

Newsletter written and compiled by
Nicole Damon

Project Spotlight: Geologic and Seismic Effects of Large-scale Groundwater Withdrawal from Northeastern Nevada Basins

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RFPs

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

For current RFP information, visit the NWRRI website (www.dri.edu/nwrri).

Groundwater in alluvial aquifers is an important water source throughout Nevada, but excessive groundwater withdrawal can lead to surface deformation and subsidence. Groundwater withdrawal in the Las Vegas Valley has caused cracks near preexisting faults and ground subsidence. These surface changes can affect regional fault motion and seismicity (González et al., 2012; Hampel and Hetzel, 2006). The goal of this project is to evaluate how fault slip rates are affected by subsidence and surface deformation from groundwater withdrawal and the possibility that it could induce seismicity in northeastern Nevada. “Through this project, we hope to gain an understanding of the interaction between fault stresses and near-surface mass-removal or pore-pressure reduction that can be applied throughout Nevada,” explains Brian Anderson, the graduate researcher on the project, which also includes Dr. Rina Schumer.

Although groundwater pumping provides valuable water resources to meet the state’s water demands, it’s also important to know if overpumping can create additional seismic hazards. “We will use

hydrologic data from previous work in Spring Valley, Nevada, to determine the magnitude of overburden mass loss under a variety of pumping scenarios,” says Anderson. “Using numerical models and analytical solutions, we will relate the magnitude of overburden mass loss to stress changes in the underlying crust, and then evaluate how it affects nearby vertical slip rates.” Because Spring Valley is geologically similar to many other fault-bounded basins in the Basin and Range Province, the principles observed in the models can also be applied to other areas across Nevada.

Once the researchers evaluate how overburden affects slip rates, they will then compare the unloading estimates that create changes in slip-rates or seismicity to the proposed pumping rates in the valley. “The overburden load from the groundwater has accumulated over time in dynamic equilibrium with the regional tectonics,” says Anderson. “If a significant amount of overburden is removed, this can reduce the normal stress on nearby faults and, in effect, unclamp the fault to a

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degree proportional to the load removal.” This small amount of unclamping could potentially prematurely rupture a fault in areas with accumulating tectonic strain. Incidents in which groundwater pumping has been implicated in inducing fault ruptures include the Mw 5.1 earthquake in Lorca, Spain, and the Mw 7.2 El Mayor-Cucapah earthquake in Southern California and northern Mexico in 2010 (González et al., 2012; Trugman et al., 2014).

Over the first year of the project, the researchers will develop a model system to evaluate the groundwater mass transfer that occurs during pumping and how the stress change affects nearby faults. “Once we have this information, we can start evaluating different pumping scenarios and get feedback on how various magnitudes of overburden removal translate to stress changes on the fault,” Anderson adds. “Studying this relationship will allow us to further constrain the possibility of increasing seismic hazards in groundwater withdrawal areas and possibly mitigate otherwise unforeseeable hazards.” ■



Aerial view of Great Basin National Park showing Spring Valley, Nevada, and the Schell Creek Range (upper left).

References

Pablo J. González, P.J., K.F. Tiampo, M. Palano, F. Cannavó, and J. Fernández, 2012. The 2011 Lorca earthquake slip distribution controlled by groundwater crustal unloading. *Nature Geoscience*, 5, pp. 821-825.

Hampel, A., and R. Hetzel, 2006. Response of normal faults to glacial-interglacial fluctuations of ice and water masses on earth's surface. *Journal of Geophysical Research* 111, B06406.

Trugman, D.T., A.A. Borsa, and D.T. Sandwell, 2014. Did stresses from the Cerro Prieto Geothermal Field influence the El Mayor-Cucapah rupture sequence? *Geophysical Research Letters* 41: 8767-8774.

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PI Spotlight: Dr. Rina Schumer

After majoring in geology at Wesleyan University, Dr. Rina Schumer worked for an environmental consulting firm, sparking her interest in hydrogeology. “I found myself encountering hydrologic data and observations that I didn’t understand and that my colleagues couldn’t explain,” Schumer says. “So I decided to go to graduate school to study hydrology.” After completing her master’s in hydrogeology, Schumer then completed a master’s in applied mathematics and a PhD in hydrogeology at the University of Nevada, Reno.

Schumer’s curiosity about how environmental systems function also inspired her interest in numerical modeling. It’s not feasible to completely observe or measure environmental variables, so modeling allows researchers to test hypotheses about how hydrologic systems function. They can use modeling to test hypothesis and

evaluate how environmental processes interact. “We can tease apart the complexities and the effects of heterogeneity in the subsurface, surface, and atmosphere,” Schumer adds. “I learn something new every time I study a new aspect of the earth surface and the natural processes that occur there.”

One of the objectives of Schumer’s newest NIWR project, “Geologic and Seismic Effects of Large Scale Groundwater Withdrawal from Northeastern Nevada Basins,” is to develop a tool that can predict subsurface deformations or changes in fault slip rates based on estimates of groundwater volume and pumping rates. When asked what she likes most about the research she does for NIWR, Schumer answered, “Historically, hydrologic research has focused



mostly on more populated, humid regions, but these projects allow me to address issues that are directly relevant to Nevada water resources.” ■

Upcoming Events

AGU 2016 Ocean Sciences Meeting
February 21-26
New Orleans, LA
osm.agu.org/2016/

NGWA Conference on Hydrology and Water
Quality in the Southwest
February 23-24
Albuquerque, NM
[www.ngwa.org/Events-Education/conferences/
Pages/5034feb16.aspx](http://www.ngwa.org/Events-Education/conferences/Pages/5034feb16.aspx)

2016 NWRA Annual Conference Week
February 29-March 3
Las Vegas, NV
www.nwra.org/2016-annual-conference-week

112th GSA Annual Meeting, Cordilleran Section
April 4-6
Ontario, CA
www.geosociety.org/sections/cord/2016mtg/



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Student Interview: Brian Anderson

We asked graduate student Brian Anderson about his current studies and his plans for the future. Here's what he had to say:

1) What field are you currently studying and what sparked your interest in that field?

I majored in geology as an undergraduate because I was really interested in tectonics and earthquakes. After I graduated, I got a job at an environmental consulting firm in Southern California. The work that I did for the consulting firm allowed me to problem solve and fix things, which I really enjoy. I wanted to pursue a master's degree to increase my capabilities in consulting, but I ended up getting lucky and was linked with a project that is aligned with my interest in tectonics as well.

2) Which NIWR project are you working on and what research are you doing?

I am working on a project that evaluates the geologic and seismic effects of large-scale groundwater extraction and transfer in eastern Nevada ("Geologic and Seismic Effects of Large-scale Groundwater Withdrawal from Northeastern Nevada Basins"). The objective of the project is to assess the capability of groundwater pumping to increase fault slip rates or possibly cause earthquakes. For my thesis work, I am using groundwater models that emulate pumping in Spring Valley to assess different scenarios of water

transfer from the basin. After converting the water to a mass, I will evaluate how that mass-removal increases or reduces key stress components on known faults in the area. Once we have that information, we will use the Coulomb failure function to assess the change in the state of stress on a given fault to provide a summary of the effects of the different pumping scenarios on the faults and compare them with the currently approved water rights applications in the valley.

3) What have you learned from working on this project?

In addition to developing skills with groundwater modeling and other numerical modeling techniques, I have gained confidence in the research process. Doing this research has shown me that being able to formulate

a hypothesis and develop sound methods to test that hypothesis are as important to a successful project as knowing the subject matter.

4) Over the course of this project, what do you hope to learn more about?

I hope to learn more about tools such as numerical modeling applications as well as implementation



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(Student Interview continued)

processes to help solve environmental science problems.

5) What have you enjoyed most about working on this project?

I have enjoyed combining two fields that I am very interested in: earthquakes and water resources. Not many projects combine both of these fields and I like being able to use the knowledge I have of both of these subjects.

6) What are your goals for the next step in your career?

When I finish, I hope to transition into project management work in the

private sector. Where that will be is yet to be determined.

7) What is one of your favorite movies or books and why?

I loved the book *Tom Brown's Field Guide to Wilderness Survival* when I was a kid and would practice wilderness survival skills in the woods behind my house. I still reference my copy now and then, and I enjoy practicing new wilderness survival skills.

8) Do you have a favorite dish that you like to make and why is it your favorite?

I lived in the Philippines several years ago and one dish I ate a lot was chicken adobo, which is basically braised chicken in vinegar and soy sauce. I have since put an American spin on it and it has become one of my favorite things to cook. ■

Events continued

UNR/NWRA Spring Dinner Forum
April 5
Reno, NV
www.nvwra.org/2016unr-nwradinnerforum

2016 NGWA Groundwater Summit
April 24-27
Denver, CO
www.groundwatersummit.org

2016 AWRA Spring Specialty Conference: Water, Energy, Environment
April 25-27
Anchorage, AK
www.awra.org/meetings/Anchorage2016/

AGU Chapman Conference: Emerging Issues in Tropical Ecohydrology
June 5-9
Cuenca, Ecuador
chapman.agu.org/ecohydrology/

Groundwater from the Mountains to the Sea in the Central Atlantic Region
June 6-7
Virginia Beach, VA
www.ngwa.org/Events-Education/conferences/Pages/5056jun16.aspx

2016 UCOWR/NIWR Annual Conference
June 21-23
Pensacola Beach, FL
ucowr.org/conferences/2016-ucowr-conference

2016 AWRA Summer Specialty Conference, GIS and Water Resources IX
July 11-13
Sacramento, CA
www.awra.org/meetings/Sacramento2016/

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

2016 GSA Annual Meeting
September 25-28
Denver, CO
www.geosociety.org/meetings/2016/

ASA, CSSA, and SSSA: Resilience Emerging from Scarcity and Abundance
November 6-9
Phoenix, AZ
www.acsmeetings.org

2016 AWRA Annual Conference
November 14-17
Orlando, FL
www.awra.org/meetings/Orlando2016/

AGU Fall Meeting 2016
December 12-16
San Francisco, CA
sites.agu.org/meetings-events/#meeting

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

For more information about the NWRRI, contact:

Amy Russell, Business Manager
702-862-5471
Amy.Russell@dri.edu

Jim Thomas, Director
775-673-7305
Jim.Thomas@dri.edu

Banner photo: Sunset Panorama in Pine Creek Canyon,
Las Vegas, Nevada, U.S. Geological Survey/
photo Alex Demas

Page 2: Wheeler Peak and Great Basin National Park
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Events, page 3: Wyoming Big Sagebrush Community
near Winnemucca, Nevada, U.S. Geological
Survey/photo David Pyke