A Selenium Reaction Module for Agricultural Groundwater Systems

Ryan T. Bailey and Timothy K. Gates
Department of Civil and Environmental Engineering, Colorado State University

Abstract. During the recent decades, elevated concentrations of selenium (Se) in soil water, groundwater, and surface waters has emerged as a serious concern in regions around the world. Although an essential micronutrient for animals and humans, elevated concentration and bio-accumulation have proven to be harmful to aquatic species, waterfowl, and human populations. In this study we present the development of a numerical model capable of simulating the reactive transport and cycling of Se species in agricultural groundwater systems, with the overall goal of providing a tool that can assess baseline conditions and investigate mitigation scenarios. The model is developed by amending the reactive transport model RT3D with a Se reaction module that simulates the fate and transport of both dissolved and organic Se species in variably-saturated groundwater systems. System inputs include Se mass in irrigation water, canal seepage, fertilizer and manure, dead root mass and after-harvest stover mass, and system outputs include discharge to surface water, crop uptake during the growing season, and groundwater pumping. Chemical reactions include sorption, organic matter decomposition, mineralization/ immobilization, chemical reduction of the dissolved Se species, and oxidation of reduced Se through the autotrophic reduction of dissolved oxygen and nitrate (NO_3). Although the module is designed for application to regional-scale systems, this study presents corroboration of the model, through one-dimensional synthetic experiments, and testing of the model, through comparison of simulation results with NO_3 and Se data collected from test-plot soil profiles. Future use of the model includes an application to a regional-scale study site within the Lower Arkansas River Valley in southeastern Colorado.