LSU

Department of Civil & Environmental Engineering

FROM THE DEPARTMENT CHAIR

I am delighted to extend a warm welcome to each of you as we embark on another exciting academic year in the Department of Civil and Environmental Engineering (CEE) at Louisiana State University (LSU). Our department continues to thrive, thanks to the dedication and brilliance of our esteemed faculty, staff, and alumni.

During 2022-2023, the CEE department was very successful in all of its academic endeavors. Our research funding was $22.552 million with corresponding CEE expenditures of $9.126 million. This is compared to the year before when our total research funding was $6.148 million and our research expenditures were $7.730 million. The funds were obtained from state, federal, industry, and private organizations.

CEE continues its excellence in teaching, research, and service. Our undergraduate enrollment has been steady over the past year, and we have maintained the highest enrollment of graduate students in the College of Engineering (CoE). This includes 10 graduate students enrolled in the Coastal and Ecological Engineering master's program. The Online LSU CE-MS degree program started in the fall of 2019, and three students graduated in this program in December 2021. Additionally, US News and World Report ranked the online program 10th, tied with Columbia University. The department also teaches service courses to more than 2,212 CoE students. The ABET visitation for both civil and environmental engineering programs were completed without any concerns related to them.

I am pleased to announce the recent appointments of two distinguished individuals to our department. Dr. Mathew Brand joins us with a wealth of expertise in multi-decadal projections of marsh habitat under sea-level rise and hydro-financial modeling. His work promises to revolutionize our understanding of adaptation project benefits and risks. Additionally, we welcome Dr. Muriel Bruckner, whose research on the numerical modeling of coastal biogeomorphic feedbacks and the impact of bank strength and dams on the dynamics of Amazonian rivers is groundbreaking. Dr. Bruckner's contributions extend to studying the transport of microplastics in aquatic systems.

It is with heavy hearts that we share the news of the passing of J. Tinsley Oden, a distinguished graduate of our department in 1959. Mr. Oden was not only an alumnus but also a great scientist whose legacy will forever resonate within the walls of our institution.

Among current research projects you'll read about in this newsletter, our department is actively involved in preserving Native American sites by exploring their geotechnical construction practices. This initiative reflects our commitment to understanding and respecting the rich history of the land along Louisiana's Gulf Coast.

Finally, I want to express my sincere gratitude to each and every one of you who has contributed to the well-being of our department. Your dedication and hard work have played a pivotal role in our continued success.

As we navigate the challenges and opportunities that lie ahead, let us forge ahead with a spirit of collaboration and innovation. Together, we will continue to elevate the Department of Civil and Environmental Engineering at LSU to new heights.

Wishing you all a productive and fulfilling academic year.

Sincerely,

Dr. George Z. Voyiadjis, D.Eng.Sc.,
Boyd Professor
Chair and Bingham C. Stewart
Distinguished Professor of Engineering

DEPARTMENT NEWS

WELCOME DR. BRAND!

Dr. Matthew Brand is joining the LSU faculty this January as an assistant professor in the Department of Civil and Environmental Engineering, with a joint appointment in the LSU Center for Computation & Technology. Dr. Brand completed his PhD in Civil and Environmental Engineering at the University of California, Irvine in 2020 and was a postdoctoral scholar at Pacific Northwest National Laboratories in the Coastal Sciences Division from 2021 until present. His research interests include developing multi-scale, process-based models of coastal systems that capture human and natural influences on dynamics, risks, and impacts. His work aims to advance understanding of coastal systems and inform adaptation in a changing climate. Areas of specific interest to him are resolving event-scale physical processes in multi-decadal projections of marsh habitat under sea-level rise, hydro-financial modeling to quantify adaptation project benefits and risks, integration of stochastic modeling techniques into decision-support tools, and in-situ and remote sensing data-model synthesis.

MULTI-DECADAL PROJECTIONS OF MARSH HABITAT UNDER SEA-LEVEL RISE

Dr. Brand's past research has focused on developing improved predictive tools and capabilities for understanding how marsh ecosystems evolve under the combined pressures of sea-level rise and extreme flow events (Figure 1). His work on sediment transport, morphodynamics, and marsh evolution has been featured in journals such as Advances in Water Resources and Journal of Geophysical Research: Earth's Surface. Dr. Brand is especially excited to apply the lessons learned on the importance of rare, but extreme, events' impact on marsh-surface evolution to marshes subjected to hurricanes in Louisiana.

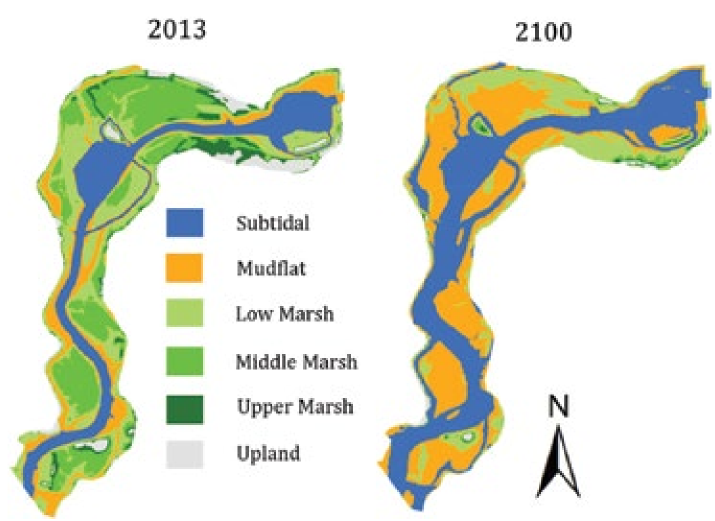


Figure 1. *Evolution of marsh habitats in Newport Bay, California, under sea-level rise and extreme riverine events.*

HYDRO-FINANCIAL MODELING TO QUANTIFY ADAPTATION PROJECT BENEFITS AND RISKS

Moving sediment to areas it is needed (i.e., subsiding marshes or building flood defense infrastructure) to areas it is not (i.e., navigation/flood control channels, ports) is expensive. Not only are initial capital costs high, but continual and indefinite maintenance coupled with inflationary pressures strain sediment management budgets. These pressures on coastal sediment management will only increase into the future as sediment needs increase for flood defense and marsh adaptation to sea-level rise. Current public investment is unlikely to be able to keep pace with this great need, facilitating the desire for innovative approaches to raising capital for sediment management.

Figure 2. *Example of unarmored channel contributing to excess cross-border sediment and trash.*

Dr. Brand's prior research focused on developing advanced cost-benefit analysis tools for quantifying the likelihood of sediment management projects succeeding using models. He applied this tool to the US-Mexico border to identify projects, such as channel armoring and hillslope revegetation, most likely to not only succeed in reducing excessive cross border pollution but also most likely to repay their initial capital costs. This work was featured in journals such as Water Resources Research and Environmental Research: Infrastructure and Sustainability. Dr. Brand is looking forward to taking the lessons learned from this work to applications focused on the ecosystem co-benefits of wetland restoration along the Gulf and Southwest Coasts.

WELCOME DR. BRÜCKNER!

In January 2024, Dr. Muriel Brückner is joining the LSU Department of Civil and Environmental Engineering faculty. After receiving her PhD at Utrecht University in biogeomorphology, she worked as a postdoctoral research associate at the University of Exeter studying the Amazon River Basin and later, at the University of Texas Austin, working on the Mississippi Delta. She is interested in understanding how species and geomorphology interact across different environments and how they are impacted by climate change and human influence. In her research, Dr. Brückner develops process-based models to represent dynamic coupling of physical and biological processes that shape coastal geomorphology, with a particular emphasis on the impact of several biological communities (i.e., vegetation, benthos). At LSU, she aims to apply her models to Louisiana's deltas and wetlands and to find ways to sustainably manage and protect these vulnerable coastal systems in the future.

NUMERICAL MODELING OF COASTAL BIOGEOMORPHIC FEEDBACKS

The geomorphology of rivers and coasts is affected by the species occupying these systems through mediation of flow and sediment transport pathways. Dr. Brückner's past work has focused on developing a novel biogeomorphic model that includes effects of multiple species on the geomorphology of estuaries and mudflats. Her model showed that species-specific habitat preferences alter species abundances and local channel networks, as well as the larger coastal system. At larger scale, different species' traits determine estuary width, mud content, and intertidal area crucial for habitat availability and coastal flooding. Her results also showed that the interactions between species and their environment affect species abundances in multi-species environments, a mechanism that alters ecosystem structure.

One of the main priorities of Dr. Brückner's future work will be disentangling the biological and physical drivers in Louisiana's diverse wetlands. Using a combination of remote sensing and biogeomorphic modeling, she aims to provide insights into the behavior and response of the variety of different species found in these wetlands to future environmental and anthropogenic change. She also plans to develop sustainable management strategies that can help protect and restore these valuable ecosystems.

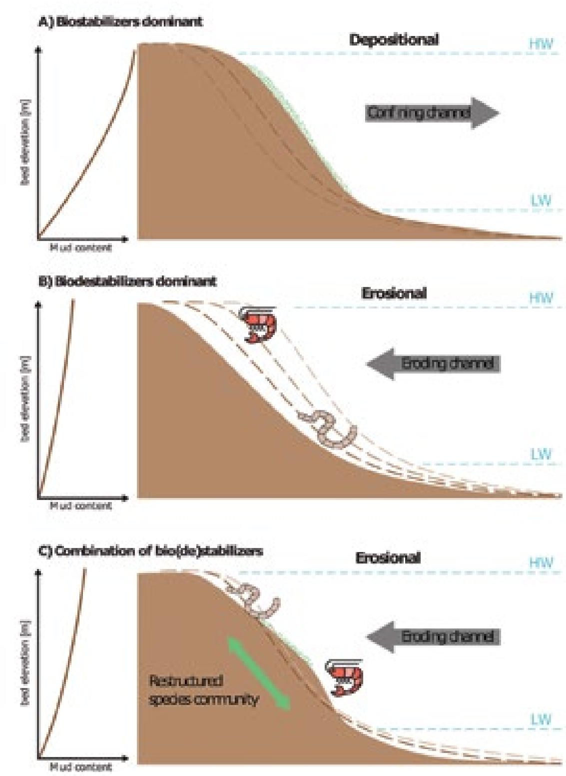


Figure 1: *Conceptual figure of the redistribution of species and the morphological response of a cross section in multi-species environments.*

IMPACTS OF BANK STRENGTH AND DAMS ON THE DYNAMICS OF AMAZONIAN RIVERS

In addition to her work along the coast, Dr. Brückner works with fluvial systems in the Amazon River Basin. The Amazon is characterized by largely free-flowing rivers, a perfect setting to study natural river dynamics and their potential response to ongoing hydroelectric dam construction. By combining field data, satellite image analyses, and versatile process-based models, Dr. Brückner showed that the geologic setting of the Amazon River determines its large-scale fluvial dynamics, which potentially also explain the behavior of other large sand bed rivers, i.e., the Mississippi River. She further showed that dams will have strong local effects on fluvial dynamics, but that the vast Amazonian floodplains are able to compensate for sediment loss in front of dams.

At LSU, she aims to combine her experiences in fluvial geomorphology with her work on the coastal responses along the Mississippi Delta. This will help her investigate anthropogenic effects on wetland response and test sustainable restoration and adaptation measures, such as dam removal or nature-based engineering works.

Figure 2: *Sediment outcrops along the Solimões River, Brazil, showing Holocene floodplain deposits along the north bank and late Pleistocene outcrops along the south bank. Researchers for scale. Image courtesy of Carlos Mazoca.*

TRANSPORT OF MICROPLASTICS IN AQUATIC SYSTEMS

Linked with her work in biogeomorphology, Dr. Brückner studies plastic pollution in aquatic systems. She has worked on microplastic transport and preservation in riverine beds and floodplains and how they can affect aquatic health. In her future projects, she is keen to improve the predictions of microplastic abundances and link those with ecotoxicology in important wetland species.

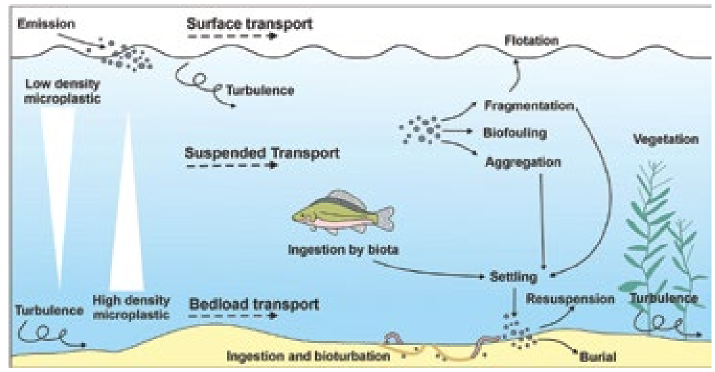


Figure 3: *Processes that affect the transport of microplastics in aquatic systems (from Waldschläger, et al., 2022).*

VOYIADJIS AWARDED 2023 BLAISE PASCAL MEDAL

Boyd Professor and Chair of the LSU Department of Civil and Environmental Engineering George Voyiadjis was recently awarded the 2023 Blaise Pascal Medal for Engineering by the European Academy of Sciences. The medal was established in 2003 to recognize "an outstanding and demonstrated personal contribution to science and technology and the promotion of excellence in research and education."

"This is a great honor for me, and I am extremely proud to be recognized by my peers in such a way," Voyiadjis said. "My experience in industry and my academic appointment in the US and overseas has allowed me to think in a more global sense and at the same time, stay relevant to engineering applications in my research endeavors. Working with my students has been the catalyst of my success in my academic career. The importance of this interaction is to challenge them but also allow them to interact with you through the evolution of the research work."

Voyiadjis was presented with the award by Giuseppe Lasidogna, head of the Engineering Division at the European Academy of Sciences. As part of the ceremony, he delivered a presentation on his groundbreaking work, exploring the intricacies of a physics-based crystal plasticity model. The talk delved into its applications, specifically in the simulation of micropillar compression and the strengthening effect of multilayered copper-graphene nanocomposites.

Voyiadjis was elected as a member of the European Academy of Sciences in 2019. In fact, he is a member of all three European Academies—the other two being the European Academy of Sciences and Arts and the Academia Europaea of Physics & Engineering Sciences. He is also a Foreign Member of both the Polish Academy of Sciences, Division IV (Technical Sciences), and the National Academy of Engineering of Korea.

In terms of past awards, Voyiadjis was the recipient of the 2008 Nathan M. Newmark Medal of the American Society of Civil Engineers and the 2012 Khan International Medal for outstanding lifelong contribution to the field of plasticity. He was also the recipient of the Damage Mechanics Medal for his significant contribution to continuum damage mechanics in 2015 and the 2022 American Society of Mechanical Engineers Nadai Medal for outstanding achievements in micro-mechanical characterization of plasticity and damage in materials and for pioneering contributions to multi-scale modeling and localization problems.

In 1980, Voyiadjis began his career at LSU as an assistant professor after working at the California Institute of Technology, where he earned his master's in civil engineering, and Columbia University, where he earned his PhD in engineering mechanics.

He is an expert in multi-scale modeling of size effects in materials with different methods of atomistic simulation and continuum-enhanced models, including gradient plasticity and gradient damage. His research activities of particular interest encompass macro- and micro-mechanical constitutive modeling, experimental procedures for quantification of crack densities, thermal effects, interfaces, failure, fracture, impact, and deflect nucleation and evolution in crystalline metals.

REMEMBERING J. TINSLEY ODEN

The LSU Department of Civil and Environmental Engineering (CEE) is saddened to learn of the passing of J. Tinsley Oden, a 1959 graduate in civil engineering and past inductee of the CEE Hall of Distinction, the College of Engineering Hall of Distinction, and the LSU Alumni Hall of Distinction.

“We are sad to hear the passing away of our dear friend, Professor J. Tinsley Oden,” said George Voyiadjis, CEE chair and Boyd Professor at LSU. “His legacy and monumental work in computational mechanics will live on and grow throughout our community. He had a long and successful career in the field of computational mechanics. He embodied what it was to be an academic and even more importantly, a superb human being. It was my honor to have known him all these years.

“I first met him in person at [the University of Texas-Austin] in 1987. He always carried himself with a zeal and zest for life, a youthful spirit and charming disposition, and a beaming smile. He was a great scientist and individual.”

Oden was one of the founding fathers of the field of computational mechanics. Over the course of his long and distinguished career, Oden served as professor of aerospace engineering and engineering mechanics, professor of mathematics, and professor of computer science at the UT-Austin. He was also the founding director and associate vice president for research of the Institute for Computational Engineering and Sciences (ICES) at UT-Austin, which was an expansion of the Texas Institute for Computational and Applied Mathematics—also directed by Oden for more than a decade.

Among the many honors bestowed on him over the years, Oden was the founding president of the United States Association for Computational Mechanics; a member of the U.S. National Academy of Engineering; a Fellow of the American Academy of Arts and Sciences, as well as several other international scientific/technical societies; an Honorary Member of the American Society of Mechanical Engineers, and a Life Member of American Society of Civil Engineers. He was also editor of Computer Methods in Applied Mechanics and Engineering; served on the editorial boards of 31 scientific journals; and was the author or editor of more than 500 scientific books, book chapters, essays, articles, and conference papers, including 50 books and monographs.

FACULTY NEWS

LSU CIVIL AND ENVIRONMENTAL ENGINEERING, GEOGRAPHY AND ANTHROPOLOGY RESEARCH PRESERVATION OF NATIVE AMERICAN SITES

Research has shown that the Louisiana coast is slipping away little by little, which will continue to impact coastal communities. One such community that goes mostly unnoticed are Native Americans, whose archaeological sites are greatly affected by coastal erosion. Wanting to help Louisiana tribes sustain their sacred ground, faculty in the LSU Department of Civil and Environmental Engineering and LSU Department of Geography and Anthropology are working alongside other Louisiana universities to evaluate and determine how these tribes can protect their land.

LSU Civil and Environmental Engineering Associate Professor Navid Jafari has teamed up with LSU Geography and Anthropology Associate Professors Kory Konsoer (principal investigator) and Jill Trepanier—along with the University of Louisiana at Lafayette anthropology department, Tulane University's archaeology department, and the National Park Service—to come up with a vulnerability and risk assessment that can inform mitigation plans for preserving Louisiana Native American tribes' archaeological sites, such as earthen mounds.

The project—officially known as the Mississippi River Delta Archaeological Mitigation, or MRDAM, project—is funded by a two-year, $293,000 grant from the U.S. Geological Survey-South Central Climate Adaptation Science Center.

"This is a really exciting project because it's interfacing archaeology with engineering," Jafari said.

"The whole motivation behind the [MRDAM] project is to focus on cultural resources that are being impacted and bring them to light," Konsoer said. "You have the coastal zone of Louisiana that is in crisis, but a lot of the emphasis is on the broader picture—ecosystem, infrastructure—and this is trying to bring a little more attention to those cultural resources that include Native American archaeological sites, like earthen mounds, some of which are single mound sites while others are more complex, such as a series of mounds typically built in an oval or circle with a central plaza communal space within in it. There are hundreds of these sites in coastal Louisiana. Some of them are already lost; some are being actively eroded; some are subsiding and becoming inundated with water. Right now, it may be subsidence or storm surge, but as we lose more land, those sites will be exposed to the coastline and have active wave erosion."

Since the sites are at different positions within the coastal zone, they will experience different pressures from climate change, sea-level rise, and land loss.

"Extreme weather behavior is expected to worsen in our changing climate, including more severe hurricanes and higher intensity precipitation," Trepanier said. "We want to try and provide as much insight as possible into what the future may look like for these sites, so they can make decisions on how to best protect their resources."

"We're working with tribes to find out which sites are most important to them, how they would like the sites preserved, listening to oral histories, and learning the significance of these sites," Konsoer said. "For myself as a geomorphologist, and [Jafari] in geotechnical engineering, we hope that through these collaborations we'll be able to learn more about how these mound sites were constructed and their erodibility."

“I think something that has been under-investigated is the construction of these mounds,” Jafari added.

He said that the LSU mounds are made of two different soils, one of which is siltier and the other more clay, meaning they were sourced from different areas.

“It’s quite interesting to get an idea of what materials they used and how they engineered them to have higher strengths, leading to high mounds without any landslide or slope issues,” Jafari said. “We’re coming from an engineering perspective to look at their strengths and index properties. When doing this, you can see how resilient they’ll be to sea level rise.”

The team’s first step is to find out which mounds are more resilient so it knows where to prioritize resources. Next, will be a discussion with the tribes on how they want to mitigate, such as doing shoreline protection to keep the mounds from eroding.

“It’s up to the tribal partners on how they’d like to move forward, whether it’s preservation or mitigation,” Konsoer said.

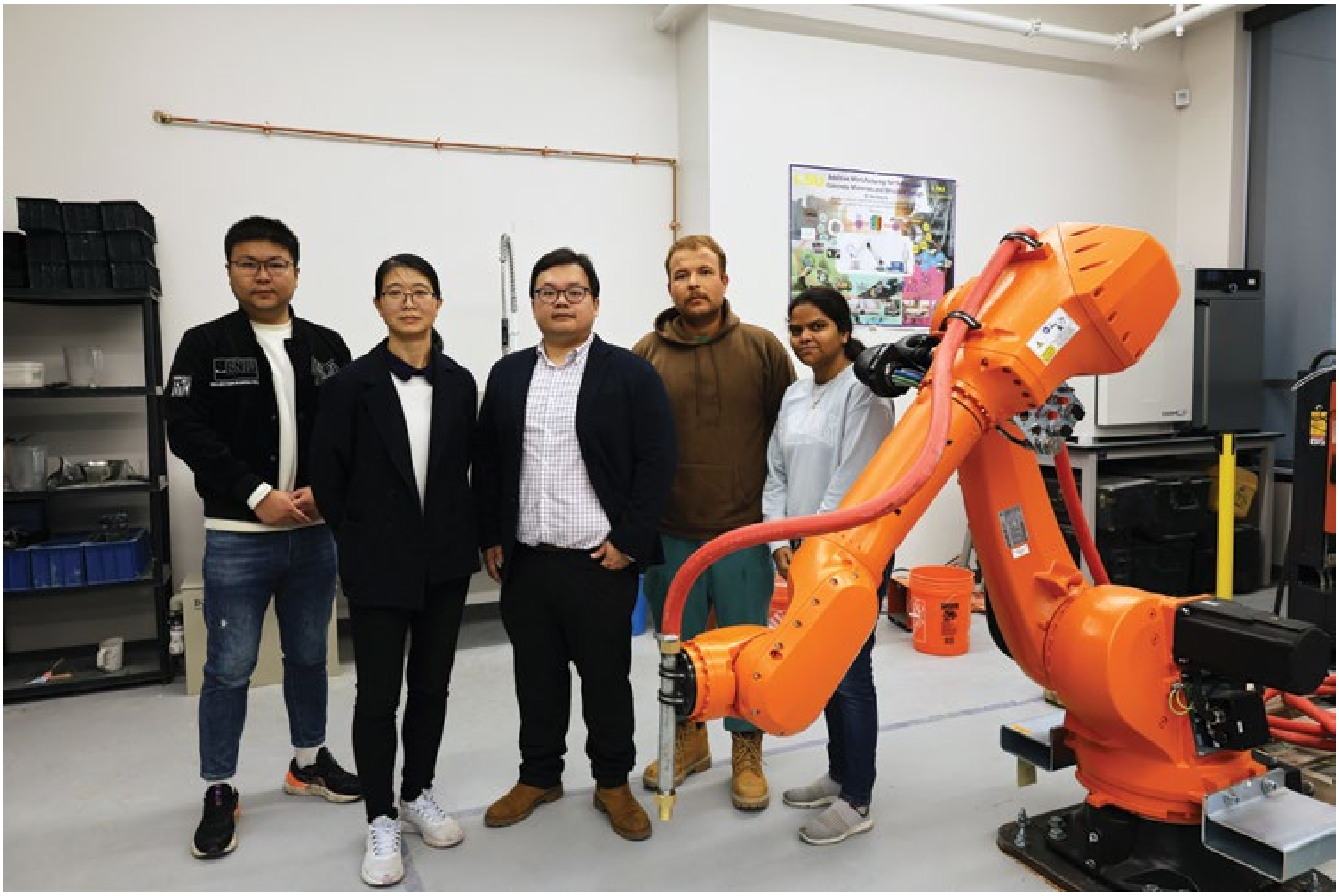
Michael Rodgers, an assistant professor of anthropology at the University of Louisiana at Lafayette, is helping on the MRDAM project and has been communicating with the tribes. He will be guiding interviews and workshops to direct MRDAM’s efforts and center the concerns of stakeholders.

“I’m serving as a cultural anthropologist, and my role is to facilitate with the Louisiana tribes to see if they’re interested in helping us with the project,” Rodgers said. “We want to put them in the driver’s seat in determining what sites are most important to them and what they want done to the sites. Mitigation is up to them.”

Rodgers said the MRDAM team would like to expand this research opportunity to as many Louisiana tribes as they can. Currently, they are looking to work with the Chitimacha tribe and have reached out to the Houma tribe.

“I think what makes this a special project is having the tribe members lead us in accomplishing what they want us to accomplish,” Rodgers said. “This is important. It’s a very existential moment for a lot of these things. It’s a very good project with a lot of talented people involved.

LSU ENGINEERING RESEARCHERS EXPLORE NOVEL AI-DRIVEN APPROACH TO CATALYZE FUTURE UNDERWATER CONSTRUCTION



In 2022, the average global sea level reached a record high at 101.2 millimeters—four inches above 1993 levels. That same year, the National Weather Service recorded an all-time high of 13 “significant weather events.” Both of these statistics signal a greater challenge when it comes to the resiliency of coastal communities and their infrastructure, but it’s one a pair of LSU Engineering researchers are taking on through a nearly $500,000 National Science Foundation Future Manufacturing Award.

LSU Civil and Environmental Engineering Assistant Professor Yen-Fang Su and LSU Chemical Engineering Assistant Professor Yaxin An are exploring the potential of additive manufacturing as an autonomous, advanced construction method to overcome the challenges of underwater construction—such as severe working conditions, restricted access, and potential ecological damage. Specifically, the pair will utilize artificial intelligence-driven material modeling to help them select and determine the best bio-based construction materials for use in underwater construction through a novel-sensing approach.

“To successfully implement underwater additive manufacturing, three key aspects must be considered—materials, manufacturing procedures, and instrumentation,” Su said. “Building upon our current work on additive manufacturing and sensing, Dr. An’s team is using molecular dynamics simulations to calculate the important thermodynamic properties in admixture/cement systems that can provide insight for us to select/design the admixtures that have better compatibility between admixture and cement.

“Our team will quantify various properties of the materials using the AI-assisted sensing method developed in our lab, which is supported by an LSU Provost’s Emerging Research Grant, based on the metrics we provided for Dr. An's group to validate and calibrate the material models. We will further develop a physics-guided, machine-learning model that takes environmental conditions, material composition, and additive-manufacturing process factors into consideration."

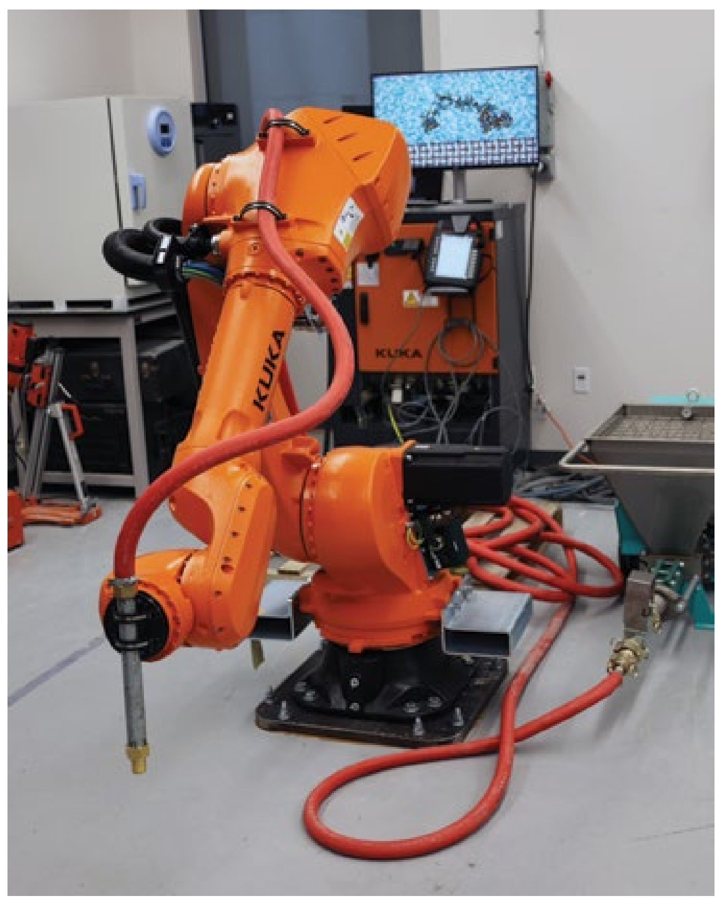
Traditionally, building underwater structural components is complicated and requires pumping or placing concrete using a tremie pipe, a long tube that extends to the seabed and ensures accurate placement while minimizing disturbance to the surrounding water. Repairing those structures once they're built requires highly-skilled divers equipped with specialized gear and techniques to carry out the process. Neither approach is ideal for various reasons.

"These traditional methods pose numerous challenges in the hazardous conditions which impact both workers and the environment, including harsh working conditions such as low visibility, strong currents, and high pressure," Su said. "Equipment and technology limitations in underwater environments also present challenges. Although advances in remotely operated vehicles and autonomous underwater vehicles have enabled the inspection and surveying of underwater environments, they have yet to fully address the challenges of underwater construction. Balancing environmental concerns is also crucial for sustainable development in underwater construction. Preserving marine ecosystems and reducing pollution by using biocompatible materials is essential for protecting the environment and ensuring long-term sustainability."

If their project is successful, both Su and An believe it will not only address those aforementioned challenges, but it will also have far-reaching benefits for the construction industry and coastal communities.

"It will improve our fundamental understanding of the interaction between organic (admixtures) and inorganic materials (cements), providing guidance into the optimization of materials formulation for underwater construction," An said. "This is the first key step to successfully implementing underwater 3D printing."

"This will mean we will have sufficient preparation—models, knowledge, technology, workforce—to face future unpredictable challenges in the engineering of future habitats and infrastructure under extreme environments," Su added. "It will also provide the insight to tackle the extraterrestrial inhospitable environments in the future. The energy sector, defense sector, and underwater robotics will experience innovation from the insights derived from this project."



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Department of Civil &
Environmental Engineering
3255 Patrick F. Taylor Hall
Baton Rouge, LA 70803

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ALUMNI REGISTRATION & UPDATES

The Department of Civil & Environmental Engineering is always interested in how our alumni are doing. We hope you will take the time to send your updates to **young2@lsu.edu** or, if you prefer, you can "snail mail" them to:

Department of Civil and Environmental Engineering
Louisiana State University
Attn: Tori Young
3255 Patrick F. Taylor Hall
Baton Rouge, LA 70803-6405

Please include basic information, such as your full name, year of graduation, degree, mailing address, email address, telephone number, company, and your title/position. For your update, please include information on your recent professional and personal developments, along with a high-resolution photo, if available.

Thanks for staying in touch!

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