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A Multi-Objective Framework for Agricultural Production and Water Use in California's Greater Kern Region under Groundwater Sustainability Regulations

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Groundwater is a major source for irrigated agriculture yet often managed unsustainably. Groundwater overdraft compromises future viability of irrigated agriculture, water for cities, streams baseflows and groundwater dependent ecosystems. The recent 2012-2016 California drought heightened the role of groundwater as a buffer resource and catalyzed the 2014 Sustainable Groundwater Management Act (SGMA). Under this regulation, by 2040 all groundwater basins need to achieve balance in recharge and extractions. Groundwater overdraft in California's Central Valley accounts for roughly 15 percent of the total agricultural use. The greater Kern region within California's Central Valley, the most productive region for fruits, nuts and vegetables in the USA, suffers from chronic overdraft and demand hardening due to a rapid increase in perennial crops. This paper presents an integrated multi-objective framework to analyze agricultural production in the greater Kern region as it achieves groundwater sustainability at the irrigation district level by 2040. The model employs a programming model approach with a selection of open access components to predict cropping decisions that maximize net economic returns, using a 1997-2015 calibration period. The agricultural production model bundles with a groundwater module based on the Integrated Water Model Flow model (IWFM) from the California Department of Water Resources to meet sustainability objectives. Modeling scenarios include SGMA groundwater restrictions, water shortages under climate change and environmental regulations, with and without markets, managed aquifer recharge and infrastructure enhancements. Results show that more flexible water allocations using markets and managed recharge can help mitigate the economic impacts from SGMA and also improve prospects for managing financial risk under economic uncertainty at the irrigation district level.