Stanford | Water in the West

Research Brief

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Benefits and Economic Costs of Managed Aquifer Recharge in California

California is in its fifth year of drought, highlighting the challenges of managing the state's water resources. Groundwater has been used as a savings account during the drought, accelerating the rate of overdraft in many of California's aquifers. Sustainable groundwater management has never been more critical for the state than now, with the passing of new groundwater legislation. The Sustainable Groundwater Management Act (SGMA) requires sustainable groundwater management across the state and will place the burden on local agencies to find ways to cut back pumping, and recharge aquifers. Although there is no single solution to increasing California's resiliency to drought and to achieving sustainable groundwater management, managed aquifer recharge (MAR) projects will play an important role in helping the newly formed Groundwater Sustainability Agencies (GSAs) under SGMA achieve their sustainability goals.

Given the vastness of California's aquifer system, MAR has significant potential to play a central role in water management. Nevertheless, little work has been done to quantify the costs of MAR projects and identify the benefits of MAR across the state. Historical groundwater data are sparse or proprietary within the state, often constraining studies to subareas within the state or making analyses difficult to perform. This study overcomes these data limitations by strategically mining information from general obligation bonds from ballot propositions; information from proposition applications is available publicly and can provide insight from projects across the state. We used proposition funding applications to identify proposed economic costs and anticipated MAR project benefits. We then used a survey to compare these costs with actual project costs and to identify factors that promote and limit the benefits of MAR projects.

Our study finds that:

1) MAR has a median cost of $410 per acre-foot recharged, but costs vary depending on the attributes of the project.

2) MAR provides many benefits in addition to groundwater recharge and storage. These benefits can increase costs ($ per acre-foot recharged), but also can increase resiliency within communities.

3) MAR can be tailored to local conditions and can result in more regional water self-reliance.

About Water in the West and the Authors

A joint program of the Stanford Woods Institute for the Environment and the Bill Lane Center for the American West, Water in the West focuses the resources of one of the world's preeminent research institutions to address one of the most urgent questions about the West's future — how can the region continue to thrive despite growing water scarcity?

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MAR Has a Median Cost of $410 Per Acre-Foot

FINDING: Our study found the median cost of proposed MAR projects is $410 per acre-foot recharged. Costs vary depending on the components of the project; if the project is focused primarily on MAR, the costs are significantly cheaper than if the project integrates MAR as a component of an integrated plan to achieve other project goals, such as recycling wastewater or managing stormwater (Figure 1). Differences in projected cost per recharge volume found in the proposals and actual cost per recharge volume were primarily a consequence of low groundwater recharge volumes, which was in turn the result of inadequate funds to purchase water, inadequate access to water, or water source availability limitations due to the current drought.

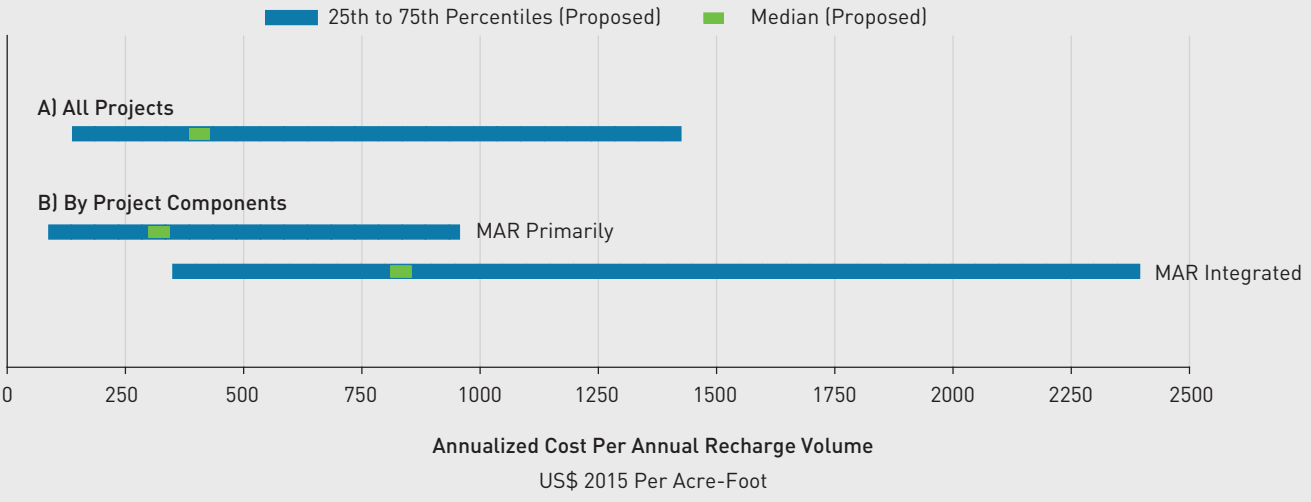
IMPLICATIONS FOR MANAGEMENT: As California progresses towards more sustainable water management, it is likely that more water agencies will adopt MAR projects as a local management tool. Funding is critical to the success of groundwater projects, because local communities bear the largest burden for financing water projects and for complying with SGMA. Demand for funding at the local level is likely to increase as Groundwater Sustainability Agencies begin to implement the management criteria under SGMA.

Our quantification of costs can assist local communities with long-term planning for funding. The recognition that access to water for MAR limited the economic efficiency of MAR storage is key in the long-term management of aquifers.

MAR Provides Many Benefits

FINDING: Our study found that many MAR projects are incorporating co-benefits such as increasing water supply, improving water quality, flood control, protecting wetland habitat, mitigating land subsidence, reducing greenhouse gas emissions, preventing seawater intrusion, providing recreational use and increasing regional self-reliance (Figure 2). Although some of the co-benefits (Figure 2, e.g., flood protection, improved water quality) can increase the price of a MAR project, such projects can have the potential to influence larger scale resiliency within communities.

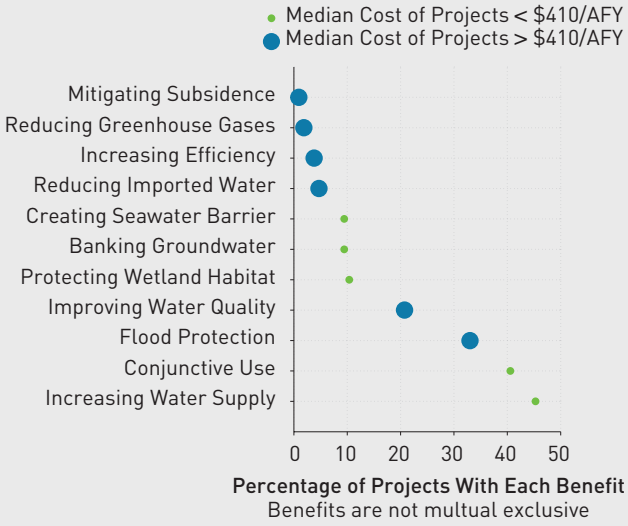
FIGURE 1



Interquartile ranges for (A) all projects and (B) projects that use MAR primarily or projects that use MAR as an integrated management approach. Figure reproduced from Perrone, D. and M. Rohde (2016) *Benefits and Economic Costs of Managed Aquifer Recharge in California.* San Francisco Estuary& Watershed Science 14(2). doi:http://dx.doi.org/10.15447/sfews.2016v14iss2art5.

IMPLICATIONS FOR MANAGEMENT: Water management that integrates a spectrum of benefits is vital to making California more resilient to drought. It is likely that water supply portfolios will need to accommodate local constraints and preferences, while also integrating a variety of co-benefits to achieve more integrative water management. For example, incorporating alternative sources of water, such as wastewater and stormwater, into a community's water resource supply portfolio can (1) augment surface water when it is not available (2) decrease vulnerability to seasonal and interannual variability of precipitation, and (3) enhance local self-sufficiency.

FIGURE 2



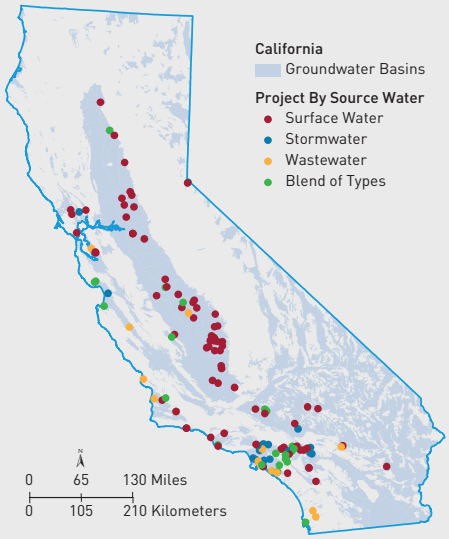
Analysis of project benefits with cost information. Projects were grouped into 11 benefit categories; projects that identified multiple benefits, were counted for each benefit identified (i.e., benefits are not mutually exclusive). The size of the dot indicates whether the median costs for projects within each benefit category is below or above the median cost of all of the projects (i.e., $410 per AFY). Figure from Perrone, D. and M. Rohde (2016) *Benefits and Economic Costs of Managed Aquifer Recharge in California.* San Francisco Estuary& Watershed Science 14(2). doi:http://dx.doi.org/10.15447/sfews.2016v14iss2art5 .

MAR Can Be Tailored To Local Conditions

FINDING: We found evidence throughout California of communities tailoring their MAR projects to local constraints. A geospatial analysis indicated that urban coastal areas use a variety of source water types. In rural communities, like in the Central Valley, stormwater and wastewater production may not be centralized, so these communities tend to use surface water primarily (Figure 3). Recharging with surface water only can still play an important role, especially during wet periods.

IMPLICATIONS FOR MANAGEMENT: MAR projects allow agencies to tailor management to locally available resources and are likely to be a strategic means of complying with California's new groundwater legislation.

FIGURE 3



Geospatial representation of projects by source water. Figure from Perrone, D. and M. Rohde (2016) *Benefits and Economic Costs of Managed Aquifer Recharge in California.* San Francisco Estuary& Watershed Science 14(2). doi: http://dx.doi.org/10.15447/sfews.2016v14iss2art5 .

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