Identifying the principal chemical processes governing fate and transport of selenium and nitrate in the stream-aquifer system of the Lower Arkansas River Valley, Colorado.

Ravi Kumar Tummalapenta and Ryan T. Bailey
Department of Civil and Environmental Engineering, Colorado State University

Abstract. Selenium (Se) contamination in environmental systems has become a major issue in many regions world-wide during the previous decades, with both elevated and deficient Se concentrations observed in groundwater, surface water, soils and associated cultivated crops. In the groundwater systems and alluvial river systems of Colorado, elevated Se concentrations in particular have become a concern in regards to aquatic life health. This study uses modeling techniques to determine the system inputs and processes that govern the fate and transport of selenium species in the stream-aquifer system of the Lower Arkansas River Valley, with the efforts focused on a 55,200 ha (33,900 ha irrigated), 71 km region between John Martin Reservoir and the Colorado-Kansas state line. The modeling framework includes a MODFLOW-UZF groundwater flow model and a UZF-RT3D reactive transport model, with Se and nitrogen (N) cycling and fate and transport processes included in the latter, and is run for the 2003-2007 time period. N cycling and transport is included due to the strong dependence of Se speciation and transformation on the presence of nitrate. Using the model, a sensitivity analysis was performed to determine the most influential system factors on selenate (SeO_4) fate and transport within the aquifer, with factors including: rate of autotrophic and heterotrophic reduction of dissolved oxygen (O_2), rate of heterotrophic reduction of NO_3 and SeO_4, rate of nitrification, rate of Se uptake by crops, SeO_4 concentration in canal water, and rate of organic soil litter and soil humus decomposition. The analysis was performed according to canal command area, with dominant system factors identified for each command area. Results indicate generally that autotrophic reduction of O_2 principally governs the concentration of SeO_4 in the aquifer, with canal concentration of SeO_4 and heterotrophic reduction of SeO_4 also providing a significant influence. In several command area, autotrophic denitrification, rate of Se uptake, and heterotrophic reduction of O_2 also significantly influence SeO_4 concentration. Results can be used to guide best-management practice implementation, field data collection efforts, and parameter estimation strategies.