UCI Samueli School of Engineering

Department of Civil and Environmental Engineering

SUMMER 2023
NEWLETTER

Nanotech, PFAS and Metals

Written by Nicole Marie Schaeffer and edited by Kaye Bilbao Regalado

As a doctor prescribes remedies for sick patients, the team in Assistant Professor Adeyemi Adeyele's lab is doing the same for the environment, focusing on detecting pollutants and minimizing heavy metals in our water and soil. Their research currently focuses on determining a class of pollutants called PFAS (per- and polyfluoroalkyl substances), and treating environmental matrices contaminated with them. To understand exactly how they brew their medicine, we dove behind the scenes to ask them:

What are PFAS?

PFAS are stubborn chemicals that we come into contact with daily as they can be found in everyday items such as clothes, carpets, food packaging or personal care products, for example.

If these chemicals surround us, why are they so bad for us?

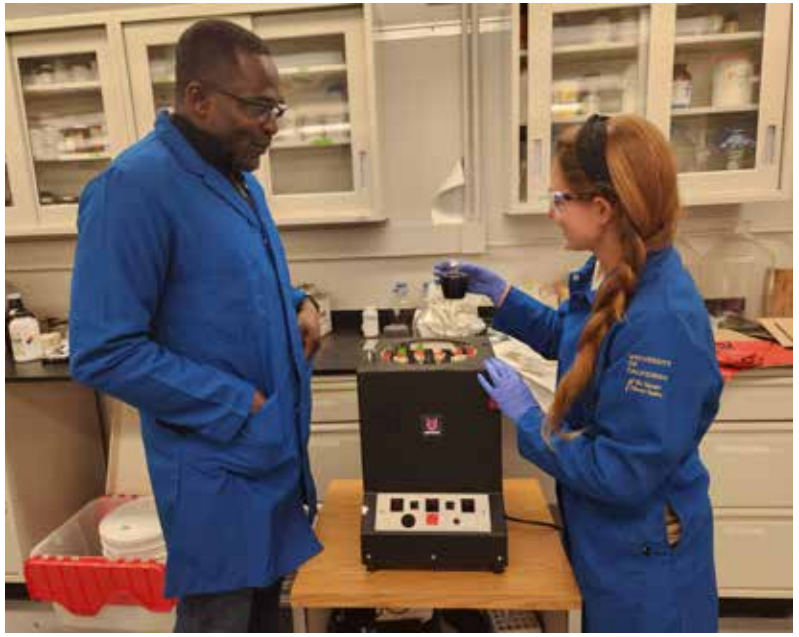
Just because they are common does not mean they are harmless. Overexposure to PFAS has been proven to increase cholesterol levels, change liver enzymes and increase risk of kidney or testicular cancer. The concern is that even low levels of exposure to PFAS can have adverse health effects over time, and the long-term consequences of exposure to these chemicals are still being studied.

If they are so bad for our health, then why do we keep making them?

A key reason is that PFAS have unique chemical properties, which make them resistant to heat, water or oil. They are commonly used for non-stick cookware, stain and water-resistant fabrics, or firefighting foams. These uses lead to exposure for humans and the environment to PFAS. PFAS have a special chemistry that makes them persist in the environment. They also tend to accumulate in living organisms, including humans.

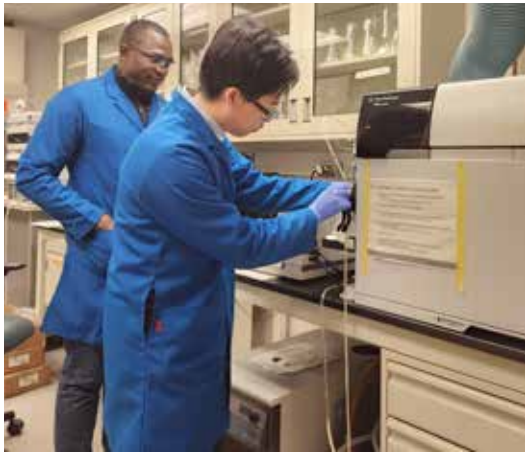
What other pollutants do you tackle?

Heavy metals are a recurring problem to the environment and humans. Such heavy metals like arsenic, cadmium, lead and mercury are most commonly found in store-bought baby food and have substantial impact on human development. Lead, for example, which used to be present in paint or gasoline, and is still used in conventional batteries, is very problematic. If ingested, it can weaken the nervous system, immune system, vascular system or cause cancer and stunt development in infants.



(above) Adeyemi Adeleye and Naomi Senehi inspect a photocatalyst that was prepared for adsorbing and degrading PFAS.

(right) Bayo Salawu preparesd samples for studying interactions between PFAS and microplastics.



(left) Adeyemi Adeleye and Ziwei Han set up the ICP-MS metal analysis.

(below) Adeleye cites the efforts of his research team as the core reason his research has made it this far. He and his team recently earned a $50,000 Hellman Fellowship to continue researching how best to keep the Earth and its people healthy. From left to right: Adeyemi Adeleye, Naomi Senehi, Ziwei Han, Bayo Salawu and Kyle Daly.

Isn't it the fault of manufacturers and consumers for not being careful enough with hazardous materials?

In fact, heavy metals can also be found naturally in geological formations of some places (called hotspots), and thus, soils formed from them. Heavy metals will also be present in water derived from such places. Plants grown in those soils or irrigated with the contaminated water can take up the heavy metals and store them in edible portions. In soil meant for agriculture, this is really bad news. Apart from the natural sources, heavy metals also get into agricultural soils from biosolids application or even the use of agrochemicals that may contain heavy metals. Studies have shown that even if parents buy their own groceries and prepare food for their babies at home, the children could still be exposed to heavy metals – it is not a problem with food processing factories so much as it is a problem with the source (farms).

Why is nanotechnology needed and how does it work?

If dissolved heavy metals precipitate or are adsorbed by other solids, then they are less likely to be taken up by crops. This is how Adeyele lab's iron-based nanotechnology is effectively used to decrease metal uptake by plants via direct and indirect methods. Direct methods include reducing heavy metals to their particulate state so that they are less mobile, and binding them with iron nanoparticles. Meanwhile, indirect methods involve increasing the pH of soil to decrease their mobility. To learn about the specifics of how the Adeleye lab precipitates heavy metals into safer solids, check out their research group *website here*.

"The goal of environmental engineering is to make our environment cleaner and more sustainable."

Building a Greener Future

Written by Nicole Marie Schaeffer and edited by Kaye Bilbao Regalado

The Biden-Harris administration set a goal of deploying 30 gigawatts of offshore wind electricity by 2030 – enough to power more than 10 million American homes with clean energy. One of these projects seeks to convert offshore winds into electricity via floating wind turbines off the coast of California. However, with the depth of ocean floors and unforgiving weather conditions at sea, how is a large turbine going to survive on the ocean, much less float and provide us with energy?

That is where Associate Professor Mo Li comes in. Just as a flower needs a stem to hold its petaled head high, Li and her team are working on creating a sturdy support system for the turbine that will be strong enough to stand tall, yet light enough to float over the waves. In order to accomplish this feat, however, a new type of cement has to be created.

Dodging Waves with Better Cement

Cement makes up 10-15% of concrete, but it requires 95% of the energy needed to make concrete. Cement is one of the most heavily consumed resources in the world. The process of manufacturing it is responsible for ~8% of global carbon dioxide (CO_2) emissions, which is released mostly when it is superheated in a kiln with coal and other minerals to make clinker, which is then ground with gypsum to obtain cement.

Li addresses these issues with her new cement mixes that are characterized by their calcium carbonate (CaO_3) content. This chemical compound does not release CO_2 when heated, and it makes concrete strong enough to withstand the waves, so it can be used to build offshore windfarms that generate sustainable wind

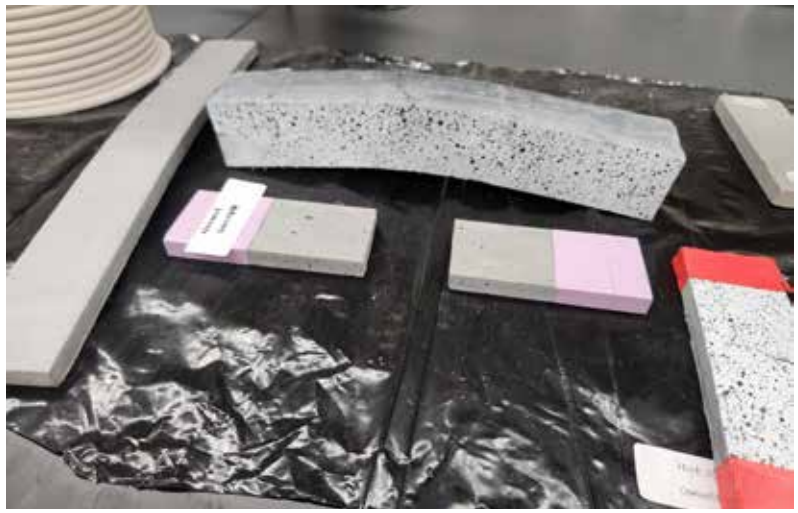
(above) A 3D printed prototype of the wind turbine Associate Professor Mo Li is working on.

(right) Different iterations of concrete created by Li and her team.

(top) Wrapped in pink is regular concrete which breaks easily under any sort of bending, but the thicker sample is of Li's design and can handle greater forces.

(middle) Li and her team conduct research in the Structures Laboratory.

(bottom) A larger prototype of the concrete left out to see if it self-heals. Several of these have been created and left both inside and outside to see how the material reacts.



energy. Thus, these turbines are sure to spin our engineering in the right direction: towards a healthier environment.

Solving A Concrete Puzzle

Back on dry land, Li is also working on cutting back carbon emissions stemming from road and bridge construction and repairs. Approximately 38% of CO_2 emissions in 2021 came from the transportation sector. Repairing the transportation infrastructure using conventional approaches slows down traffic and further contributes to air pollution and CO_2 emissions. To address this problem, the newest method of construction builds pieces offsite and then fits them together on-site like a puzzle, which significantly reduces traffic delays. However, in order for this method to work, the different pieces need to be flexible, yet durable.

In her lab, Li is developing another form of cement that will be strong and flexible enough for this new approach but have much reduced CO_2 emissions to promote a greener future.

Why U.C. yourself at UCI?

Li believes that good engineers must be ready for any possibility, and this includes different environmental factors.

"I wanted to base my research in California because of its geographic diversity, so I could access both onshore and offshore environments, and I have access to both urban and suburban communities," she explains.

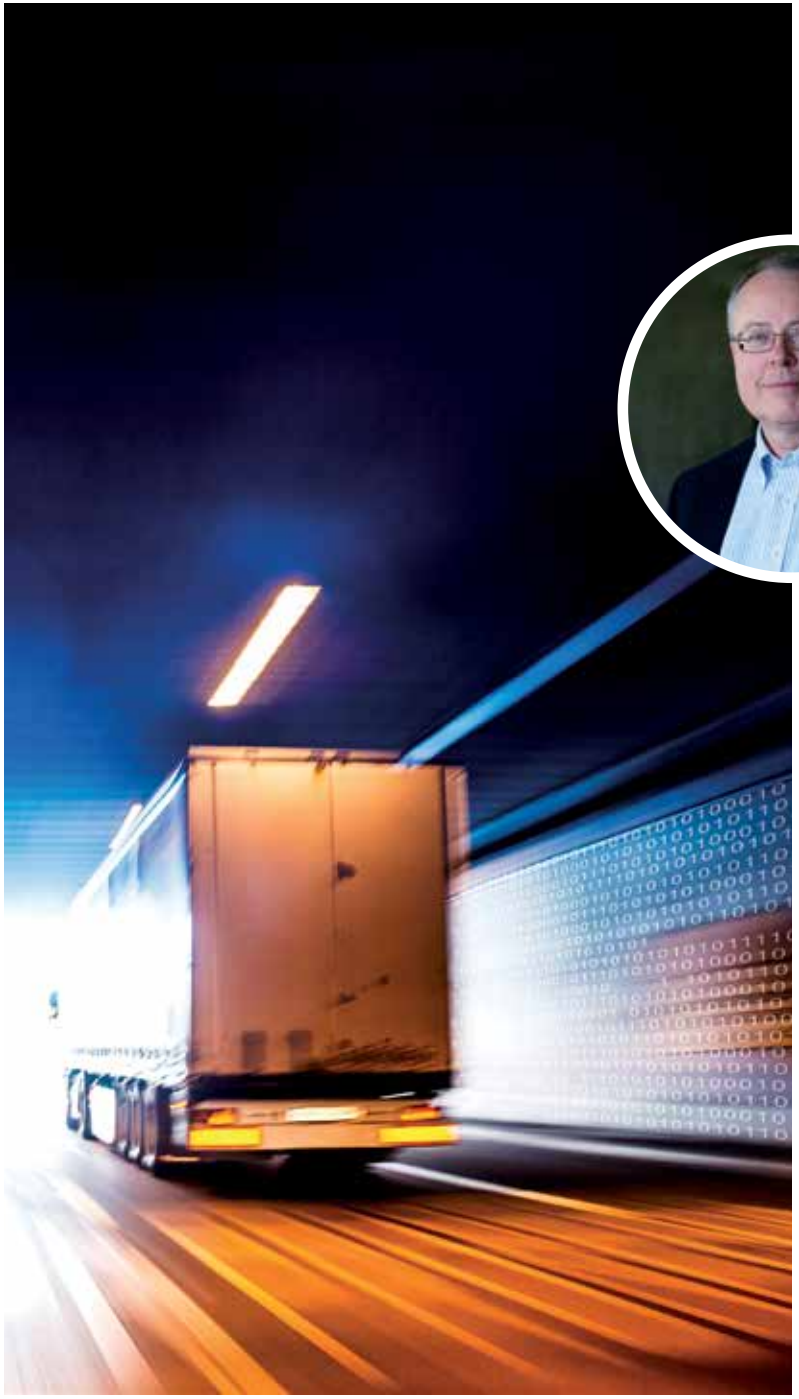
Li wants to change the world by creating stronger and more durable materials. In order to do that, she needs to be able to test her creations in a broad range of environments.

"At UCI, I can have so many connections with industry and agencies like Caltrans, wonderful faculty and great students who come from diverse backgrounds," says Li. "I would not have gotten this far without all the support I have received here."

"UCI is the best place for innovation in solutions to climate change and renewable energy."

Counting Trucks for Greening Freight

Written by Nicole Francis Wong and edited by Kaye Bilbao Regalado



The importance of freight transportation is often overlooked in the field of sustainability and for deployment of emerging technologies. In 2021, California's value of imports ranked number one in the U.S., totaling over $470B, with most of these goods passing through the ports of Los Angeles and Long Beach. Recently, the truck share (vs rail) of moving import containers through the ports has almost doubled, increasing from 32% in 2019 to 59% in April 2022. And nationally, in 2023, 75% of freight by value is expected to move by truck. However, in California, heavy-duty diesel vehicles represent one of the largest sources of air pollution, contributing to approximately 40% of total statewide mobile source oxides of nitrogen (NOx) and 15% of mobile source diesel particulate matter (PM) emissions. There is a need for substantial PM and NOx reductions from on-road heavy duty diesel vehicles to achieve ambient air quality goals, especially in the South Coast and San Joaquin Valley regions of California. This requires innovative policies and enforcement strategies to achieve further emissions reductions from such vehicles, which in turn requires a more detailed understanding of fleet characteristics and activity patterns of in- and out-of-state heavy-duty trucks operating on California's roadways. But despite the critical importance of freight movements and trucking to the U.S. economy and supply chains, publicly available freight data is still scarce, mostly comprising truck counts in limited regions and limited time periods.

This is the focus of Professor Stephen Ritchie's research. Ritchie, who serves as director of the Institute of Transportation Studies (ITS) at UC Irvine, has been devising better ways of collecting freight data to support sustainable transportation policy. With funding from the California Department of Transportation (Caltrans) and the California Air Resources Board (CARB), Professor Ritchie and his team of Ph.D. students (including ITS Testbed Manager Andre Tok) developed the Truck Activity Monitoring System (TAMS), which is based on machine learning methods and advanced vehicle detection technology that cost-effectively utilizes existing in-pavement inductive traffic sensors. TAMS can provide real-time truck counts with unprecedented detail about truck and trailer body types and classifications. Although this

approach is more sophisticated than previous technology, not all information about a truck can be obtained. Indeed, heavy-duty vehicle data is highly variable with many individual truck characteristics of interest (e.g., model, age, fuel type and speed) to estimate greenhouse gas and air pollutant emissions often not available in traditional truck count datasets.

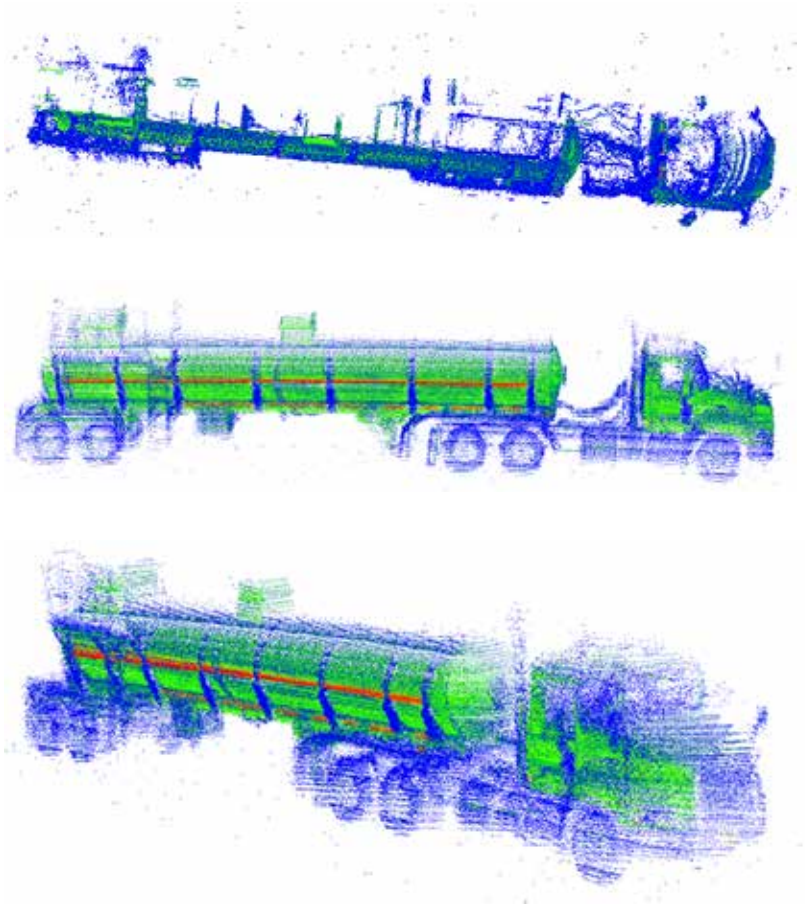
"By knowing how much pollution is being emitted, and where, there can be better estimates for how impactful zero-emission vehicles can be in terms of overall climate impacts as well as environmental justice for nearby communities," Ritchie says.

Fortunately, more advances are on the horizon. The Freight Mobility Living Laboratory (FML2) is a real-time, scalable system that advances the technology from TAMS. FML2 also obtains data from roadside Light Detection And Ranging (LiDAR) and Automated License Plate Recognition (ALPR) systems. LiDAR can generate 3-D images based on measuring the time that it takes for reflected laser light to return to the receiver, and ALPR uses video camera images and optical character recognition to determine the license plate number and state of registration of a vehicle. LiDAR not only helps with truck classification, but it also can be used to anonymously track the trajectory of vehicles, which can be used to map out the movement and frequency of paths of different types of trucks on the road. ALPR enables CARB to obtain a truck's age and fuel type, which helps in estimating emissions of air pollutants and greenhouse gases. The license plate information also gives insight on the distribution and characteristics of out-of-state vehicles, and can be used to estimate their emission impacts while they operate in California.

Fusing or combining various types of sensor data can be used to improve estimates of CO2 emissions, further map out heavy freight operations, and see how they impact surrounding communities. Comprehensive data is also essential to support pavement design, freight planning, and for analyzing road freight impacts on public health, since pollution often disproportionately affects disadvantaged communities.

With such cutting-edge technology, Ritchie hopes to expand the FML2 system throughout the state of California, and beyond. Currently, there are 126 sites in place, 4 with LiDAR and 10 with ALPR. Caltrans is currently deploying about 80 additional sites in Southern California's Inland Empire region, which is a key logistics center for both the state and the nation.

"These are exciting times to be in the transportation engineering field."



Ritchie and his team use LiDAR reconstruction of tractor and single tank trailers as part of their Truck Activity Monitoring System.

Unraveling Mysteries of the Weather

Written by Kaye Bilbao Regalado

For all data, there is an archive. Traditional archives are associated with libraries, books on organized shelves that have information in them. The Center for Hydrometeorology and Remote Sensing (CHRS) in UCI's CEE department is, despite its lengthy title, an archive as well – a digital archive of satellite rainfall measurements.

The CHRS's archive of rainfall isn't just a static data set. A lot of decisions lie on the stories told in these data sets. Decisions such as how we can best capture water to be used by people, how we distribute water, and how we prepare for extreme events like floods and droughts – though these aren't decisions made by the CHRS itself, the data CHRS collects is crucial for decision- and policymakers, and helps them make informed decisions.

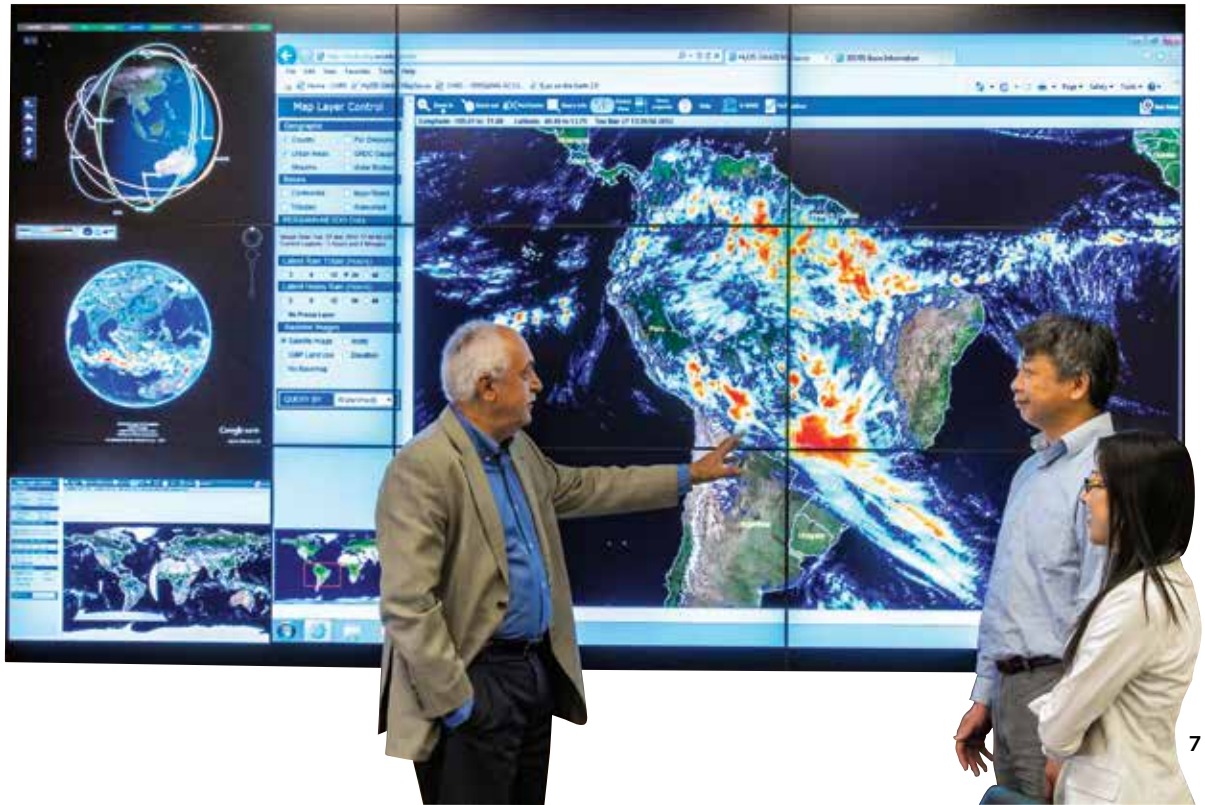
"We do the modeling and algorithm development as part of estimating the rain," says Professor Soroosh Sorooshian, the director of CHRS. "We try to produce the information and give it to people who make the decisions."

Professor Sorooshian describes himself as a systems engineer who assists and heads the center's computational work. In the center, computer systems specialists perform tasks such as gathering satellite data, cleaning up data and feeding that data into algorithms and models developed by students and center scientists. After all the computations, the data comes out.

"We, essentially, provide the nuts and bolts," Sorooshian says. "You need to have that fundamental stuff. That's, really, what we do."

But where that "fundamental stuff" really becomes the foundation is when this rainfall data is shared. One receiver of this information, for example, is UNESCO (the United Nations Educational, Scientific and Cultural Organization), which has partnered with CHRS for many years. CHRS sends UNESCO the rainfall data, but more importantly, that data is shared with people in developing countries.

"We suffer from extreme events, whether lack of rainfall, which means big droughts, or we get lots of rain in a short time, which creates floods. So studying the rainfall, the process, and time and space in which heavy rain may fall is important – because it can save lives," Sorooshian explains.



Professor Sorooshian discusses a rainfall map of South America with some colleagues.

CHRS was established in 2004, and was one of the first groups to start using machine learning, using information from satellites to estimate the amount of rainfall. Currently, CHRS provides estimates of rainfall that are updated every half hour. There are several publicly available websites which disseminate the data.

As for Sorooshian, he has a background in hydrologic systems, flood forecasting, weather forecasting, and most notably, now - in remote sensing.

> **“The end goal is to try and unravel the impact of climate change on water, on ecosystems and the weather.”**

But he notes, with a chuckle, that his career has been “all by accident.”

Wanting to be an aerospace engineer, he started off in mechanical engineering at Cal Poly San Luis Obispo, and then went to UCLA to do work affiliated with NASA’s Jet Propulsion Lab (JPL). Even after getting his master’s in operations research, he still wasn’t sure what he wanted to do in his life. While in a conversation with a department secretary, a professor handed him a book about hydrology. Because his parents were farmers, he decided to delve deeper into hydrology.

Wanting a change of place, he moved to Arizona in 1983. A few years later, he recruited a Ph.D. student interning at JPL. She wanted to learn hydrology from him. After learning from him, they switched roles when she expressed interest in remote sensing. Sorooshian, as the mentor, learned a lot about remote sensing, and those collaborative efforts led to a proposal to NASA, which was funded for 10 years.

“Everything is by, I guess, destiny,” he says with a laugh.

But it seems like it was destiny, too, for Sorooshian to become a mentor. Professor Sorooshian’s proudest achievement is the satisfaction he gets from training young people like graduate students. Over the years, he has advised and co-advised 60 PhD students. “Their success is the most gratifying part,” he says. “They’re family – academic family.”

Rainfall data is essential to the study of climate change. Whether it is scholarly citation in academic essays and dissertations, or researchers observing the changes in rainfall throughout the years, quantifying rainfall is essential to understanding how our world is changing.

“Nature is a complex system. Trying to understand it takes a lot of work. Our research is a small piece of that puzzle. That’s rainfall.”

CHRS is globally known. It has been accessed all over the world, including places like India, China, Israel, alongside 214 other countries. Since CHRS’s website homepage creation on January 1st, 2010, more than 1.2 million people have accessed CHRS resources. Every day, people continue to visit CHRS’ websites and publications to access critical data.

While rainfall will never truly end, Sorooshian explains, “The end goal is to try and unravel the impact of climate change on water, on ecosystems and the weather – the changing temperatures of the Earth, or the changing patterns of rainfall all over the globe. That’s the exciting part.”

Meet Assistant Professor Shakira Hobbs

Written by Francis Wong

Shakira Hobbs recently joined CEE@UCI as an assistant professor. She researches complex problems in the food-energy-water nexus, three areas that are essential to human well-being, poverty reduction and sustainable development.

Almost a quarter of landfill waste in the United States is food waste. This is problematic because decomposing organic material produces methane, which is a potent greenhouse gas. Hobbs is exploring ways to turn food waste into energy and recover methane to be used as an energy source. Besides food waste, she also studies water quality in various communities. She samples their water, advocates for sustainable waste management and partners with them to better understand their needs.

Currently, Hobbs and her team also investigate the impacts of herbicides on the environment and human health. Her lab tracks how herbicides enter water systems, and builds models to forecast contaminated locations. Hobbs' research team is composed of one Ph.D. student and three undergraduate students. An additional Ph.D. student has committed to joining her lab in Fall 2023. Hobbs and her team recently invented a novel technique to detect minute concentrations of glyphosate, an active ingredient in weed killers. Their robust method can detect glyphosate in concentrations as low as 0.1 parts per billion. Their models can now predict how much glyphosate enters different water systems, and track how much runoff from heavy rainfall or precipitation enters surface water, ground water and even tap water.

The World Health Organization currently lists glyphosate as a probable carcinogen, while the Environmental Protection Agency allows for a maximum level of glyphosate in drinking water of 700 parts per billion.

"While regional agencies are still deciding on acceptable toxicity levels and impact on human health, we want to be proactive to detect glyphosate at any level, and develop models and remediations for strategies to protect human health," Hobbs says. "We want to develop tools to safeguard human health."

From left to right: Pedro Jesse Martin, Asst. Prof. Shakira Hobbs, Alexander Ramirez, Yvonne Wen, and Kendrick Pham.

Undergraduate: Fernando Cors Chi

Written by Nicole Marie Schaeffer and edited by Kaye Bilbao Regalado

Fernando Cors Chi is a second-year civil engineering major and an active member of the Society of Hispanic Professional Engineers (SHPE). In his spare time, he can be found biking to new places to take pictures or playing fútbol with his friends.

How would you describe yourself in a few words?

I'm a student from Mexico who likes to experience new things. I take civil engineering very seriously, but I also know how to have fun and know how to appreciate the world around me, which is why I really like the whimsical nature of UCI's campus. I like to travel, and to record the places I visit by "capturing life," as I like to call photography. My favorite sport is fútbol, not soccer.

Why engineering? Why civil engineering?

Since middle school, I always found a passion in doing math. I like the objectivity of it, and that there always is a concrete answer to math problems. Civil engineering was a field in which I saw the most beautiful application of math: seeing blueprints full of calculations and numbers become buildings, roads, and basically the society we live in, was always inspiring to me.

How do you want to apply yourself to civil Engineering in the future?

I want to keep my opportunities open, whether I get a job in Irvine, the United States or Mexico, is something I'll find out in the future. But, if there's something I'm sure about, it is that civil engineering will allow me to make the place we all live in a more sustainable/productive place. As long as I'm doing that, I won't mind where I'll be doing it.

What is the greatest challenge you've faced, and how did you overcome it to be who you are today?

After I decided to come to UCI, the simple prospect of moving to another country, by myself, made me extremely nervous. I didn't know how everything would play out in an unknown environment: the language barrier, the responsibilities of living alone and trying to embark on a new chapter in my life – all at the same time – was definitely a daunting prospect. But, thanks to a mix between the campus's resources, the excitement to be in a new place, and a welcoming environment, I feel that I have adjusted well to the U.S.

What is something outside of engineering you enjoy?

I really enjoy biking. More than a fun way of doing exercise, there's some very pretty sights that might be hidden if you drive, making it a great way to know places around campus and even throughout Orange County, if you have the time!

Why was UCI the best fit for you?

Heading to another country to continue my education wasn't an easy choice; I was very close to staying in my home country. But sometimes you just have to ask yourself: what is the best for me in the long run? Is it better to stay in a similar environment, as the one I've been use to my whole life, or is it better to get out of my comfort zone, to encounter completely new and different opportunities/challenges? I saw all of this potential at UCI, and so far, I don't regret my decision a single bit.

What is the most important part of being at UCI?

I feel that UCI is a place where a lot of opportunities appear: meeting and networking with new people, finding clubs of people with similar interests and goals as me, such as SHPE and, generally speaking, being part of a campus that enables me to realize my academic, social and personal goals through its installations, academic resources and community life.

How has UCI helped you grow, academically and as a person?

I feel the way UCI lays its courses enables me to have a good understanding of important things that I will apply in the future. I've started to see that things I learned on previous courses have helped me a lot in present courses (from general procedures to programs), and I feel this way of learning will help me internalize procedures that will endure in my professional life. Besides that, having to live in a different country, especially in a university as academically challenging as UCI, has definitely given me an immense amount of responsibilities. Finding a balance between academic responsibilities, social life and other factors definitely helped me become a more independent and resilient person.

In three sentences, what advice would you give to your past self?

No seas tímido conociendo gente nueva. (Don't be shy to meet new people). Siempre busca lo que sea mejor para ti a largo plazo. (Always look for what's better for you in the long term). Siempre intenta convertirte en una mejor persona comparado con quien fuiste ayer. (Try to always become a better person compared to who you were yesterday).

Undergraduate: Karen Luong

Written by Nicole Marie Schaeffer and edited by Kaye Bilbao Regalado

Karen Luong is a fourth-year civil engineering major and outgoing president of American Society of Civil Engineers (ASCE) affiliated with UCI. In her spare time, she can be found crocheting gifts for family and friends.

How would you describe yourself in a few words?

In a few words, I would describe myself as optimistic, supportive, and detail-oriented.

Why engineering? Why civil engineering?

I chose engineering because I wanted to give back to my community and help those in need by pursuing one of its numerous routes filled with problem-solving towards the benefit and growth of society. It is a field that never stops advancing as the world continues to progress, so the work I will be doing will never be exactly the same. I also wanted to grow my critical thinking, collaboration and communication skills as I enter higher education and later work professionally in the industry.

I initially chose Civil Engineering because of my interest in transportation engineering in high school. I loved learning about the steps and processes in transportation projects, from the preliminary design to later seeing through with the construction. Learning about how there are so many considerations to take into account when designing a freeway or signalized intersection makes no one project the same. I am choosing to stay in civil engineering for these same reasons, along with the immensely supportive community of students, faculty and professionals I have met so far

How do you want to apply yourself to civil engineering in the future?

I want to apply myself to civil engineering in the future by continuing to grow my knowledge in the field and sharing it with others. As one who has gained several mentors over the past four years, I want to give back by passing their lessons and advice down, along with what I have learned and experienced in my undergraduate education, internships and soon full-time employment.

What is the greatest challenge you've faced, and how did you overcome it to be who you are today?

One of the most significant challenges I have faced was balancing my personal life, academics and being the President of UCI's student chapter of the American Society of Civil Engineers (ASCE) this past year. I overcame this challenge by learning my limits when it comes to workload and knowing when to ask for help. While having to oversee a large cabinet and board requires a lot of time, it also means I have a large group of people I can rely on. The person I am today compared to myself as a freshman is more efficient, communicative and team-oriented.

What is something outside of engineering you enjoy?

Something outside of engineering that I enjoy is crocheting. I self-taught myself through YouTube videos during quarantine in 2020. I love being able to choose the level of difficulty of a project and making gifts for friends and family.

Why was UCI the best fit for you?

UCI was the best fit for me because it aligned with my top factors in choosing a college. It has an amazing engineering program and is close to home. Additionally, when I started out as a freshman and began to adjust to being a college student, I found that I was supported in every corner, from my fellow undergraduates to the faculty. Everyone is always open to lending a hand to others.

What is the most important part of being at UCI?

The most important part of being at UCI is embracing being an Anteater and getting involved on campus. Being proud of UCI's heritage and getting involved in organizations or programs fosters groups that make up UCI's diverse and inclusive community.

How has UCI helped you grow, academically and as a person?

UCI has helped me grow academically and personally with the numerous resources it provides and the community that supports it. Academically, I was challenged by professors in my coursework and as a result, I became more disciplined and attentive in both my work and personal life. Since coming to UCI, I have met a more diverse world of people and expanded my network, becoming more open-minded and empathetic from it.

In three sentences, what advice would you give to your past self?

Do not let anything stand in the way of the goals you already have set. Go out to as many events as possible, those held by student organizations, the department and the school. Celebrate every achievement, even the smallest ones.

Researcher: Monica Ramirez Ibarra, Ph.D.

Written by Francis Wong and edited by Kaye Bilbao Regalado

Monica Ramirez Ibarra recently became an assistant project scientist in CEE@UCI in the Institute of Transportation Studies. She earned a Ph.D. in transportation systems engineering, a master's in urban and regional planning, and a master's in civil and environmental engineering from UCI. She is working on decarbonizing transportation and enhancing transportation justice.

In a few words, can you tell us about yourself?

I'm Monica Ramirez Ibarra, and I'm transitioning from finishing my Ph.D. to an assistant project scientist. I started as a postdoc and worked with Professor Saphores. I just had a baby two months ago, so I'm still adjusting to life being busier than usual.

What is your research about and why is it important?

My research focuses on modeling road transportation (using simulation), estimating the resulting health impacts, and understanding their environmental justice implications. I am currently working on several papers. One of them is an extension of a large project funded by CalEPA, which estimated the benefits of decarbonizing road transportation in California and its subsequent health impacts. I worked with researchers from several UC campuses. For that project, I modeled health impacts at different points in time, all the way to year 2045. I had to project characteristics of the California population, project vehicle miles travelled for different years in the future, estimate emissions from traffic (mostly heavy-duty trucks), and their health impacts. A key takeaway resulting from the research is that decarbonizing freeway transportation so that much of the light and heavy- duty fleets would be zero emissions by 2045, approximately 30 billion dollars would be saved from preventable health impacts in 2045 alone.

Why did you decide to pursue your masters and Ph.D. at UCI? How is your experience as an assistant project scientist been?

I originally came to UCI for a dual master's in urban and regional planning and civil and environmental engineering; I worked with Professor Saphores for my thesis. However, after completing these two degrees, I felt that more could be done so I decided to stay longer, to study for a Ph.D. and continue my research. In September of 2022, I finished my doctorate and published three papers based on my work. After a few months as a postdoc, I am now an assistant project scientist. The transition from graduate student to assistant project scientist happened very organically since I was already working closely with Professor Saphores from my previous research.

Currently, I am working on a project that aims to identify feasible pathways for decarbonizing off-road equipment and vehicles, mainly in construction, mining, agriculture and industrial sectors. As part of this project, we will also perform a total cost of ownership analysis for selected equipment in each of these four sectors. I am also working on a second project whose goal is to model the flows of specific recyclable materials (i.e., fibers from packaging, e-waste, metals, and plastics) in the State of California, and perform a life-cycle analysis of energy and GHG emissions related to recycling and reuse of these materials.

What advice do you have for current and prospective CEE graduate students?

Try to find passion in your work and try to focus on spending time learning and identifying what you like. The time we get as graduate students is precious. Take full advantage of it.

What is one thing you liked about UCI as a student here?

I really liked how open and friendly people are (faculty, staff and students), how people relate, and the opportunity to discuss career and research opportunities.

Building a Sustainable House

Edited by Nhi Yen Hoang, Jackie Yoo, Nicholas Mao and Professor Ayman Mosallam

The Orange County Sustainability Decathlon (OCSD) is an inaugural competition where teams of undergraduate and graduate students design innovative homes of the future powered by renewable energy. The UCI-CEE team is one of 15 teams designing and building a carbon emission neutral, net-zero energy and reduced water usage house.

The UCI-CEE team will complete its house in Summer 2023 and will display it publicly from October 5-15, 2023 at the OC Fairgrounds in Costa Mesa, Orange County. From planning, constructing, furnishing the house - every element and option is meticulously evaluated to maximize the house's sustainability. The UCI-CEE team is organized in five sub-teams that focus on different aspects of the project. Collectively, the UCI-CEE team is led by Professor Mosallam.

UCI -CEE Communications and Marketing team participate at Sustainability Resource Center's Sustainival. From left: Emily Song, Nicholas Mao, Ashley Chung, Nhi Hoang, and Spencer Vu [Photo by Nicholas Mao]

Materials & Structures: Led by Ph.D. students Fahad Allheedan and Faisal Almegren, this team works on the structural design of the house and also performs materials testing. Early on in the project process, the Materials & Structures Team performed detailed 7, 14, and 28-day concrete tests to experiment with the best concrete-mixing formula to support the house's strength and design.

Sustainability: Led by Jimmy Wong, environmental engineering undergraduate, the Sustainability team evaluates the environmental efficiency of materials used in the assembly of the house. The team performed life cycle assessments to evaluate the environmental impacts of all the project's materials, products, and services. This includes concrete, paint, wallpaper, lightbulbs, chairs and even toasters. Meticulous records of material quantities, prices and production have been evaluated to ensure minimal environmental impact.

Water: Led by Edith Carranza, civil engineering undergraduate, the water team evaluates the water source, supply, demand and method of delivery within the house. Notably, the team has designed a greywater (i.e., water that has been used for washing dishes, laundering clothes or bathing) reclamation system,

which reduces and reuses wastewater from laundry, bathing or showering. The team has also designed the plumbing system and its layout in the house.

Interior Design & Project Management: Led by team captain Jackie Yoo, civil engineering undergraduate, this team ensures that all sub-teams stay in active communication and meet the deadlines for each task and sub-task. The team also collaborates with the Sustainability and Water teams to complete the interior of the house. They help determine the placement and layout of the furniture or location of the piping and water system.

Communications and Marketing: Led by Nicholas Mao, civil engineering undergraduate, this team arranges the UCI-CEE team's involvement and presence in campus-wide events, creates video and photo documentation of the team's activities, and collaborates with other on-campus organizations to help recruit for the project and market the house.

The UCI-CEE Team has partnered with multiple professors at UCI and several engineering companies, incorporating professional feedback and input in the house's planning process, material acquisition and production, and overall research, development, and design. Mr. Aravind Batra, the CEO of P2S engineering, and Dr. Shazad Ghanbari, the President of Westgroup Designs, have been working with CEE@UCI students on the house design and completion of milestones in the building process. Additionally, LA Urban Farms has generously donated aeroponic tower gardens to the house, which will be equipped with a custom water control system designed by Professor Quoc-Viet Dang and his students.

The team is grateful to have received professional assistance and input from these companies and UCI faculty, and is always open to additional collaboration and contribution. Whether it's a financial donation, assistance at a materials testing lab for a day, or just a few extra hands at the next campus fair, UCI-CEE welcomes people of any and all majors and interests. Those who may be interested in joining the team or just hearing more about UCI-CEE can contact the Team Captain Jackie Yoo jacquyy1@uci.edu or Professor Ayman Mosallam mosallam@uci.edu.

(left) CEE@UCI Team Working in Developing Light-weight Sustainable Concrete at CEE SETH Lab. From left: Nicholas Mao, Yasaman Sheikhi, Spencer Vu [Photo by Emily Song]

(right)Visiting the LA Urban Gardens' Bruin Tower Garden at UCLA. From left: Emily Song, Nicholas Mao, Shanni Wu, Faisal Almegren, Wendy Coleman (LA Urban Farms CEO), Professor Ayman Mosallam, and Edith Carranza [Photo by Jackie Yoo]

UCI Samueli School of Engineering | Department of Civil and Environmental Engineering

E4130 Engineering Gateway Building
Irvine, CA 92697-2175

(949) 824-5333

cee@uci.edu