CONTAM 02 Observations in Rivers and Urban Streams: Merced River Net Daily Metabolism Studies

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Overview

This project is part of the ongoing CENS investigation into whole stream metabolism (or net daily metabolism) in human-dominated watersheds. More specifically, we are focusing on assessing primary production and respiration at various spatial and temporal scales, motivated by the need to understand the connection between human land management activities and stream metabolism.

Specific Objectives

Continuing last year's work, this project examined net daily metabolism (NDM) changes stemming from large human disturbances on the river. In this case, the disturbances were large, pulse-releases of cold water from upstream reservoirs. The specific research objectives were as follows:

- Developing and test a long-term water quality gauging station on the Merced River and use it to collect dissolved oxygen, temperature and other water quality data before, during and after large disturbance events.
- Estimate whole stream metabolism values on a daily basis and use these estimates to assess whether or not significant changes in metabolism occur as a consequence of such a disturbance.

Progress in 2010-11

- We successfully installed a semi-permanent station on private property along the Merced River and continue to collect water quality data (Figure 1). Several large disturbances have been captured and interpreted with respect to net daily metabolism changes.

Approach

We have installed a semi-permanent station for continuously estimating whole stream metabolism parameters, namely Gross Primary Productivity (GPP) and Community Respiration (CR) rates, or their ratio (P/R). Our approach is to use these to evaluate river ecosystem structure and function because it directly assesses the balance between energy supply and demand within the system. We are examining multiple scales of temporal variability in ecosystem metabolism rates including (1) seasonal, (2) daily, (3) episodic, and (4) inter-annual. Over the past year we have focused in episodic variability, which can also be described in terms of disturbance (an abrupt event that can drastically change ecosystem characteristics).

System Description and Experiments

The semi-permanent station is installed on the Lower Merced River approximately halfway between two government river gauging stations. While the government stations monitor stage and flow, the CENS station monitors stage and water quality. Specifically, the station houses a Hydrolab DSS unit and monitors water depth, water temperature, dissolved oxygen, specific conductance (salinity), and pH. Data from this station is transmitted wirelessly to the UC Merced campus, where CENS investigators can interpret it scientifically or identify signs that maintenance is necessary (e.g., the sensors typically require cleaning after major flood events).

The experiments entail monitoring dissolved oxygen and temperature before, during and after significant disturbance events on the river. Disturbance here is in the ecological context, and refers to substantial changes in flow or water...
quality as a result of natural processes or human activities. A specific example involves mandated seasonal releases from the upstream reservoir (Lake McLure) in support of anadromous fish migration. Each spring (May) and Fall (October or November), the reservoir operators send a large pulse of cold water down the Lower Merced River under this agreement. The flow disturbance for this release in Fall 2010 is shown in Figure 2 (top).

Accomplishments
We successfully installed the semi-permanent station with has been operational since September 2010. The system has enabled the observation and interpretation of several major disturbance events in 2010-11. In addition, we have identified but did not yet interpret numerous lesser disturbances. We presented our results at the Fall 2010 Meeting of the American Geophysical Union.

The data shown in Figure 2 depict the flow disturbance (top) and corresponding dissolved oxygen (middle-blue) and temperature (middle-red) signals before and after the disturbance. Note that the extreme nature of the disturbance disrupted data acquisition during its peak. We have since reinforced the system such that should tolerate such disturbances in the future. The bottom plot in Figure 2 demonstrates the change in river metabolic rates due to the disturbance. This can also be seen in the change in amplitude of the dissolved oxygen pulses. The metabolism estimates yield daily averages of gross primary production (GPP) and community respiration (CR24). Consistent with the limited literature on disturbances, there is a clear decrease in GPP with the arrival of the cooler water, while CR24 values increase, most likely in response to the additional nutrients in the water as a result of the greater flows. These results validate that our system is providing useful important data on the nature of river ecosystem disturbances and resilience.

Future Directions
As noted above, we are interested in using our system to study disturbance and resilience phenomena across a variety of temporal scales. This will require automation of the metabolism calculations, and we are currently working with researchers at the USC Information Science Institute to develop work flow software supporting this goal. Automation will enable us to analyze potential disturbances which are smaller and more frequent, or of a different nature (e.g., salinity pulses) than the cold water pulses. Specifically, we intend to address the following questions:

- What magnitude of flow alteration constitutes an ecological disturbance over various seasons and water years?
• Under what conditions do chemical releases from agricultural drainage, wastewater treatment plants and other sources constitute disturbances?

• What role does non-point source pollution, as from groundwater seepage, play in river metabolism and its change?

In addition to addressing a wider range of temporal scales, we are interested in expanding our investigation to encompass greater spatial scales along the river and surrounding watershed. This will start with the installation of a duplicate station approximately 40 river-km upstream of the current station. We are also commencing a series of synoptic surveys between the two stations in an effort to learn how to integrate landscape processes (e.g., surface water runoff, groundwater-surface water discharges) into our interpretation of stream metabolism changes.