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Optimizing Groundwater Pumping for a Complex Groundwater/Surface Water System

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Abstract : Over-pumping of groundwater resources is a serious problem world-wide. In addition to depleting this valuable resource, hydraulically connected sensitive ecological resources like wetlands and surface water bodies are often impacted and even destroyed by over-pumping. Effectively managing groundwater in a way that satisfy human demand while preserving natural resources is a daunting challenge that will only worsen with growing human populations and climate change. As presented in this paper, a numerical flow model developed for a hypothetical but realistic groundwater/surface water system was combined with formal optimization. Response coefficients were used in an optimization management model to maximize groundwater pumping in a complex, multi-layered aquifer system while protecting against groundwater over-draft, streamflow depletion, and wetland impacts. Pumping optimization was performed for different constraint sets that reflect different resource protection preferences, yielding significantly different optimal pumping solutions. A sensitivity analysis on the optimal solutions was performed on select response coefficients to identify differences between wet and dry periods. Stochastic optimization was also performed, where uncertainty associated with changing irrigation demand due to changing weather conditions are accounted for. One of the strengths of this optimization approach is that it can efficiently and accurately identify superior management strategies that minimize risk and adverse environmental impacts associated with groundwater pumping under different hydrologic conditions.

Keywords : numerical groundwater flow modeling, water management optimization, groundwater overdraft, streamflow depletion
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