Title
Multidimensional Flow and Transport Characterization Efforts at the Merced River-San Joaquin River Confluence

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Introduction: Observations along confluence reach

Multiscale sensor approach

- **Current approach**
  - Agency gauging stations record sparse data at regional scale.
  - Human observations identify areas of interest.
- **Field robotics**
  - Rapidly deployable or aquatic networked infomechanical systems, (*NIMS RD* or *NIMS AQ* respectively), allows infrastructure for motion.

[Above] NIMS RD moving sensor package across river transect.

- **In-situ sensor observations**
  - Commercial sensors provide data for *bathymetry*, *velocity*, *temperature*, *salinity*, *pH*, *dissolved oxygen*, and *oxidation-reduction potential*.

Study site potential

- **Engineering perspective**
  - Test site for field robotic systems, features, and *path planning algorithms*.
  - Evaluation of *sensor performance*.
  - Applying appropriate *statistical data analysis*.
- **Scientific perspective**
  - Understanding *hydrodynamics*, (mixing, turbulence, boundary conditions, groundwater-surface water exchange).
  - Observing *nutrient transport* effects on local ecology and water quality.

Problem Description: Improving mass balance with higher resolution

[Above] Overview of the two distinct river regimes. The cleaner Merced River flows from the left side; the dirtier San Joaquin River flows from the right.

On a regional scale, gauging stations provide one-dimensional data for flow and water quality parameters useful for agricultural and municipal water regulation. Moving to smaller scales, however, gauging stations do not adequately describe the local dynamics, such as mixing and groundwater-surface water exchange, that are useful in context of habitat restoration efforts. The Merced-San Joaquin confluence provides an interesting site characterized by the mixing of distinctly different waters. With the aid of NIMS RD, dense two-dimensional scans with water quality and velocity sensors define a cross-sectional mass flux. Deploying NIMS RD transects on each river individually and downstream of the confluence zone aims to *describe mixing processes* and *quantify potential groundwater inputs* through *mass balance calculations*.

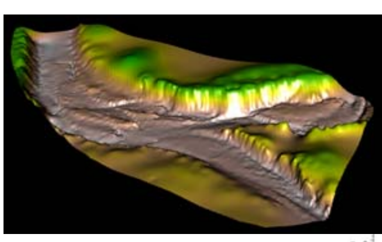
Proposed Solution: Multiple transects along confluence reach

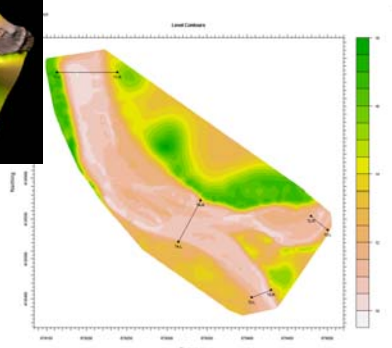
Basic mass balance approach

- General equation for mass balance or mixing:

$$Q_{mer}C_{mer} + Q_{sjr}C_{sjr} = Q_0C_0$$

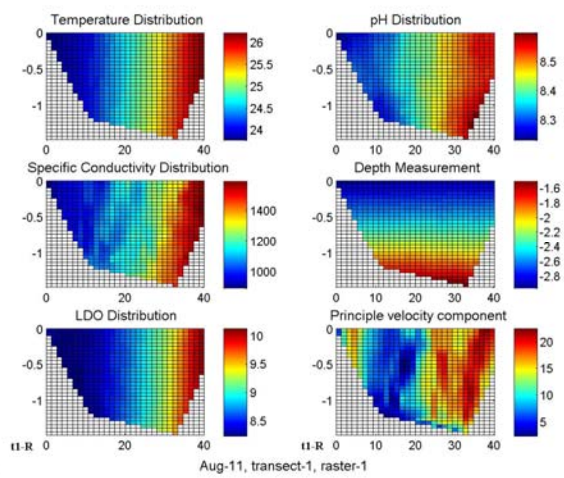
  Where Q represents volumetric flow rate and C represents the concentration of the constituent observed. Subscripts "mer", "sjr", and "0", identify quantities pertaining to the Merced River, the San Joaquin River, and after the confluence respectively.
- Imbalances in the equation can be to *external sources or sinks*, such as groundwater, and/or *internal dynamics*, such as nutrient cycling.
- Multiple transects chosen such that the mixing model could be parameterized and the principle flow is perpendicular to transect.
- Deployment from Aug. 6-16th in hopes of capturing "snapshot" of flow.
- Bathymetric data from *echosounder* and *surveying*.
- Velocity profile from *Sontek acoustic doppler velocimeter*.
- Water quality parameters from *Hydrolab multiprobe package*.



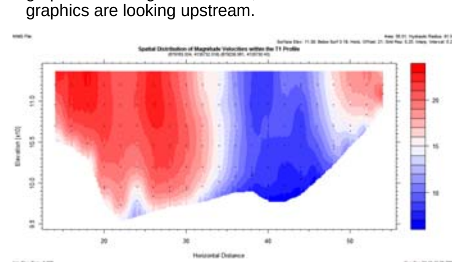


[Above & Right] 3-d and 2-d interpolation of bathymetry data. To the right, the lines represent the chosen NIMS RD transects.

Examples of the data



[Above & Below] Sample data from transect 1. Above shows preliminary data interpolation for velocity and water quality parameters. Below presents further interpolation schemes to decrease the area size needed for flow measurements. Note, the bottom graphic is looking downstream, while the above graphics are looking upstream.



Future Directions

- Continue data filtering and data analysis schemes.
- Refine path planning algorithms to account for temporally varying parameters.