WATER RESILIENT CALIFORNIA

Strategically siting groundwater recharge projects to benefit communities and ecosystems

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Motivation

Water in California

California depends on groundwater to meet agricultural, industrial and domestic water needs, especially during droughts. Several decades of unsustainable extraction have caused a depletion of groundwater across California, especially in the southern portion of the semi-arid, intensely cultivated Central Valley. Due to climate change, drought conditions may worsen, and the annual availability of surface water from rain and snowmelt is expected to be increasingly variable.

Sustainable Groundwater Management Act

The Sustainable Groundwater Management Act (SGMA) of 2014 requires regional managers in critically overdrafted basins to develop and implement plans by 2040 to halt and reverse unsustainable use of groundwater that is causing undesirable results.

Why Groundwater Recharge?

Underground aquifers in California have tremendous storage capacity, at least 17 times the volume of surface water storage in the state according to estimates by the California Department of Water Resources (1). There is an opportunity to take advantage of this capacity to store large volumes of available surface water during wet years for sustainable withdrawal during dry years.

Managed aquifer recharge is one method that Groundwater Sustainability Agencies plan to use to achieve their goals under the Sustainable Groundwater Management Act. Additionally, managed aquifer recharge can generate multiple benefits, including for communities and ecosystems, if located strategically.

The Problem

Many groundwater managers throughout the Central Valley lack the information needed to inform strategic siting of groundwater recharge projects in a way that can achieve benefits for communities and ecosystems.

Our Approach

We developed a customizable decision support tool to locate optimal sites for groundwater recharge projects in California's Central Valley that have the potential to produce benefits to communities and ecosystems while increasing local water resilience.

(1) Choy, McGhee, Rohde. *Recharge: Groundwater's Second Act.* https://waterinthewest.stanford.edu/groundwater/recharge/

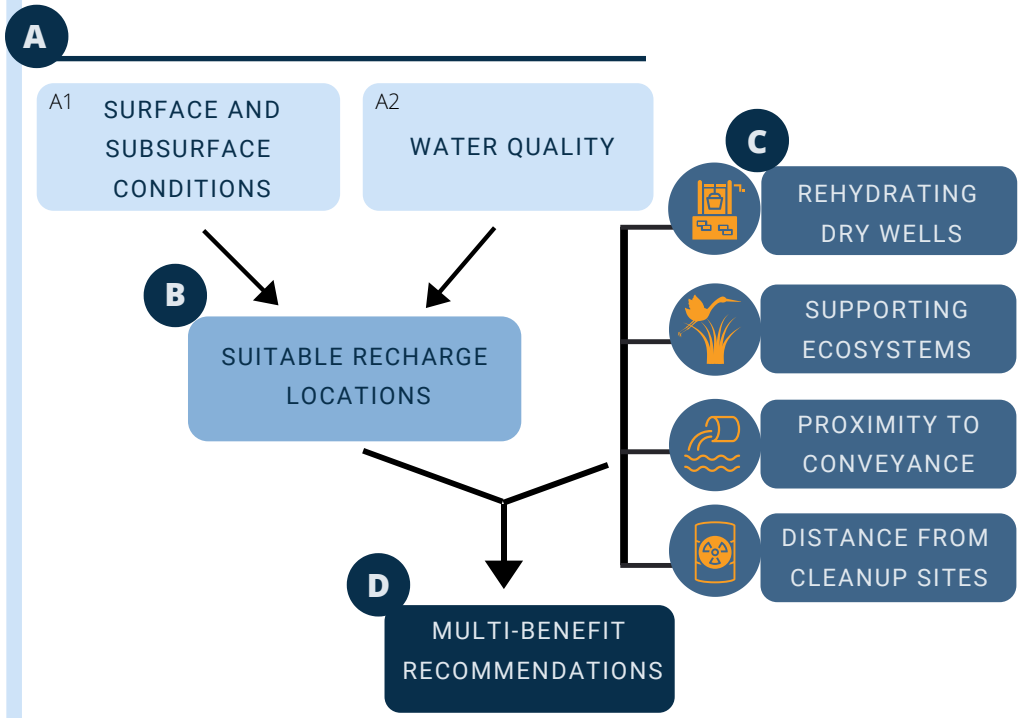
Decision Support Tool

We developed our tool in ArcMap Model Builder using publicly available datasets from California state agencies or research institutions. The tool is transferable to any groundwater basin within the Central Valley. We designed the tool to allow the user to customize the output to reflect local priorities for groundwater recharge projects related to benefits or feasibility considerations.

A

A1. Surface and Subsurface Conditions - Ranks locations on their relative ability to allow water at the land surface to reach the groundwater table. Considers physical properties such as topography, soil characteristics, and depth to groundwater.

A2. Water Quality - Ranks locations on their relative likelihood of introducing new nitrogen contamination into groundwater. Nitrogen accumulation in soil is largely due to past land uses.



B

Suitable Recharge Locations - A combination of surface and subsurface conditions and water quality, in areas with appropriate land use types, from which only the best 10% of land is retained. This step identifies locations within a basin where clean water can most easily percolate down to the groundwater table.

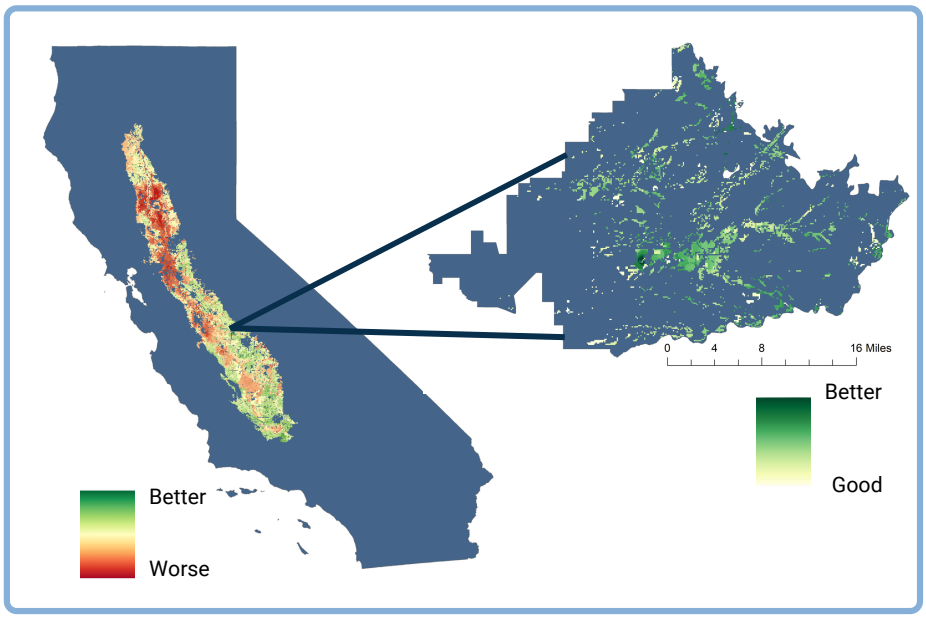
C

Additional Considerations - These include benefits and feasibility considerations that users may be interested in considering when siting groundwater recharge projects. A user can specify how much priority is given to each of these considerations, and this customized weighting scheme changes the resulting multiple benefit recommendations.

D

Multi-benefit recommendations - Identifies preferred locations to site groundwater recharge projects within a basin based on the customized priorities a user sets for the additional considerations. Customized priorities are overlaid on suitable recharge locations to identify most preferred sites.

Key Findings



Suitable Recharge Locations

The maps to the left show ranked recharge locations for the Central Valley, and suitable recharge locations in the Madera Subbasin. Suitable recharge locations identify areas where water can most easily reach underlying aquifers while minimizing the risk of introducing new nitrogen contamination.

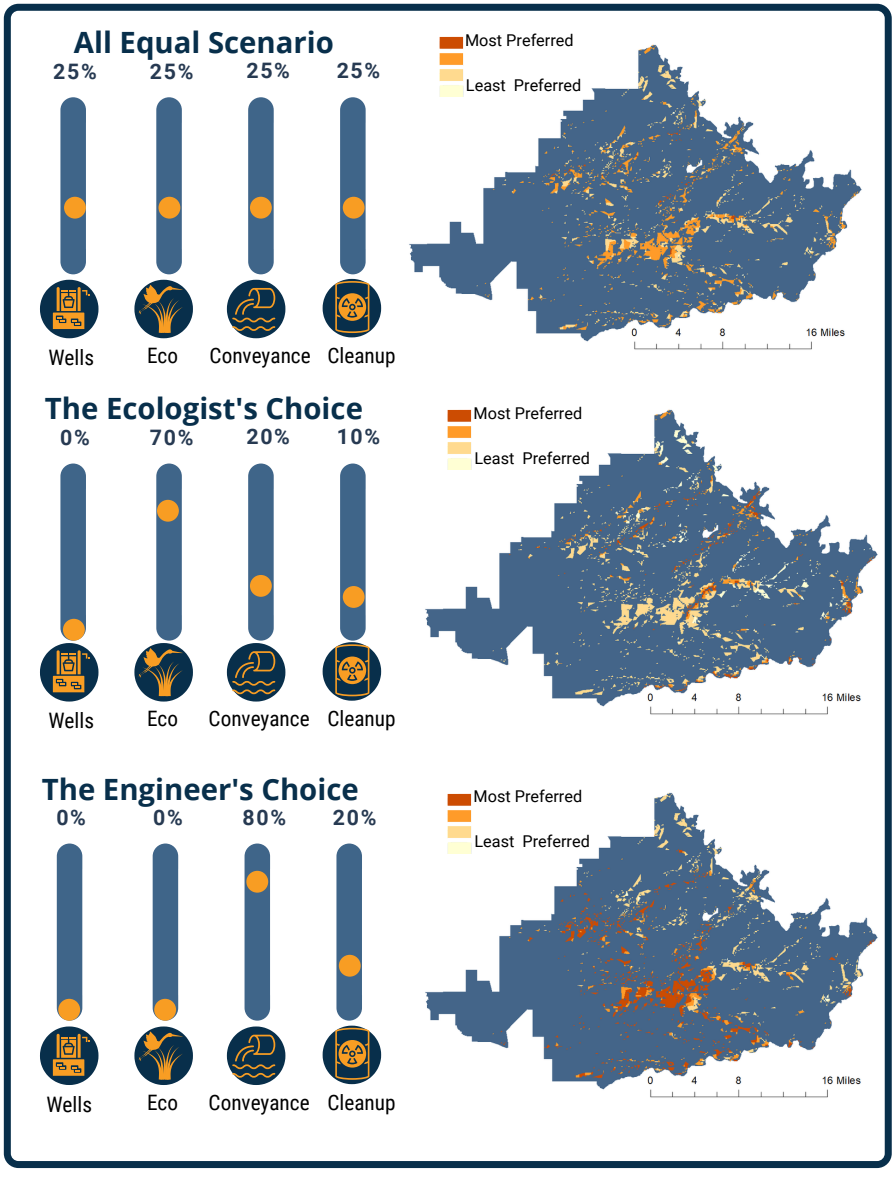
Our tool can be applied to any geographic area within the Central Valley; we used the Madera Subbasin to test our tool on the groundwater basin scale.

Multi-Benefit Recommendations

Groundwater managers also have the option to generate customized multi-benefit recommendations within their basin's suitable recharge locations based on local needs and priorities. Managers can assign preference (0-100%) to each of the four additional considerations:

- Rehydrating domestic wells that have run dry
- Supporting groundwater dependent ecosystems
- Minimizing the need for new conveyance infrastructure
- Protecting water quality

The three maps to the right show how the most preferred locations to site recharge projects change based on hypothetical customized priorities. All three maps highlight the same areas shown in the suitable recharge locations map above. The preference ranking (orange to yellow) of these areas changes based on the specified priorities.



Discussion

Our tool considers the primary goal of replenishing the aquifer by incorporating information related to surface and subsurface conditions that affect recharge rates along with potential risks to groundwater quality. The tool applies a suitability ranking to the relative best 10% of land area within a basin. If more land area needs to be considered during project planning, managers can adjust the percent of land area in the output.

Groundwater managers can use the tool to assign weights (0-100%) to each additional benefit consideration based on their basin's priorities and create a customized location recommendation map for implementing groundwater recharge in their basins.

For example, the Madera Subbasin Groundwater Sustainability Plan identifies the need to construct 350 acres of dedicated groundwater recharge basins to reach sustainability by 2040.

The outputs of our tool help managers to:

- Narrow land area under consideration from 350,000 acres to the most suitable 28,000 acres
- Allow for exploration of other benefits to be gained, and basin specific prioritization based on community and stakeholder goals
- Consider both flooding farm fields for recharge and constructing dedicated recharge basins to increase implementation flexibility

Management Application

The customizable outputs of our tool allow for a streamlined assessment of the most suitable areas to consider recharge within any groundwater basin in the Central Valley.

Conclusion

Our decision support tool gives water managers the information that they need to consider how to best achieve multiple benefits of managed groundwater recharge projects. As groundwater basins throughout California's Central Valley begin to implement projects to meet the requirements of the Sustainable Groundwater Management Act, our analysis will help water managers plan for a more resilient water future.

Learn More

If you are interested in learning more about our project, accessing references to the data we used, or receiving a copy of the decision support tool, please visit our website:
waterresilience.wixsite.com/waterresilienceca

or email us:
gp-waterresilience@bren.ucsb.edu

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