

Toward field-scale groundwater pumping and improved groundwater management using remote sensing and climate data

Thomas J Ott¹, Sayantan Majumdar¹, Justin Huntington², Christopher Pearson², Matt Bromley¹, Blake A Minor¹, Peter Revelle², Charles Morton², Sachiko Sueki¹, Jordan P Beamer³, and Richard Jasoni¹

¹Desert Research Institute

²Affiliation not available

³Oregon Water Resources Department

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Abstract

Groundwater overdraft in the western United States has prompted water managers to develop groundwater management plans that include mandatory reporting of groundwater pumping (GP). However, most irrigation systems in this region are not equipped with irrigation water flow meters to record GP and performing quality control of the available metered GP data is difficult due to the scarcity of reliable secondary GP estimates. We hypothesize that Landsat-based actual evapotranspiration (ET) estimates from OpenET can be used to predict GP and aid in quality control of the metered GP data. The objectives of this study are to: 1) pair OpenET estimates of consumptive use (Net ET, i.e., actual ET less effective precipitation) and metered annual GP data from Diamond Valley, Nevada, and Harney Basin, Oregon; 2) evaluate linear regression and machine learning models to establish the GP vs Net ET relationship; and 3) compare GP estimates at the field- and basin-scales. Results from using a bootstrapping technique showed that the mean absolute errors and root mean square errors for field-scale GP depth are 11 % and 14 % across Diamond Valley and Harney Basin based on the OpenET ensemble mean, which showed the highest skill among all the OpenET ET models. Moreover, the regression models explained 50 %-70 % variance in GP depth and 90 % variance in GP volumes. Our GP volume estimates are also within 7 % and 17 % of the total reported and measured volumes in Diamond Valley and Harney Basin, respectively, and the estimated average irrigation efficiency of 87 % aligns with known center-pivot system efficiencies. Additionally, the OpenET ensemble proves to be useful for identifying discrepancies in metered GP data, which are subsequently flagged as outliers. Results from this study illustrate usefulness of satellite-based ET estimates for estimating GP and metered GP data quality control and have the potential to help estimate historical GP.

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