THE UNIVERSITY OF ALABAMA® | Alabama Water Institute

NEWSLETTER

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NATIONAL LEADER IN WATER RESOURCES TO HEAD ALABAMA WATER INSTITUTE

Scott Rayder, an expert on building opportunities and funding for scientific organizations, was selected as the new executive director of the Alabama Water Institute.

By Adam Jones

Scott Rayder

Water is a signature research and academic focus at UA, and AWI was formed to conduct integrated research and education on complex issues of water quantity, quality and security globally and locally.

"The University of Alabama strategically focused on water as a signature research thrust not only because of the profound importance of water in all facets of life, but also because we believe the University is ideally positioned to become a national and influential leader in the discipline. I believe Scott has both the vision and ability to work with faculty and students to make this happen," said President Stuart Bell.

The executive director position and AWI are vital to UA's plan to increase research productivity and innovation in research, scholarship and creative activities that impact economic and societal development. Rayder will play a key role in continuing collaboration with the National Water Center, a National Oceanic and Atmospheric Administration center located on the UA campus.

Currently senior advisor to the University Corporation for Atmospheric Research (UCAR) and to the president and vice president of the UCAR Foundation, Rayder will join UA Aug. 1.

He has extensive experience in building relationships and opportunities with both the private and public sector, including longstanding relationships with federal funding agencies such as the U.S. Department of Energy, National Science Foundation, NOAA, U.S. Geological Survey and National Institute of Standards and Technology.

"The University of Alabama has the unique opportunity, working with federal, state and industry partners, to propel the state of Alabama to become the epicenter for water research, water resource management and the new water economy in the United States. Scott is well-known both nationally and internationally and is the ideal leader to take full advantage of this opportunity," said Dr. Russell J. Mumper, vice president for research and economic development.

Rayder's involvement with higher education and research extends to the beginning of his career at NOAA, and includes nearly two decades of experience in senior leadership positions in large government, not-for-profit and private sector companies.

"I am honored to be joining the dedicated AWI team. UA science, policy and engineering expertise is uniquely positioned to help improve our understanding and application of the latest science and technology in support of critical water issues that affect everyone across the globe to citizens right here in Alabama," Rayder said. "I look forward to engaging with the faculty, public and private stakeholders, philanthropists and future Alabama graduates in growing this capability here at the University."

His work at UCAR in support of the National Center for Atmospheric Research as well as at the Center for Ocean Leadership included working with research universities and private sector partners in the pursuit of funding to better understand and utilize the world's resources.

Rayder holds a bachelor's degree in government and geology from Hamilton College, New York, and a master's in public administration with a concentration in science and technology policy from the Maxwell School of Citizenship and Public Affairs at Syracuse University.

The committee for this national search was co-led by Dr. Mark Elliott, associate professor of civil, construction and environmental engineering, and Dr. Behzad Mortazavi, professor and chair of biological sciences. Dr. Patricia Sobecky, UA's associate provost for academic affairs, professor of biological sciences and founding executive director of AWI, was also integral to the search process.

"We are grateful to Dr. Sobecky for her dedication in standing up the Alabama Water Institute as founding executive director," Mumper said. "Her leadership created an excellent foundation for transformative research and economic development relating to water."

WEATHER, DEFENSE PROFESSIONAL TO LEAD UA WATER SECURITY INITIATIVE

An experienced weather and intelligence professional in the military and intelligence communities will lead global water and security initiatives at The University of Alabama.

By Adam Jones

Michael Gremillion

For more than 27 years Michael Gremillion provided scientific leadership and expertise for national security environmental support under the U.S. Department of Defense. At UA, he is charged with directing federal initiatives to mitigate the impact of water-related disasters. He begins Sept. 7.

"Mike's history of innovative solutions and operational expertise in environmental systems that support our national security will enrich the efforts of our faculty and students in providing applied scientific techniques and groundbreaking research in the area of water security," said Dr. Russell J. Mumper, vice president for research and economic development. "He will be crucial in developing strategic relationships with defense and intelligence agencies that benefit our researchers and our educational mission."

Gremillion comes to UA from the National Geospatial-Intelligence Agency, where he is the senior meteorology and oceanography officer. Before joining NGA in March, he worked nearly seven years at the U.S. Air Force headquarters in the Pentagon, with his last assignment as deputy director of weather. He held posts of increasing responsibility and influence within the Air Force since joining in 1993.

He has engaged the White House, congressional leaders and senior personnel within the national security, defense and intelligence communities on environmental policy issues during his career.

Some of his career achievements include facilitating procurement of a $30 million high performance computer installed at Oak Ridge National Lab that improved numerical weather prediction and operated the first-ever operational global hydrological model. He also initiated development of a climate analysis, monitoring and prediction system that provided strategic indications and warnings to prepare leaders for humanitarian assistance and disaster relief missions, security instability, disaster risk reduction and public health contingencies.

"Mike is exactly the type of operational professional that can fully develop this unique capability at UA by migrating cutting-edge research into operations and these products will be of great use to both the government and private sector."
Scott Rayder,
incoming Executive Director, AWI

At UA, he will work with researchers connected through the Alabama Water Institute to develop the tools and analysis that allow policy makers to plan for potential water security impacts, predict future water security issues, and improve mitigation, recovery and restoration.

"AWI intends to establish a first-of-its-kind global water security initiative at The University of Alabama. Alabama will harness its intellectual power and associated analytical capability in order to predict and mitigate the impact of water-related disasters," said Scott Rayder, incoming executive director of the Alabama Water Institute.

"Mike is exactly the type of operational professional that can fully develop this unique capability at UA by migrating cutting-edge research into operations and these products will be of great use to both the government and private sector."

Water is a signature research and academic focus at UA. AWI was formed to find transformative solutions for complex water management, security and policies challenges. AWI promotes applied research and knowledge gains in areas of remote sensing, biodiversity of aquatic systems, hydro-informatics and disaster management.

"I am excited about this opportunity to leverage my personal and professional interests to achieve groundbreaking results in water security that benefit our society and further the University's mission of teaching, research and service," Gremillion said.

Gremillion earned a bachelor's degree in atmospheric science from the University of Kansas, a master's degree in meteorology from Texas A&M University and a master's in business administration from Regis University.

Affiliated Member Information:

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

UA RESEARCHER STUDYING LINK BETWEEN POLLUTANTS & HERMAPHRODITIC FISH

By Brock Parker

Dr. Ryan Earley

Pollution and chemical imbalances in water could have an adverse effect on animal behavior, particularly in fish that make their home among the mangrove trees along the Florida coast. Dr. Ryan Earley and his students are charting multiple courses to determine what causes changes in how the fish function.

"Our research program has a bunch of different prongs to it," said Earley, an associate professor in The University of Alabama's Department of Biological Sciences. "I would say the biggest prong is asking questions about how pollutants infiltrate the environment, especially aquatic ecosystems, and then have damaging effects on the individuals who live there."

One species of fish in particular caught Earley's attention. Mangrove rivulus, sometimes referred to as mangrove killifish, live in the waters surrounding their namesake trees, which stretch from the Tampa area to the Florida Keys. They are small fish, and their color ranges between speckled gray and dark brown. What makes them particularly unique, though, is how they reproduce.

"They exist as self-fertilizing hermaphrodites, which basically means they have both boy and girl reproductive parts, make sperm and egg and then can fertilize their own eggs," Earley said. "This is the only vertebrate that can do it."

However, that's not the only way mangrove rivulus can reproduce. Hermaphrodites can change sex into males and mate with other individuals that retain both sexes, although mating between them is rare. Earley and his students are trying to find out why rivulus switch to males if they can self-fertilize from the beginning of life.

Based upon the data his lab has gathered, it's physically cheaper to be male. Maintaining ovaries takes about six times the amount of energy as testes, so becoming a male could mean dedicating that extra energy to survival against predators or other environmental factors.

"If you took a basic ecology class, you'd be taught that it's always good for mating to happen because you make new combinations of your genes that might be better at combating any challenges that are in the environment," he said.

While survival could be the underlying reason the rivulus changes sex, Earley is investigating if pollutants, specifically pharmaceutical drugs, also play a role.

"I think at this point in time it's a safe bet that all of the waters that we interact with are polluted to some degree," he said. "It can come in the form of, for example, synthetic estrogens for regulating reproductive cycles, and all of these things eventually get into our natural waterways."

Earley said synthetic estrogens are endocrine disrupting compounds, which can wreak havoc on the human body as they introduce a new source of artificial hormones. As the body discharges these synthetic hormones into water sources, nanogram levels of these chemicals make their way back into the wild, eventually reaching the fish population and altering their physiology.

"Their ovaries essentially shrivel up, and then we have all sorts of changes," he said. "All their behaviors go out of whack, and they're no longer behaving in a way that would be adaptive or beneficial for them in their environment."

That's where Earley's work dives deeper. He and his students take trips to the mangroves in Florida and return with fish, water and sediment samples. In his lab, they can control the environment and establish some form of relationship between the endocrine disrupting compounds and the physiological changes. In their samples, they found four nanograms of synthetic estrogen per liter of ocean water. Using that amount, they expose the fish to these chemicals at various stages of their lives and monitor any changes.

"For example, one of my students demonstrated that when you expose embryos to these synthetic estrogen compounds, you get a really non-intuitive result, which is more sex change to male, which is weird," he said. "Estrogens are usually thought of as female hormones, yet, when exposed to these chemicals, the fish convert to male more often."

They also witnessed behaviors linked to survival and reproductive success, such as aggression, risk taking, exploration, activity levels and feeding habits. For them, it was surprising to see how small of a dose made such a dramatic difference at all stages.

"It just blew my mind to see that the ovaries are literally shriveling up in these animals," said Earley. "I also felt like the whole reorganization of their behavior was unexpected. Not that we don't think that the hormones have an effect on the brain, but just the extent to which the brain must be changing for those behaviors to change in such an incredible way. We've got a lot of work to do, but suffice it to say that these chemicals can be really bad."

Earley thinks researchers can also determine how these chemicals potentially alter human behavior and physiology.

"It's a huge leap to go from a fish to a human, but maybe 10 or 20 years down the road somebody will see the data that we've collected and be like, 'now we can help with these aberrant behaviors that humans are showing and that may be related to exposure to synthetic chemicals,'" he said.

That's why he urges his students to take what they're learning at UA, further their academic careers and multiply their knowledge.

THE LAST FRONTIER

Antarctica's unique role helps UA research push boundaries of discovery.

By Adam Jones

At the bottom of the world, Antarctica sits as if another planet. The brutal conditions of the frozen continent leave it mostly barren.

Antarctica, though, is a natural laboratory for scientific discovery, and researchers at The University of Alabama are playing critical roles in global efforts to use Antarctica to understand the Earth's geology, past, climate and biological diversity and to get a better grasp on the cosmos.

"To me, it feels very pure because it's virtually untouched by humans," says Dr. Rebecca Totten Minzoni, a marine geologist and paleontologist at UA.

Totten Minzoni is one of several UA scientists and engineers who have done field work in and around Antarctica the past few years. Their inventive work is moving knowledge forward and enhancing the education of UA students.
Four people huddle over a map on a table.

She was part of an expedition just offshore of Antarctica to study what many scientists are hoping to resolve: Antarctica's contribution to sea level. The research project involving over 100 international scientists is one of the most detailed and extensive examinations of the massive Thwaites Glacier, which accounts for about 4 percent of global sea-level rise today — an amount that has doubled since the mid-1990s.

It's part of the West Antarctic Ice Sheet, which is experiencing drastic changes each season that signal its response to a changing climate, she said.

She uses her expertise in finding microscopic clues to the past behavior of Thwaites Glacier, searching through mud offshore of the glacier for tiny, singlecelled plankton. Through analyzing what the glacier and ocean left behind, her team can inform models of how the glacier will behave in the future.

Two UA researchers traveled aboard the Nathaniel B. Palmer, a research vessel and ice breaker, to Antarctica to study the continent's contribution to sea level. (photo credit: Linda Welzenbach, Rice University)

In 2019, she and a veteran UA graduate student, Victoria Rios Fitzgerald, travelled aboard a research vessel and ice breaker where they were part of a team that extracted cores of sediment from the sea floor to reveal the conditions around the ice sheet for the past 12,000 years.

"Antarctica has a really important role to play in the climate system, for better or worse, and we need to understand how it's changing in both long timescales as well as shorter timescales," Totten Minzoni said.

UA engineering researchers are also helping uncover Antarctica's past for clues with radar imaging. The UA Remote Sensing Center is part of another large international effort to find the oldest ice on Antarctica, hoping an analysis of the gasses trapped inside can reveal more about the Earth's climate through the ages to provide perspective and an understanding of how the ice will react in the decades ahead.

In the middle of nowhere – hours away by snowmobile from the nearest, isolated research station – Dr. Drew Taylor, an electrical engineer, dragged a large radar across the ice, penetrating nearly two miles below to discover if an area identified by researchers from Europe held the oldest ice.

The unique radar developed at UA provides an accurate image of what occurs at the base of the ice. The radar is the first of its kind, advancing the use of ultra-wideband surface-based radar for scanning the interior of ice and providing high-resolution images. Before its work in Antarctica, it was used in Greenland for similar purposes.

"We're proving we have the expertise in remote sensing with our radar systems and design to provide unique solutions to answer the questions the scientists have about the ice and our climate," Taylor said.

Along with what Antarctica can reveal about how the Earth will respond to climate change, there is more to learn about the continent itself. Dr. Samantha Hansen, a UA geologist, oversaw a study of the Transantarctic Mountains that showed a layer of heated earth just below portions of Antarctica are pushing the mountains up from the ground.

"Antarctica is arguably the last frontier in that we know very little about that continent," she said.

Unlike the vast majority of mountain ranges across Earth, the Transantarctic Mountains did not form through compression, or two continental plates smashing into each other, such as with the Rocky Mountains. The Transantarctic Mountains is the longest and tallest noncompressional mountain range on Earth, even though much of it is buried under snow and ice, which makes understanding how it formed difficult.

Hansen and students in her UA lab, which focuses on earthquake seismology, deployed a seismic network during four trips that collected data for three years. Similar to a medical

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scan of the body, the 15 stations in the network buried in Antarctica used seismic waves created by earthquakes from around the globe to create an image of the Earth below the mountains.

The seismic images reveal areas where the Earth's crust is thin around the mountains, creating shallow spots where the next deepest layer, the hotter mantle, is closer to the surface.

"It's interesting being some place where there are no trees and no animals, no people and no houses," Hansen said. "Some of the sites we've visited … no other human had ever been to before. That's pretty cool, especially in this day and age, going someplace that you are the first human beings to be there."

Researchers lower seismic equipment into place at one of the stations as part of research into the Transantarctic Mountains (photo credit: Lindsey Kenyon.)

Another UA researcher has looked at the rocks in Antarctica. Dr. Tom Tobin, paleontologist, used Antarctica to grasp more about the mass extinction of dinosaurs, since the fossil and geological record in outcrops are untouched.

"Its remote location means that its fossil record has not been significantly disturbed by amateur collecting," Tobin said. "There are some unique challenges with logistics in getting there, and, of course, dealing with the cold and wind while working, but it's really exciting to work in a place where few people ever get to visit."

On a research vessel outside Antarctica, UA researchers Dr. Rebecca Totten Minzoni, center at table, and Victoria Fitzgerald, back, plan surveys and core drilling sites with Dr. Alastair Graham of the University of Central Florida and Dr. Robert Larter of British Antarctic Survey. (photo credit: Linda Welzenbach, Rice University)

Tobin worked in the sediments exposed on a small archipelago off the northeast coast of the Antarctic Peninsula. There, highly-visible and numerous layers of rock allow for discerning the state of the climate about 66 million years ago. This enables researchers to see how the climate may have contributed to the mass extinction of land-based dinosaurs. Along with the preserved geological record, Antarctica's location on the South Pole allows it to be a better proxy for the Earth's climate at the time, since changes are felt more strongly at the poles, Tobin said.

Antarctica and its coastal waters can also reveal much about life now. Dr. Kevin Kocot, a UA zoologist, will travel to the continent twice as part of a study using cutting edge techniques to speed up identification of new species of a group of worm-like mollusks, while also training the next generation of scientists studying invertebrates.

Two expeditions over the next four years aim to find new species of aplacophorans and use advanced imaging and DNA sequencing techniques to identify and classify them. Aplacophorans are diverse and ecologically important in the deep sea and polar regions, but few researchers study them. "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."

Along with geologists and biologists, two astronomers at UA are members of a team using Antarctica to peer into the universe and learn more about a curious particle. Drs. Dawn Williams and Marcos Santander play a critical role in the IceCube Neutrino Observatory, an array of 5,160 basketball-sized optical sensors deeply encased within a cubic kilometer of clear Antarctic ice.

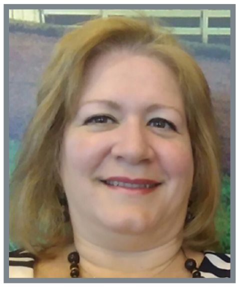
The observatory was set up to detect neutrinos, abundant subatomic particles famous for passing through anything and everything, rarely interacting with matter. The project found evidence of the source of neutrinos, a discovery that opens the door to using these particles to observe the universe.

"IceCube is looking for light from neutrinos interacting in the ice, and the ice at the South Pole has excellent optical transparency," Williams said. "Light from a high energy neutrino interaction can travel for hundreds of meters in ice, which means we can space the sensors fairly far apart, which reduces drilling costs."

She is part of an international effort to upgrade the massive cosmic particle detector, coordinating enhancements to its calibration, and she will likely travel again to the frozen continent.

BALANCING THE COST OF DISASTERS

By Brock Parker



Dr. Silvana Croope

During extreme events, such as a global pandemic or natural disaster, financial resources can become strained. Many governments are self-insured, and a growing number of incidents can hinder their abilities to help local regions and municipalities financially recover. Understanding and creating different types of strategies to offset those problems is something that needs careful attention.

"There is an economic and a financial impact of risk tolerance that government and businesses have and the never-ending payment of debt because disasters continue to happen," said Dr. Silvana Croope, an expert in infrastructure resilience with the Alabama Transportation Institute's Transportation Policy Research Center. "All of these are parts of very complex problems that we need to investigate and research to see if we can help improve things much more than they are today."

Larger and more well-known disasters can cost billions of dollars, but what some people don't take into consideration are many smaller and generally unnoticed events that can also quickly add up. Croope said that's where agencies need to start looking and coming up with new strategies to mitigate costs.

"We see this on a small scale, for example, when FEMA recommends flood insurance for individuals, they want to know how many times disasters happen in a certain place and collect the data if they get struck time and again," said Croope. "If you show repetitive damage, either you strengthen your design or change it. There's not going to be more money for them (the government) to keep on giving it to you because there's no positive return of investment."

In the transportation realm, one of the biggest problems is flooding. Croope said she is a fan of strategies that look into the future, and one of those is buried infrastructure, or putting things underground. While there might be some larger costs upfront with installation, there will be fewer chances for those utilities, such as power lines, fiber optics and portable water, to be damaged as long as they are properly protected.

Another strategic consideration includes the creation of floating structures that are on or close to water, such as bridges, roadways and potentially even cities. Croope's experiences in Delaware during Hurricane Sandy highlighted the differences in coastal area needs versus areas without much water. The bridge spanning Indian River Inlet was built high above the water, but near it was an old road on level land. The bridge wasn't damaged nor tilted by the hurricane, but the lower road wasn't as fortunate.

"We had a problem," said Croope. "A ton of sand was covering the traditional roadway that was completing the pathway to that bridge, so that roadway wasn't able to be used for a few days. That is a main path for tourists, residents and for supply chains, and that sand basically disrupted all access."

Inspired by that experience, her research at The University of Alabama involves working with a new type of inexpensive sensor that can be installed at multiple points around roadways and other transportation assets. The traditional system for environmental sensing of federal highways is called the Road Weather Information System. It captures different types of data such as wind, humidity, temperature and water. Croope said one of those units can cost upward of $300,000, which includes the system, engineering and construction. That high price also extends over time with continuous high-dollar disbursements for maintenance and operations, and that limits the number of units that can be purchased for a given area.

According to Croope, the Department of Homeland Security began investing in newer sensors that drastically reduced that cost to approximately $1,000 per unit. However, with support from FEMA, she and other university researchers were able to re-engineer a design that focused on dry surface roadways, lowered the cost to around $150 per unit and establish a small network of them for less than $500. This makes it financially feasible for more than one sensor to be deployed in a given area, which in turn allows for more data to be collected, new strategies to be developed and a potential reduction in future damage and insurance payouts. The lower cost also helps a sensor to be replaced and data collection and other data-dependent services to continue if it is somehow damaged or washed away during a flooding event.

"The beauty of these sensors is that being so tiny, if they get dragged out of their location, we can put another one at a very low cost," said Croope. "Decreasing the financial risk and then being able to replace that, it's not something that you're going to cry about because you don't have funding anymore."

Croope said exploring new options, such as these sensors, can help governments and agencies better utilize how their dollars are spent in the present versus after a disaster.

"If you think that $300,000 would be an investment cost for one, when that amount of funding is put into these lower cost sensors, we can probably deploy them all over the state," said Croope. "This is how you actually are able to lower the cost to get to these types of solutions."

NATURAL RECORDS

UA Researchers use nature to discover how waterways behaved before recorded history.

By Adam Jones

Graduate student Ray Lombardi studies sediment at different depths from a hole dug near the Tennessee River as part of a project to uncover historical floods.

In 1867, melting snow from the Smoky Mountains and four days of rain wrought Biblical destruction along the Tennessee River Valley. In Knoxville, Tennessee, the flooded river took out the town's only bridge and stranded the residents on a hilltop downtown. Chattanooga, Tennessee, was nearly wiped off the map before the flood waters swelled downstream in rural parts of Alabama.

The Tennessee River crested 58 feet above normal in Chattanooga, nearly double the recognized flood level. It's the high water mark, if you will, for floods along the middle Tennessee River. In scientific jargon, it's the flood of record.

But what is a record? At its most basic, a record is data collected and stored, usually by humans. Modern methods of recording weather and streamflow, at best, go back 150 years in a few areas in the Southeastern United States. Historical records, such as newspapers, might reach 200 years into the past, again, in spots.

Oral histories, particularly those passed by Native Americans, can go back centuries, but pegging them to specific years can be difficult. In fact, newspaper accounts from near the 1867 flood record some Native Americans with knowledge of a larger flood perhaps 100 years prior.

"Our records of floods have several issues, but one of the big problems is our records start when people start using instrumentation," said Dr. Lisa Davis, a geomorphologist at The University of Alabama. "Calculating the flood of record depends on your record."

A record's length and the number of extreme events contained will affect estimates of how often floods occur. That knowledge can be found in records not kept by humans. Etched in trees or buried beneath the ground, these natural records can reveal how the Earth's systems have behaved over long periods, possibly as far back as 10,000 years.

Davis and her graduate student, Ray Lombardi, found at least three floods in the last 2,300 years along the Tennessee River that were as large as the 1867 flood. They also found three substantially larger than the flood of 1867 that occurred in the last 5,000 years.

"We suspect a lot of the changes in the frequency and magnitude of floods are driven by longer cycles of climate that operate on centennial to millennial timescales, and if your instrument record only goes back 50 to 100 years, which is very typical, it's very hard to believe that record represents those sorts of processes," Davis said.

Records of these older floods lead to better understanding of the longer processes of change that affect the timing, size and frequency of floods while allowing for better predictions and preparation of large floods in the future, she said.

Davis is part of a group of researchers called the Collaborative Research on Paleoenvironments and Society, or CoRPS, at the University. They focus on the science of past environmental changes and paleoclimate, or climate information from before recorded history. Several in the group study floods and droughts, events that can disrupt society.

Using innovative methods and leveraging crossdiscipline collaborations, the researchers are providing crucial information to help manage and mitigate the dangers from floods and droughts across the Southeast.

"Instead of designing our water allocation system based on the observed record, we can incorporate the paleo record that gives us a better representation of what's happening," said Dr. Glenn Tootle, an environmental engineer at UA.

Tootle is involved in a project examining droughts in Alabama and across the Southeast. Using recorded information on how much water flows in a stream, Tootle is working with Dr. Matthew Therrell, a dendrochronologist at UA who examines rings from trees around waterways to determine the frequency and extent of droughts on a long timeline.

"Both floods and droughts are hydroclimatology, and both are informed by paleo proxies," Therrell said. "We are using natural archives to determine what the range of natural variability in the system is since the instrumental record is so short."

Their work has already shown a massive decline in streamflow over the past 30 years, and they are putting that in perspective with tree ring records that reach hundreds, sometimes thousands, of years in the past depending on the age of the tree.

Tree rings, which record the annual growth cycle, can tell a lot about environmental change around the tree, and can pinpoint when floods and droughts occur. A wide tree ring

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NATURAL RECORDS

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indicates the tree took on a lot of water that year, and marks in the ring can indicate floodwaters brought debris that hit the tree. On the other side, a narrow ring means the tree lacked water compared to normal years.

"We know exactly the age of every ring," Therrell said. "Trees can tell you the exact year and maybe the season of an event."

Therrell is also working with Davis and others on the paleoflood study along the Tennessee River. The data from tree rings can line up with the instrumental record and verify data Davis and her team get from the soil. The team also draws upon archeology to date artifacts found in the sediment to provide another verification for the time of an event.

"By comparing these different proxies, you get a much better idea of what happened," Therrell said. "We're stepping back in time with each different proxy."

Davis' project is looking for changes in the sediment, packed like cake layers below the surface. Cores of sediment were pulled from some sites, and, generally, a change to larger sizes of sediment particles and a change in the elemental composition indicates a big flood laid down that layer of sediment, Davis said. Collected piles of dirt on an pan sit while a hand points to scientific information in a notebook.

The samples are examined with x-ray fluorescence and dated with radiocarbon and optically stimulated luminescence techniques and compared across sites to develop a robust chronology of past flood activity along the river.

Although tree rings do not do as well as sediment cores at revealing the magnitude of a flood event, the combination with sediment cores reveal both frequency and magnitude of flooding within the system.
The information will be used by energy utilities, including the Tennessee Valley Authority, to have a fuller picture of the flood record.

"Managing a working river with nuclear power plants and numerous dams, such as the Tennessee River, means you need to know about the biggest floods possible," Davis said. "These types of events are under-represented in streamflow records because of their rarity and the fact they destroy streamflow monitoring instruments when they do occur."

UA researchers are at the forefront of using paleoenvironmental information to understand how the region's waterways have behaved through time and even modeling that behavior into the future. Investigators Davis and Therrell, for instance, both serve as advisers to the Nuclear Regulatory Commission and are helping develop guidelines and processes for assessing extreme flood risk.

"In the eastern U.S., our knowledge of long-term climate, long-term streamflow, and long-term flood frequency is limited," Davis said. "Our methods are opening up new records and new places to investigate."

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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

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