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Coupling a spatiotemporally distributed soil water budget with stream-depletion functions to inform stakeholder-driven management of groundwater-dependent ecosystems

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[1] Groundwater pumping, even if only seasonal, may significantly impact groundwater-dependent ecosystems through increased streamflow depletion, particularly in semiarid and arid regions. The effects are exacerbated, under some conditions, by climate change. In social sciences, the management of groundwater-dependent ecosystems is generally considered a "wicked" problem due to the complexity of affected stakeholder groups, disconnected legal frameworks, and a divergence of policies and science at the cross road between groundwater and surface water, and between ecosystems and water quality. A range of often simplified scientific tools plays an important role in addressing such problems. Here we develop a spatiotemporally distributed soil water budget model that we couple with an analytical model for stream depletion from groundwater pumping to rapidly assess seasonal impacts of groundwater pumping on streamflow during critical low flow periods. We demonstrate the applicability of the tool for the Scott Valley in Northern California, where protected salmon depend on summer streamflow fed by cool groundwater. In this example, simulations suggest that increased recharge in the period immediately preceding the critical low streamflow season, and transfer of groundwater pumping away from the stream are potentially promising tools to address ecosystem concerns, albeit raising difficult infrastructure and water trading issues. In contrast, additional winter recharge at the expense of later spring recharge, whether intentional or driven by climate may reduce summer streamflows. Comparison to existing detailed numerical groundwater model results suggests that the coupled soil water mass balance—stream depletion function approach provides a viable tool for scenario development among stakeholders, to constructively inform the search for potential solutions, and to direct more detailed, complex site-specific feasibility studies. The tool also identifies important field monitoring efforts needed to improve the understanding and quantification of site-specific groundwater-stream interactions.

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