Wireless Sensor Network Based Continuous Plume Monitoring: Proof of Concept in Intermediate-Scale Tank Test, Preliminary Results.

Lisa Porta[1] and Tissa H. Illangasekare
Center for Experimental Study of Subsurface Environmental Processes (CESEP), Division of Environmental Sciences and Engineering, Colorado School of Mines, Golden, CO

Philip Loden and Qi Han
Department of Mathematical and Computer Sciences, Colorado School of Mines, Golden, CO

Denney Liptak and Anura Jayasumana
Department of Electrical and Computer Engineering, Colorado State University, Fort Collins, CO

Abstract. The current practice for monitoring of subsurface plumes involves the laboratory analysis of water samples from monitoring wells to determine chemical concentrations. This data is used in modeling and site management. Cost and time constraints limit the collection and analysis of numerous samples and this approach becomes impractical for continuous monitoring of large, transient plumes. With the expected advances made in new sensor technologies and wireless sensor networks (WSNs), the potential exists to develop new and efficient subsurface data collection to monitor plumes. The goal is to automatically collect data from the sensors and wirelessly transmit them to a computer for continuous plume monitoring. This data will also be used for automatic inverse modeling which permits a dynamic and improved transport model calibration with every new set of data received as the plume migrates. Many technological and operational challenges related to sensor calibration, placement and distribution, automation of real-time data collection, wireless communication, and modeling have to be overcome before the implementation of this technology in the field. This preliminary proof of concept demonstration study assesses this technology using a physical aquifer test bed constructed in an intermediate scale tank. The test system includes a set of ten conductivity probes individually connected to wireless sensor boards (motes). The tank was packed using three well-characterized silica sands to represent a heterogeneous aquifer. Bromide tracer was injected as a slug into a steady flow field and concentration at different points in the tank was measured with ten calibrated soil moisture/electrical conductivity sensors attached to five different motes connected to the computer. Wireless communication between the motes allowed selective gathering of data to be used in the model calibration. The accuracy of the sensor-measured concentrations was tested against traditional grab samples analyzed using an ion chromatograph. Inverse modeling will be used to determine subsurface parameters needed for predictive modeling. This preliminary study is the starting step in the development of a more complex wireless sensing communication system to be used in field applications involving remediation design, performance assessment, risk analysis and exposure assessment.

[1] Colorado School of Mines, Division of Environmental Sciences and Engineering
1500 Illinois Street
Golden, CO 80401
Tel: (303) 273 3483
Email: lporta@mines.edu