Preliminary Assessment of Salinity Transport Modeling in an Agricultural Groundwater System

Saman Tavakoli, Ryan T. Bailey
Department of Civil and Environmental Engineering, Colorado State University

Abstract. The Lower Arkansas River Valley (LARV) in southeastern Colorado is a key resource for stakeholders in southeastern Colorado due to its valuable agriculture production. Because of a rising water table due to excessive irrigation and canal seepage, much of the soil-aquifer system in the valley has become salinized, thereby negatively impacting crop yield. High groundwater salinity loading to the Arkansas River stream network also impacts downstream areas, with saline river water diverted for application on irrigated fields. The overall aim of this project is to develop a numerical modeling framework capable of simulating the transport of salt ions within the stream-aquifer-soil system, so that current conditions of salinity can be assessed and possible remediation strategies in the region can be explored. This presentation summarizes accomplishments during the first phase of the project, which includes: 1) Simulating the fate and transport of sulfur species (principally sulfate SO_4) in a 500 km^2 region of the LARV using the UZF-RT3D groundwater reactive transport model; 2) Developing a comprehensive salinity module that can be coupled with the UZF-RT3D model and that accounts for equilibrium chemistry and precipitation-dissolution processes; and 3) Collecting field data at multiple scales to enable future model testing. The developed UZF-RT3D model was used to simulate cycling and transport of sulfur species, and accounts for advection-dispersion processes, first-order kinetic reactions, and sources and sinks of SO_4 such as irrigation water loading, canal seepage, crop uptake, groundwater pumping, and mass loading to/from the river network. Results of this preliminary modeling study indicate that these processes and sources/sinks cannot account for the high groundwater SO_4 concentrations and loadings to the Arkansas River. Hence, an additional salinity module currently is being developed which accounts for salt ion equilibrium chemistry and precipitation-dissolution processes to improve the model results. Initial model testing with the nested equilibrium module will occur at the field scale, with model results compared with collected salinity data from a lysimeter site at the Arkansas Valley Research Center in Rocky Ford, CO.