Innovative Groundwater Monitoring Through Data/Simulation Technologies

Haruko Wainwright

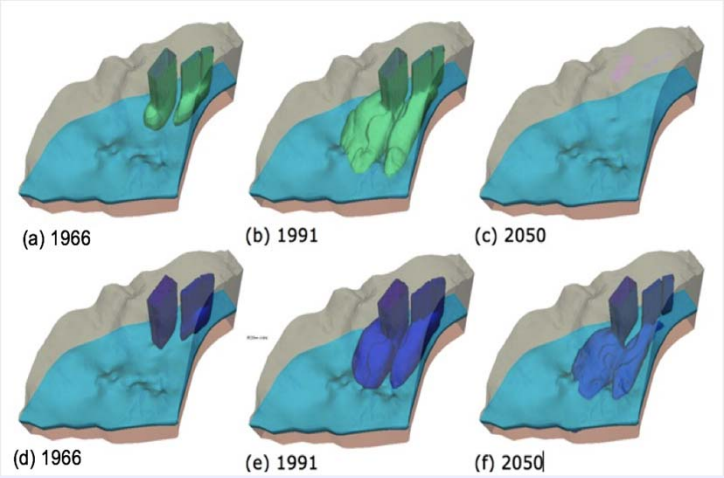
werri.lbl.gov

Motivation

A large-volume plume with relatively low contaminant concentrations is a significant problem at many sites. In situ treatments are no longer effective, while soil removal is cost prohibitive. Monitored natural attenuation and enhanced natural attenuation have been proposed as sustainable options to reduce remediation cost, waste, energy use and ecological disturbances. Their implementation requires extensive monitoring activities to prove site safety and regulatory compliance.

Technological Challenges

Current monitoring programs are often ad-hoc and based on groundwater sampling sparse in time and space missing critical moments and locations. In collaboration with SRNL, LBNL is developing innovative monitoring strategies including state-of-art in situ sensors, data analytics, and high-performance reactive transport simulators.

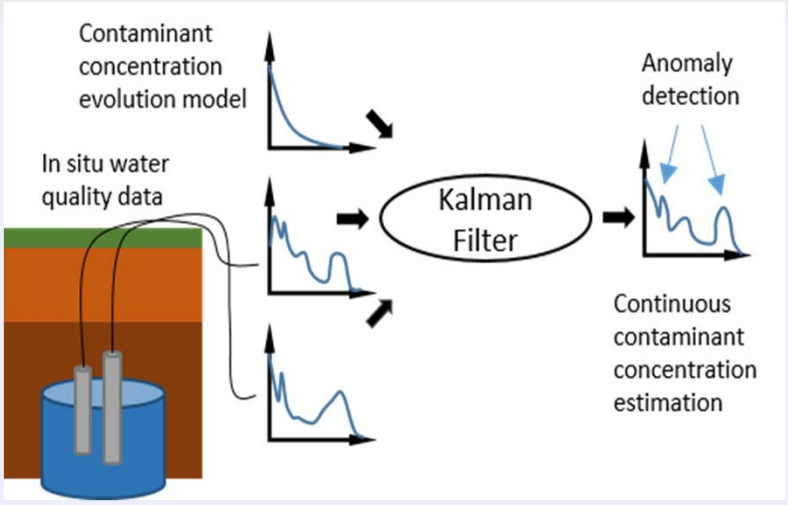


3D plume evolution at Savannah River Site F-Area of (a-c) acidic plume and (d-f) uranium plume

References:

Schmidt. F. et al., “In-Situ Monitoring of Groundwater Contamination for Sustainable Remediation Using the Kalman Filter”, under revision in Environmental Sciences and Technology.

Wainwright, H.M. et al., “Sustainable Remediation in Complex Geological Environment”, accepted in Encyclopedia of Inorganic and Bioinorganic Chemistry.



Kalman-filter based in situ real-time monitoring system (Schmidt et al., under revision in EST)

Research:

In Situ Sensing and Data Analytics for Long-term Monitoring

A variety of in situ sensors are becoming available to monitor groundwater conditions that are indicative of plume migration (e.g., electrical conductivity, pH, water table). In addition, autonomous data logging, wireless network, and cloud computing systems enables real-time data transfer and processing. By integrating these in situ data through machine learning, we are developing a continuous real-time groundwater monitoring system, which can reduce sampling frequency and serve as an early warning system.

High-performance Reactive Transport Modeling for Long-term Monitoring Optimization

The effectiveness of monitoring strategies has to be considered in various conditions and future scenarios such as future plume locations or the responses to extreme events (e.g., flooding). The reactive transport simulator ASCEM developed under DOE-EM can provide predictive understanding of the plume behavior in the future, including realistic geological and engineering conditions as well as complex geochemical reactions. It serves as a virtual testbed to evaluate the proposed long-term monitoring methods, and other new technologies such as geophysics and fiber optics.

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