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## **Posters**

### **Title**

An Overview of CENS Contaminant Transport Observation and Management Research

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## An Overview of CENS Contaminant Transport Observation and Management Research

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### Introduction: An overview of contaminant assessment and management research projects

#### Overview of Projects

##### Deploying a Multi-Scale Soil Sensor Network in Support of Groundwater Quality Protection

- Soil pylon development and test bed deployments

##### Observations in Rivers and Urban Streams

- River mixing dynamics and mass balances
- Surface water-groundwater flux estimates using Temperature Javelins
- Characterization of urban stream quality and algal dynamics

##### Embedded Networked Sensing in Soils

- A stochastic data assimilation approach to network design and real-time state and parameter estimation

##### Embedded Networked Sensing for Observation and Analysis of Groundwater Arsenic Mobilization

- Identification of diurnal redox cycling influences on Arsenic mobilization

#### Technologies

##### Multi-scale embedded networked sensing:

##### Mobile platforms: Rapidly Deployable Networked Infomechanical System (NIMS RD)

Technology for observing spatiotemporal hydraulic and chemical properties across stream channels.

##### Static platform: Javelin Array

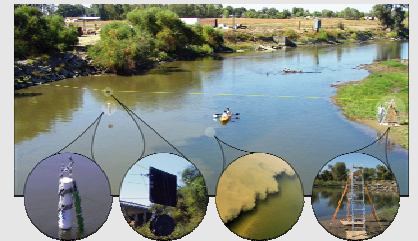
Enables in-river (inputs from tributaries, canals) and sub-river (hyporheic zone) observations.

##### Static platform: Soil Pylon Array

The soil pylon is a vertical array of soil sensors used to delineate mass and energy fluxes in subsurface systems.

### Description: Observational strategies for soil, groundwater, and riparian systems

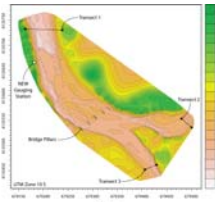
The contaminant assessment and management (or "Contam") research area focuses on developing and implementing **embedded networked sensing** (ENS) technology to support this new observational strategy in the context of mass and energy distributions and fluxes across a range of temporal and synoptic scales. The specific areas of interest for Contam include **soils, groundwater, and riparian systems**. The Contam application domain is unique relative to the other three CENS applications in that it is often concerned with enabling adaptive management of environmental problems through engineered responses triggered by ENS observations. Example applications include improving our understanding of **river metabolism** in relation to adjacent and upstream land management practices, creating closed-loop feedback-control systems for conserving irrigation water and avoiding excessive nitrogen application in agricultural systems, delineating nutrient fluxes between groundwater and surface water, and rapid identification of coastal pollutants.



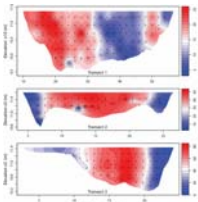
Super-resolution scanning of flow and water quality using the NIMS RD system within the San Joaquin

### Proposed Solution: Implementing embedded networked sensing technology

#### River Mixing Dynamics and Mass Balances



Data collected during the San Joaquin River **NIMS RD** deployment: **Bathymetry and DEM map** (left) and **velocity** (right) distributions are shown for upstream and downstream transects at the San Joaquin - Merced confluence.



#### Closed-loop Soil Moisture and Nutrient Cycling



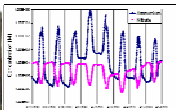
(left) Closed-loop salinity feedback irrigation control test bed experimental setup. Sensors record **moisture, salinity, and temperature** within the soil profile. A **micro-climate station** provides data on current climatic conditions. (right) Response of embedded **nitrate** and **ammonium** inside a saturated soil column at various flow rates.



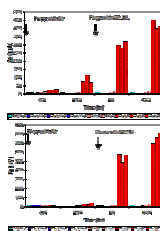
#### Diurnal Redox Cycle Effects on Arsenic Mobilization



(above) Lab microcosm experiments to determine diurnal cycling effects on **Arsenic** mobilization in native (Bangladesh) soils.

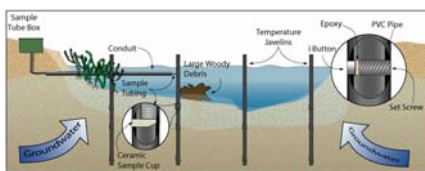


(left) Nitrate and ammonium diurnal cycling results.



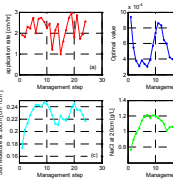
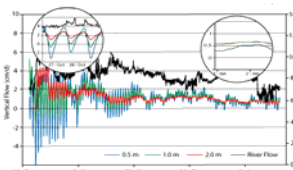
(right) Results of mobilization of iron and **Arsenic** after purging of anoxic gas showing redox changes may lead to As partitioning from solid to aqueous phase.

#### Quantifying Groundwater Fluxes into the Merced River

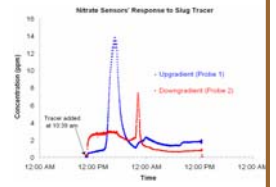


(left) Conceptual depiction of **Temperature Javelins** used to quantify groundwater fluxes into rivers through the use of heat as a tracer. Integrated sampling cups and iButton self logging thermistors are highlighted.

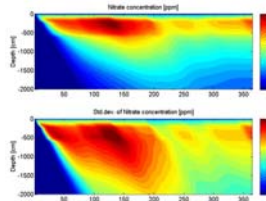
(right) Results of vertical groundwater discharge velocities measured at three depths below the streambed and over a three month deployment at the Merced River. **Diurnal groundwater discharge cycles** during variable and steady-state river conditions are highlighted.



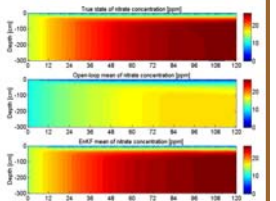
(left) Results for the real-time **closed-loop** soil salinity management systems; (right) Results of nitrate sensors response to tracer injection within the soil column.



#### A Stochastic Data Assimilation in support of Real-time State and Parameter Estimation



(left) Simulations of mean and standard deviation **nitrate** profiles over 1 yr. (right) Comparison of open-loop system with **Ensemble Kalman Filter** approach.



#### Hydrologic influences on Tiger Salamander Habitat

(right) Field setup aimed at capturing hydrologic influences on **Tiger Salamander** habitat and organism behavior in and around a vernal pond at the Blue Oak Ranch Reserve. Pressure transducers, and soil moisture sensors track the drawdown of the local water table. eKo (Crossbow®) wireless loggers relay matrix potential, soil moisture, and local meteorological conditions to a local gateway.

