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Field Deployment of Potentiometric Nitrate Sensor System

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Field Deployment of Potentiometric Nitrate Sensor System

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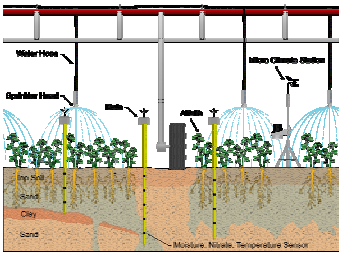
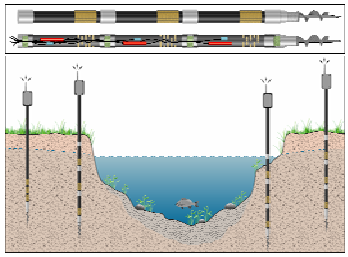
Introduction: Needs for scaleable nitrate sensing in environmental assessment

Applying nitrate as fertilizer in agriculture: what is the assimilative capacity of this heterogeneous soil-plant domain?

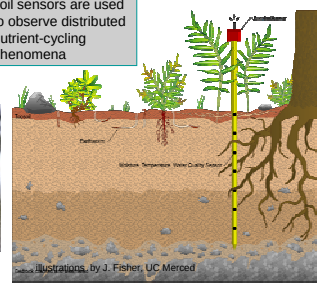


Describing transport of chemical substances within river systems: estimation of mass transfer across the rivers surface water – groundwater interface using javelin platforms



- *Javelin*: stationary vertical sensor array
- Rapidly deployable, for probing water-saturated sediments

In natural systems, soil sensors are used to observe distributed nutrient-cycling phenomena



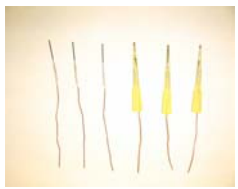
Abstract. Many water quality problems would be better understood and more effectively managed if relevant environmental system could be observed overtime in a spatially distributed manner. Current commercially available chemical sensors are relatively expensive, or are generally not optimally packaged for field deployments. This work examines the potential for use of nitrate selective electrodes in distributed sensor networks in environmental systems. Short-lived polypyrrole-based nitrate selective sensors are fabricated on mechanical pencil lead substrates and tested for selectivity over other environmental anions. Results for these sensors are compared against more expensive commercial nitrate sensors in two soil testbeds under irrigation conditions. The results demonstrate the potential for fabricating numerous inexpensive sensors that are scaleable to applications in distributed environmental observation networks. Discrepancies between larger commercial sensor results and the PPy sensors suggest that more tests are needed to determine the most accurate strategy for coupling sensors with targeted environmental medium. Nitrate-selective mini-sensors with polyvinylchloride membranes have been developed as an attempt to improve sensor lifetime in the field, results of pre-deployment experiments showed that these mini-sensors can be used for field deployments.

Proposed Solution: Potentiometric Nitrate Micro- and Mini-sensors

- We are creating ***scalable*** nitrate micro- and mini-sensors suitable for dense, spatially distributed deployment in environmental media.
- In addition to precise and accurate, our sensors must be ***inexpensive*** and have ***low impact*** on the observations (e.g, avoid flow disturbances)

Conducting polymer-based nitrate ISEs: (single-($PPyNO_3$) and double-layer ($PPyNO_3$+Bis-EDOT) electrodes)

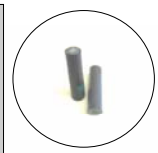
Potentiometric nitrate microsensors based on doped polypyrrole films protectively packaged for soil deployments.



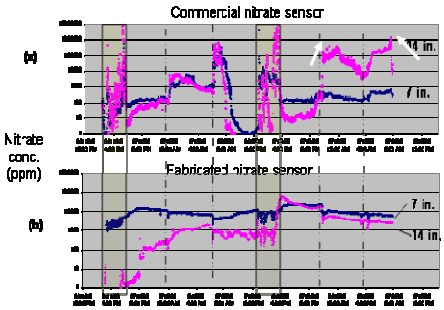
Selectivity

J^- (interfering anion)	$PPy(NO_3)$ pencil lead - based ISE (K^{pot} values)
HCO_3^-	3.8×10^{-3}
Cl^-	1.20×10^{-2}
PO_4^{3-}	2.00×10^{-4}
Br^-	9.10×10^{-2}
NO_2^-	2.22×10^{-4}
ClO_4^-	2.93×10^{-3}

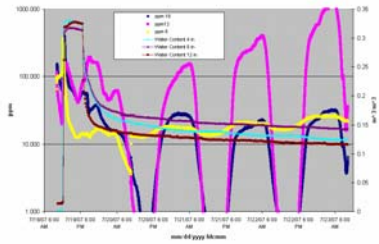
Possible *solution* for the *problem of sensor's lifetime in the field*: sensors with PVC membranes containing liquid anion exchangers



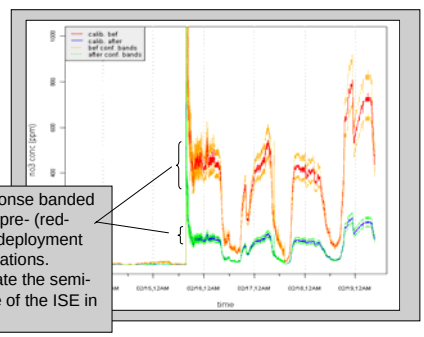
Deployment at Palmdale test bed: $PPy(NO_3)$ sensors loose their sensitivity during direct exposure to flowing water; however, the sensors can be reconditioned



PVC-type sensor (commercial) behavior in Merced dairy test bed: diurnal pulses

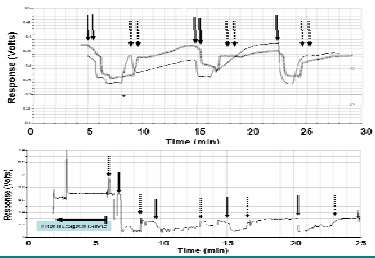


Characterizing sensor uncertainty (San Joaquin River javelin test bed)



Mean sensor response banded by 95% C.I. using pre- (red-orange) and post-deployment (blue-green) calibrations. Results demonstrate the semi-quantitative nature of the ISE in field deployments

James Reserve AMARSS Transect: testing in-situ calibration method (James Reserve moist soil)



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