THE UNIVERSITY OF ALABAMA® | Alabama Water Institute

QUARTERLY NEWSLETTER • Volume 5 No. 3

UA AWARDED $3M FOR GRADUATE TRAINING IN WATER OPERATIONS AND FORECASTING

The University of Alabama's award from the National Science Foundation establishes a unique hydrologic science research and training program for graduate students.

By Brock Parker

The NSF Research Traineeship award, or NRT, will bring together master's and doctoral students from a variety of water disciplines. UA's new project, called Water-R2O, will start them on a career path that will meet the research-to-operations needs of hydrologic researchers, forecasters and decision makers in government, private and academic sectors.

"We're facing major water challenges, and this provides an opportunity, a model, for how we can prepare students to enter into the workforce, address those challenges and to help cutting edge water research be fast-tracked for use in water operations and forecasting," said Dr. Steven Burian, director of science for the Alabama Water Institute and professor of civil, construction and environmental engineering.

Water-R2O will be overseen by a group of 11 faculty members and welcome its first class of students in the fall of 2023. While taking classes in their respective disciplines, students will earn credit towards an operational hydrology program certificate.

The program will aim to train 117 students over the first five years of the program, including 28 funded trainees from civil engineering, computer science, geography and others in the future.

"Our expertise is in hydrologic prediction and forecasting. To advance it further, we are working towards integration of physics-based models with machine learning-based methods," said Dr. Mukesh Kumar, an associate professor of civil, construction and environmental engineering. "Collaboration with computer scientists is needed in that regard. This project nicely groups us together."

The program will aim to train 117 students over the first five years of the program, including 28 funded trainees from civil engineering, computer science, geography and others in the future.

Dr. Jiaqi Gong, associate professor of computer science, said they have two focuses as it applies to artificial intelligence and machine learning for Water-R2O. On the research side, they will examine how models are being developed and what the limitations are from a mathematical perspective. From an educational standpoint, they want to make sure students fully understand how these fit into the overall picture.

"AI and machine learning are both getting a lot of attention from different research fields and how they are applied to the decision-making process of water operations systems," said Gong. "This is a great opportunity to work together with the other majors and help to clear up any questions about them."

Dr. Lisa Davis, associate professor of geography, said her research with natural environmental records brings a different perspective to improving forecasts and water modeling. Natural records, such as tree rings and flood sediments, contain long archives filled with centuries to millennia of data about a variety of extreme events that are underrepresented in instrument records.

"Combining long data sets from natural archives with instrument data greatly reduces the uncertainty associated with forecasts of extreme floods and droughts because the natural data contain substantially more observations of extreme events," said Davis. "This approach has been underused in water operations and forecasting to date because natural scientists, engineers, and water operations communities are disconnected, and we aim to change this. A big focus of the NRT is establishing and growing water community connec-

(continued on next page)

UA AWARDED $3M FOR GRADUATE TRAINING

(continued from previous page)

Dr. Steven Burian

tions through educational endeavors."

Dr. Wanyun Shao, a social scientist and assistant professor of geography, said she will integrate her research expertise on risk decision making within a geographic context into the program.

"Students will learn about the theories and methods in risk perceptions and judgments under uncertainty, risk mitigation behaviors and risk communication in order to identify means and tools to close the knowledge gaps between scientists and end users," said Shao. "This training can prepare them better to translate cutting-edge hydrological research into actionable information for end users."

Seven external partners will collaborate with UA faculty members for the NRT: NOAA's National Water Center; U.S. Geological Survey; Tennessee Valley Authority; RTI International; Baron Weather Inc.; Jupiter Intelligence; and Pacific Northwest National Laboratory.

They are interested in a hands-on approach and will be involved as advisors and mentors, as well as help design the research projects and host the students as interns. UA's team points to this as a key part of the research-to-operations aspect of the program.

"There will be instances where students take classes with them and will work on real problems and data sets," said Davis. "This obviously meets the purpose of mentoring the students in operations and forecasting, but it also helps introduce them to different corporate and workplace cultures so they can see what's out there and what's the best fit for them."

The AWI also has a role in terms of project coordination, administrative duties and helping with external partnerships and relationships. Both faculty members and AWI will foster education, research and collaboration not only nationally, but regionally as well.

"A big motivation for the development of our team is to help solve and work towards solutions in all of water," Davis said. "That need also exists at the community level, and we are interested in increasing partnerships here in the state and at the municipality levels."

Students interested in the Water-R2O program will have to apply.

The team will be introducing the program and recruiting students over the next academic year.

"It will be an aggressive recruiting process to attract the best students," said Burian. "We'll be looking for a cohort with strong interests in applying research to create solutions to ongoing and future water challenges facing society."

The NRT Program is designed to encourage the development and implementation of bold, new potentially transformative models for STEM graduate education training. The program is dedicated to effective training of STEM graduate students in high priority interdisciplinary or convergent research areas through comprehensive traineeship models that are innovative, evidence-based and aligned with changing workforce and research needs.

AWI NAMES SECOND CLASS OF FACULTY FELLOWSHIP RECIPIENTS

The Alabama Water Institute has selected three faculty members from The University of Alabama to serve as 2022-25 fellows in the AWI Faculty Fellowship Program.

By Brock Parker

The program recognizes UA faculty for outstanding research, extension and education programs that significantly advance UA's interdisciplinary water-related communities of science.

The 2022 Early Career AWI Faculty Fellows include:

Hamed Moftakhari, assistant professor of civil, construction and environmental engineering, College of Engineering.

Matthew VanDyke, associate professor of advertising and public relations, College of Communication and Information Sciences.

The 2022 Distinguished AWI Faculty Fellow includes:

Gregory Starr, professor of biological sciences, College of Arts and Sciences.

"These AWI Fellows exemplify the depth and quality of our faculty at The University of Alabama, as well as the research they conduct," said Scott Rayder, AWI executive director. "I am excited to work with these new fellows who will be terrific ambassadors for water research here in Alabama and beyond."

Two Early Career and one Distinguished Faculty Fellowships are awarded each year by AWI to candidates affiliated with the institute. Each fellowship has a tenure of three academic years and is accompanied by an annual salary stipend.

Selected fellows have shown evidence of strong interdisciplinary, water-related research, education and extension programs. Their research, education and extension priorities align with AWI's mission to both carry out cutting-edge and applied research and to train the next generation of scientists to provide actionable, novel solutions for a more water-secure world.

The 2022 AWI Faculty Fellows are Dr. Gregory Starr, left, Dr. Hamed Moftakhari, middle, and Dr. Matthew VanDyke, right.

AWI Faculty Fellows serve as representatives committed to contribute to AWI's initiatives during their term and help promote the institute across UA, its partners and to the public. AWI Faculty Fellows also increase the visibility and impact of the institute by participating in its monthly talk series and by submitting two interdisciplinary AWI proposals.

The creation of the AWI demonstrated the commitment of UA to be a premier research and education institution around water-related issues. AWI's goal is to become a world-class interdisciplinary water research institute that develops pathbreaking, holistic and environmentally friendly solutions to ensure people and ecological systems in our community, state, nation and around the world have access to clean water and are resilient to extreme events.

AWI Faculty Fellows collectively provide a community of science to the UA campus that can respond to multiple interdisciplinary research opportunities and build a portfolio of projects and initiatives that benefit not only the University, but all of society.

HOW TO GET AFFILIATED WITH THE ALABAMA WATER INSTITUTE

If you have expertise that could contribute to addressing complex water issues, please register yourself on our website. All registered members are considered affiliated with AWI and have access to all AWI resources.

To register, visit the AWI website: *awi.ua.edu*

Eligibility Criteria:

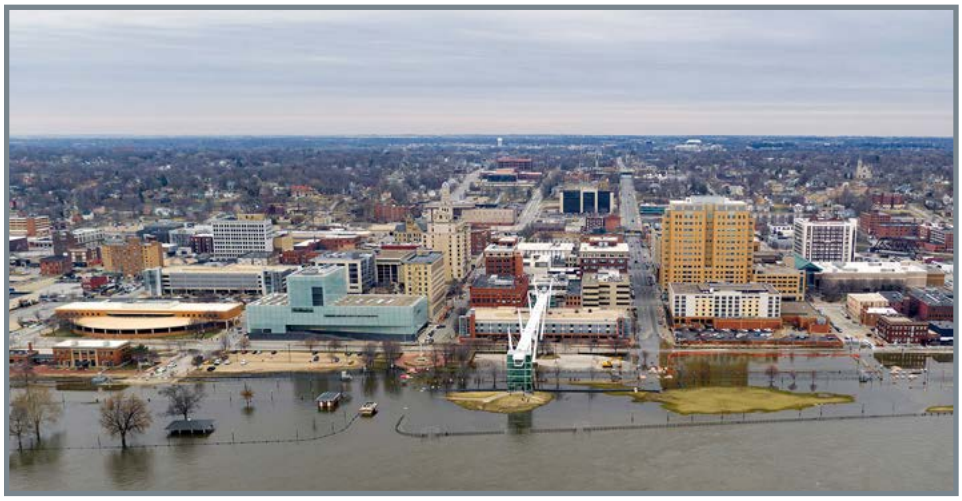
- A faculty/staff/student appointment at UA.
- Research expertise in a water-related field.
- Completion of registration form.

For questions contact Stefanie O'Neill at: soneill2@ua.edu or 205-348-9128

Affiliated Member Information:

awi.ua.edu/awi-affiliated-members/

PILOT PROJECT TO SUPPORT EQUITABLE CLIMATE RESILIENCE ALONG THE UPPER MISSISSIPPI RIVER



NOAA and its partners are launching a new pilot project to study flooding on the Mississippi River and how to better protect the most vulnerable communities.

The pilot project, "Building Knowledge to Support Equitable Climate Resilience," which includes a $150,000 NOAA investment in FY22 and in-kind services from partners at the Cooperative Institute for Research to Operations in Hydrology through the University of Alabama, the University of Minnesota, and the Upper Mississippi River Basin Association, has two objectives:

Better understanding the flow patterns of the upper Mississippi River to provide data on how the river will likely respond to changing climate conditions. This data is crucial for communities to plan for both flood and low flow conditions.

Engaging vulnerable communities to enhance their climate resilience. Customized community engagement strategies for key sets of stakeholders allows NOAA and partners to collaboratively build long-term, respectful partnerships and relationships with underserved communities. Overall, his work is intended to improve the understanding, interpretation and use of these forecasts and hydrological data products and services to improve preparedness and resilience.

"Equity and resilience are core drivers of the work that happens every day at the Commerce Department," said Deputy Secretary of Commerce Don Graves. "Bringing together NOAA's climate science expertise and the local needs of upper Mississippi River communities will ultimately help our most vulnerable populations be more ready and resilient to climate threats."

"This project demonstrates how NOAA puts equity into action by working with communities from start to finish to provide meaningful insight into climate risks," said NOAA Administrator Rick Spinrad, Ph.D. "Ensuring that vulnerable communities are better equipped to prepare for and respond to extreme weather and climate change is a critical part of building a Climate-Ready Nation."

The pilot project was developed in response to feedback received during a 2021 climate and equity roundtable focused on flooding and resilience in the Mississippi River Basin, one of eight roundtables hosted by NOAA across the country with underserved and vulnerable communities and bridge organizations to better understand the issues they face in regards to climate change.

"Often, communities know what they need to be resilient — what they need is our help getting there," said Vankita Brown, NOAA senior advisor for equity. "NOAA is proud to strengthen these meaningful connections with communities along the Mississippi River, and develop climate products that benefit all users."

"The NOAA Climate and Equity Roundtable provided valuable insight into the unique and shared challenges of communities in responding to, and preparing for natural disasters along the Mississippi River," said Kirsten Wallace, executive director of the Upper Mississippi River Basin Association. "The Roundtable also created a helpful forum for connecting various individuals and entities working separately but towards the same common goals of improving climate resilience and social equity."

This pilot builds on NOAA's commitment to sustained engagement with underserved communities, and is part of an investment in seven pilot projects in the coming years. Each regional pilot will respond directly to feedback received from partners during climate and equity roundtable discussions that were conducted in 2021. Pilots will take a unique, place-based approach to helping vulnerable communities better understand, prepare for, and respond to climate change.

Article reprinted from NOAA's website: https://www.noaa.gov/news-release/pilot-project-to-support-equitable-climate-resilience-along-upper-mississippi-river

Please follow us on social media.

@AlabamaWaterInstitute
@AlabamaWater
@Alabama_Water
Alabama Water Institute

UA RESEARCHER INVESTIGATES DRIVERS OF ANTARCTIC ICE RETREAT

An investigation of how an Antarctic ice sheet melted thousands of years ago will improve contemporary climate models and projections of rising sea level, according to a recently published study with contributions from The University of Alabama.

By Adam Jones

Led by the University of Tokyo, researchers identified the mechanism for large-scale melting and retreat of the West Antarctic Ice Sheet 9,000 to 6,000 years ago, and current conditions suggest this mechanism is also a major driver of extensive melting events over the past 30 years, according a paper published in Nature Communications in May.

The research team analyzed sediment samples from the seafloor near part of the ice sheet in the Amundsen Sea.

"The samples were actually collected during my first expedition to Antarctica many years ago, and from tiny fossils in sediment on the seafloor, we were able to show that warm ocean water melted an ice shelf from below thousands of years ago," said Dr. Rebecca Totten, UA assistant professor of geological sciences. "The great thing about this collaborative study is that we applied a new chemical technique to those samples and found that earlier periods of atmospheric warming were also really critical to the stability of major glaciers in Antarctica's past."

The team's work revealed an influx of warm and moist air from an "atmospheric river" blowing over the ice sheet from the Pacific Ocean was triggered during a massive glacial retreat roughly 11,000 years ago. Recently, a similar band of humid air has been observed over the South Pole, causing temperatures to rise close to 14 degrees Fahrenheit, or about 70 degrees higher than normal, in March 2022.

Photo courtesy of Linda Welzenbach, Rice University

Climate scientists are focused on the stability of the West Antarctic Ice Sheet, which is experiencing drastic changes each season that signal its response to a changing climate, as its melting is a major contributor to global sea-level rise, possibly raising sea level by 5 meters if melted away.

"The great thing about this collaborative study is that we applied a new chemical technique to those samples and found that earlier periods of atmospheric warming were also really critical to the stability of major glaciers in Antarctica's past."
-Dr. Rebecca Totten

However, attention has been mostly focused on warm seawater flowing against the ice sheet, and less was known about whether atmospheric conditions were directly causing surface melting in this region.

Totten, a marine geologist and paleontologist, searches for microscopic clues to the past ice behavior by searching through the mud offshore for tiny, single-celled plankton. By studying what the ice sheet and ocean left behind, her team can inform models of how the West Antarctic Ice Sheet will behave in the future.

"It's just like stepping back in time because each layer of sediment tells you about a different time period and how the ocean and glaciers were changing," she said.

Specifically, Totten and her students look for the remains of microscopic, single-celled organisms, called diatoms and foraminifera, that have been preserved in these offshore sediments for thousands of years. The abundance of the microfossil remains and the species that were living at different intervals provide clues about the water that nourished them.

Totten's work, alongside the new chemical analysis of sediment at the Atmosphere and Ocean Research Institute of the University of Tokyo, reveals that not only did warm seawater melt ice shelves from below, but atmospheric warming melted major regions of West Antarctica in the past due to warming through atmospheric rivers.

Building a fuller picture of the ice sheets' behavior in the past, especially during major events in global climate change, will provide information for predictive models of ice stability and global sea-level rise, which will ultimately impact populated coastal areas in Alabama and the northern Gulf of Mexico.

The work was supported by the Japan Society for the Promotion of Science and the National Science Foundation.

UA RESEARCHERS TO STUDY GULF COAST SEVERE WEATHER COMMUNICATIONS

A new study by a team of professors from The University of Alabama's College of Communication and Information Sciences will examine the effectiveness of public messaging to help residents along the Gulf Coast stay safe during extreme weather events.

By Brock Parker

Drs. Cory Armstrong, professor of journalism and creative media, Matthew VanDyke, assistant professor of advertising and public relations, and Brian Britt, associate professor of advertising and public relations, are supported by the the Mississippi-Alabama Sea Grant Consortium for the project.

They will analyze social media discussions and conduct interviews and surveys to understand the information channels, tools and resources that coastal emergency managers, community leaders and residents use for short-term and long-term decision-making when preparing and going through severe weather.

"We're not weather experts, but we're communication experts," Armstrong said. "What we can bring to this project, and what's appealing to the Sea Grant folks, is that we can understand communication and distribution of these messages and how to measure that, how to understand it and how to then give recommendations for how these experts get their messages out."

Understanding how the public receives and acts upon severe weather alerts and warnings can help emergency managers craft the most effective messages to save lives. The team will focus on the three southernmost emergency management areas of Mississippi and the two southernmost areas in Alabama.

The study will take place during three phases over the course of two years. The first phase will consist of analyzing conversation patterns on social media. By searching keywords, hashtags and specific date ranges on those platforms, the team can evaluate how people seek and relay information and concerns before, during and after extreme weather events.

"Before these tools were available, you'd have to rely on survey data and retrospective-type stuff that would be harder to get a full and perhaps accurate picture of how things played out," said VanDyke. "This is an exciting new application for the theory, but to also get a more valid snapshot of what public discussion looks like in these areas."

The second phase has an engagement plan where the team will interview decision-makers, such as emergency managers and city officials, to understand when they decide to start preparing before a storm arrives, what tools they use in making those decisions and how they process risk factors to their areas.

"Decision-makers may or may not have the technical background and understanding to be able to decipher the meaning of uncertainty," VanDyke said. "What scientists mean by uncertainty might be different than how we in the general public interpret uncertainty, so being able to marry both public and decision-maker needs is really important."

Focus groups will also be conducted with community members and public opinion leaders to see how they evaluate official messages and how they're going to make choices during these storms.

"Comprehension and terminology are the big issues," said Armstrong. "I can see the need for training and awareness of what watches, warnings and these types of terms mean, or maybe coming up with some more uniform terms to talk about coastal issues."

The third phase will use large-scale sample surveys to determine the differences in information processing and tools, with a specific focus on comparing underserved, urban and rural populations.

"People who live in urban areas have this belief that it's not going to happen to them or not going to be that big of a deal," Armstrong said. "Then there's the people in rural areas that live in flood plains. Every time a huge storm comes in, they're getting flooded, and it may be that they're more prepared than others because it happens so frequently."

Armstrong said taking all this information and coming up with a mitigation plan, especially in underserved areas, is one of the key goals of this study.

"We're talking about people with limited resources who don't have ways to evacuate," she said. "Hurricane Katrina proved sometimes you just can't leave. What kind of plans can we make for these people who can't or won't evacuate? I'm always concerned about that."

The team will be providing their findings after each phase so decision-makers can continuously analyze and update their plans as the project progresses. A summary of the entire study will be made available to the academic and practitioner communities at the end of the two-year period.

"Here at Alabama, there's a big push to get more resources built, more information pooled, more accurate forecasts, and it's just marrying that with where people actually are," said VanDyke. "In a lot of cases, it's not an information problem as much as it is an infrastructure problem, or as much as it is values or personal experience or whatever that barrier is that prevents people from using that information."

UA RESEARCHERS DEVELOP CHEMICAL SENSORS TO DETECT ANTIBIOTIC OVERUSE IN WATER

By Brock Parker

Antibiotics are widely used medications that can prevent or slow down the growth of bacteria in humans and animals. They can also be added to animal feed to improve growth rates and the effectiveness of the food.

There are significant downsides to their widespread use. If antibiotics are misused or even counterfeited, they can damage a living being's health, reduce their efficacy, and harm the environment. Researchers at The University of Alabama have developed an easily accessible rapid and portable optical chemical sensor method to detect antibiotic overuse, counterfeiting and pollution in water.

Dr. Marco Bonizzoni, associate professor in The University of Alabama's Department of Chemistry and Biochemistry, and Yifei Xu, a chemistry graduate student, published their findings in the journal Sensors. Two papers detailing their research appeared in the journal's special issue, "Sensors and Applications in Diagnostics, Food and Environmental Analysis."

"We use this family of relatively complex polymers that are called poly(amidoamine), or starburst dendrimers," said Bonizzoni. "The magic is to combine them with fluorescent dyes in appropriate conditions and proportions that we found optimal. The great part is all of these components are commercially and readily available off the shelf."

Bonizzoni and Xu developed this method to test for antibiotics in surface water and agricultural runoff downstream from farms. Animal waste winds up in the water, and the chemical sensors can detect if excessive amounts of antibiotics are present.

A dangerous consequence of overuse is forcing natural selection into the bacteria population. Abuse creates multiantibiotic-resistant strands of bacteria. If an overabundance of antibiotics is found in animals, those antibiotics can later wind up in humans after consumption. Similarly, antibiotic-resistant bacteria can then infect the human population as well.

Water samples are already sent to labs for testing on a regular basis, so field testing and determination can reduce the time and resources of shipping and analysis.

"We're not going to replace a trained chemist in a specialized lab, but we may be able to unburden them," said Bonizzoni. "Instead of sending them 100 samples, you would send them the 10 that you think are likely to lead to something."

Using chemical sensors for instant determination can lead to a more efficient process for regulation and enforcement, particularly when drug components are imported into the United States from another country.

Bonizzoni said like all drugs for animal or human use, antibiotics are a target for fraud. Their method can give you an idea of whether you actually received the antibiotic listed on the box. Using chemical sensors for instant determination can lead to a more efficient process for regulation and enforcement, particularly when drug components are imported into the United States from another country.

"If a shipment of antibiotics arrives at customs, do I want to block it there and send it out for extra analysis, or do I just release it? If I can do a quick test that says it is probably fine, then you just release it and move on," said Bonizzoni. "The container doesn't sit there, and the customer is happy. If you have some doubts, then you fall back on your regular routine."

Bonizzoni and Xu's first journal article established their sensor method could be used to detect biomedically relevant targets in water. When it proved successful, they expanded on that idea to show their platform is general enough to be applied to environmental problems as well as the drug counterfeiting issues.

"On one hand, you had very simple, yet very hard to detect carboxylate anions that are elusive targets because they are really small and kind of featureless," he said. "On the opposite end of the scale, we went with something big and complicated to show that we could do that, too. It just so happens that both of those are interesting in their own right, but to us, they were both opportunities to showcase the fundamental principle of the method that we developed."

Bonizzoni said the data processing for the field work is very simple and can be done on a smartphone. He hopes to later have an app developed to further enhance their testing, but their chemical sensor recipe for detecting antibiotics in the field is proving successful thus far.

"It has to be portable, simple and pretty robust so it can be used in the field as a point of use and application, so we hit the sweet spot for that because the components of our system are off-the-shelf," he said. "All you have to do is mix these things according to the recipe we developed, and you have a relatively easy and portable way of detection."

UA RESEARCHERS HIGHLIGHT NEED FOR GAUGES IN INTERMITTENT WATERWAYS

By Brock Parker

One of the keys to managing freshwater ecosystems is knowing where and how rivers flow. Stream gauges provide that information, but they are located predominantly in large perennial, or constantly flowing, waterways. However, researchers at The University of Alabama suggest that focusing on non-perennial streams and rivers, or waterways that dry on a regular basis, provides critical information for water and natural resource management.

Dr. Nate Jones, assistant professor of ecohydrology in UA's Department of Biological Sciences, is one of the authors of a paper recently published in the journal Nature that stresses the need for more stream gauges where water runs out.

"We often pay for stream gauges because there's some sort of human need associated with them, such as predicting floods, monitoring drought and understanding ecosystems," said Jones. "It's important that we have those gauges, but we aren't gauging in the non-perennial streams where over 60% of the river miles globally go dry on a regular basis."

According to Jones, even 40% of Alabama's streams dry up every year. That may come as a surprise because one-tenth of all freshwater in the United States begins or flows through the state, but it is a concern.

"We predict we're going to see more and more drying here in the Southeast, and I think it's going to play an important role in both water and ecosystem management," he said. "We're spending so much time studying these because we think that having actionable knowledge is going to be quite important within the next 30-40 years."

While southeastern states are typically rich with water, the story is much different out west. Here in the Southeast, you can step across streams when they dry up. In the western U.S., entire rivers can disappear, causing water resource concerns for officials. Adding more stream gauges in the places that routinely lose water can help water managers determine how to more efficiently manage their supplies.

"When you're in the more arid environments, the duration of that drying is really important," Jones said. "People need to understand how long that tap will be turned off before they can get more water."

From a water quality perspective, Jones compared intermittent streams to capillaries in the lungs. There are a lot of them, but because they're so small, you might not think it's a big deal if one becomes damaged. Together, though, they take up a lot of surface area where the gas exchange of oxygen and carbon dioxide occurs in the body.

"When you think about carbon and nitrogen fluxes in water, the small streams are like the capillaries of a river network," he said. "They're really the first place the carbon and nitrogen enter the stream network and start spiraling downstream."

From a biological viewpoint, the disturbance regime, the drying and re-wetting of these non-perennial streams, plays an important role in partitioning the different types of species and the biodiversity of these environments.

The lack of gauges in intermittent streams is not only a problem that needs solving here in the U.S., but also around the world. Global stream gauge data is publicly available for researchers to use in models and forecasts. Extra gauges in low-flow areas will be beneficial because so much of the world's freshwater originates in those locations.

"As an example, we know water and natural resource managers have to make decisions that balance multiple objectives," said Jones. "By providing actionable information about non-perennial streams and rivers, we can help managers better optimize those decisions to improve downstream water quality and promote biodiversity while also balancing other competing objective associated with water quantity."

Jones said their research highlights the need to address current gauge placement biases by investing in and prioritizing the installation of new gauging stations to increase accessibility of local and regional gauging data to support human responses to water challenges.

"We wanted to quantify the bias for the scientific community to understand where our gap in knowledge is and how it affects our understanding of hydrologic systems and ecosystems," he said. "We can start to correct that through research grants, modeling and the like so that it's no longer an 'unknown' unknown."

Alabama Water Institute Newsletter
Vol. 5 No. 3

Executive Director: Scott Rayder
Comm. Director: Zach Krauss
Sr. Designer: David Galinat
Sr. Editor/Writer: Brock Parker

THE UNIVERSITY OF ALABAMA | Research & Economic Development
Alabama Water Institute

PART OF THE University of Alabama System