The Importance of accounting for well capacity in hydro-economic modeling

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Abstract. Concerns regarding groundwater depletion propel stakeholders and governance institutions to develop conservation policies to address aquifer sustainability. Hydro-economic models inform the design of efficient conservation policies by providing insight into the dynamics that link hydrology and the economics of groundwater fed irrigated agriculture. Most hydro-economic literature links economic and hydrologic systems through changes in depth to groundwater which increase the energy costs of groundwater pumping. More recent work by Foster (2015) demonstrates the importance of well capacity, which is physical constraint on the volume of groundwater a well can pump per unit of time, in determining optimal irrigated acreage and well-level profit outcomes. We take these insights as a starting point and develop a spatially explicit, dynamic hydro-economic model of the Republican River Basin of Colorado that links economic and hydrologic systems via changes in well capacity and depth to groundwater. We utilize a novel methodology to translate MODFLOW output into well-level changes in pumping capacity which then serves as input into an economic model of optimal planting and pumping decisions. We compare modeling results with outcomes generated assuming fixed well capacity across time and find that the inclusion of capacity significantly alters the predicted impacts of groundwater conservation policies. Our results suggest that accounting for changes in well capacity increases the policy relevance and validity of hydro-economic models.