Quantifying the relative contribution of climatic and pumping impacts to coastal aquifer depletion using a highly parameterised groundwater model: Uley South Basin (South Australia)

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ABSTRACT

Coastal aquifer depletion is becoming increasingly widespread given the growing demand for freshwater globally. Understanding the extent to which aquifer depletion is caused by groundwater pumping, as opposed to natural factors such as climatic variability (e.g., recharge patterns, land use change), is essential for effective groundwater management. Despite this, the relative contribution of climatic and pumping impacts on groundwater response is rarely quantified. The relative contribution of these impacts can be assessed by comparing calibration-constrained model predictions of natural groundwater level time series (i.e., in the absence of groundwater pumping) and observed groundwater level time series. Previous studies that adopt this approach employ lumped-parameter models, and thus only offer preliminary insight into specific causes of aquifer depletion given that the model's ability to represent complex spatially distributed system responses is limited. In this study, we build on previous modelling strategies for distinguishing between climatic and pumping impacts by using a highly parameterised, regional groundwater model to investigate the relative spatial and temporal contributions of climatic and pumping impacts to aquifer depletion in a regional setting. The analysis is applied using a groundwater model of the Uley South Basin (USB), South Australia, where there is conjecture surrounding the cause of declining groundwater levels. Results show that the relative impact of climate variability and pumping is highly variable spatially. Preliminary findings demonstrate that the relative contribution of pumping impacts to groundwater decline is greater than that of climate variability over the majority of USB. A representative groundwater level time series is given in Figure 1. The magnitude of these impacts is shown to be dependent on (1) proximity to the coastal boundary condition, (2) hydraulic property estimates (achieved ultimately through model calibration), and (3) effects of aquifer desaturation. Results also show that historical groundwater level variation in the coastal zone of USB is controlled to an approximately equal extent by climatic and pumping impacts, which is an important outcome for informing groundwater management given the risk of seawater intrusion. This study demonstrates the ability of state-of-the-art groundwater (and seawater intrusion) models to provide unique insight into climate-versus-pumping-induced aquifer impacts.

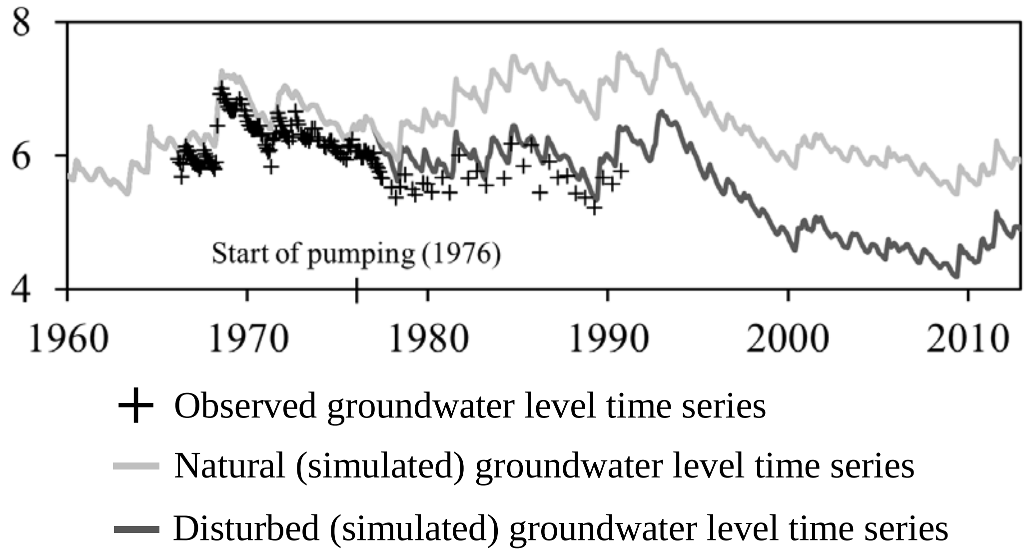

Figure 1: Natural and disturbed (i.e., pumped) groundwater level time series (in m AHD) at observation well ULE136.

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