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Regional-Scale Hydrologic Modeling of Flow and Reactive Salt Transport in Irrigated Agriculture

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We present simulation results of a hydro-salinity model that integrates subsurface hydrology with reactive salt transport for a 1,400-km2 study area in California. First, effective model parameters were identified using inverse modeling and data on water table depths, groundwater pumping and subsurface drainage. The model was subsequently used to reconstruct historical changes in salt storage by irrigated agriculture over the past 60 years. The hydrologic component simulated the dynamics of the regional variation in water table depths well. Observed long-term changes in the flow dynamics of the coupled vadose zone/groundwater system include a general rise in water table levels, following the transition from locally pumped groundwater to imported canal water as the main source for irrigation water. The accompanying simulated trends in soil and groundwater salinity generally agreed well with available soil surveys and groundwater sampling information. We show that patterns in soil and groundwater salinity were caused by spatial variations in soil hydrology, the change from local groundwater to snowmelt water as the main irrigation water supply, and by occasional droughts. Gypsum dissolution was a critical component of the regional salt balance. Although results show that the total salt input and output were about equal for the past 20 years, the model also predicts salinization of the deeper aquifers, thereby questioning the sustainability of irrigated agriculture.