THE UNIVERSITY OF ALABAMA® | Alabama Water Institute

NEWSLETTER

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USGS DIRECTOR REVEALS VISION, NEW FACILITY PLANS FOR COLLABORATION WITH ALABAMA WATER INSTITUTE

During a recent visit to The University of Alabama, U.S. Geological Survey Director Dr. Jim Reilly touted his vision for USGS Water Resources, as well as what the future holds with its partnership with the Alabama Water Institute.

By Brock Parker

Reilly met with several members of the UA leadership and faculty members, including an online town hall in which he and USGS Associate Director for Water Resources Dr. Don Cline discussed the agency's strategy for water.

"Water is the core solvent for any carbon lifeform, so without water we're pretty well out of luck," Reilly said. "It is the one agent that is going to stand atop pretty much everything we do."

Reilly laid out USGS' goals when it comes to water science strategy. The first is to provide society the information it needs regarding the amount and quality of water in all components of the water cycle, as well as helping understand the processes that determine water availability. As changes in climate, population, land use and management occur, they want to predict variables in the quantity and quality of water resources. He said they also want to elevate anticipation and response to water-related emergencies and strive to deliver timely data, analysis and tools anywhere in the U.S. to support water resource decisions.

USGS operates the largest water observation system in the country with more than 10,000 real-time streamgages, which provide in excess of 80,000 streamflow measurements per year. The agency also observes groundwater conditions at more than 17,000 wells and continuously monitors water quality at 2,100 stations.

With more than 1.2 billion water observation data requests in 2019, they are identifying ways to upgrade their capabilities. Reilly said they are working on the USGS Next Generation Water Observing System, which will gather higher-resolution, real-time data using modernized collection, storage and delivery methods. He said they want to get that data out more quickly to organizations that need it, and it's becoming more imperative to collaborate with other entities.

"It's now becoming integrated and will go interagency," Reilly said. "There are lots of efforts that will go into this work that we'll combine with NOAA, for example, which is one of the reasons we really like where we're headed on The University of Alabama campus."

Within the next few years, the USGS will have a physical home at UA. A new Hydrologic Instrumentation Facility, or H.I.F., will be constructed close to the current location of the AWI and NOAA's National Water Center.

"It's important because it's the backbone of our entire observation framework," Cline said. "Every instrument we have across the country, the streamgages, the groundwater wells, all the sampling we do, goes through the H.I.F. for tests and calibrations."

Cline described the H.I.F. as a large hydrological laboratory with a variety of tanks, flumes and groundwater test facilities. It can take any instrument that is designed to measure water and test it to make sure it's ready to go out into the field. He said it's part of their national consistency program where all instruments are cross-calibrated against national standards.

Cline said one new feature for the UA-based H.I.F. is a research area as the current building is strictly operational. Included in that new section is a large-scale test water basin which will allow them to build and deconstruct any type of water containment they desire in an internally controlled lab setting.

"It will allow us to test new flow studies or new instrumentation," said Cline. "It'll give us many opportunities to innovate and interact with those activities."

The new building at UA will replace the current H.I.F. in Bay St. Louis, Mississippi.

"The building we're currently in was built to support the Apollo space program, so it's pretty old," said Cline. "We received funding to build a new state-of-the-art facility, so we chose the Tuscaloosa campus."

Cline said the design process is almost complete, and construction should begin in the summer of 2021. It should be complete by the end of the following year.

FOUR PROFESSORS RECEIVE EARLY CAREER RESEARCH AWARDS

Over the summer, four professors at The University of Alabama received national recognition early in their careers for innovative research that will increase understanding of our world while boosting UA's educational mission.

By Adam Jones

Clockwise from top right, Dr. Kasra Momeni, Dr. Sonya Pritzker, Dr. Feng Yan and Dr. Carla Atkinson.

The National Science Foundation selected the four professors for a CAREER Award, one of the nation's most prestigious recognition of top-performing young scientists. The grants allow each researcher to train and motivate a new generation of scientists and engineers not only at UA through instruction and hands-on lab work, but also through outreach efforts to schools and community.

"NSF CAREER Awards are outside validation that the University has some of the brightest, nationally recognized researchers teaching and mentoring our students," said Dr. Russell J. Mumper, vice president for research and economic development. "The research behind these awards will help move science and engineering forward and benefit society."

The NSF Faculty Early Career Development, or CAREER, Program is a Foundation-wide activity offering the most prestigious awards in support of early-career faculty with the potential to serve as academic role models in research and education and to lead advances in the mission of their department or organization.

Currently, 32 UA faculty from disciplines across campus received NSF CAREER Awards during their tenure. During the 2019-2020 academic year, seven professors received this award, the most awards in a single year at UA.

An NSF CAREER Award will fund projects by Dr. Carla Atkinson, associate professor of biological sciences; Dr. Kasra Momeni, associate professor of mechanical engineering; Dr. Sonya Pritzker, associate professor of anthropology; and Dr. Feng Yan, assistant professor of metallurgical and materials engineering.

With her award, Atkinson will continue her work studying freshwater mussels, an imperiled faunal group that clean water by filtering small organic particles out of the water column and into their gill chambers. While freshwater mussels can be overlooked, they are incredibly diverse in Alabama and play key roles in the ecology of aquatic ecosystems. This project will help in understanding the role of freshwater mussels in maintaining water quality through cycling of important nutrients in river ecosystems, informing conservation of the species.

Momeni's award will assist in a project that seeks to better understand synthesis of two-dimensional solid materials consisting of a single atomic layer. These materials are critical in advancing the capabilities of several technologies, including electronic devices, water purification and solar power applications. Momeni plans to develop computer models that accurately simulate the growth of these materials not only to understand the process, but develop a database of knowledge on how they grow and apply artificial intelligence to discover optimal and novel synthesis processes.

For Pritzker, the award will fund a multi-phase, longitudinal project investigating the relationship between everyday interaction and embodiment among individuals and couples involved with either social justice or civic engagement in the United States and internationally. The study will provide insight into how long-term relationships are mediated by multiple social, historical and local factors beyond the couple. It will also continue to develop a new method of anthropological research combining linguistic and biological anthropology, which Pritzker is developing with other UA professors.

The award to Yan will develop an emerging solar cell technology through advanced materials and device engineering to efficiently convert solar energy to electricity, which uses a new class of earth-abundant and environmentally friendly materials, known as antimony chalcogenides. The project aims to unlock the fundamental mechanisms of the power conversion efficiency loss via a systematic materials science and device physics understanding. This work will pave the way to commercialize and scale up this newly developed solar cell technology to provide more affordable and sustainable solar electricity.

Affiliated Member Information:

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

A WORLDWIDE VIEW OF WATER

By Brock Parker

Earth is made up of approximately 71 percent water, and the majority of people might be lucky enough to see a fraction of that with their own eyes. For Dr. Glenn Tootle, he's seen more than the average person. His passion for one of life's most precious resources takes him around the globe to study how it flows and impacts the world around us. It's also recently earned him a Fulbright Scholar Grant to continue his research abroad.

Tootle's career as a civil engineer specializing in water seemed like it was meant to happen from the beginning. Growing up in Florida, he was working as a state park lifeguard during his senior year and noticed people from the U.S. Geological Survey measuring the flow rate of the nearby river. Watching them work piqued his interest, and he soon pursued his bachelor's and master's degrees from the University of Florida. He would eventually earn his Ph.D. in 2005 from the University of Nevada, Las Vegas before establishing his teaching career.

"I'm not the traditional faculty member," said Tootle, a professor in UA's Civil, Construction and Environmental Engineering. "I took a 12-year break and was employed as a civil engineer in consulting engineering and the private sector doing water resources."

During that time, he also served as a commissioned officer in the U.S. Navy as part of the Seabees. He said people often ask if his love of water brought him to that specific branch of the Armed Forces.

"I've never been on a ship in my life," he said. "That's a true statement other than touring the U.S.S. Missouri and Pearl Harbor. I simply thought that the Seabees is the most prestigious group of civil engineers in our military."

Tootle was drawn to that unit thanks to "The Fighting Seabees," a 1944 movie featuring John Wayne. He said if "The Duke" can make a movie about them, then they have to be pretty special. However, their mission is what solidified his love for the unit.

Tootle (foreground) with Dr. Wolfgang Gurgiser of the University of Innsbruck (far right) and University of Alabama students completing a mass balance experiment on Stubaier Glacier near Innsbruck, Austria.

"It's amazing what the Seabees do all over the world not just in combat, but also in a humanitarian assistance environment," he said. "They provide clean water as far as water well operations, building schools and those types of things."

Tootle retired as a captain from the Navy after 25 years, which included two mobilizations after 9/11 and service as commanding officer for Naval Mobile Construction Battalion Two Five. Upon finishing his Ph.D. at UNLV, his academic career began out West where he and his students started researching glaciers and streamflow by using paleohydrology, which is the study of how water flowed before recorded history.

One thing he learned is how paleohydrology is more established in the West than in the South. For example, the Colorado River Compact of 1922 allocated a certain amount of water per acre to the states served by the river. That compact was signed when the flow was at its peak, but by using paleohydrology, studying how sediment has shifted and examining tree rings, researchers can look back 500 to 1,000 years and see that the flow is naturally less and cannot deliver what was promised a century ago.

"You have the double-edged sword, so to speak," he said. "You have the set allocations for these states of water. Combine that with the fact that you've had tremendous population growth in these areas, and the water just is not there."

In the South, precipitation, moisture and water have historically been more abundant than in the West, so the need for paleohydrology hasn't been as extensive. However, it doesn't mean that part of the country couldn't use the help. The three most southeastern states have been involved in legal battles over water distribution for decades. Paleohydrology can help determine where certain allocations can be most helpful, such as for shellfish in Florida, agriculture in southern Georgia and energy resources in Alabama.

"I've been able to learn a lot from some really smart people out in the western part of the U.S.," said Tootle. "Bringing that knowledge to the South, partnering up with some superstars here at The University of Alabama and doing this work will allow us to see what happened in the past in the South, what's happening right now and where we think we're going to go."

That work has also taken Tootle beyond American borders to see how streamflow and snowpack behaves. Every year since 2012, he has taken students to the University of Innsbruck in Austria. That area is a natural draw for him as he not only spent time in that region while in the Navy, but he is able to take the students onto a glacier. There they can see the water challenges facing a different area firsthand and how important the glaciers are in providing water for hydropower, drinking and agricultural needs.

"The scientists look more at the physics of the glacier," he said. "The civil engineers, we're more interested in how much water are we going to have, and are we going to be able to actually run this power plant? If we can't, what do we need to do to keep power going to provide what they need to keep the towns and villages going?"

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A WORLDWIDE VIEW OF WATER

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International education and research are two of Tootle's biggest passions. After spending more than three decades in Europe between his military and teaching careers, he applied for his first Fulbright grant and was awarded a Fulbright Teaching and Research Scholar Award to the University of Trento in Italy. UniTrento was searching for someone with a civil engineering background, and he was the perfect fit.

"I haven't seen much in the literature where they've done a lot of the paleo work over there," he said. "The work my students and I have done in the past on glaciers and glacial recession, that being a glaciated region very similar to Innsbruck and Wyoming almost where you have the high mountains with the glaciers providing streamflow in the summer months, was an attraction."

Tootle plans to spend up to four months teaching and researching at UniTrento. He said he makes it analogous to when he left the South to work and get his Ph.D. out West. He learned a lot about Western water, so learning about European water in northern Italy and Alpine watersheds is a project on which he's ready to embark.

While there, he will also work on developing an exchange program with students from UA, UniTrento and the University of Innsbruck. In 2021, he is looking to expand his current study abroad program by partnering with a colleague from the University of Florida. With that joint venture, Tootle will be leading courses on paleohydrology while UF's Dr. Ray Huffaker will teach economics and water policy.

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UA RESEARCHERS PROVIDE U.S. DROUGHT VULNERABILITY RANKINGS

If asked where in the United States is most vulnerable to drought, those states in the West currently suffering under hot and dry conditions and raging wildfires might come first to mind. However, according to research led by The University of Alabama, what makes a state vulnerable is driven by more than just a lack of rain.

According to the new NOAA-funded assessment done by UA researchers, drought vulnerability comes from a combination of how susceptible a state is to drought and whether it's prepared for impacts. The most and least vulnerable states could surprise.

These maps show each state's overall drought vulnerability in red and how it ranks in the three individual categories that make up the score: sensitivity in blue, exposure in yellow-orange and ability to adapt in purple. Darker colors show higher overall drought vulnerability and a greater degree of factors that increase the state's vulnerability.

Sensitivity is the likelihood of negative economic impacts, which is based on the percentage of agricultural land, number of cattle, how much the state relies on hydropower, and recreational lakes. The exposure score reflects how often a state experiences drought and what assets, like the number of people and freshwater ecosystems, are at risk when it occurs. The ability to adapt score ranks how well the state can cope with and recover from drought, which depends on whether the state has a drought plan, how equipped it is to irrigate its land, and whether it is financially strong overall.

By this scoring system, the most vulnerable states are Oklahoma, Montana and Iowa, while Delaware, Massachusetts, Connecticut and California are least vulnerable to drought. Oklahoma gets its high vulnerability score from having an outdated drought plan and limited irrigation, a low ability to adapt, as well as extensive agricultural activities and cattle ranching, a high sensitivity. Despite facing recurring multi-year droughts, meaning relatively high exposure, California ranks low in drought vulnerability. Thanks to a strong economy and well-developed adaptation measures, it's better prepared for an extreme drought when it occurs than most other states.

On the east coast, the region is generally less vulnerable than other areas, given its wetter climate and lack of farming – except for New Jersey. As the most densely populated state in the country, meaning very high exposure, it gets the region's highest vulnerability score.

By breaking down drought vulnerability into three components, this assessment can help decision makers identify what makes their state vulnerable for better planning. And, as the study shows, even states that receive lots of rain can still be vulnerable.

Though drought is one of the costliest natural hazards in the United States, there are actions states can take to become more resilient.

This research was led by Dr. Johanna Engström, former postdoctoral researcher at the UA Center for Complex Hydrosystems Research, Dr. Keighobad Jafarzadegan, postdoctoral researcher at the center, and Dr. Hamid Moradkhani, the Alton N. Scott Chair Professor of Civil and Environmental Engineering and director of the center.

The work was funded in part by NOAA's Climate Program Office through its Modeling, Analysis, Predictions, and Projection program. The MAPP Program enhances understanding, predicting, and projecting variability and long-term changes in Earth's climate system.

This was adapted from an article by Alison Stevens with NOAA and posted on climate.gov.

UA RESEARCHERS PART OF NATIONAL PROJECT TO STUDY INTERMITTENT STREAMS

Biologists at The University of Alabama are part of a national research project that addresses water quality at the critical connection between streams that flow continuously and those with intermittent flow.

The 4-year project will create the field infrastructure needed to study intermittent streams and train researchers to interpret and use the data collected at the sites. The project, led by the University of Kansas, involves 18 professors at eight institutions across the United States in all.

In an effort dubbed the Aquatic Intermittency effects on Microbiomes in Streams, or AIMS, project, the researchers plan to install new sensors and field sites, train a dozen graduate students and numerous undergraduates in team-science approaches, train 36 new instructors in teaching data science methods, and boost workforce development and education. The work will also inform sometimes thorny policy and legal debates.

UA will receive $1.7 million from the National Science Foundation grant. Dr. Carla Atkinson, associate professor of biological sciences, will lead work at UA that includes Dr. Jon Benstead, professor of biological sciences, and Dr. Nathaniel Jones, assistant professor of biological sciences.

"At The University of Alabama, we're excited to incorporate intermittent streams into our river ecosystem research program," Atkinson said. "We're particularly excited to see how our regional analysis in the southeast U.S. compares to work being conducted across the broad geographic scale that the AIMS project encompasses, while also engaging a diversity of researchers across career stages."

The team will address knowledge gaps on intermittently flowing streams, which control the quantity and quality of water delivered downstream to perennial streams and rivers. While much of the understanding of the linkages among microbial communities, stream health and water quality rely on studies of perennially flowing streams, more than half of global stream-miles do not flow continuously. These intermittent streams are found across the entire U.S.

Alabama is home to a wide range of important water resources. As the state's geography transitions from Appalachia to coastal lowlands, the state's rivers and streams support one of the most diverse aquatic ecosystems in the world. This project will examine how connectivity between terrestrial and aquatic systems impacts downstream water quality and ecosystem integrity.

About 40 percent of Alabama's streams and rivers go dry annually, but not much is known about what drives this drying, and importantly, how it impacts downstream water quality. This gap in knowledge comes from lack of physical infrastructure designed to measure intermittency, and scientific training that straddles aquatic and terrestrial ecology, Atkins said.

photo courtesy of AL.com

UA researchers on the project include, from left, Dr. Carla Atkinson, Dr. Nathaniel Jones and Dr. Jon Benstead.

The AIMS project will address the first obstacle by creating a network of instrumented sites designed to generate "Big Data" to quantify flow intermittency, stream microbiomes and water quality. AIMS will confront the second obstacle by using its network to provide training in collaborative science and interdisciplinary methods to study intermittent streams, and by providing workforce training in environmental data tools through a new On Ramps to Data Science program, which will focus on data generated by microbiome sequencing, environmental sensors and Geographic Information Systems.

Research results could help resolve difficulties defining ecological connections between perennial and intermittent streams that lie at the heart of an ongoing policy debate over legal protection of isolated water bodies, as recently demonstrated by the late 2019 repeal of the 2015 Waters of the U.S. Rule. The researchers said the infrastructure installation planned under the AIMS project is designed to confront these difficulties head-on.

UA's project in the Southeast region will engage a diverse group of students, including undergraduates at Alabama A&M in Huntsville.

Information from an article at the University of Kansas was used in this report.

UA, AUBURN, OTHERS JOIN FOR ANTARCTIC BIOLOGICAL RESEARCH

Twenty scientists embark on a 14-week voyage to study unexplored Antarctic waters to improve understanding of biodiversity undergoing rapid changes because of a changing climate.

By Adam Jones

Dr. Kevin M. Kocot

The expedition includes researchers from The University of Alabama, Auburn University, Central Michigan University, the University of Alaska Anchorage and other institutions who will also train the next generation of zoologists in developing expertise on marine invertebrate animals using traditional and cutting-edge techniques.

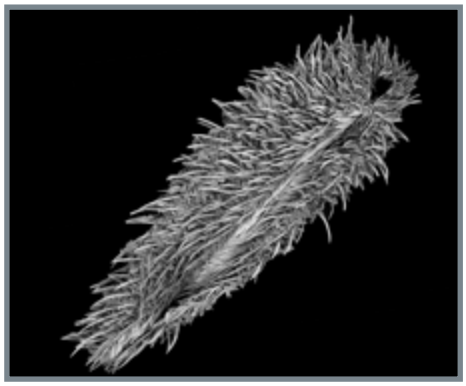
Funded by four grants totaling more than $2 million from the National Science Foundation, researchers will explore the biodiversity, evolution and biogeographic patterns of animals and microbes living in the Weddell Sea. Using data and biological samples collected during the trip, the scientists will use morphological and molecular tools to assess Antarctic biodiversity and unrecognized genetic variation and patterns of relatedness between populations of marine Antarctic species.

The research is led by Dr. Kenneth M. Halanych, professor and Schneller Endowed Chair of biological sciences at Auburn; Dr. Kevin M. Kocot, UA assistant professor of biological sciences and curator of invertebrate zoology for the Alabama Museum of Natural History; Dr. Andrew Mahon, professor of biology at CMU; Dr. Deric Learman, professor of biology at CMU; and Dr. Sarah Gerken, professor of biological sciences at UAA.

"Antarctica is changing more quickly than anywhere else in the world," Kocot said. "Conserving the deep sea and polar regions is really important even if people don't see it. Having this baseline of what lives there, and having more people who can do that in the future is really important."

Antarctica is among the most rapidly warming places on the planet, and some reports suggest the Antarctic environment is approaching, or possibly beyond, the tipping point for ice shelf collapse. The loss of ice around Antarctica is dramatically changing habitat availability for marine life, particularly invertebrate species living on the ocean floor.

The joint research by Halanych at Auburn and Mahon at CMU attempts



The mollusk pruvotinid solenogaster from Antarctica, imaged in Kocot's lab, is part of the group Aplacophora.

to understand environmental factors shaping patterns of diversity in the invertebrates living on the ocean floor in the Southern Ocean through studying their DNA. The findings will inform predictions about how species distributions may change as Antarctic ice sheets melt and how organisms adjust their geographic range in response to environmental changes.

"An organism's history is written in their genome," Halanych said. "We will use evolutionary genomic tools to explore biodiversity in Antarctic marine invertebrates and use this information to inform us on how human-mediated climate change may shape populations of marine animals in the future."

For Kocot, this will be the first of two trips to the Antarctic waters over the next four years to find new species of aplacophorans, a group of poorly known worm-like mollusks with scales or spines, and use advanced imaging and DNA sequencing techniques to identify and classify them.

Aplacophora is one of many groups of organisms diverse and ecologically important in the deep sea and polar regions, but studied by just a handful of researchers worldwide. Kocot and his students aim to understand the diversity of this group and its evolution.

"If we don't know what's down there, we can't know what we're losing," he said. "We have to continue to explore the world."

Similarly, Gerken is a leading expert on "comma shrimp," formally called Cumacea, that are small crustaceans living in ocean sediment. Cumaceans are potentially ecologically important, occasionally occurring in high enough densities that grey whales prey on them, and yet not much is known about them. Her planned monograph on the Antarctic Cumacea will provide a resource for future work in the region.

"It is a constant surprise how much there is left to learn about our world."

Work led by Learman at Central Michigan aims to better understand how tiny organisms in the sea floor called microbes are impacting carbon cycling in an ecosystem experiencing massive changes. Through studying the genetics and function of microbes collected during the expedition, researchers will determine the species in the community and how they break down organic matter, which drives the distribution of nutrients in the sediment's ecosystem.

"While microorganisms are the smallest forms of life on Earth, they are the gatekeepers of the cycling of essential nutrients, such as carbon and nitrogen, and the foundation of the food chain that support larger and more complex forms of life," Learman said.

UA RESEARCH CONTINUES TO SURGE

By Adam Jones

For the seventh consecutive year, The University of Alabama earned record external funding for research and other sponsored activities, further securing its stature as a major comprehensive research-intensive university and one of the fastest growing research enterprises in the nation.

For the 2020 fiscal year, sponsored awards at UA, a part of The University of Alabama System, reached more than $168.4 million, an increase of more than 27% over the previous year, which was also record breaking. In the last two fiscal years, sponsored awards increased by 70%. Sponsored awards include all competitive external funding for research, instruction, other sponsored activity, fellowships and construction.

"UA's research enterprise is thriving and making a difference to our students and to the lives of citizens in our state and beyond," said UA president Stuart R. Bell. "Innovation in research at UA promotes economic development through faculty and student-led start-up companies, providing solutions to industry partners and critical services to Alabama communities, businesses and the state."

External grants and contracts directly supporting UA research in fiscal year 2020 also reached record levels with an increase of more than 30% from 2019 fiscal year. This is the third consecutive year that total externally sponsored research has hit record highs.

"UA is making huge strides to advance its strategic goal of increasing the University's productivity and innovation in research, scholarship and creative activities that impact economic and societal development," said Dr. Russell J. Mumper, UA vice president for research and economic development. "This progress is a testament to the high quality of our faculty, staff and students."

In 2019, the Office for Research and Economic Development announced its five-year strategic plan. The plan centers on growing and developing faculty; involving students in research; enhancing the role and impact of the Alabama Research Institutes; investing in transformative initiatives; and engaging with industry. In August 2020, ORED published its Year 1 Annual Report of its strategic plan, detailing progress made in achieving its goals.

"To a large extent, UA promotes its signature research areas through the Alabama Research Institutes, which focus on transportation, water, life research, cyber and multi-scale analytical sciences," Mumper said. "I would like to thank our Congressional and state Legislative delegations for their support and dedication in advancing our research mission and securing critical resources aligned with the Alabama Research Institutes."

The Alabama Water Institute is currently seeking guests for its podcast. Take advantage of this opportunity to promote your research to a wider audience.

Contact Brock Parker at: brockparker@ua.edu or 205-348-5328

for more details and to schedule a recording.

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