Dissolved Organic Carbon Concentrations in Tempe Town Lake: biogeochemical & hydrologic processes

Hilairy Hartnett[1,2] and Bradley Brown[2]

[1]Department of Geological Sciences, 871404, Arizona State University, Tempe, AZ 85287-1404
[2] Department of Chemistry & Biochemistry, 871604, Arizona State University, Tempe, AZ 85287-1604

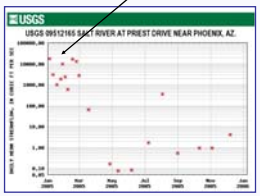
Abstract

Tempe Town Lake in downtown Tempe, AZ is a man-made lake isolating a short segment of the Salt River channel. Most of the year, the lake is enclosed by two inflatable dams and the Salt river proper has a very low flow rate. In January of 2005, high winter rainfall led to significant water flows in the Salt and Verde Rivers and for the first time since the lake was built, the dams were lowered and the river allowed to flow in a relatively normal fashion. We took advantage of this "natural experiment" to monitor basic water quality parameters (Temperature, pH, Conductivity, dissolved Oxygen) and concentrations of dissolved organic carbon (DOC) in the Salt River as it flowed through Tempe, and to examine how these properties evolved in Tempe Town Lake after the dams were raised. Samples of the river/lake have been collected daily over the last twelve months. In the winter, while the river was flowing, dissolved organic carbon concentrations were relatively high (5-7 mg C/L). After the dams were raised in early March, dissolved organic carbon decreased monotonically to ~3.5 mg C/L over the course of the spring and early summer. Conductivity increased dramatically from ~200 μS to >850 μS as a result of evaporation during this same period. With the onset of the summer monsoon rains, dissolved organic carbon concentrations in the lake increased again and became more variable (3-6 mg C/L). These results suggest that during rainy seasons organic carbon from the land is washed into the river/lake. During dry periods however, biogeochemical process that may include photo-chemical oxidation, microbial degradation, flocculation and settling decrease the organic carbon concentrations in the lake.

Study Site

Under 'normal' conditions, little or no water flows into or out of the lake; evaporation is "made up" from canal water and seepage recharge wells.

Inflatable dams were lowered to accommodate high flow during winter storms in Jan. 2005, dams were raised on 4 Mar. 2005 and water flowed through the lake until mid Apr. 2005



January 2005

Methods

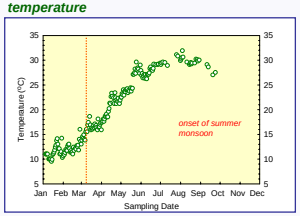
- Temperature, Conductivity, pH, and turbidity are measured in the field with hand-held meters
- Alkalinity is titrated using H_2SO_4 with phenolthalein and bromcresol green/methyl red indicators
- Sediment load determined as the mass of sediment filtered from a known volume of river water
- Dissolved organic carbon is determined by high-temperature catalytic oxidation on a Shimadzu TOC V analyzer

Biogeochemical and Physical Processes

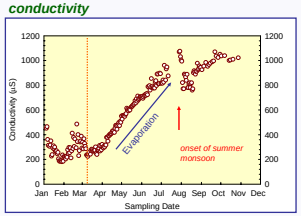
	DOC Concentration	DOC Composition
EVAPORATION	↑	same
MICROBIAL DEGRADATION	↓	changes
PHYTOPLANKTON PRODUCTION	↑	changes
SORPTION TO PARTICLES, FLOCCULATION	↓	changes
PHOTOCHEMICAL OXIDATION	↓	changes

Results

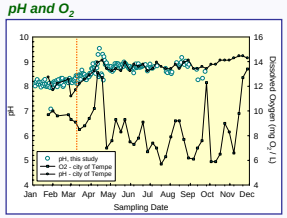
temperature



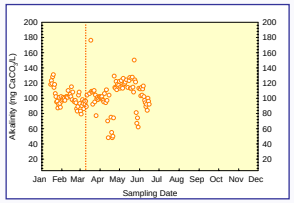
conductivity



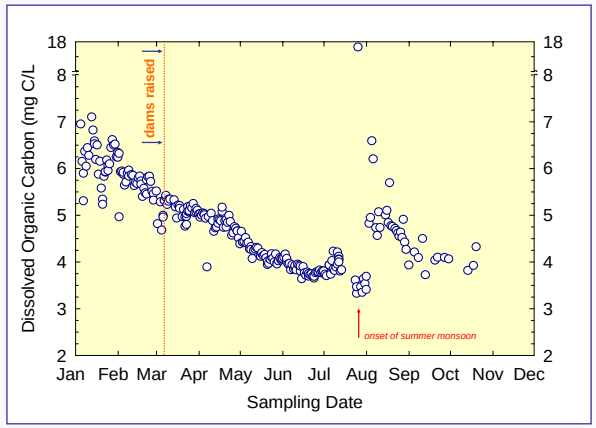
pH and O_2



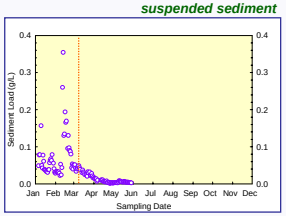
alkalinity



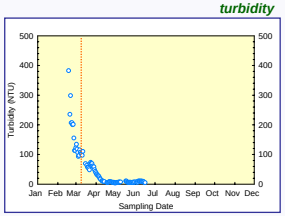
DISSOLVED ORGANIC CARBON



suspended sediment



turbidity



Discussion

The lake experiences three distinct periods over the course of the year:

Winter storm period (Jan05 – Mar05)
- High flow rates
- Low conductivity
- High suspended sediment load
- High dissolved organic carbon

Evaporative spring/summer period (Mar05 - Aug05)
- Low flow rates
- Increasing conductivity due to evaporation
- Increasing temperature due to seasonal warming
- Low suspended sediment load
- Decreasing dissolved organic carbon

Post Monsoon period (Aug05 – Nov05)
- Low to moderate flow rates
- Decreasing/more variable conductivity
- Very low suspended sediment load
- Increased and variable dissolved organic carbon

Results suggest that DOC is controlled by a range of biological and physical processes. During high flow periods, DOC is likely of terrestrial or soil origin. During the evaporative period, DOC is consumed by heterotrophs or lost to photooxidation and sorption faster than it is produced by algal productivity suggesting that the lake may be net heterotrophic at this time. With the onset of monsoon rains, DOC increases and is again likely to have a terrestrial source, but perhaps a different one than found in the winter period. Carbon characterization by ESI-MS will confirm these differences in source.

Future Plans…

Given that there appears to be a range of sources for DOC in Tempe Town Lake and a range of processes that are affecting the amount of carbon in the water an assessment of the composition of the DOC is in order

- Electrospray Ionization Mass Spectrometry gives a "fingerprint" of the organic compounds present in solution
- Samples from the winter storm period, the evaporative period, and the post-monsoon period are likely to show differences in the distribution and types of compounds present

Hypotheses to be tested
- Winter storms bring terrestrial organic matter to the lake
- Microbial decomposition during the evaporative period will break down large compounds, thus increasing the abundance of lower molecular weight compounds
- Monsoon rains will be a source of terrestrial organic matter to the lake

References

http://www.tempe.gov/lake/
http://waterdata.usgs.gov/az/nwis

Questions or further information? Hilairy Hartnett, phone: 480-965-5593, email: h.hartnett@asu.edu