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Nevada Water Resources Research Institute

Newsletter written and compiled by
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Inside this issue:

Project Spotlight 1

Student Interview 4

Events List 6

RFPs

If you have questions about submitting a NWRRI proposal, email Suzanne Hudson (Suzanne.Hudson@dri.edu).

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

Engineered Processes for the Separation and Degradation of Microplastics in Freshwater

This project is funded through the National Institutes for Water Resources (NIWR) 104(b) grant.

Microplastics, plastic fragments that are smaller than 5 mm in any dimension, have been found in ecosystems worldwide. These emerging contaminants are even in environments that are supposed to be free from human contact, such as Antarctica and the deep ocean floor, and their toxic properties make them a significant environmental hazard. "After the first acknowledgement of microplastics in the early 2000s, their presence in the environment has raised ever-increasing concerns because of their effects on organisms and ecosystems, and because approximately 1.5 million tons of microplastics are estimated to be released into aquatic environments every year[1]," explains Dr. Erick Bandala, the principal investigator of this project, which also includes Dr. Menake Piyasena from New Mexico Tech, graduate research assistants Adam Clurman and Ahdee Zeidman, and summer intern Yajahira Dircio. "Unfortunately, very little is known about the capability of engineered separation and/or degradation

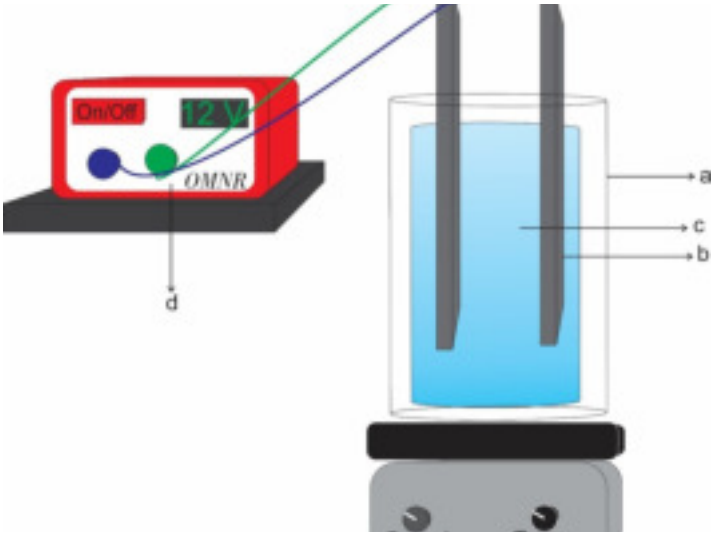
Adam Clurman, an undergraduate student at Nevada State College, is conducting the electrocoagulation experiments for the project (photo by Erick Bandala).

(Project Spotlight continued)

technologies to remove this highly ubiquitous contaminant."

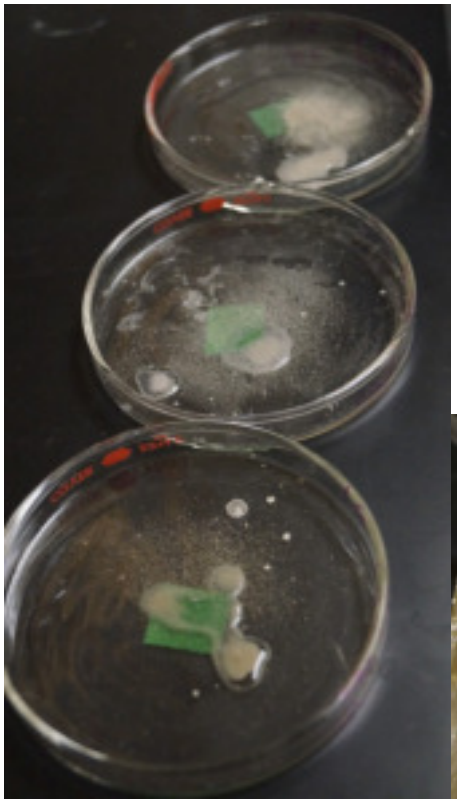
Commercial products that are manufactured to contain microplastics—such as personal care and pharmaceutical products, industrial abrasives, drilling fluids, and 3D printing products—are the primary sources of microplastics. However, the degradation of plastic debris can also generate microplastics. "Wastewater treatment plant effluents are the main pathway for microplastics to be released into aquatic environments," Bandala says. "Although the microplastic removal rate of a conventional wastewater treatment plant is reported to be in the range of 73 to 79 percent, the treated effluent can carry as much as 220,000 to 1.5 million[1] microplastic particles per day."

In recent years, the effects microplastics have been found to have on aquatic species and their unknown effects on human health have increased concerns about their presence in water sources. "Because conventional water treatment processes are unable to effectively eliminate microplastics in water, developing new technologies that can separate them from effluents and prevent their release into the environment is a high priority to protect water quality and water security," Bandala says.



Schematic of electrocoagulation setup used to remove microplastics from water: a) 1.5 L beaker, b) aluminum electrodes, c) water sample, and d) power supply (schematic courtesy of Erick Bandala).

For this project, the researchers will use acoustic focusing and electrocoagulation to separate microplastics from freshwater effluents and determine the removal process mechanisms. "Acoustic standing waves are a fast, noncontact, gentle particle-manipulation technique for microfluidic conditions that have emerged as a promising new technology for the purification, separation, and concentration of beads and biological cell samples," Bandala explains. The researchers will also assess the efficacy of using electrocoagulation to remove MPs from wastewater. "Electrocoagulation has several significant advantages to conventional chemical coagulation, such as it increases treatment efficiency, generates less sludge, requires less space, and prevents chemical storage," Bandala adds. "It has been proven to be highly efficient in removing contaminants. Our research group has used it for water defluoridation and to pretreat effluents that were heavily contaminated with petrochemicals."



Left: Petri dishes of hydrochar prepared using MPs that will be used in advanced oxidation processes.
Right: The sand band used to prepare hydrochar from MPs (photos by Erick Bandala).

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(Project Spotlight continued)

Because microplastics are increasingly detected in freshwater, it is even more important to find effective water treatment process that remove them. "Although ultrafiltration, or microfiltration, have microplastic removal efficiencies as high as 99.4 percent, they also have high operational and maintenance costs and require skilled operators," Bandala explains. "Finding efficient, cost-effective methods to separate microplastics from freshwater effluents is critical to preventing population exposure."

Another challenge that microplastics present is how to dispose of them once they are removed from water. For this project, the researchers will use advanced oxidation processes (AOPs) as complementary processes to degrade the plastic waste after it has been separated from the wastewater. Advanced oxidation processes are an eco-friendly way to degrade organic compounds. In previous projects, the research group has tested the capability of these processes to degrade a wide variety of dissolved organic contaminants in water. "Advanced oxidation processes have been used to degrade organics and have shown high cost-efficiency and short detention time compared with conventional water treatment processes," Bandala explains. "Using AOPs to degrade microplastics will not only be an interesting challenge because of the complexity of their polymeric chains, but also because these contaminants are suspended in water and treating contaminants in a different phase in water using AOPs has not yet been reported."

Yajahira Dircio, a student at Rancho High School and summer intern on the project, is preparing hydrochar from MPs using a sand band (photo by Erick Bandala).

Maintaining the quality of water sources is an increasing issue, particularly in arid and semiarid regions with rapidly growing populations, such as Nevada. "Desert Research Institute has reported the presence of MPs in places such as the Sierra Nevada and Lake Tahoe, which are the origin of several drinking water supply systems in Nevada," Bandala explains. "We live in a region with a moderate-high water stress and as Nevadans, we need to protect our water sources from contamination to ensure the sustainable development of our communities." ■

Reference

[1]Pico, Y., A. Alfarhan, and D. Barcelo, 2019. Nano- and microplastic analysis: Focus on their occurrence in freshwater ecosystems and remediation technologies. *TrAC Trends in Analytical Chemistry,* 113, 409-425, doi:10.1016/j.trac.2018.08.022.

"We live in a region with a moderate-high water stress and as Nevadans, we need to protect our water sources from contamination to ensure the sustainable development of our communities." – Erick Bandala

Student Interview: Joanna Joseph

We asked graduate research assistant Joanna Joseph about her current studies and plans for the future. Here's what she had to say:

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

I'm a graduate student at the University of Nevada, Las Vegas, and I'm pursuing a master's degree in public health with an emphasis on epidemiology and biostatistics. I'm also a research assistant in the Division of Hydrologic Sciences at Desert Research Institute (DRI). I graduated from the University of Nevada, Reno, with a bachelor's degree in molecular microbiology and immunology with a minor in biochemistry. My degree covered several biological disciplines, but I was most interested in learning about the transmission and pathogenesis of bacteria, parasites, and viruses. I wanted to learn about disease processes and how they are diagnosed and treated so that one day I can contribute to addressing ongoing public health concerns.

After completing my bachelor's degree, I became interested in Dr. Xuelian Bai's research on chemical contaminants, such as pharmaceuticals, and how chemicals entering the environment can affect aquatic species and human health. I learned that we must first understand the relationship between humans and the environment to find satisfactory solutions to the problems affecting the well-being of humans and the environment. This research sparked my interest not only because of the scientific questions we tackle, but also because of the relevant social and ethical issues about the effects of human activity on environmental and population health.


Photo by Janelle Joseph

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

I'm currently working on the NWRRI project "Evaluation of Antibiotic Resistance Genes (ARGs) in the Urban Wetland Ecosystem: Las Vegas Wash." We collected water and soil samples from the Las Vegas Wash wetlands. I then extracted DNA from these samples and ran them through a qPCR (quantitative polymerase chain reaction) to detect and quantify ARGs in the soil and water samples.

I'm also working on a project that assesses the uptake of microplastics in the species *Daphnia magna*. *Daphnia* are freshwater planktonic organisms that are also filter feeders. I am responsible for raising the *Daphnia* in controlled aquatic environments. I feed them algae and microparticles, as well as monitor the number of microparticles they consume over a certain amount of time. To count the microparticles, I chemically isolate the *Daphnia* from the microparticles and count them using a microscope. I'm also studying how the consumption of the microparticles by *Daphnia* affects their health and reproduction rate. This project will help us understand how certain contaminants affect aquatic environments and how they can pose a threat to both aquatic and human life.

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

For our research on ARGs, I would like to know if different amounts of antibiotic concentrations contribute to the amount of ARGs identified. I would also like to identify and isolate the bacteria found in our water and soil samples and determine if they are resistant to certain antibiotics. This can give us information on how prevalent antibiotic resistance is within the Las Vegas community.

As we continue to assess the uptake of microparticles by *Daphnia*, I hope to learn more about the effects of polyfluoroalkyl substances on human health. Polyfluoroalkyl substances are potentially carcinogenic, so learning as much as possible about them could help us raise awareness about using products that contain these substances.

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

I'm looking forward to using the data we collect from these projects to raise awareness about antibiotic resistance and emerging water contaminants in our local water sources. This research raises questions about how effective our current wastewater treatment processes are in targeting harmful substances and chemicals. It also raises questions about the safety of our drinking water and the water and soil we use to grow food.

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

While I pursue my master's in public health, I hope to continue researching the fate and effects of emerging contaminants in our water systems. I hope that this research will raise public awareness about the role human activities play in environmental and public health.

My ultimate goal is to become a physician. I want to become a doctor who considers more than just diagnosis and treatment. I also want to consider the implications of disease in the community and the environment. I believe this research at DRI brings me a step closer to this goal.

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

One of my favorite books of all time is *Frankenstein* by Mary Shelley. Many people think they know this story because of the many popular movies and TV shows, but the book isn't like the mainstream adaptations. In the story, Frankenstein is the doctor who creates the monster. It is interesting to read about how the creature was never initially a monster, but his creator's inhumanity and lack of empathy transformed him into one. The creation of the monster was a great scientific achievement, but it makes me wonder whether it was worth it in the end. The story is haunting, suspenseful, and very thought-provoking. Every time I read it, I learn something new.

7) Cake or Pie?

Ice cream and brownies all the way. ■

"I want to become a doctor who considers more than just diagnosis and treatment. I also want to consider the implications of disease in the community and the environment." – Joanna Joseph

Upcoming Events

Please keep an eye on the event websites for changes in conference schedules.

Water Rights in Nevada Class
September 15, 2020
Winnemucca, NV
www.nvwra.org/2020-sept-water-rights-class

Advanced Water Rights in Nevada Class
September 16, 2020
Winnemucca, NV
www.nvwra.org/2020-sept-advanced-water-rights-class

Webinar: Failure is Not an Option: Using Social Infrastructure for Urban Water Delivery When There's No Engineering Solution
September 23, 2020
www.awra.org/Members/Events_and_Education/2020_Webinars/WEBINAR_Failure_is_Not_an_Option.aspx

GSA 2020 Connects Online
October 26-30, 2020
community.geosociety.org/gsa2020/home

2020 Virtual Annual Water Resources Conference
November 9-12, 2020
www.awra.org/Members/Events_and_Education/Events/2020_Annual_Water_Resources_Conference.aspx

2021 NWRA Annual Conference Week
January 25-28, 2021
Sparks, NV
www.nvwra.org/2021-ac-week

Nevada National Security Test Site Tour
March 31, 2021
Las Vegas, NV
www.nvwra.org/2021-march-nnss-tour

Truckee River Tour
May 6 & 7, 2021
Reno, NV
www.nvwra.org/2021-truckee-river-tour

2012 June Well & Water Week
June 14-17, 2021
Reno, NV
www.nvwra.org/2021-june-well-water-week

Nevada Gold Mines Tour of Twin Creeks Mine
September 14-15, 2021
Winnemucca, NV
www.nvwra.org/2021-nevada-gold-mines-tour

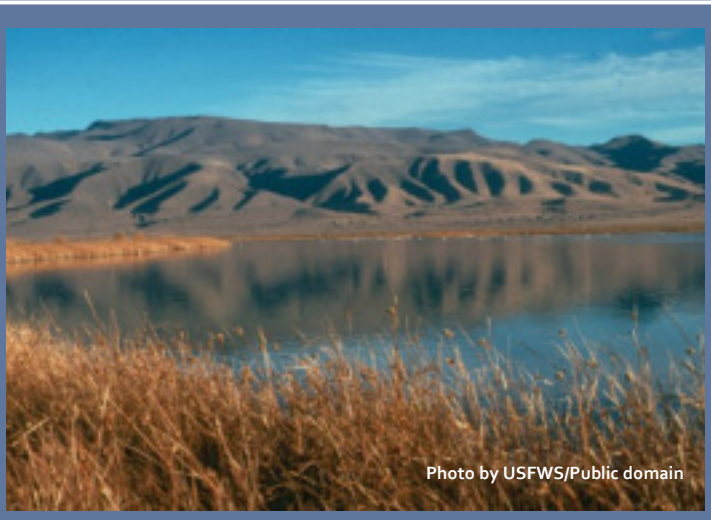

Photo by USFWS/Public domain

2021 Tour of Marlette Lake Water System
September 22, 2021
Washoe Valley, NV
www.nvwra.org/2020-marlette-lake-tour

2022 NWRA Annual Conference Week
January 31- February 3, 2022
Las Vegas, NV
www.nvwra.org/2022-annual-conference-week

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.

DRI Desert Research Institute | Nevada Water Resources Research Institute

www.dri.edu/nwrri

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