Exploiting an Underutilized Trove of Agrohydrology Information: Interpretation of Hydrographs from Aquifers Supporting Irrigated Agriculture

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Abstract

Many of the world's major aquifers are under severe stress as a result of intensive pumping in support of irrigated agriculture. The question of what the future holds for these aquifers and the agricultural production they support is of paramount importance in a world of burgeoning populations, dietary shifts, and climate change. Addressing that question requires a better understanding of the how and why of a particular aquifer's response to pumping. One important, but largely underutilized, source of information is the data from monitoring well networks that provide near-continuous records of water levels through time. Although many regions have such networks operated by local, state, or Federal entities, the vast majority of efforts are, by fiscal necessity, focused on keeping the networks up and running. Little, if any, time is spent on interpreting the acquired hydrographs. The index well network in the High Plains aquifer (HPA) in central and western Kansas is an exception, as hydrograph interpretation is an important program emphasis. Examination of multiyear hydrographs has resulted in the development of profound insights concerning, for example, the frequency of episodic recharge, the magnitude and variability of net inflow, characteristics of the monitored aquifer (continuity, hydraulic regime, etc.), and the impact of extreme meteorological events. These insights have allowed us to develop a significantly better understanding of how the aquifer will respond to proposed management actions; such an understanding is critical for charting more sustainable paths for aquifers across the globe. We will demonstrate these points through an examination of two multiyear hydrographs from the HPA in western Kansas with an emphasis on the insights that shed light on the prospects for the sustainability of this heavily stressed system and the agricultural production that it supports.

UPLOAD LOGO

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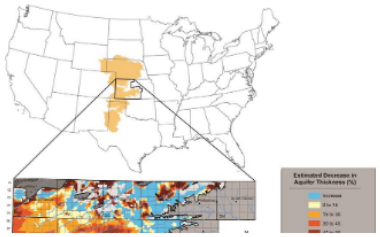
UPLOAD AUTHOR PHOTOS

The High Plains Aquifer



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Kansas HPA Index Well Program

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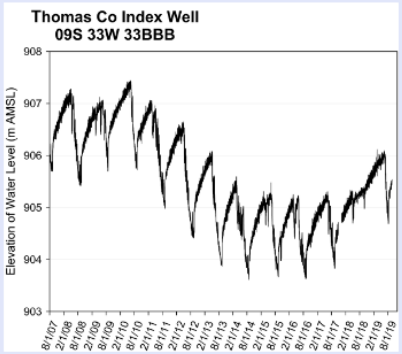
Thomas County Index Well



Key features from hydrograph:

- seasonally pumped unconfined aquifer;
- depth to water likely large;
- levels rise until the next pumping season;
- small yearly changes in average to wet years;
- sizable yearly decreases in dry years;
- irrigation schedule from pumping history;
- no indication of episodic recharge;
- near-constant and relatively large net inflow;
- aquifer response to meteorological extremes;
- significant impact of large pumping reductions.

Overall conclusion: Although the HPA in this area has undergone relatively large water-level declines, the hydrograph indicates that modest

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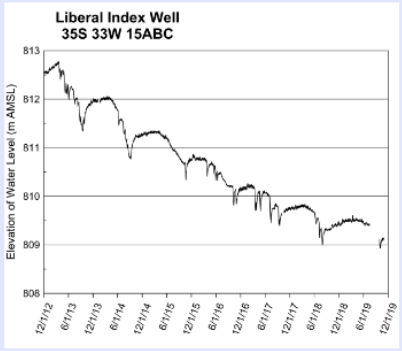
Liberal 436 Index Well



Key features from hydrograph:

- seasonally pumped confined aquifer;
- water levels stabilize each recovery season;
- recovery often faster than duration of pumping;
- decreases in water level every year;
- larger decreases in dry years;
- irrigation schedule from pumping history;
- no indication of episodic recharge;
- aquifer interval appears laterally isolated;
- large reductions will not stop declines.

Overall conclusion: Although the HPA in this area has undergone relatively small declines, the hydrograph indicates that there is little potential for stabilizing water levels. Pumping reductions will lessen the rate of decline, but the declines will

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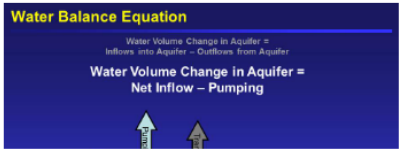
Insights for Agrohydrology

Kansas HPA hydrographs reveal:

1. Temporal variations in net inflow are small
   - magnitude estimated from field data
     - see Butler et al. (2016, 2018);
   - net inflow tightly linked to pumping reductions.



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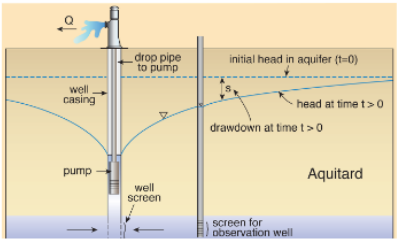
Final Comments



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