University of California
Agriculture and Natural Resources | California Institute for Water Resources

Enhancing Groundwater Recharge through Distributed Storm water Capture

***Principal Investigators*:**

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Project Summary

California leads the nation in both overall fresh water demand and use of groundwater. California also faces an ongoing water supply crisis, with many parts of the state not having access to high-quality water where and when it is needed. The problem is exacerbated by limitations in the availability of new surface water storage (and the political challenges in developing new surface storage facilities); a massive, complex, expensive, energy-demanding, and over-allocated system for state-wide conveyance of fresh water; rapid population growth and associated demand for housing, infrastructure, and services in some of the driest parts of the state; a changing climate that influences the magnitude, timing, locations, and forms of fresh water available throughout the year; and the need to plan for variability and uncertainty.

One result of the ongoing imbalance between fresh water supply and demand is massive, statewide groundwater overdraft (estimated to be millions of acre-feet/year). Although it is a common phenomenon, the ultimate causes and impacts of groundwater overdraft are locally variable. Specific problems include: ground subsidence and permanent loss of storage, seawater intrusion, upflow of lower-quality water from depth, losses from critical surface systems (streams, lakes, and wetlands), and damage to fragile aquatic ecosystems.

Our overall project objectives are to (1) create regional partnerships among resource managers, regulators, landowners and other stakeholders, (2) help to establish managed aquifer recharge (MAR) systems as highly controlled, quasi-natural systems that are manipulated and monitored in real-time, and (3) use stormwater runoff, excess winter stream and wetland flows, and recycled water to improve both the quantity and quality of fresh water resources. NIWR funding on this project supported part of the costs for development, instrumentation, and monitoring of a field site where an MAR system was installed, so that we and project partners can quantify the processes and properties that are most important in making these system successful. NIWR funding also supported completion of a geographical information system and modeling study of a groundwater basin in overdraft, to identify locations where future MAR projects might be best placed.

Project development, operation and monitoring occurred during the 2013-14 water year at the Bokariza-Drobac Ranch (BDR). This site comprises ~125 acres that are actively farmed and ranched, draining into a collection basin having an area of 2.5 acres. Drainage is controlled through manipulation of a series of channels and gates, so that inflows during major storm events can be regulated. Soils in the collection basin are mainly sandy loam and clayey sand, and infiltration rates are estimated to be on the order of 0.2 to 4 m/day. Inflow to the collection basin occurs mainly through a single culvert. Instruments deployed during the project period included: pressure gauges and staff plates to measure inflow and water levels in the basin, thermal probes to determine infiltration rates across the basin, a precipitation gauge and time-lapse camera, and sediment monitoring and collection systems to assess what kinds of maintenance may be needed year by year to maintain this system.

This year we also installed a data logger and transmission system to telemeter some of our field data back in near-real time, so that we could monitor system performance. Unfortunately this was a drought year in California, so total inflows to this system were only about 20 ac-ft. But when this information is combined with monitoring from previous years, we have data that suggests that normal to wet year benefit should be on the order of 100-150 ac-ft/yr. In addition, sediment collection studies from the last water year demonstrate that the basin collected about 450 tons of sediment along with inflowing water, and this sediment has a grain size that is finer, on average, than native soil. These observations suggest that site maintenance will be required to assure that the collection basin is not clogged over time.

We also completed a regional analysis of the Pajaro Valley Groundwater Basin to (a) assess regional suitability for MAR, and (b) quantify the relative impact of MAR activities on groundwater levels and seawater intrusion. The first step comprised an analysis of surface and subsurface hydrologic properties and conditions, using a GIS. Surface and subsurface data coverages were compiled, georeferenced, reclassified, and integrated (including novel approaches for combining related data sets) to derive a spatial distribution of MAR suitability values. In the second step, results from the GIS analysis were used with a regional groundwater model to assess the hydrologic impact of potential MAR placement and operating scenarios. GIS results suggest that about 7% (15 km^2) of the basin may be highly suitable for MAR. Modeling suggests that simulated MAR projects placed near the coast help to reduce seawater intrusion more rapidly, but these projects also result in increased groundwater flows to the ocean. In contrast, projects placed farther inland result in more long-term reduction in seawater intrusion and less groundwater flowing to the ocean. This work shows how combined GIS analysis and modeling can assist with regional water supply planning, including evaluation of options for enhancing groundwater resources.

Information Transfer/Outreach Program

We have presented results of this work at numerous public meetings and, as a result, there is growing interest regionally in applying what we have learned to other settings.

Invited presentations were made during the reporting period to the following groups. Presentations made to a general audience are marked with *. Other presentations were technical in nature:

2014	*UCSC Chancellor's Associates reception	Santa Cruz, CA
	*California Naturalists Program, UCSC	Santa Cruz, CA
	Climate Change, Water and Society IGERT, UCD	Davis CA
	*Bay View Elementary School, Fourth Grade	Santa Cruz, CA
2013	*Rotary Club, Santa Cruz Chapter	Santa Cruz, CA
	*Community Water Dialog, Pajaro Valley	Watsonville, CA
	*Chancellor's Associates reception, Chancellor's residence	Santa Cruz, CA

Managed Aquifer Recharge in the Urban Environment, GRA, Burlingame, CA
CA
Human-Environmental Security in Asia Pacific: Water-Energy-Food Nexus San Francisco, CA

We were interviewed by the following media groups, generating stories that were published in popular media:

- KUSP public radio story on Groundwater Recharge, Santa Cruz, CA
- National Geographic online story on the California Drought and methods needed to address it.

Students supported with NIWR and associated funds, in part, during the project:
Sarah Beganskas, Ph.D. student (2012-)
Ryan Harmon, B.S. (expected June 2014)
Eric Lujan, B.S. (expected June 2014)
Emily Edwards, B.S. (2013)
Barbara Taylor, B.S. (2013)

	Total Project Funding		Supplemental Awards	**Total**
	Federal Funding	State Funding		
Professional Researchers	0	0	0	**0**
Masters Students	0	0	1	**1**
PhD. Students	1	0	0	**1**
Acad. Coordinator	0	0	0	**0**
Other Acad./Researchers	0	0	0	**0**
Professor/summer	0	0	1	**1**
Total	1	0	2	**3**

Notable Achievements

We have demonstrated initial efficacy of stormwater capture linked to MAR, and will be preparing peer-reviewed publications based on this work (after collecting one more year of field data). We also tested and demonstrated utility of real-time data monitoring of MAR. In part on the basis of this work, we prepared two successful proposals, in collaboration with the Resource Conservation District of Santa Cruz County. Funding for both projects should arrive later in 2014 (about $200k in total).

One project (funded by the California State Coastal Conservancy) involves a GIS and runoff analysis to assess application of stormwater capture and MAR on a regional basis. The other project (funded by the CA Department of Water Resources through the Integrated Regional

Watershed Management Program) involves installation of two new MAR systems to capture stormwater runoff. We are conducting initial meetings and field visits to start work on both of these projects in Spring 2014. We recruited two outstanding new graduate students to work on these projects, starting in Fall 2014. Lead PI was also invited to consult with Governor Brown's Science and Policy staff on development of new responses to the ongoing drought, at a meeting in Sacramento (with other selected UC faculty).