC concentrations in spring might correspond to input of allochthonous carbon from increased discharge.
- Sampling in Nov. 2004 followed a major rain event which could explain high DOC concentrations due to input of allochtonous from runoff.



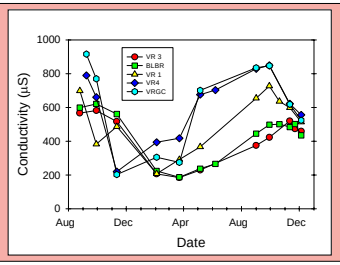
Seasonal Tends in Temperature

- As assumed, water temperature in the winter is lower than in the summer.
- Temperature follows a trend of increasing in downstream sites, other than VR3 (which is water that is released from Bartlett's penstock.



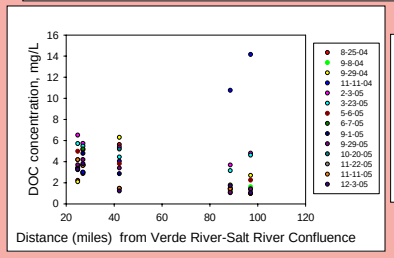
Invariability of pH

- pH does not show any trends in seasons or over the course of the river.



Conductivity Data

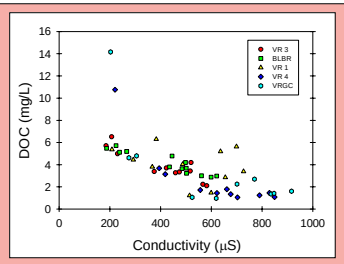
- Conductivity is generally higher in the upstream sites than in the downstream sites. This suggests input from tributaries such as Fossil Creek. Sampling of this tributary does in fact show lower conductivity than Verde River.
- An increase in conductivity is seen in the fall after the monsoon season. This might be attributed to an increase in stream flow and input from runoff.



Distance from Confluence	Site
• 23.5	VR 3
• 25	BLBR
• 42.5	VR 1
• 87	VR 4
• 95	VRGC

Variability in DOC Concentrations due to Human Influences

- VR 3, BLBR, and VR 1 (sites where flow is controlled) generally have higher DOC concentrations but are less variable than upstream sites where flow is natural.
- Higher concentration in downstream sites suggest inputs of carbon. This could be from phytoplankton or microbial alteration.

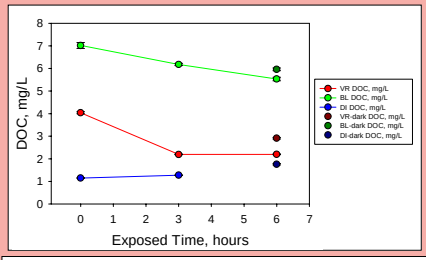


Inverse relationship between conductivty and DOC

- The inverse relationship between conductivity and DOC concentration suggest that although fresh water with a lower conductivity is being fed into the system, there is a source of DOC downstream.
- Possible sources of DOC are, phytoplankton, macroalgae, chemoautotrophic nonoplankton, and picoplankton.

Experimental Design for Photochemical Alteration Experiment

- Sterile filtered samples of Verde River and Bartlett Lake were exposed to direct sunlight. Initial samples along with samples collected after 3 and 6 hours were analyzed using high temperature combustion.
- Control samples were samples that were kept dark throughout the duration of the experiment so that carbon would not be altered photochemically.



Analysis of Photochemical Results

- Bartlett Lake samples show an approximate 21% decrease while the Verde River samples show an approximate 46% decrease over six hours.
- This study shows the potential for alteration of carbon due to photochemical alteration within the Verde River system.
- Decreases in our control samples might be attributed to experimental design. This experiment took place on the roof during the summer, where the temperature of the samples reached 53° C

Future Plans

- Continue to collect samples to determine long-term seasonal and distance trends.
- Analyze all samples with ESI-MS to determine chemical variability.