Title

Closing the Loop on Groundwater-Surface Water Interactions, River Hydrodynamics, and Metabolism on the San Joaquin River Basin

Authors

Harmon, Thomas
Villamizar Amaya, Sandra
Butler, Christopher
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Closing the Loop on Groundwater-Surface Water Interactions, River Hydrodynamics, and Metabolism on the San Joaquin River Basin

Thomas C. Harmon[1], Sandra Villamizar Amaya[1], Christopher A. Butler[1], Henry Pai[1], Patrick Barnes[1], Jason Fisher[1], Fabio Silva[2], Thanos Stathopoulos[3], William Kaiser[3]

[1] School of Engineering, UC Merced, [2] Information Sciences Institute, USC, [3] Electrical Engineering, UCLA

Introduction: Investigations within the San Joaquin Basin

Studies

- **Hydrodynamic modeling at the confluence**
  - Study mixing and mass balance along the San Joaquin River (SJR)-Merced River confluence.
- **Streambed temperature profiles**
  - Study local groundwater fluxes (GW) into Merced River using heat and mass transfer.
- **Metabolic rates in lotic systems**
  - Study Net Ecosystem Productivity (NEP) using dissolved oxygen (DO) as a proxy and accounting for reaeration.

Multiscale Sensing

- **Regional scale**
  - Existing **gauging stations** for flow, salinity, and temperature values.
  - Installation of **permanent sensor network** for GW and surface water (SW) quality.
- **Local scale**
  - Hydrolab **multi-parameter sonde** for water quality measurements.
  - Sontek acoustic Doppler **velocimeter** and **profiler** for water velocity measurements.
  - **Networked Infomechanical Systems** (NIMS) to actuate sensors.
  - Valeport Midas **echosounder** and Leica **total station** for topography.
  - **iButtons** for streambed temperatures.
  - HOBO **pendants** for temperature and light.
  - Davis and Vaisala **weather stations** for weather parameters.

Problem Description: Quantifying water sources and aquatic ecosystem response

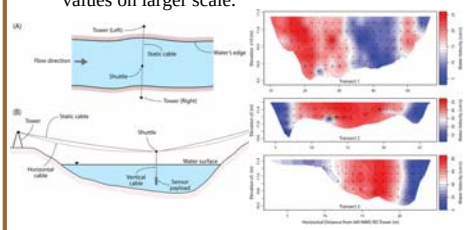
Linkages between land use and chemical transport and fate along the soil zone-GW-SW flow path is difficult to quantify. In the SJR basin, agricultural drainage percolates to the GW supply, eventually recharging SW which impact SW quality and ecosystem health. This work describes the efforts to create a prototypical observation-modeling-management (feedback-control) system in the following sub-projects: (1) Application of high-resolution multi-scale observations to define a 2-D hydrodynamic model at the confluence and parameterize models for river metabolism, (2) The use of embedded sensor systems known as temperature javelins to estimate local groundwater fluxes into the Merced River upstream of the confluence, and (3) The installation of long-term sensor systems aimed at continuously observing the flow path between agricultural systems and the Merced River.

Two study sites at the SJR-Merced River confluence and further upstream on the Merced River. →

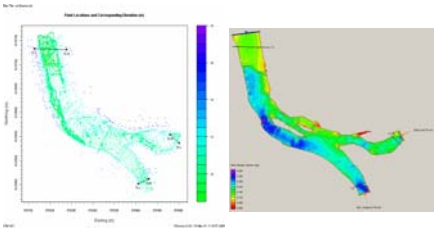
Proposed Solution: Hydrodynamic modeling, temperature javelins, and river metabolism

River Hydrodynamics

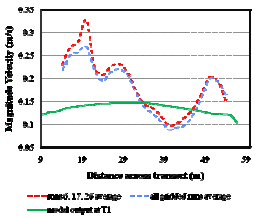
- Modeling provides depth averaged velocity values on larger scale.



↑ Top and side views of NIMS RD (Rapidly Deployable) shown left. Sample interpolated flow inputs from point ADV measurements shown right.



↑ Point plot of the surveyed and echosounder points are shown left. Model results from a finite element model in a commercial GUI shown right.



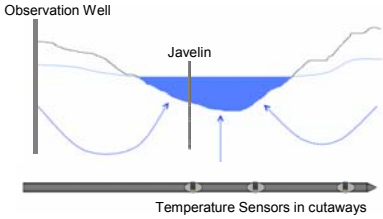
← Recorded and modeled velocity profiles at downstream transect.

Well sampling for water quality. Taken back to ion chromatography for analysis. →

- Challenges include unsteady conditions with limited time-series data sets for flow boundary conditions and changing streambed.

Temperature Javelins

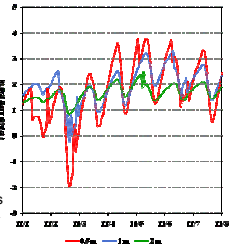
- Temperature gradients between observation well and javelins and between different depths of embedded temperature sensors in the javelins provide estimates of groundwater flux into the stream.



↑ Cross-sectional view of temperature javelin setup with a zoom in of the javelin.

↑ Pressure, temperature, and EC (conductivity) sensors in observation well.

← Networked logger for observation wells and weather station.

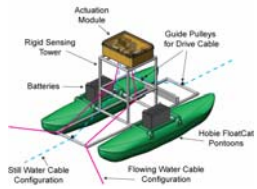


GW velocity calculations into SW from one javelin from 11/1/08-11/8/08. Positive values indicate flow from GW to SW. →

- Challenges include limitation of model to only calculate recharge (GW feeds SW).

River Metabolism

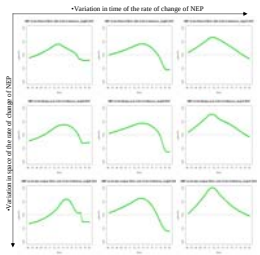
- DO variations, monitored with the Hydrolab sonde, serve as a proxy for the calculation of river metabolism (primary productivity and community respiration).
- Local river velocities, measured with the ADV or ADP, account for reaeration correction.
- River ecosystem health indicators such as gross primary production (GPP) or NEP offer challenges for measuring in flowing waters.



← NIMS AQ (Aquatic) actuates sensors for high resolution cross-sectional spatial data.

- Riparian vegetation, unsteady flow, and natural and human-induced disturbances (i.e. water management) cause spatiotemporal variations.

Calculation of NEP from the SJR-Merced River confluence. Different rows show spatial variability, while columns indicate changes in time. →



Future work

- Permanently networked sensor infrastructure for temporal sensitive measurements.
- Integrating local models with regional models.
- Hardening system methods to increase spatial coverage of data.
- Characterization of the human-dominated river continuum.