Spatial River Survey System (SpaRSS): an efficient protocol for mapping water quality and riparian zone features

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Introduction: Investigations along the Merced River

Studies
- River water quality surveys
  - Periodic large scale (10s km) navigation equipped with multi-parameter probes
- Supporting studies on:
  - Metabolism in lotic systems
  - Groundwater-surface water interactions
  - Land management-water quality linkages

Multiscale data approach
- Point coverage, high frequency
  - Existing gauging stations collecting water quality data and flow.
  - User-installed multi-parameter sonde (Hydrolab MS5) for water quality data.
- Continuous coverage, low frequency
  - Motorized kayak for transport.
  - Geo-referenced data acquisition (GPS)
  - Multi-parameter sonde for water quality data (Hydrolab).
  - Real-time spectrometer for nitrate, TOC/DOC, turbidity (s:can Spectro:lyzer)
- Smart phone-based stream inlet and outlet mapping

Problem Description: Synoptic data for different flow and seasonal conditions

Stream flow and water quality often vary with seasonal conditions and demand fluctuations. Typically, monitoring stations are sparsely situated in space, but capture relatively high resolution temporal data (e.g., hourly) to gauge flow and key water quality parameters such as temperature and salinity. Along the Merced River, spatiotemporally distributed fluxes from groundwater (GW) and drainage and diversion channels remain ungauged or difficult to quantify, rendering accurate forecasting water quality conditions challenging. This work demonstrates the spatial river survey system (SpaRSS), presenting a set of synoptic water quality traces collected on the Merced River. SpaRSS synchronizes a high frequency GPS coordinates on a kayak equipped with multiparameter water quality sensors. High-density spatial data collection under different flow and seasonal conditions can help identify key river segments for with respect to landscape-river interactions.

Proposed Solution: Data collection and analysis

Data collection
- Raw data
  - GPS collects time-stamped locations of motorized kayak.
  - Digital camera catalogs noticeable water fluxes (pumps, canals, etc.) with time-stamps.
  - Multi-parameter sonde collects time-stamped water quality data (temperature, SC or SpCond, DO).
  - S:can Spectro:lyzer collects time-stamped spectrum data for the UV-visible range, wavelengths of 220-720 nm, for nitrate (NO$_3^-$), turbidity, and total and dissolved organic carbon (TOC and DOC respectively).
- Filtering
  - Miscellaneous data collected when the motor battery needed swapping and passenger switching.
  - Criteria searches for low spatial gradients (< 1 m spatial difference) indicating a stationary kayak.

Preliminary analysis
- Large-scale water quality traces
  - Point intensity plots of major water quality parameters: SC, temperature, DO, and NO$_3^-$.  

Future work
- Distinguish anomalies from background data
  - Compare SC and temperature with gauging stations.
  - Install permanent station with water quality parameters of interest to account for changing background conditions.
- Develop criteria to identify zones of ‘interest’
  - For instance, after correcting for background of a conservative constituents (SC and temperature), gradient fluctuations may imply canals and pumps, and GW fluxes.
- Ecosystem health of different zones
  - Strategically placed stations to help estimate local metabolism parameters (production, respiration).