FLOOD FORWARD

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Clients: California Department of Water Resources & Environmental Defense Fund

Motivation

Groundwater is a critical component of California's water supply portfolio. Due to unsustainable pumping, groundwater has been depleted in many basins, causing undesirable results. The Sustainable Groundwater Management Act (SGMA) of 2014 requires critically over-drafted groundwater basins to develop and implement Groundwater Sustainability Plans (GSPs) to balance inflows and outflows of groundwater by 2040.

The Problem

The capacity of Flood-MAR to achieve multiple benefits is spatially dependent and remains largely unknown. Lack of data is an obstacle that water managers are faced with when trying to determine what sites are best suited for Flood-MAR projects. Our project provides a spatial analysis approach that water managers can use as a preliminary investigation into determining priority sites for Flood-MAR implementation with multiple benefits.

Why Flood Managed Aquifer Recharge?

Compliance with SGMA will require the implementation of new and innovative water management strategies, such as Flood Managed Aquifer Recharge (Flood-MAR). Flood-MAR is an integrated water management strategy that utilizes excess flood waters from rainfall or snow melt for managed aquifer recharge on agricultural, working, and natural landscapes (Figure 1). The California Department of Water Resources emphasizes Flood-MAR as a strategy with the potential to provide multiple benefits in addition to groundwater recharge. These benefits include water supply reliability, flood risk reduction, drought preparedness, water quality enhancement, subsidence mitigation, ecosystem enhancement, and climate change adaptation.

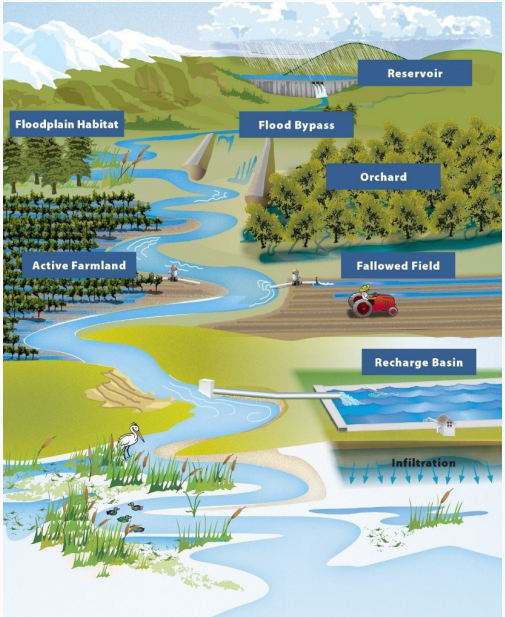


Image Credit: CA Department of Water Resources

Flood Risk Reduction & Ecosystem Enhancement Benefits

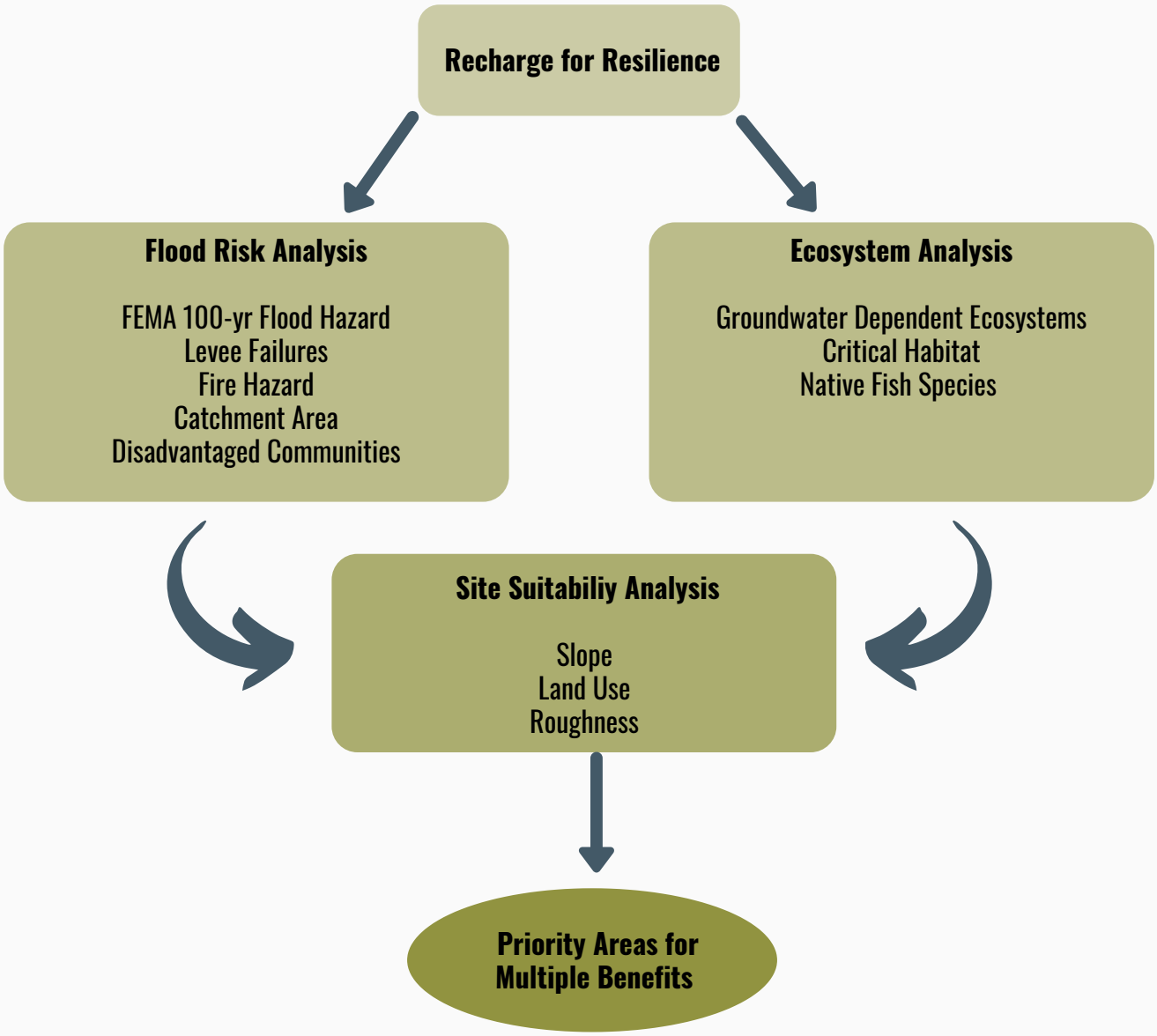
Our analysis focuses on prioritizing areas that can best achieve the two benefits of flood risk reduction and ecosystem enhancement through Flood-MAR and floodplain restoration activities. Climate change is projected to enhance the intensity, duration, and frequency of extreme rain and drought events. Additionally, over 90% of floodplain habitat has been altered throughout the Central Valley. Flood-MAR and floodplain restoration can help protect communities and enhance resiliency against the variable impacts of climate change.

Madera County As A Case Study

Our project builds upon previous work from the 2020 Bren School Masters group project, Recharge for Resilience. Recharge for Resilience created a decision support tool to locate optimal sites for groundwater recharge projects throughout the Central Valley. Due to this prior work, our team decided to focus our work in assessing how Flood-MAR can achieve groundwater recharge and the co benefits of ecosystem enhancement and flood risk reduction in Madera County as a case study. The Madera subbasin is identified as critically overdrafted. Our analysis can help additional counties to achieve the goals outlined in their Groundwater Sustainability Plans.

The Approach

We performed a flood risk, ecosystem, and site suitability analysis in ArcMap ModelBuilder. We primarily used publicly available datasets so that our framework can easily be reproduced for other geographies. If applicable, more locally specific datasets can be substituted as inputs.



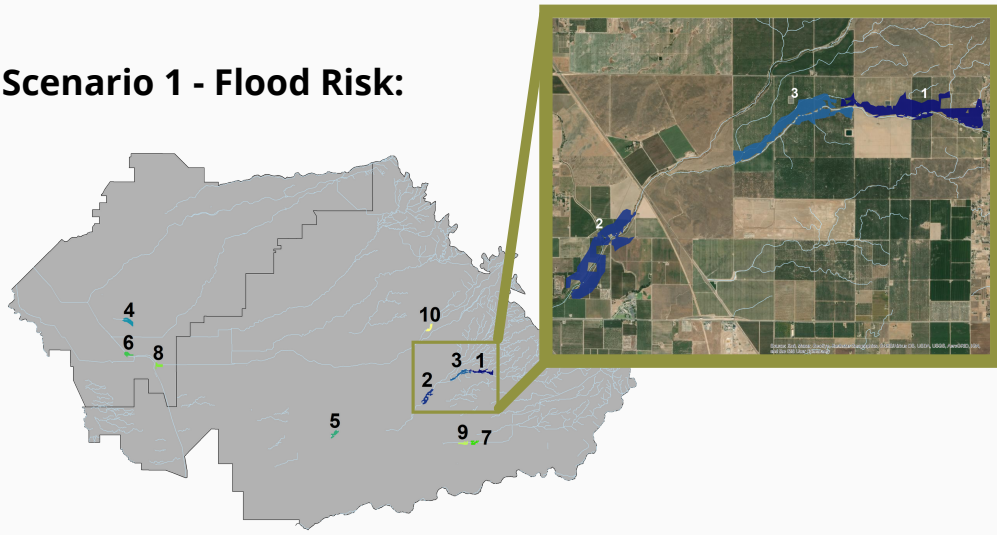
Key Findings - Tradeoff Analysis

To produce final site prioritization outputs, the flood risk reduction and ecosystem enhancement results were assigned various weighting factors reflecting possible tradeoffs between the two co-benefits. Given the possibility of varying water management goals among stakeholders, three specific scenarios were considered to show how the tradeoff between co-benefits impacted final project location prioritization results:

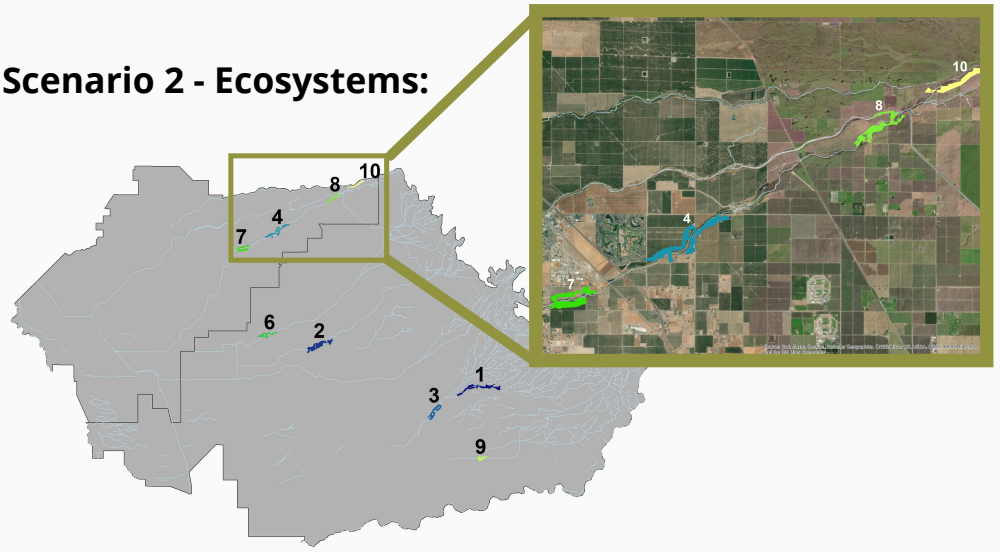
1. **Flood Risk** - 100% weighting assigned to the flood risk reduction score
2. **Ecosystems** - 100% weighting assigned to the ecosystem enhancement score
3. **Equal Weighting** - both co-benefits assigned weightings of 50% each

For each of the scenarios, the top 10 largest and contiguous areas of high priority riparian recharge lands are highlighted (in the figures on the right) based on variable input weighting.

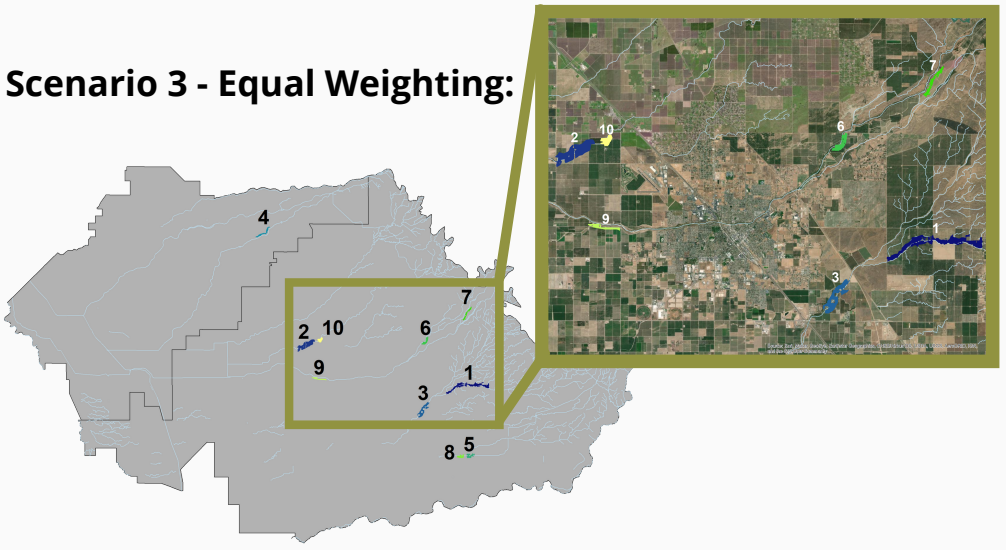
Scenario 1 - Flood Risk:



Scenario 2 - Ecosystems:

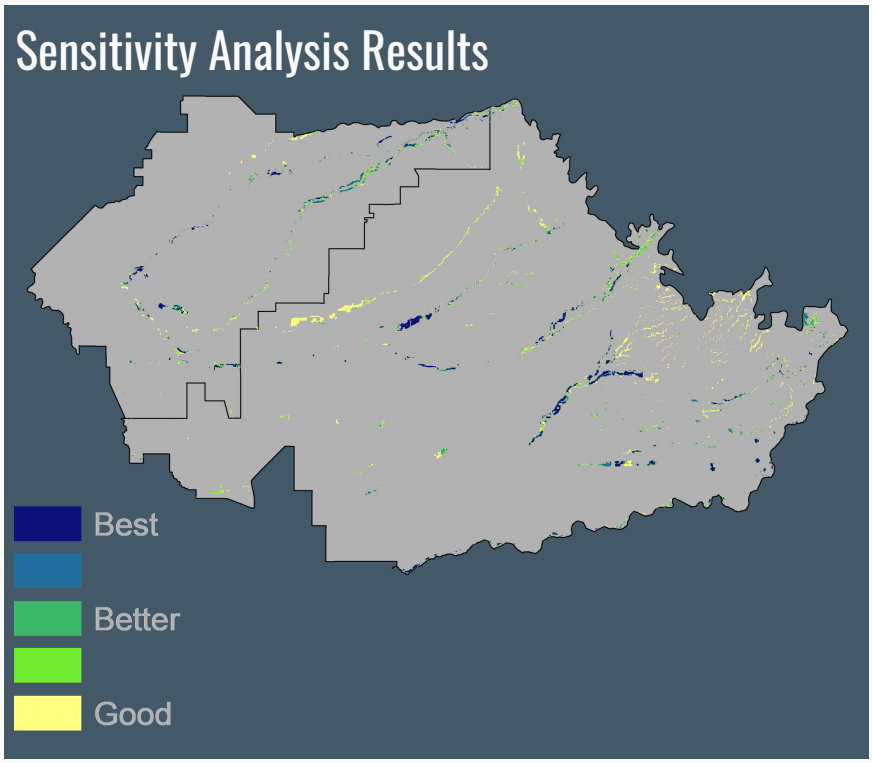


Scenario 3 - Equal Weighting:



Discussion

A key question when planning and implementing multi-benefit aquifer recharge projects is: where will each of the potential benefits be achieved and in what capacity? While the priority locations change based on variable weighting of the inputs, we find that the results are rather robust. After 32 iterations of the analysis using different weightings for each parameter, a number of locations continue to show up as suitable. The consistency of the outputs helps to bolster confidence in these priority areas as restoration and recharge opportunities; and this helps to ease the decision making burden for water managers when siting groundwater recharge projects.



Conclusion

Our analysis provides a framework for water managers to understand where groundwater recharge projects can be implemented along river channels with the goals of reducing local flood risk and reconciling native riparian habitat. Groundwater recharge in conjunction with the expansion of floodplains provides a cutting edge strategy to mimic the natural hydrology of the Central Valley and help comply with the Sustainable Groundwater Management Act.

Learn More

To learn more about our project, access the executive summary, comprehensive report, and interactive web tool, please visit
floodforward.wixsite.com/website

or email us at
gp-floodforward@bren.ucsb.edu

Acknowledgements

We would like to thank our project partners, the Environmental Defense Fund and the California Department of Water Resources; our faculty advisor, Scott Jasechko; as well as our entire external advisory team. We would also like to thank the Bren School for support throughout the project.