Analyzing alternative groundwater replenishment strategies in California’s San Joaquin Valley

**MOTIVATION**

California’s San Joaquin Valley is a major agricultural economy with:
- 4.2 million acres of irrigated cropland
- $31 billion annual agricultural revenue
- 218,500 individuals employed
- 250 crops

From 2012-2018, groundwater provided 60% of agricultural irrigation. The over-depletion of groundwater supplies has led to the drying up of wells, contaminated water supplies, and infrastructure instability from land subsidence.

In 2014, California passed the Sustainable Groundwater Management Act (SGMA) to bring groundwater basins back into balance by 2040. To meet this goal, it is estimated that farmers may have to fallow 500,000 acres across the San Joaquin Valley.

**OBJECTIVES**

1. Under what conditions can landowners benefit from groundwater replenishment strategies?
2. Where can landowners cost-effectively conserve groundwater and achieve habitat benefits?

**LANDOWNER COST-BENEFIT ANALYSIS**

Optimal Replenishment Strategies Vary by Crop

To comply with SGMA, landowners in the San Joaquin Valley will need to diversify their portfolio of groundwater management strategies. One strategy to ensure reliable groundwater supplies is through replenishment. Traditional replenishment methods include 1) In-farm recharge – purchasing surface water for irrigation in place of groundwater and 2) on-farm recharge – using excess storm and flood flows in place of groundwater. Landowners can also pursue multi-benefit strategies that provide economic benefits and ecosystem enhancements. Multi-benefit replenishment methods include 3) fallow with upland habitat and 4) fallow with wetland habitat.

We found that landowners with high profit margin crops, such as grapes, should pursue traditional strategies that allow for full production. Landowners with low profit margin crops or crops with high water demand, such as alfalfa and almonds respectively, benefit most from multi-benefit strategies.

**A Snapshot of Replenishment Strategies for Almonds**

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<thead>
<tr>
<th>Strategy</th>
<th>Full Production w/ Groundwater</th>
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<tbody>
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<td>1. Baseline Fallow</td>
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<td>2. On-Farm Recharge</td>
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<td>3. Fallow w/ Upland Habitat</td>
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<td>4. Fallow w/ Wetland Habitat</td>
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We compared the economic outcomes of these four groundwater replenishment strategies against a baseline fallow scenario, where a landowner only retires agricultural land from production without a replenishment project. Looking at a case study for almonds, we estimated that a producer with 5,000 acres will face $2 million in lost revenue between 2018-2045 to comply with SGMA. The fallow with wetland habitat strategy is the best option in this case, allowing a landowner to offset over 50% of the lost revenue from the baseline fallow scenario.

**CONCLUSIONS**

Multi-benefit groundwater replenishment projects can compensate landowners for creating upland and wetland endangered species habitat. Such projects can be optimally placed across the Valley to minimize lost agricultural revenues. Given a specific groundwater reduction target in Kern County, a larger acreage of upland habitat can be achieved in comparison to wetland habitat.

A landowner will choose either a traditional groundwater replenishment or multi-benefit project based on crop profitability and crop water demand. To achieve a specific groundwater reduction target, wetland projects require less land than upland projects. Wetland projects, however, have an additional cost of water acquisition.

Without secure funding sources, a landowner’s economic benefits from replenishment projects with additional habitat will diminish greatly. Habitat credits and other funding are what offset the cost of lost revenues from fallowing. Without these payments, habitat creation is no longer more beneficial than baseline fallowing.

**NEXT STEPS**

Using our model, we have recommended pilot project sites for a landowner, expected to break ground in 2019.

**ACKNOWLEDGEMENTS**

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