Evaluation of the Glover Solution for Estimating Depletion of Groundwater Return Flows to Streams due to Land Fallowing in the Lower Arkansas River Valley, Colorado

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

Abstract. In recent decades, water demand has risen to levels that have created a need for more accurate water management tools in many arid and semi-arid parts of the world, including Colorado. Recognition of the interconnectedness between groundwater and streams has accompanied the need to comply with state water law and interstate compact in developing administrative rules for better ways of managing Colorado's water resources. A current desire to implement lease-fallowing in the Lower Arkansas River Valley (LARV) in southeastern Colorado, with land owners transferring irrigation water rights to municipalities, has created a demand to determine impacts on flows in the Arkansas River and its tributaries due to a reduction in applied irrigation water. As the use of computationally-efficient, analytical models is a desired approach to assess these impacts, this study investigates the accuracy of the Glover solution in estimating stream depletion due to a decrease in groundwater recharge and return flow, through comparison with results from a calibrated MODFLOW-UZF model for the LARV. Inputs for the Glover equation, including transmissivity, specific yield, and change in recharge rate, are obtained from the MODFLOW-UZF model. Changes in recharge are determined on a weekly basis by comparing the baseline MODFLOW-UZF simulation with an accompanying MODFLOW-UZF simulation in which one or more fields are fallowed. Using the principle of superposition, the Glover solution is applied each week using the change in recharge to estimate the change in groundwater return flow to the river. The results of the MODFLOW-UZF fallow scenarios were compared to the original MODFLOW-UZF results to determine the change in return flow to the Arkansas River, thus creating a metric to test the accuracy of the Glover solution. This comparison was applied to fields varying in location and distance from the Arkansas River, including using image wells with the Glover solution to account for recharge and impermeable boundary conditions.