



# **Groundwater Dynamics in Sacramento Aquifers Following California's Historic Drought**

*Principal Investigator:*  
**Amelia Vankeuren, Cal State Sacramento**

**Technical Completion Report**  
**Project Period: March 1, 2017 – February 28, 2019**

## Project Summary

We developed a model for groundwater-surface water interaction in the Sacramento area to investigate how groundwater recharge could be altered by climate change. The model was calibrated with field data collected for this project (mean groundwater ages, recharge temperatures, etc.) and historic groundwater level data. The model simulated groundwater recharge through the year 2100 for four different climate change scenarios used by the State of California (Cal-Adapt.org). Results indicate that recharge from precipitation varies by 30% depending on the climate change scenario, while recharge from the lower American River varies by 2.5%, with an overall recharge difference of 4.5%. Though groundwater levels did not show declining trends over the course of the model, there were many years where groundwater levels were 2 meters lower in the hotter-drier climate scenario. This indicates a loss of groundwater storage and is equivalent to the change in groundwater levels measured during California's historic 5 year drought during 2012-2016. These results suggest that climate change could create challenges for groundwater sustainability in the Sacramento area over the next century. In an already tight groundwater budget, a 4.5% decrease in recharge would require offsets by other measures such as demand reduction through reduced groundwater pumping. Benefits from this project include hands-on training for students in field sampling, laboratory analysis, and presentation skills, as well as networking with local groundwater professionals. The project has also led to a new collaboration between research scientists at Lawrence Livermore National Laboratory and the CSUS Geology Department.

## Outreach

Results from this project have been presented to local groundwater professionals from the government, industry, and academia in three separate venues: 1) Groundwater Resources Association of California (GRAC) Western Groundwater Congress. This conference is held annually and draws groundwater professionals from throughout California and other western states (e.g., Arizona, New Mexico). 2) GRAC Sacramento Branch meeting student night. This is a meeting for groundwater professionals from the Sacramento metropolitan area, including many local and state water agencies (Regional Water Authority, Department of Water Resources, State Water Resources Control Board, etc.). 3) California State University Water Resources and Policy Initiatives annual conference. This conference is attended by faculty and students from twenty three California State University campuses who are working on water resources from a variety of fields such as engineering, geology, economics, history, etc. Results have also been written up in the form of a master's thesis and will be developed into a manuscript for submission to a peer reviewed scientific journal.

## Notable Achievements and Awards

This project leveraged funding from multiple sources to accomplish a broader agenda. Additional funding was supplied by the CSUS Faculty Research and Creative Activities Award program to cover the time required for groundwater sampling activities and a portion of

laboratory costs. CIWR funding supported research for a master's student thesis. Another master's student analyzed the samples for this project at the Lawrence Livermore National Laboratory (LLNL) supported by a Glenn T. Seaborg Institute Summer Internship in Nuclear Forensics and Radiochemistry. Finally an undergraduate student research project analyzing dissolved inorganic carbon in these samples was funded by the Groundwater Resources Association of California Sacramento Branch through a CSUS Geology Student Research Grant.

This project also sparked a collaboration between Dr. Amelia Vankeuren and Dr. Ate Visser, a research scientist in the environmental Noble Gas Mass Spectrometry laboratory of the Nuclear and Chemical Sciences division at LLNL. Dr. Vankeuren and Dr. Visser are now collaborating on other groundwater-surface water interaction projects including a study of groundwater quality during off-season irrigation for agricultural managed aquifer recharge irrigation during the winter when crops don't need water to recharge aquifers.

Broader impacts include training students to be the next generation of hydrogeologists. Students in Dr. Vankeuren's undergraduate Hydrogeology class helped collect groundwater samples using industry standard techniques. A subsequent class then used the data as part of a course-based undergraduate research experience to answer student-led research questions relating to local groundwater quality or quantity. Three students – two graduate and one undergraduate – also participated in faculty mentored research with Dr. Vankeuren as part of this project. All of these students presented their work at conferences and received training on public speaking in preparation for their presentations. One master's student presented this research at the Groundwater Resources Association of California Western Groundwater Congress and received that conference's award for "Best Student Research Presentation".

## **Publications & Products**

### Dissertations

- George, Austin, 2019, Using Natural Tracers and Water Chemistry to Quantify Recharge and Aquifer Dynamics in East Sacramento, California, MS Dissertation, Geology Department, California State University, Sacramento, Sacramento, CA. 52 pages.

### Outreach events and conference presentations

- Vankeuren, Amelia; Austin George; Ate Visser; Marissa Loustale. Evaluating and Enhancing Groundwater Recharge in the Sacramento Area. California State University Water Resources & Policy Initiatives annual meeting. Talk. 4/25/2019. Chico, CA.
- \*George, Austin; Amelia Vankeuren; Ate Visser; Marissa Loustale. Using Natural Tracers and Water Chemistry to Quantify Recharge and Aquifer Dynamics in East Sacramento, California. Groundwater Resources Association of California Western Groundwater Congress, Poster, 9/25/2018, Sacramento, CA.
- \*George, Austin; Amelia Vankeuren; Ate Visser; Marissa Loustale. Quantifying Recharge and Aquifer Dynamics in East Sacramento, California. Groundwater Resources Association of California Sacramento Branch Student Night, Talk, 3/13/2019, Sacramento, CA.

\*Student presenter