BASIN BENEFITS

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

1 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.

Sustainable
Groundwater
Management
Act

2 OBJECTIVES

1. Under what conditions can landowners benefit from groundwater replenishment strategies?

2. Where can landowners cost-effectively conserve groundwater and achieve habitat benefits?

Replenishment with Upland Habitat

- Removing a portion of agriculture from production to save irrigation water
- Restoring fallowed fields to native, terrestrial habitat

Replenishment with Wetland Habitat

- Removing a portion of agriculture from production to install a recharge pond
- Using the recharge pond to function as wetland habitat

3 KERN COUNTY, CALIFORNIA

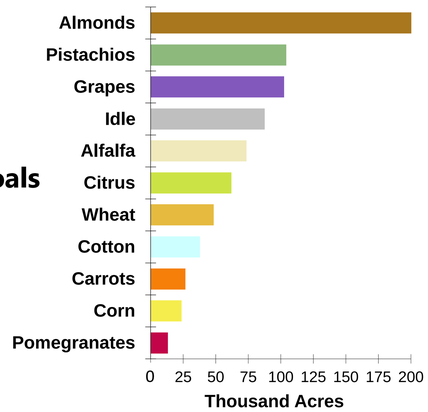
Why Focus on Kern County?

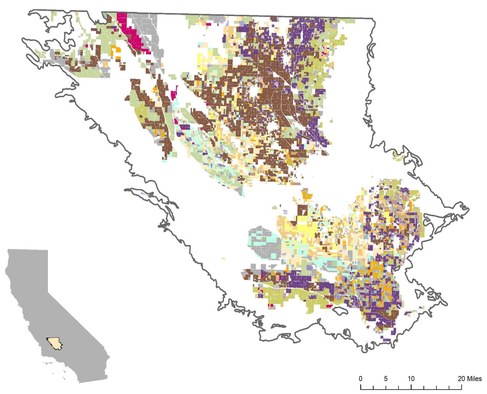
- #1 agricultural value county in the United States
- $7.3 billion agricultural economy
- Critically over-drafted
- 857,000 harvested acres
- 14 endangered species

Replenishment Project Goals

- **Minimize Cost**
- **Maximize Groundwater Savings**
- **Optimize Habitat Creation**

Kern Agriculture



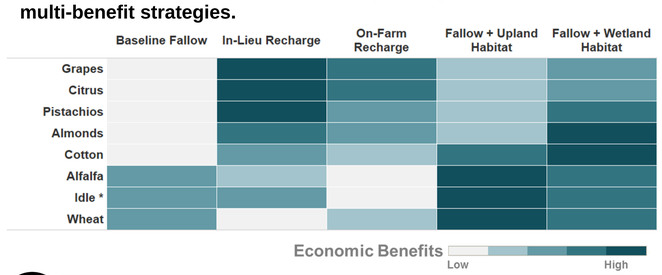


4 LANDOWNER COST-BENEFIT ANALYSIS

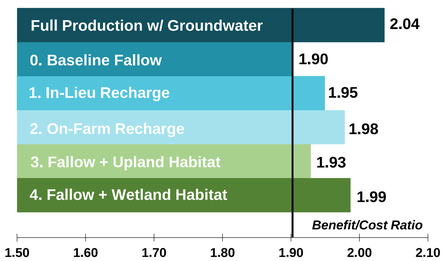
Optimal Replenishment Strategies Vary by Crop

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-lieu 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



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 $22 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.**

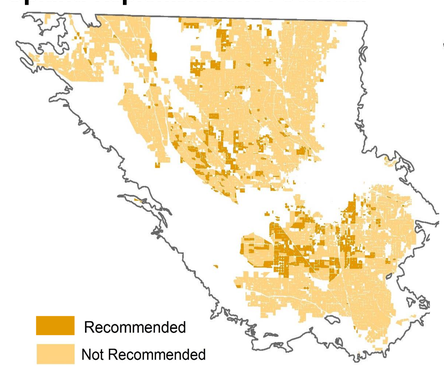
5 SPATIAL MULTI-BENEFIT OPTIMIZATION MODEL

Our group developed the **Multi-Benefit Optimization Model (MBOM),** which combines spatial research on crop revenues, hydrogeologic factors, and endangered species habitat**.** Based on user-variable inputs, **MBOM determines where to strategically place multi-benefit groundwater replenishment projects** in California's San Joaquin Valley.

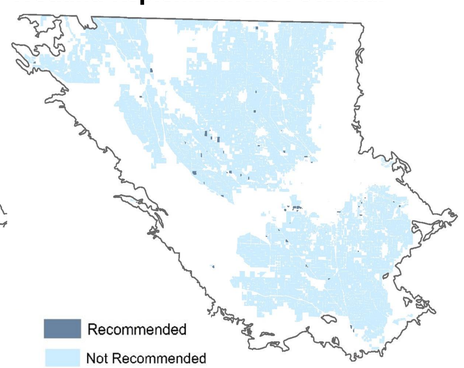
Saving Groundwater at Minimal Cost

In Kern County, we set a target to reduce groundwater use by 15% while minimizing lost agricultural revenues. In the upland scenario, the MBOM recommends cropland and idle land equivalent to 3.6% of annual revenues, achieving over 120,000 habitat acres. For the wetland scenario, MBOM recommends cropland and idle land equivalent to 4% of annual revenues, with a habitat achievement of 3,665 acres.

Upland Replenishment Potential



Wetland Replenishment Potential



Upland Achievements

- $269.6 million
  3.6% of annual revenue
- 426,670 acre-feet/year
  15% of groundwater use
- 120,950 acres
  14% of Kern agriculture

Wetland Achievements

- $288.8 million
  4% of annual revenue
- 426,580 acre-feet/year
  15% of groundwater use
- 3,665 acres
  0.4% of Kern agriculture

6 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.

7 NEXT STEPS

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

EDF is exploring collaborations with diverse stakeholders to expand the applicability of the cost-benefit and spatial models.

THE TEAM

More information on the BasinBenefits project can be found at: https://basinbenefits.weebly.com

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