



Newsletter written and compiled by  
Nicole Damon

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#### RFPs

If you have questions  
about submitting a  
NWRRI proposal,  
email Amy Russell  
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For current RFP  
information, visit the  
NWRRI website  
([www.dri.edu/nwrri](http://www.dri.edu/nwrri)).

### *Improving Wastewater Treatment using Biofilms that Degrade Phenolic and Aromatic Contaminants*

Although wastewater treatment facilities use oxidation ponds to eliminate organic materials, some phenolic and aromatic compounds are particularly resistant to current treatment processes. If these compounds are released into the environment with treated wastewater, they could affect environmental and human health. “Animal studies show that exposure to these compounds can affect reproduction and development,” says Dr. Henry Sun, the principal investigator of this project. “In humans, long-term exposure can cause a variety of health problems, including irregular breathing and muscle atrophy. This is why the EPS standard for permissible

phenols in surface waters is very stringent, less than one parts per billion.”

For this project, the researchers will test a biotechnology that uses bacteria isolated from local soil, *Bacillus mojavensis*, to create biofilms that can degrade phenolic and aromatic compounds. “Phenols persist in the environment because aromatic rings are very stable,” Sun says. “Even bacteria cannot metabolize them until the rings are opened up and linearized, which can only be done through reaction with hydroxyl radicals. This is why these compounds are traditionally treated with ozone and UV irradiation.” *B. mojavensis* produces hydrogen peroxide, which generates



Treated wastewater from the Las Vegas Wash empties into Lake Mead, which is the primary drinking water source for the Las Vegas Valley.

*(Project Spotlight continued)*

free radicals in combination with dissolved iron that can oxidize amino acids that are aromatic and contain stable rings.

During the first phase of the project, the researchers will raise a biofilm of *B. mojavensis*. The benefit of using a biofilm is that it concentrates the hydrogen peroxide and extracellular hydrolytic enzymes produced by the bacteria, which increases the bacteria's ability to oxidize harmful compounds. "When bacteria are stressed, they form biofilms," Sun explains. "To recycle dead cells within these biofilms, the bacteria upregulate their oxidative activity. Our project will use the biofilm's elevated oxidative activity to degrade aromatic pollution."

The researchers hypothesize that the biofilm will oxidize the target phenolic compounds and release carbon dioxide. This hypothesis is based on Sun's previous research on D-amino acids, or right-handed amino acids. "Amino acids come in two forms: left-handed or right-handed. All living organisms synthesize left-handed amino acids," he says. "D-amino acids are generated in the environment by racemization of left-handed amino acids, and they are toxic. Bacteria possess specific oxidases that catalyze their oxidative degradation, turning a toxic substance into a nutrient source. We believe such oxidative power in biofilms can be used to degrade phenols." To test their hypothesis, the researchers will assess the biofilm's ability to degrade



As populations in semiarid regions such as Nevada continue to grow, finding ways to preserve and extend limited water resources will become even more critical.

compounds with increasing aromaticity, specifically phenol, bisphenol, and Congo Red.

After the researchers test the initial biofilm, they will raise a complex natural biofilm in Las Vegas Wash water and assess its degradation efficiency. One of the things that Sun finds most exciting about this project is its potential to improve municipal and industrial wastewater treatment. "Microorganisms and bacteria in the environment are genetically diverse and there are few things that

microorganisms cannot learn to degrade," Sun says. "And microorganisms are already a big part of the current municipal wastewater treatment. Oxidation ponds are designed to increase the aerobic oxidation of organics by the bacteria present in the ponds."

Currently, the researchers are testing how to grow a stable biofilm and its capability to degrade phenols. "Ultimately we want to scale it up and process a large amount of polluted water rapidly," Sun says. "We just

*"We have to continually innovate because the existing treatment schemes may not be able to deal with the new synthetic compounds being added to waste streams. As long as synthetic chemists and pharmaceutical companies exist, there will be a need to update our wastewater treatment systems with new biotechnologies." – Henry Sun*



*(Project Spotlight continued)*

began talking to civil engineers who can help us down the road with incorporating this technique into the existing treatment facilities.” Sun’s long-term research goal is to find ways to use biotechnology to help conserve and manage valuable water resources. “We have to continually innovate because the existing treatment schemes may not be able to deal with the new synthetic compounds being added to waste streams,” Sun says.

“As long as synthetic chemists and pharmaceutical companies exist, there will be a need to update our wastewater treatment systems with new biotechnologies.”

Research into technologies that improve wastewater treatment processes and address emerging contaminants is particularly significant for semiarid regions such as Nevada. The limited water resources in semiarid regions and the

increasing necessity of reusing water as these areas become more populated make preserving water quality even more important. “In southern Nevada, for instance, treated municipal wastewater is returned to Lake Mead, where we get our drinking water,” Sun says. “To protect public health and the natural ecosystem, all toxic substances must be removed from wastewater before it is released into the environment.” ■

## *PI Spotlight: Dr. Henry Sun*

Dr. Henry Sun’s interest in microorganisms was first sparked on a field expedition in China during his undergraduate studies. “An American professor showed me cyanobacteria living inside a porous rock,” Sun says. “The next year, I started my graduate research as his student and started studying the same desert microbes he showed me.”

Microorganisms continue to fascinate Sun and they are still a focus of his research areas of interest, which include the survival and adaptation of life in extreme environments—such as endolithic microorganisms in the Atacama Desert and Death Valley—and detecting planetary life. “The possibility of discovering new organisms capable of doing new things is always exciting,” he adds. “It is even more exciting when one can find a way to utilize basic knowledge to solve practical problems, which is what we are doing in our Nevada Water Resources Research project.”



Another aspect of the project that Sun finds interesting is the unique properties of the bacteria that he is working with. “Bacteria that grow in the desert have properties that bacteria in other regions do not

have,” Sun says. “They are not only extreme hardy, but they also have powerful oxidative metabolisms, which is a characteristic we are specifically trying to utilize in our project.”

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*(PI Spotlight continued)*

In addition to his interest in microorganisms, Sun's other research interests include water recycling and reuse in totally enclosed habitats, such as would be used on the international space station—or a human colony on Mars. "The challenges faced by these closed environments are not unlike the challenges that desert communities face," Sun explains. "I hope that

through this project, we can generate insights that could lead to complete water reuse."

Outside of his research interests, Sun also likes to play pickup basketball. And when asked what one of his favorite books is, he answered: "My favorite book is *1984* by George Orwell because it transcends culture, time, and space. What an English novelist imagined in the 1940s about

life in a socialist England is what I lived through 20 years later in communist China. The similarities are uncanny and chilling." ■

## Upcoming Events

17th Annual Truckee River Field Study Course  
May 2-3, 2019  
Reno, NV  
[www.nvwra.org/2019truckee-river-tour](http://www.nvwra.org/2019truckee-river-tour)

NGWA Forum on Managing Groundwater and Surface Water as a Single Resource: Merging Science and Policies  
May 14-15, 2019  
Salt Lake City, UT  
[www.ngwa.org/detail/event/2019/05/14/default-calendar/5043may19](http://www.ngwa.org/detail/event/2019/05/14/default-calendar/5043may19)

2019 GSA Cordilleran Section 115th Annual Meeting  
May 15-17, 2019  
Portland, OR  
[www.geosociety.org/GSA/Events/Section\\_Meetings/GSA/Sections/cd/2019mtg/home.aspx](http://www.geosociety.org/GSA/Events/Section_Meetings/GSA/Sections/cd/2019mtg/home.aspx)

Well Design, Construction & Rehab Workshop  
May 16-17, 2019  
Reno, NV  
[www.nvwra.org/2019well-design](http://www.nvwra.org/2019well-design)

Barrick Pipeline/Crossroads Tour  
May 21-22, 2019  
Elko, NV  
[www.nvwra.org/2019barrickminetour](http://www.nvwra.org/2019barrickminetour)

2019 June Well & Water Week  
June 10-14, 2019  
Reno, NV  
[www.nvwra.org/2019-june-well-water-week](http://www.nvwra.org/2019-june-well-water-week)



AGU-SEG Airborne Geophysics Workshop  
June 11-13, 2019  
Davie, FL  
[connect.agu.org/2019aguseg/home](http://connect.agu.org/2019aguseg/home)

Sparks Marina Tour  
June 12, 2019  
Sparks, NV  
[www.nvwra.org/2019sparksmarinatour](http://www.nvwra.org/2019sparksmarinatour)

Summer Conference: Improving Water Infrastructure through Resilient Adaptation  
June 16-19, 2019  
Sparks, NV  
[www.awra.org/Members/Events\\_and\\_Networking/Events/Summer\\_2019\\_Specialty\\_Conference.aspx](http://www.awra.org/Members/Events_and_Networking/Events/Summer_2019_Specialty_Conference.aspx)

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## Student Interview: Yuan Luo

We asked PhD graduate research assistant Yuan Luo about his current studies and 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'm currently studying soil physics in arid areas, which is especially important here in the southwestern United States. My bachelor's degree is in water resources engineering and since I was a freshmen, I've enjoyed the water-related research we did. I also assisted one of my professors with hydrodynamic research for various hydraulic projects. We built models and tested their performance using different extreme conditions. Later on, I worked at a civil engineering company building hydraulic structures. By that time, I learned how soil types make a difference in the way we treat the foundation of hydraulic structures. I began to gain interests in the field of soil physics. Fortunately, I had the opportunity to work with Dr. Markus Berli and he showed me a new world of soil physics. Understanding the soil water dynamics of arid areas can help solve many environmental and economic problems because one-third of the earth's land is located in arid climates.

### 2) What research project are you currently working on and what

### research are you doing?

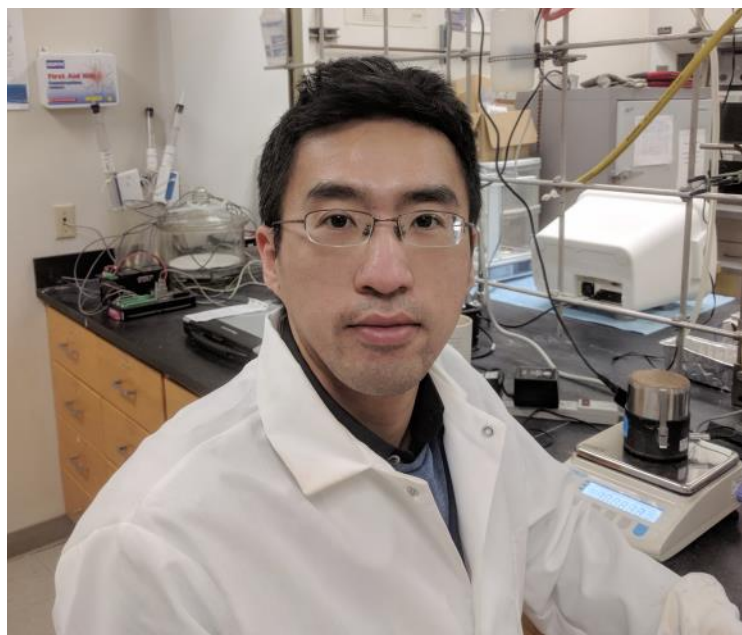
I'm currently working on the Solar Energy-Water-Environment Nexus project, which includes cooperation from community leaders, industries, federal and state agencies, landowners, and tribal communities. My research is on how solar arrays can change the hydrology of desert environments.

### 3) What do you hope to learn more about from this project?

I hope to learn how to understand water dynamics in near-surface dry soil—including infiltration, evaporation, and water redistribution—using our finite element model.

### 4) What are you looking forward to most about working on this project?

I'm looking forward to developing a comprehensive and powerful tool to capture and predict water dynamics in arid soil. Once we have this tool, we can not only help with potential



environmental issues associated with solar facilities in Nevada, but also apply our research to many other disciplines related to desert environments, such as flooding and erosion, cloud and dust formation, fragile desert ecosystems, and waste disposal.

### 5) What are your goals for the next steps in your studies/career?

I don't really have a specific goal for the next steps in my studies, but if possible, I hope that our research on water dynamics in arid soil will be applicable to other arid places around the world.

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

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*(Student Interview continued)*

My favorite book is *The Three-Body Problem* by Cixin Liu. He is the first author from Asia to win the Hugo Award for Best Novel. It's about an alien invasion, but it's not a cliché one. It is mind-blowing and brings deeper perspective on what humans should do when the principle of the universe is so dark and simple that

the top mission for any creature is to survive. I think every sci-fi lover should read it. Another reason to read it is that the author of the book is an alumnus of my college.

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

My favorite dish is tomato and scrambled eggs. It is very easy to make and is a really good source of protein and vitamins. Also, it is a great dish to serve with white rice or noodles. ■

## Events Continued

The PFAS Management, Mitigation, and Remediation Conference  
June 19-20, 2019  
Westerville, OH  
[www.ngwa.org/detail/event/2019/06/19/default-calendar/5010jun19](http://www.ngwa.org/detail/event/2019/06/19/default-calendar/5010jun19)

AbSciCon 2019  
June 24-28, 2019  
Bellevue, WA  
[connect.agu.org/abscicon/home](http://connect.agu.org/abscicon/home)

2019 Legislative Updates – Las Vegas  
July 18, 2019  
Las Vegas, NV  
[www.nvwra.org/2019legislativeupdates](http://www.nvwra.org/2019legislativeupdates)

2019 Legislative Updates – Reno  
July 24, 2019  
Reno, NV  
[www.nvwra.org/2019legislativeupdates](http://www.nvwra.org/2019legislativeupdates)

Groundwater Solutions: Innovating to Address Emerging Issues for Groundwater Resources Conference  
August 6-7, 2019  
Arlington, VA  
[www.ngwa.org/detail/event/2019/08/06/default-calendar/5013aug19](http://www.ngwa.org/detail/event/2019/08/06/default-calendar/5013aug19)

Chapman Conference: Understanding Carbon Climate Feedbacks  
August 26-29, 2019  
San Diego, CA  
[connect.agu.org/aguchapmanconference/upcoming-chapmans/carbon-climate](http://connect.agu.org/aguchapmanconference/upcoming-chapmans/carbon-climate)



23rd International Conference on Environmental Indicators  
September 9-12, 2019  
Haifa, Israel  
[icei-site.catom.site/Home](http://icei-site.catom.site/Home)

International Conference: Water Security, New Technology and Institutions  
September 16-18, 2019  
Beijing, China  
[www.awra.org/Members/Events\\_and\\_Networking/Events/INTERNATIONAL\\_CONFERENCE\\_Water\\_Security\\_New\\_Technologies\\_Strategies\\_Policies\\_and\\_Institutions.aspx](http://www.awra.org/Members/Events_and_Networking/Events/INTERNATIONAL_CONFERENCE_Water_Security_New_Technologies_Strategies_Policies_and_Institutions.aspx)

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## Events Continued

Newmont Phoenix Mine Tour  
September 17, 2019  
Elko, NV  
[www.nvwra.org/2019-september-newmont-mine-tour](http://www.nvwra.org/2019-september-newmont-mine-tour)

Water Rights in Nevada Class  
September 17, 2019  
Elko, NV  
[www.nvwra.org/2019-water-rights-seminar-sept](http://www.nvwra.org/2019-water-rights-seminar-sept)

GSA 2019  
September 22-25, 2019  
Phoenix, AZ  
[www.geosociety.org/GSA/Events/Annual\\_Meeting/GSA/Events/2019info.aspx](http://www.geosociety.org/GSA/Events/Annual_Meeting/GSA/Events/2019info.aspx)

2019 NGWA Conference on Fractured Rock and Groundwater  
September 23-24, 2019  
Burlington, VT  
[www.ngwa.org/detail/event/2019/09/23/default-calendar/5017sep19](http://www.ngwa.org/detail/event/2019/09/23/default-calendar/5017sep19)

2019 Fall Week of Water Events & Symposium  
September 23-26, 2019  
Reno, NV  
[www.nvwra.org/2019fallweekofwater](http://www.nvwra.org/2019fallweekofwater)  
[www.nvwra.org/2019-fall-symposium](http://www.nvwra.org/2019-fall-symposium)

SWITCH Tour  
September 23, 2019  
Reno, NV  
[www.nvwra.org/2019-sept-switch-tour](http://www.nvwra.org/2019-sept-switch-tour)

Operational Value of the Well  
September 26, 2019  
Reno, NV  
[www.nvwra.org/2019-operational-value-of-the-well-workshop](http://www.nvwra.org/2019-operational-value-of-the-well-workshop)

2019 Marlette Lake Water System Tour  
September 26, 2019  
Carson City, NV  
[www.nvwra.org/2019-marlette-lake-tour](http://www.nvwra.org/2019-marlette-lake-tour)

Chapman Conference: Large-scale Volcanism in the Arctic, the Role of the Mantle and Tectonics  
October 13-18, 2019  
Selfoss, Iceland  
[connect.agu.org/aguchapmanconference/upcoming-chapmans/arctic-volcanism](http://connect.agu.org/aguchapmanconference/upcoming-chapmans/arctic-volcanism)

Chapman Conference: Winter Limnology in a Changing World  
October 14-18, 2019  
Polson, MT  
[connect.agu.org/aguchapmanconference/upcoming-chapmans/winter-limnology](http://connect.agu.org/aguchapmanconference/upcoming-chapmans/winter-limnology)

Chapman Conference: The Quest for Sustainability of Heavily Stressed Aquifers at Regional to Global Scales  
October 21-24, 2019  
Valencia, Spain  
[connect.agu.org/aguchapmanconference/upcoming-chapmans/aquifers-sustainability](http://connect.agu.org/aguchapmanconference/upcoming-chapmans/aquifers-sustainability)

AWRA Annual Water Resources Conference  
November 3-7, 2019  
Salt Lake City, UT  
[www.awra.org/Members/Events\\_and\\_Networking/Events/ANNUAL\\_WATER\\_RESOURCES\\_CONFERENCE.aspx](http://www.awra.org/Members/Events_and_Networking/Events/ANNUAL_WATER_RESOURCES_CONFERENCE.aspx)

Groundwater Week  
December 3-5, 2019  
Las Vegas, NV  
[groundwaterweek.com](http://groundwaterweek.com)

AGU Fall Meeting 2019  
December 9-13, 2019  
San Francisco, CA  
[meetings.agu.org/fall-meeting-2019/](http://meetings.agu.org/fall-meeting-2019/)

Chapman Conference: Evolution of the Monsoon Biosphere and Mountain Building in Cenozoic Asia  
January 5-9, 2020  
Washington, D.C.  
[connect.agu.org/aguchapmanconference/upcoming-chapmans/monsoon-evolution](http://connect.agu.org/aguchapmanconference/upcoming-chapmans/monsoon-evolution)

2020 NWRA Annual Conference Week Activities  
February 10-13, 2020  
Las Vegas, NV  
[www.nvwra.org/2020-annual-conference-week](http://www.nvwra.org/2020-annual-conference-week)

AWRA Geospatial Water Technology Conference: Complex Systems Tribute to David Maidment  
March 23-26, 2020  
Austin, TX  
[www.awra.org/Members/Events\\_and\\_Networking/Events/Spring\\_2020\\_Specialty\\_Conference.aspx](http://www.awra.org/Members/Events_and_Networking/Events/Spring_2020_Specialty_Conference.aspx)

## 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.*

*The work conducted through the NWRRI program is supported by the U.S. Geological Survey under Grant/ Cooperative Agreement No. G16AP00069.*



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

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Page 1: Las Vegas Wash emptying into Las Vegas Bay, southern Nevada, by Stan Shebs [CC BY-SA 3.0 (<https://creativecommons.org/licenses/by-sa/3.0>)]

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Events list, page 4: Sunset at Valley of Fire State Park, NV, by John Fowler from Placitas, NM, USA [CC BY 2.0 (<https://creativecommons.org/licenses/by/2.0>)], via Wikimedia Commons

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