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Evaluation of Different Water Management Practices for the Sustainable Use of Groundwater Resources in the Konya Closed Basin

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The Konya Closed Basin (KCB) in central Turkey is a vast fertile plain that is one of the major agricultural regions of the country and critical to its food supply and security. KCB is characterized by a semi-arid climate, with mean annual precipitation of 379 mm. Since most of the rain occurs in the winter months outside the agricultural season, groundwater is used extensively for irrigation. In recent years, groundwater levels have experienced sharp declines due to the expansion of irrigated lands and the switch to more water-demanding crops. This problem is exacerbated by a large number of unregulated groundwater extraction wells. A regional numerical surface-subsurface water flow model based on the UZF1-MODFLOW computer program was developed for the science-based management of this vital resource. The model simulates transient vertical flow through the vadose zone and groundwater flow through the underlying aquifer system. Because of the lack of direct measurements of groundwater abstraction rates, the time-dependent monthly rate of groundwater abstraction was estimated indirectly based on crop water requirements and historical land allocation for the different crops. The hydrogeology of the site was characterized from borehole data and conducted pumping tests. Historical groundwater level observations between the years 2000-2020 were used to calibrate the model. The key calibration parameter was irrigation efficiency. The challenges of developing and calibrating a regional water flow model are discussed. The calibrated model was then used to simulate the impact of different groundwater conservation scenarios: a slow and a fast transition to less water-demanding crops and the adoption of an optimized cropping pattern. The scenarios are evaluated against the business-as-usual scenario that assumes historical water demand trends remain unchanged. The results underline the urgent need to consider a holistic approach to address the water deficit of the basin. Overall, the model can help policy and decision-makers explore more efficient and sustainable groundwater management practices.

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