Evaluating Best Land and Water Management Practices to Improve Water Quality Using a Coupled Stream-Aquifer Reactive Transport Model

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Abstract. Water quality issues related to nutrients and trace elements in irrigated agricultural hydrologic systems have become a widespread concern in recent decades. Elevated concentrations of these elements can be harmful to aquatic biota, livestock, or even humans. This study uses a numerical model that has been developed to simulate flow and solute reactive transport in a coupled stream-aquifer system. Flow modeling is performed using a calibrated MODFLOW model that includes streamflow routing (SFR2 package), while the coupled RT3D-OTIS model simulates reactive transport in both the aquifer and the stream systems. For the latter, the OTIS model, which computes one-dimensional solute transport within a stream network, is coupled with a version of RT3D that simulates cycling and transport of solutes in both the unsaturated and saturated zones of the subsurface. Solutes are exchanged between the stream and aquifer daily using flows simulated by the MODFLOW-SFR2 model. The coupled modeling system is applied to a 500 km^2 study region in the Lower Arkansas River Valley, southeastern Colorado, to investigate the effect of proposed alternative land and water best management practices (BMPs) on decreasing selenium (Se) and nitrate (NO_3) surface water concentrations, groundwater concentrations, and mass loading to the Arkansas River system. The overall aim is to decrease concentrations of Se and NO_3 to better comply with the state of Colorado's respective chronic criteria and interim standard. Model results indicate the potential effectiveness of BMPs, especially combinations of BMPs, in markedly decreasing Se concentrations, but only limited effectiveness for NO_3 concentrations.