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ABSTRACT TITLE: System Scale Imaging and Modeling of Groundwater-River Water Exchange at the Hanford 300 Area

ABSTRACT: System-scale groundwater-river water exchange at the Hanford 300 Area is being measured and modeled to study its impact on groundwater geochemistry and microbial populations at the site. Groundwater flow and biogeochemical transport within the Hanford 300 Area are strongly coupled and exhibit complex behavior as the river stage fluctuates due to seasonal loading and daily upstream dam operations. As a result, the water table rapidly fluctuates causing river water to enter, mix with groundwater, and recede from the aquifer. The mixing process impacts water chemistry and subsequently microbial populations and activities at the site because river water chemistry and microbiology differs significantly from that of the groundwater. The mixing also directly impacts the migration of contaminants at the site.

River water intrusion is being monitored with an array of continuous pressure, temperature, and specific conductance probes installed in wells. In addition, large-scale (300 m x 300 m) 3D electrical resistivity tomography (ERT) has been deployed to monitor river water intrusion using a novel time lapse ERT imaging methodology that explicitly accommodates the water table contrast, providing 3D images of river water intrusion at a temporal resolution of three images per day. The ultimate objective of this research is to invert for hydrologic parameters within a system scale model of the site by assimilating data from the well sensors and ERT monitoring array. A Bayesian data assimilation framework is being used that requires the execution of ensembles of simulations. To address the computational demands, we are coupling PFLOTRAN (Hammond et al, 2012) with E4D (Johnson et al., 2010) to provide a parallel multiphysics (fluid flow, solute transport, and current flow) capability to simulate all field data. The optimized hydrologic model will be used as the base flow model for the PNNL SFA's biogeochemical transport modeling effort where PFLOTRAN will further be employed to simulate the fate and transport of microbial populations at the site.

Accomplishments of this research will include the development of a parameterized system scale model that can be used to (1) predict variably saturated flow and biogeochemical transport within the Hanford 300 Area given future river water and groundwater elevation measurements and geochemistry, (2) determine ecological processes controlling microbial populations within the site, and (3) assess indirect climatic impacts to biogeochemical cycles within the domain. The research will also demonstrate a novel inverse method for incorporating geophysical data in hydrologic parameter estimation.