



Newsletter written and compiled by Nicole Damon

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## *Project Spotlight: Theoretical Analysis of Optimal Groundwater Basin Development*

Responsible aquifer management requires an understanding of the interrelationships among inputs and outputs of water in the aquifer. The goal of this project is to develop a scaling analysis to estimate water table conditions for potential basin-wide water development. The results of the project will determine the conditions under which drastic drops in the water table can occur.

The main misconception about groundwater pumping is that as long as the amount of water pumped from a basin doesn't

exceed recharge from precipitation, the basin can be sustainably managed. "It would seem to make sense because the amount of water in the aquifer will increase over time if annual pumping is less than what is added through recharge," says Dr. Clay Cooper, who is the principal investigator for the project. "However, increasing the amount of water that is withdrawn can actually increase the amount of water available if recharge is induced from other sources of water on the land surface." Induced recharge pulls water from

### RFPs

If you have questions about submitting a NWRRRI proposal, e-mail Amy Russell (Amy.Russell@dri.edu).

For current RFP information, visit the NWRRRI website ([www.dri.edu/nwrrri](http://www.dri.edu/nwrrri)).

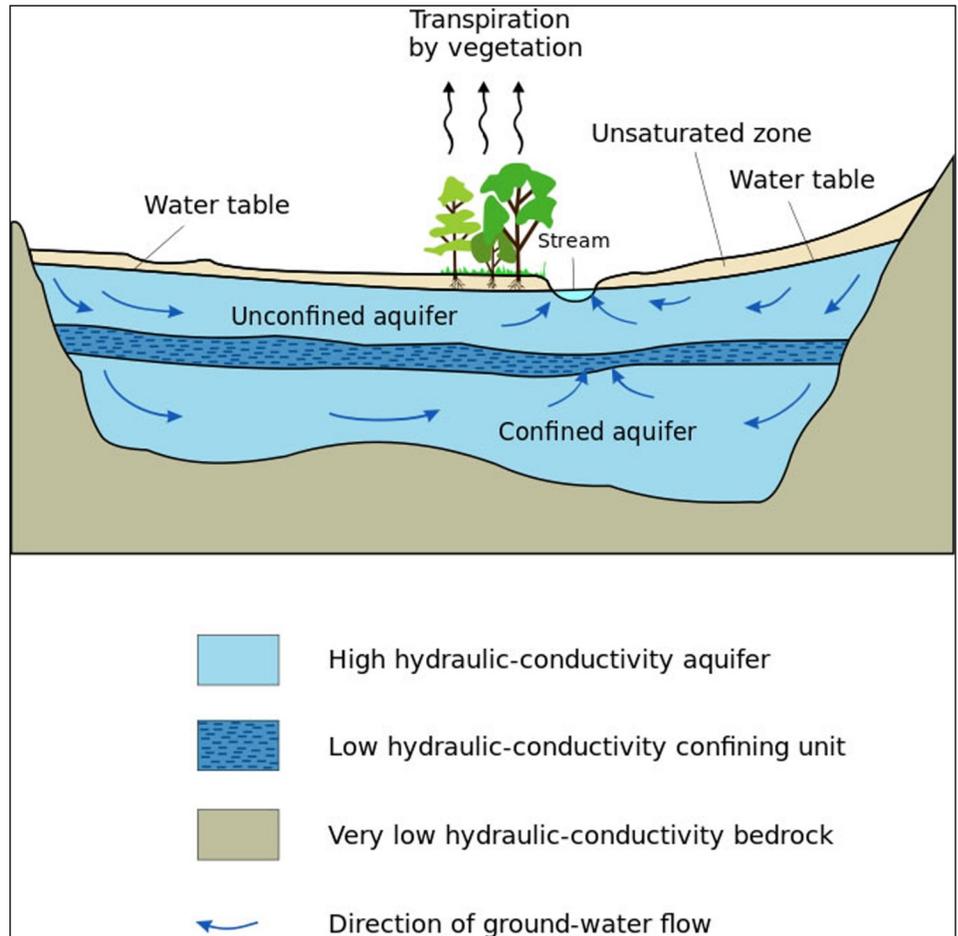


Because hydrologic systems connect groundwater and surface water, groundwater pumping can also affect available water in rivers, streams, and springs.

*(Project Spotlight continued)*

surrounding surface water resources. This means that even though it refills the aquifer, the surface water sources from which the water is withdrawn suffer. “Some aquifers can be pumped so much that water is eventually withdrawn from distant rivers, streams, and springs,” Cooper adds, “which can significantly affect valuable surface water resources, particularly in arid and semiarid regions.”

This project will evaluate what happens during groundwater withdrawal and how it affects the stability of groundwater basins. “Groundwater pumping lowers the water table in unconfined aquifers and drops the pressure in confined aquifers until a new steady state is reached, which stabilizes the water level or pressure in the aquifer,” Cooper explains. “This is how aquifers are supposed to function. However, my hypothesis is that under certain scenarios, excessive pumping can result in a drastic water table decline in unconfined aquifers, and this bifurcation in water level could result in groundwater mining.” Cooper developed the idea for this project based on papers by USGS hydrologists Charles Theis, John Bredehoeft, Leonard Konikow, and William Alley, as well as Allan Freeze from the University of British Columbia. The research conducted for this project will help determine the conditions



Cross section of a typical aquifer.

that might lead to significant bifurcating behavior or unstable groundwater levels.

This research is important for managing groundwater resources in Nevada because it will help water managers understand the available water in aquifers and how it interacts with surface water resources. “Overall, groundwater in Nevada is managed far better than

many other states and has been for over one hundred years,” Cooper explains. “However, the competing water needs for mining and irrigation, as well as municipal, industrial, and recreational uses make managing water resources a complex issue. I hope that this work results in an easy-to-use tool that can help with basin management.” ■

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## *PI Spotlight: Dr. Clay Cooper*

Dr. Clay Cooper first became interested in water resources research when he was studying geology for his bachelor's degree at Northern Arizona University in the 1970s. "At that time, geology was largely a descriptive science, with little understanding of the coupling and feedbacks of the different chemical, physical, and biological processes of an observed phenomenon," Cooper says. "For example, a geological engineer could estimate a rate of erosion from a hillslope, but that would have been largely intuitive or based on crude measurements. Hydrology seemed more quantitative and because I enjoyed math and physics, that's the field I decided to pursue in graduate school."

The interaction of time scales of different hydrologic processes in arid environments is one of the aspects of water resources research that Cooper finds particularly interesting. "Water residency times vary greatly. In the atmosphere, it is on the order of a few weeks and in streams it is days to months," Cooper explains. "In arid environments, the mean residence time of groundwater can be several tens of thousands of years compared with several thousand

years in oceans, which contain over 95 percent of Earth's water. So groundwater is a choke in the hydrologic cycle, but it is balanced out by the fluxes in and out of different reservoirs."

What Cooper finds most interesting about the research he is doing for the NIWR project "Theoretical Analysis of Optimal Groundwater Basin Development" is the qualitative study of differential equations. "I think this research is important and I will be interested to see what the peer response is so that I can improve on the methods I'm developing," he says. "I'm learning a lot as I make progress on this project." Another aspect of groundwater research that Cooper finds particularly fascinating is thermal and solute convection in porous media. "Our understanding of the processes controlling groundwater



convection in fractured, heterogeneous geothermal reservoirs is largely known through analytical and numerical studies," he says. "Very few laboratory experiments have been conducted and they have been mostly in uniform porous media."

When it comes to working in the lab or in the field, Cooper prefers lab work. "I have done quite a bit of field work in the past, but I like laboratory studies because they are largely underutilized in hydrology, especially in some of the areas in which I work," he says. "I believe pretty strongly that advances are

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*(PI Spotlight continued)*

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In his spare time, Cooper likes to read popular science books and research monographs and

textbooks. “The book I’m currently reading is *Flow in Porous Rocks* by Andrew W. Woods,” he says. “I’m also reading *Barbarian Days: A Surfing Life* by William Finnegan. I’m not a surfer, but it’s a great read.” Outside of his research interests, Cooper is also a jazz drummer and enjoys making

*chile relleno* casserole, which is one of his favorite dishes to make. And for dessert, if he has a choice between cake or pie, there’s only one answer: “Warm strawberry rhubarb pie with ice cream,” he says. “Every time.” ■

## Postdoc Interview: Xuelian Bai

We asked Maki Postdoctoral Fellow Dr. Xuelian Bai about her current research and her continuing research plans. Here’s what she had to say:

### 1) What sparked your interest in water resources research?

Environmental pollution is an important issue for both researchers and the public. Although many known and regulated contaminants have been widely studied, there are increasing concerns regarding emerging contaminants because their presence, transport, life cycles, and effects on humans and wildlife are largely unknown. I am interested in this type of research because I want to understand how emerging contaminants affect the environment. Human activities affect ecosystems and we are exposed to chemicals through water, air, soil, and food. The production and consumption of numerous chemicals might cause ecological risks and the continuous release and ubiquitous distribution of these chemicals could potentially affect human and wildlife health.

### 2) What do you find most interesting about water resources

**research, particularly working in an arid/semiarid environment such as Nevada?**

In an arid/semiarid area such as Nevada, water scarcity and water quality are significant issues. In southern Nevada, Lake Mead is both our major drinking water source and a reservoir for receiving wastewater discharge. The water quality in Lake Mead is a critical issue because we rely on it as a water source. Because Lake Mead is a receiving water body for treated wastewater, we want to ensure that the nutrients and regulated pollutants have been removed from the wastewater. We also need to evaluate untreated chemicals that could affect the water quality of the lake. This unique situation means

that the performance of wastewater treatment plants, the types and concentrations of untreated chemicals in wastewater discharge, and the life cycles of those chemicals in the ecosystem and their potential adverse effects on humans and wildlife are important research topics. These topics are also the ones I find most interesting.



*(Continued on page 5)*

*(Postdoc Interview continued)*

**3) What research projects are you currently working on and what have you learned so far from your research?**

I am currently working on the uptake of pharmaceutical and personal care products (PPCPs) by freshwater algae and quagga mussels from Lake Mead. Algae can play a major role in removing PPCPs in aquatic ecosystems. The advantage of this process is that algae can remove PPCPs or other organic chemicals from water bodies. The disadvantage of this process is that algae are the major food source for higher-trophic-level organisms, such as mussels and fish. Therefore, contaminants can be transferred through the food web and accumulate in aquatic organisms, which may cause adverse effects. Quagga mussels are a dominant invasive species in Lake Mead and my current research evaluates the role quagga mussels play in removing and accumulating PPCPs. Understanding these processes will help us evaluate the potential exposure routes and ecological effects associated with PPCPs so that we can make recommendations to regulators and agencies to mitigate the risks.

**4) What do you hope to learn more about from the research you are doing?**

My current research focuses on the uptake process of PPCPs by algae and mussels, including

sorption and degradation. I am interested in studying sources of emerging contaminants for the entire southern Nevada water system, including wastewater treatment facilities, urban runoff, the Las Vegas Wash, and Lake Mead. I am also interested in studying antibiotic resistance in the Las Vegas Wash and Lake Mead. Many types of antibiotics have been detected in the lake and wash, which makes potential antibiotic resistance in this aquatic ecosystem an important research topic.

**5) Do you have a preference for lab work or field work, and if so, why?**

The majority of my research is laboratory based, but it also includes some minor field work. We do field sampling for water and mussels from Lake Mead, and then we analyze the samples in the lab to find out the ambient concentrations of the contaminants in the environmental samples. Laboratory-based experiments under controlled conditions are preferable for understanding the mechanisms of fate and transport and the ecological impacts associated with the contaminants.

**6) What are some of your other research interests? Do you have any goals for incorporating those interests into your work as you continue in your career?**

My other research interests include industrial water quality

issues, such as cooling towers, as well as advanced water treatment technologies. I also have a background in soil science, so I'm interested in research topics related with soil quality and health. My long-term research interests are to understand fate and transport and the risks of contaminants in both aquatic and agroecosystems.

**7) If you were shipwrecked on a deserted island, but all of your human needs (food, water, etc.) were taken care of, what two items would you want to have with you?**

I'd want to have my Kindle with lots of books and a painting kit. I'd really enjoy having the time to read the books I have on my Kindle that I haven't had a chance to finish. I'd also want to have the time to learn how to paint. I bought a painting kit years ago, but haven't opened it yet.

**8) If you had six months with no obligations or financial constraints, what would you do with the time?**

I would learn how to scuba dive and surf. ■

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## Upcoming Events

2016 AWRA Summer Conference:  
GIS and Water Resources IX  
July 11-13  
Sacramento, CA  
[www.awra.org/meetings/Sacramento2016/](http://www.awra.org/meetings/Sacramento2016/)

2016 Water Rights in Nevada  
Seminar  
July 12  
Lovelock, NV  
[www.nvwra.org/2016-july-water-rights-seminar](http://www.nvwra.org/2016-july-water-rights-seminar)

2016 Advanced Water Rights in  
Nevada Seminar  
July 13  
Lovelock, NV  
[www.nvwra.org/2016-july-advanced-water-rights-seminar](http://www.nvwra.org/2016-july-advanced-water-rights-seminar)

10th International Rangeland  
Congress  
July 16-22  
Saskatoon, Saskatchewan, Canada  
[2016canada.rangelandcongress.org/#sthash.PsffxtKs.dpbs](http://2016canada.rangelandcongress.org/#sthash.PsffxtKs.dpbs)

8th International Acid Sulfate Soils  
Conference  
July 17-23  
College Park, MD  
[www.midatlanticsoilscientists.org/acid-sulfate-soils-conference](http://www.midatlanticsoilscientists.org/acid-sulfate-soils-conference)

3rd International Conference on  
Hydropedology  
August 16-19  
Beijing, China  
[hydropedology2016.csp.escience.cn/dct/page/1](http://hydropedology2016.csp.escience.cn/dct/page/1)

Marlette Lake Water System Tour  
August 24  
Marlette Lake, NV  
[www.nvwra.org/marllettelaketour2016](http://www.nvwra.org/marllettelaketour2016)

Connecting the Dots: Groundwater,  
Surface Water, and Climate  
Connections  
September 8-9  
Portland, OR  
[www.ngwa.org/Events-Education/conferences/Pages/5029sep16.aspx](http://www.ngwa.org/Events-Education/conferences/Pages/5029sep16.aspx)



2016 GSA Annual Meeting  
September 25-28  
Denver, CO  
[community.geosociety.org/gsa2016/home](http://community.geosociety.org/gsa2016/home)

Fall 2016 History of Water in  
Nevada Event  
October 24-25  
Reno, NV  
<http://www.nvwra.org/2016-water-history-event>

2016 Borehole Geophysical Logging  
Workshop  
October 26  
Reno, NV  
[www.nvwra.org/2016borehole-geophysical-logging-workshop](http://www.nvwra.org/2016borehole-geophysical-logging-workshop)

Lithium Workshop  
October 27  
Reno, NV  
[www.nvwra.org/2016lithium-workshop](http://www.nvwra.org/2016lithium-workshop)

2016 Nevada Well Drilling  
Regulations & Forms Class and  
Water Well Drilling Exam Tutorial  
October 27  
[www.nvwra.org/2016wellregs](http://www.nvwra.org/2016wellregs)

ASA, CSSA, and SSSA: Resilience  
Emerging from Scarcity and  
Abundance  
November 6-9  
Phoenix, AZ  
[www.acsmeetings.org/about](http://www.acsmeetings.org/about)

Emerging Leaders Alliance  
Conference  
November 9-12  
Falls Church, VA  
[www.ngwa.org/Events-Education/conferences/Pages/elanov16.aspx](http://www.ngwa.org/Events-Education/conferences/Pages/elanov16.aspx)

2016 AWRA Annual Conference  
November 13-17  
Orlando, FL  
[www.awra.org/meetings/Orlando2016/](http://www.awra.org/meetings/Orlando2016/)

Groundwater Week  
December 6-8  
Las Vegas, NV  
[groundwaterweek.com/](http://groundwaterweek.com/)

AGU Fall Meeting 2016  
December 12-16  
San Francisco, CA  
[fallmeeting.agu.org/2016/](http://fallmeeting.agu.org/2016/)

## NWRRI - Desert Research Institute

*Success and the dedication to quality research have established the Division of Hydrologic Sciences (DHS) as the Nevada Water Resources Research Institute (NWRRI) under the Water Resources Research Act of 1984 (as amended). As the NWRRI, the continuing goals of DHS are to develop the water sciences knowledge and expertise that support Nevada's water needs, encourage our nation to manage water more responsibly, and train students to become productive professionals.*

*Desert Research Institute, the nonprofit research campus of the Nevada System of Higher Education, strives to be the world leader in environmental sciences through the application of knowledge and technologies to improve people's lives throughout Nevada and the world.*

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[www.dri.edu/nwrri](http://www.dri.edu/nwrri)

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For more information about the NWRRI, contact:

*Amy Russell, Business Manager*  
702-862-5471  
[Amy.Russell@dri.edu](mailto:Amy.Russell@dri.edu)

*Jim Thomas, Director*  
775-673-7305  
[Jim.Thomas@dri.edu](mailto:Jim.Thomas@dri.edu)

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Page 1: Reese River near Austin, NV, by Famartin - Own work, CC BY-SA 4.0, <https://commons.wikimedia.org/w/index.php?curid=34556137>

Page 2: Aquifer cross section by © Hans Hillewaert /, Public Domain, <https://commons.wikimedia.org/w/index.php?curid=2152154>

Events listing: Big Bend of the Colorado River courtesy of Nevada State Parks, [parks.nv.gov](http://parks.nv.gov)