Field Validation of Analytical Stream Depletion Functions for Groundwater Pumping Impacts in Humboldt County

CSU Water Conference 2023 at CSU Monterey

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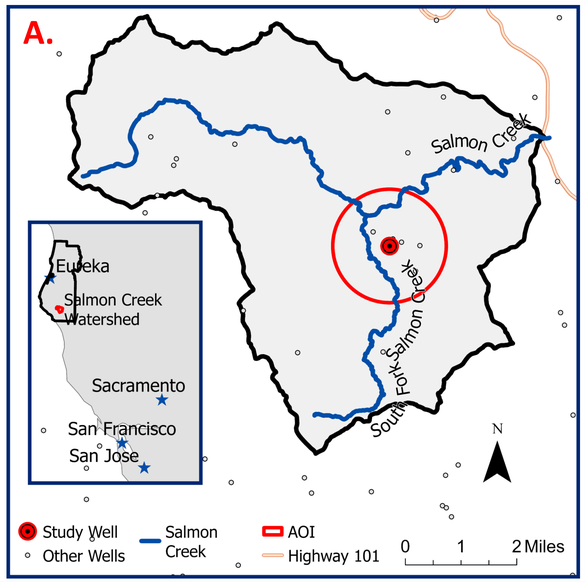
Background

Groundwater pumping can have significant impacts on the surrounding ecosystem, which makes accurately estimating stream depletion from pumping essential for effective water management[1]. This study aims to validate the use of StreamDepletR[2] as a practical tool for estimating stream depletion in Humboldt County, California. This poster provides an overview of the study's modeling and field methods, expected results, and its significance. Accurate estimates of stream depletion are crucial for preventing detrimental effects on aquatic habitats, ecosystems, and beneficial water users[3]. While the study is still in its early stages, this poster shows a hypothetical simulation of a large-scale agricultural farm in the Salmon Creek Watershed (**Figure A**) and demonstrates the model's potential. The field tests for this study are set to begin in the mid-spring of 2023.

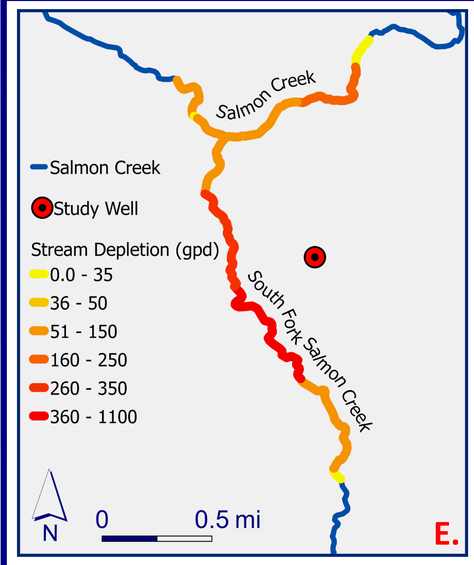
A.

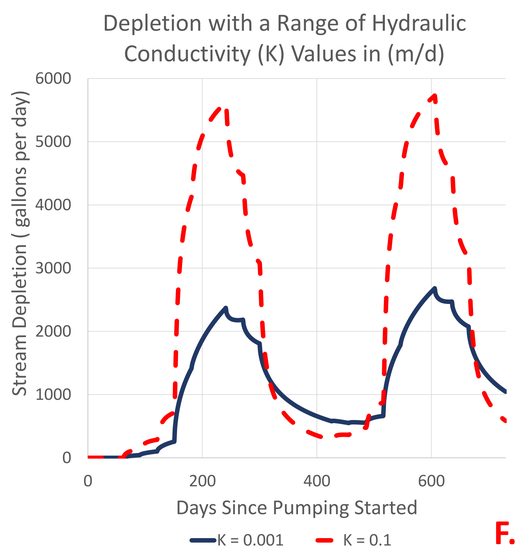


Field Methods

- Monitor two study wells and associated stream reaches.
- Install upstream and downstream stream gages.
- Measure and log well discharge and depth to water.
- Conduct pumping tests to analyze aquifer parameters.
- Collect data with a telemetry system and conduct equipment inspections.
- Validate and analyze the stream depletion model with field data and statistical analysis.

Expected Results

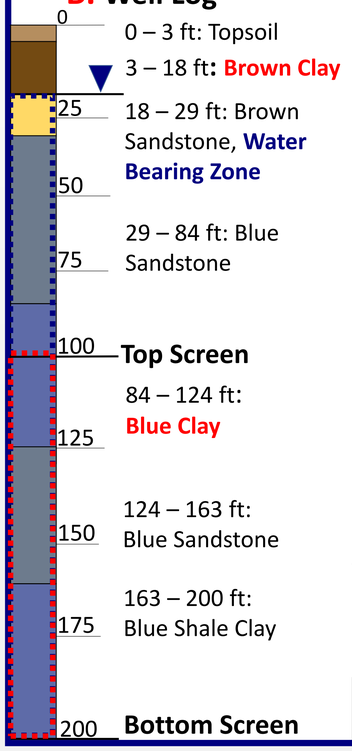




Humboldt County's complex geology requires sub-watershed calibration and validation for accurate modeling. **Figure E** displays what future results may look like. Figure E shows results from a preliminary analysis of a well used for large-scale agricultural cultivation, indicating depletion in each stream segment ranging from less than 35 GPD (gallons per day) to up to 1,100 GPD during the maximum depletion day of a two-year hypothetical simulation where a range of daily pumping rates[7] was applied. **Figure F** illustrates the total depletion in all stream segments modeled on the day of maximum depletion, reflecting a range of possible hydraulic conductivity values. We accounted for a 20ft thick clay layer which reduced bulk transmissivity and storativity of the aquifer. Variations in hydraulic conductivity can significantly impact stream depletion, with lower conductivity resulting in less depletion and vice versa for larger hydraulic conductivity values. Analytical stream depletion models will have to simplify the intricate Humboldt County geology, presenting a challenge for validating the model. The study results are expected in the fall of 2023.

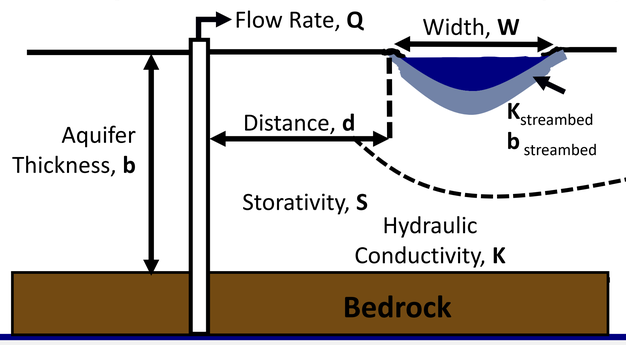
Modeling Methods

B. Well Log

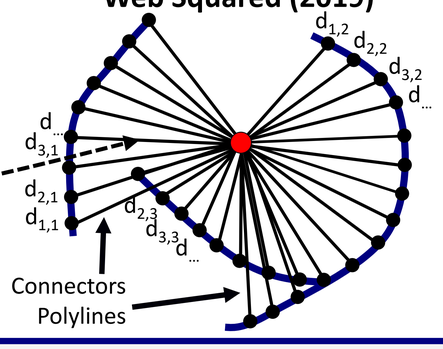


The Stream Depletion model estimates the impact on streams from groundwater pumping using analytical depletion functions developed in the R package StreamDepletR. Aquifer characteristics, such as depth to bedrock, depth to water, and aquifer thickness, are used as inputs to the model, and these can be obtained from well-completion reports[4] (see **Figure B**), pumping tests, or other methods used for estimating subsurface properties. The hydraulic conductivities, storage coefficients, and aquifer thickness determined in Field Tests will be used to estimate variables such as transmissivity and storativity. The Hunt Method[5] (see **Figure C**), an analytical model, is then used to estimate the radius of influence of the well. In the model, streams are segmented into equidistant stream points. Connector polylines connect streams points to wells, and for each connector, the bulk transmissivity, bulk storativity, and distance are estimated. The Hunt method is used again in the model, but this time to calculate the depletion apportionment using the Web Squared Method[6] (**Figure D**), using the distance to each segment, transmissivity, and storativity determined in each connector polyline, and a pumping schedule. Finally, the depletion is summed throughout each segment to determine the total depletion in each stream reach within the radius of influence of the well.

C. Analytical Model: The Hunt Method (1999)



D. Depletion Apportionment: Web Squared (2019)



Significance

- Field validation improves the analytical model's reliability and accuracy, advancing scientific knowledge.
- Analytical models are a practical option for water managers due to their simplicity and low computational requirements.
- Validation of the model provides an effective tool for estimating stream depletion, a critical issue in water resources management

Acknowledgments

I would like to thank the CSU system for accepting my poster submission, CSU Monterey for hosting the CSU Water conference, my advisors Tesfa Yacob, Christine Manhart, Margaret Lang, and Jim Graham and a special thanks to Sam Zipper and his team for developing this R model and David Fisch from Fisch Drilling for all his valuable insight and knowledge that contributed to this project.

References