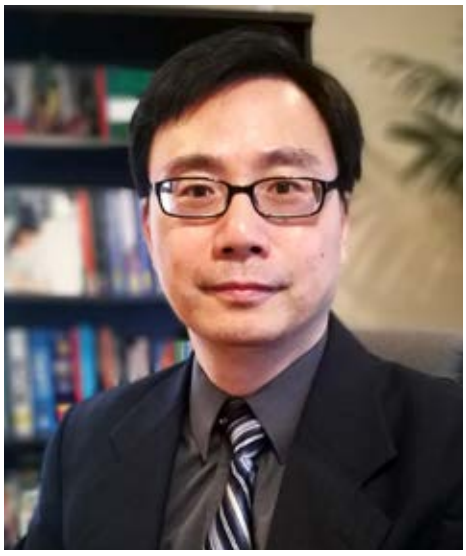
TICKLE COLLEGE OF ENGINEERING
INSTITUTE FOR A SECURE & SUSTAINABLE ENVIRONMENT

News from ISSE

Spring Magazine 2022

Institute for a Secure & Sustainable Environment

Director's Message



ISSE Director Dr. Mingzhou Jin

I am pleased to highlight ISSE's current research, educational, and outreach projects in our 2022 Spring Magazine. To summarize our state of research, ISSE principal investigators are currently leading 22 active, sponsored projects for ISSE, and there are 17 individual agencies funding these projects. ISSE also has six funded seed grant projects in progress.

ISSE has five areas of research: clean energy and energy efficiency, climate change, regional sustainability, water research, and sustainable food systems. Each ISSE program has conducted significant research: water resources through US Geological Survey projects; methane hydrates and global soil moisture datasets; ways to reduce food loss and waste; and trends in Appalachian tourism and diversity. ISSE research projects have engaged more than 50 UT faculty members, two post-doctoral associates, and many graduate and undergraduate students.

ISSE provides an important platform for interdisciplinary research to promote environmental sustainability. The Healthy Environment team led by Dr. Qiang He won the 2021 UTK Success in Multidisciplinary Research award. The team integrates expertise in environmental engineering, health, infrastructure, human factors, automation, systems engineering, and data science to attack complex health problems in a systematic way. Besides Dr. He, the team includes ISSE affiliates Shuai Li and Mingzhou Jin and five other researchers from the Tickle College of Engineering, College of Arts & Sciences, College of Nursing, and the UT Institute of Agriculture.

Dr. Jon Hathaway (CEE) has obtained NSF funding for *The Green Infrastructure for Sustainable Urban Environments Research Experience for Undergraduates (REU)*. This is a 10-week summer program designed to expose and immerse 10 undergraduate students per year to Green Infrastructure research. Green Infrastructure is a unique way to restore and improve urban infrastructure. The first class of REU participants has been selected, and the program will kick off at the end of May 2022 and wrap up in August.

The U.S. Department of Energy recently announced a national program called EMPOWER (Equitable Mobility Powering Opportunities for Workplace Electrification Readiness) to promote electric vehicle workplace charging. The project team will receive $3,970,539 in federal funds and secure $1,000,000 in cost share from non-federal sources. Leveraging their experience with the Drive Electric USA program, ISSE-based East Tennessee Clean Fuels (ETCF) will provide administrative support and project management guidance for the EMPOWER program. ISSE has a major role in the EMPOWER project, overseeing data management and analysis. The integrated data and analysis results will be shared with national labs to inform research and development of modeling tools related to workplace charging.

As always, ISSE is indebted to the support given by the Tickle College of Engineering. It is the key to our continuing success.

ISSE Welcomes New Staff

Madelyn Collins, ETCF Communications Consultant

Madelyn joined ETCleanFuels 2019 as the Digital Media Coordinator. After spending time away to focus on community organizing, she rejoined ETCleanFuels to help make her home a greener and cleaner place, especially for the most vulnerable populations of Tennessee.

Susan Fusaro, ETCF Fiscal & Memberships Coordinator

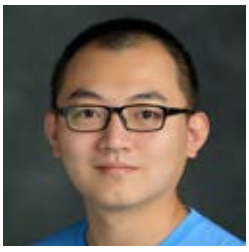
Susan has spent the past ten years in energy management, working to track and reduce energy consumption; save money, avoid costs, and help the environment along the way. Susan is an experienced coordinator who can wear any and all hats needed in the office.

Savannah Robertson, Drive Electric TN Coordinator

Savannah handles DET's working groups and planning events. She is most passionate about supporting people to thrive in our ever-changing world. Before joining ETCleanFuels, she managed Smart Trips, a federally funded program that encourages sustainable transportation.

Ainsley Kelso, ETCF Communications Coordinator

Ainsley joined the ETCleanFuels team June 2020. She is now a full-time employee, using her research, writing, and media management skills to promote cleaner transportation. Ainsley is passionate about advocating for others and helping the world around her.



Xu (Scott) Zheng, Post-doctoral Research Associate

Scott Zheng began at ISSE as a visiting scholar in 2019. He received his Ph.D. from the University of Science and Technology of China in 2021. His research lies in the areas of modeling, optimization, scheduling, and the industrial application of machine learning to create a sustainable, energy-saving industry and environment.

Jason Brown, Research Associate II

Jason joined Tennessee Water Resources Research Center at the beginning of 2022. As a graduate student at UT, he examined the effects of acid rain deposition in the Great Smoky Mountains National Park, including wet and dry deposition of acidic compounds and metals to soils. His research areas are environmental monitoring technology, stream restoration, water quality modeling, watershed management, and environmental chemistry.

Current Research Activity

2022 ACTIVE SPONSORED PROJECTS

PI	*Sponsor*	*Title*	*Start*
Khalid Alshibli	National Science Foundation	3D Dynamic Evolution of Pore Water-Air Interaction within Saturated Sheared Sand	Continued
Mingzhou Jin	US - NSF - National Science Foundation	Coupled FEWS-Sustain Global Crop US-China	Continued
Mingzhou Jin	DOE - ORNL - UT Battelle - Oak Ridge National Laboratory	Policy Study - Adoption of Alternative Fuel Vehicles	Continued
Mingzhou Jin	DOE - ORNL - UT Battelle - Oak Ridge National Laboratory	Smart Manufacturing	Continued
Mingzhou Jin	DOE - ORNL - UT Battelle - Oak Ridge National Laboratory	Analysis for Regional and Global Land Ecosystem Modeling	Continued
Mingzhou Jin	East Tennessee Clean Fuels Coalition	Administrative Support for East Tennessee Clean Fuels	Continued
Mingzhou Jin	OnTrackNorthAmerica	Support for Land Freight Lifecycle	7/15/2021
Mingzhou Jin	US - NSF - National Science Foundation	SRS RN Planning Grant	1/1/2022
Timothy Ezzell	Appalachian Regional Commission	Appalachian Leadership Insitute	Continued
Timothy Ezzell	East Tennessee State University	Appalachian Teaching Project 2021-2022	8/15/2021
Jon Hathaway	US - EPA - US Environmental Protection Agency	Restoring Floodplain Wetlands and Hydrologic Connectivity Using Regenerative Stormwater Conveyance	Continued
Jon Hathaway	US - NSF - National Science Foundation	REU Site: Green Infrastructure for Sustainable Urban Environments	10/1/2021
Qiang He	Aramco Services Company	AOP for Wastewater	Date of contract
John Schwartz	Metropolitan Government of Nashville and Davidson County	Urban Waters Report Card	3/4/2021
John Schwartz	Shelby County	Urban Waters Report Card	9/1/2021
John Schwartz	Tennessee Dept of Environment and Conservation	TN Stream Quantification Tool Training	Continued
John Schwartz	National Park Service-Great Smoky Mountains	Improving the GRSM's understanding of its natural resources and processes thereby enhancing protection of the Park's resources	Continued
John Schwartz	West Virginia University	Appalachian Community Technical Assistance and Training Program	Continued
Schwartz/Gangaware/ Hathaway/Wang	DOI - USGS - US Geological Survey	Tennessee Water Resources Research Center Program	Continued
Sheila Webster	National Partnership for Environmental Technology Education	National PETE DOE Worker Training	Continued
Yaoping Wang	DOE - ORNL - UT Battelle - Oak Ridge National Laboratory	Data Analytics Support for Integrated Earth Model	Continued
Hongyu Zhou	DOE-NETL	Utilizing coal-derived solid carbon materials towards next-generation smart and multifunction pavements	Continued

RESEARCH

Research

Each ISSE program has conducted significant research this past year: water resources through four US Geological Survey projects; methane hydrates and global soil moisture datasets; ways to establish a US-China transdisciplinary research coordination network for identifying grand challenges at the nexus of food-energy-water systems (FEWS); and trends in Appalachian tourism and diversity. ISSE research projects have engaged more than 50 UT faculty members, post-doctoral students, and many graduate and undergraduate students. ISSE's five main areas of research are

- Clean Energy & Energy Efficiency
- Climate Change
- Regional Sustainability
- Water Research
- Sustainable Food Systems

Clean Energy & Energy Efficiency

In Tennessee, increasing the use of cleaner American fuels, vehicles, and energy-saving transportation technologies will improve air quality and health, curb dependence on imported petroleum and support Tennessee's economy. Through ETCleanFuels, ISSE works to implement alt fuel projects and lead a sustainable coalition of involved participants from across East Tennessee. ETCleanFuels serves as a fleet guide to navigate alternative fuels and advanced vehicle technologies in the 21st century. DriveElectricTN promotes the adoption of electric vehicles for fleets and individuals across Tennessee with a goal of getting 200,000 EVs on TN's roads by 2028.

East TN Clean Fuels - TDOT I-40 Alternative Fuels Corridor Continuation Project
Jonathan Overly, PI
Thanks to a 2019 federal grant, TDOT received funding to build a partnership across Arkansas, Tennessee and North Carolina to fill the gaps in compressed natural gas (CNG) and electric vehicle direct current fast charging (DCFC) refueling infrastructure along I-40. The project was completed in 2020, and the results led to a TDOT-UTK contract involving ETCF and ISSE researchers who will develop a How-To including prioritization criteria, a site selection formula, and sustainable funding strategies. Work will conclude in fall 2022.

Drive Electric TN - DRIVE Electric USA DOE Project
Jonathan Overly, PI
East Tennessee Clean Fuels is the project lead on this 2020 DOE-funded project that includes 14 mostly "flyover" states that are building statewide 'Drive Electric' programs. The project includes work on these priority areas:

- Developing those branded statewide efforts, websites, and outreach and social media campaigns,
- Consumer education including developing state chapters,
- Utility and regulator engagement,
- EV charging infrastructure planning,
- Local and state government official education,
- Dealer engagement, and
- Fleet partnerships and EV adoption.

In year one, efforts began on all priority areas and coalitions started assembling their branded programs. This included partnership building and logo development as statewide plan development is a top priority. Chapter development, building utility relationships, and dealer and fleet planning are other significant tasks underway in year one.

Before project completion, it is important that we develop long-term funding approaches and expand the program to include additional states beyond the original 14 (as that was included in project activities). During summer 2021, the project added four states (Indiana, Kentucky, Connecticut, and New York) and discussions are underway with another dozen Clean Cities Coalitions and states to bring them into the fold. Additional states will be able to utilize any materials developed from the project to help develop their initiatives.

Climate Change

Climate change is one of the most critical challenges faced by human being and our planet. Researchers at ISSE, closely working with the Climate Change Science Institute at Oak Ridge National Lab (ORNL), is advancing our understanding of climate change and its impacts on human and natural systems. We use Earth system modeling, integrated ground and remote sensing observations, and advanced data analytical tools to study climate change and its impacts on water availability, soil moisture, wildfires, and vegetation. The team is Drs. Yaoping Wang, Yulong Zhang, Jiafu Mao (Joint Professor at ORNL), Joshua Fu, and Mingzhou Jin.

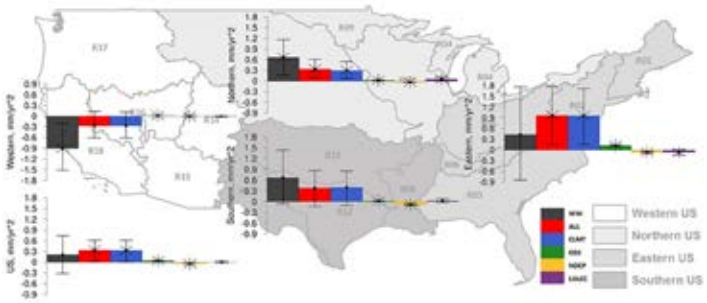
Water Availability

PIs: Yaoping Wang, Mingzhou Jin, Jiafu Mao, Yulong Zhang, Joshua Fu

Water (or runoff) is an essential resource for the terrestrial biosphere as well as for human society; thus, it is important to detect and understand the potential drivers of changes in the hydrological cycle. Here We studied annual and seasonal runoff in the contiguous United States and streamflow in the Columbia River Basin for the period 1950 – 2010 and 1950 – 2008, respectively. For forcings, the effects of climate change and variability, CO2 concentration, nitrogen deposition, and land use and land cover change are used in both studies. Monthly observations of runoff from WaterWatch of the United States Geological Survey, and an ensemble of semi-factorial land surface model simulations were used to quantify the effects due to external forcings. United States runoff had significant and insignificant increases in the east, north, and south, and a strong significant decrease in the west. These changes were detected in the effects of climate change and variability, but could not be attributed due to the dry bias in the precipitation driver leading to underestimation in the model simulations. However, for the Columbia River Basin, the changes in annual total, center of timing of, and summer mean streamflow were attributed to climate change and variability. The most significant changes were the declines in the June – October months. On average, these months account for approximately 49% of the annual total flow. More specifically, the greatest decline was 28% for June which comprised approximately 22% of the total annual flow.

Soil Moisture: Data Analytics Support for Integrated Earth Model, Funded by DOE, UT-Battelle & ORNL

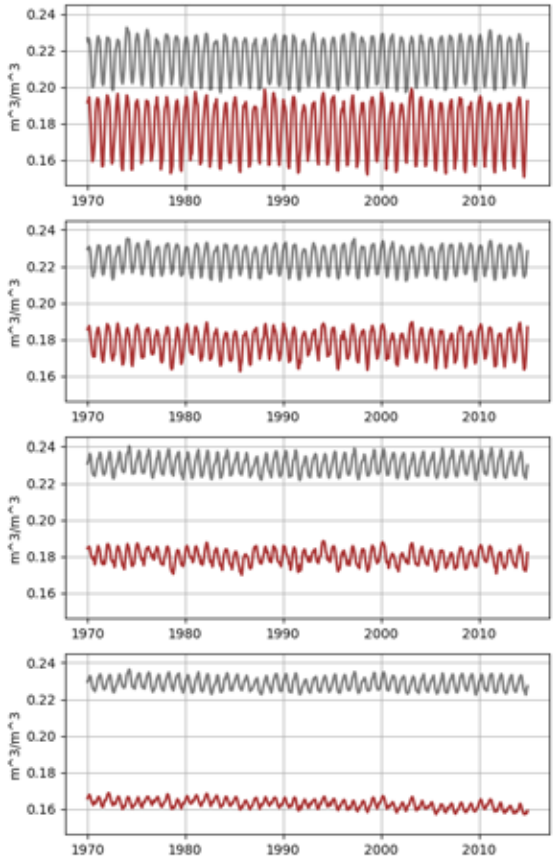
PIs: Yaoping Wang, Mingzhou Jin, Jiafu Mao



Regional Trends for US Annual Total Runoff (Forbes et al., 2018)

Soil moisture is an important variable for understanding the terrestrial ecosystems and land-atmosphere interactions. Climate change induces changes in soil moisture by increasing atmospheric demand for evapotranspiration and changing the global precipitation, vegetation cover and behavior, and snow cover. Accurate quantification of soil moisture changes using statistical and modeling approaches require high-quality historical data sets and comprehensive benchmarking of model performance. However, current availability and accuracy of long-term, gap-free soil moisture data sets are limited. This limitation translates to high uncertainty in current understanding of the impacts of human forcings (e.g., emissions of greenhouse gases and aerosols) on soil moisture, and the lack of modeling benchmarking on soil moisture. The project aims to (1) develop global, gap-free, long-term, multi-layer soil moisture data sets with improved accuracy over existing data sets, (2) use the developed data sets to conduct formal detection and attribution analysis to understand the impacts of human forcings on soil moisture, (3) add the developed data sets to the International Land Model Benchmarking Project (ILAMB) package.

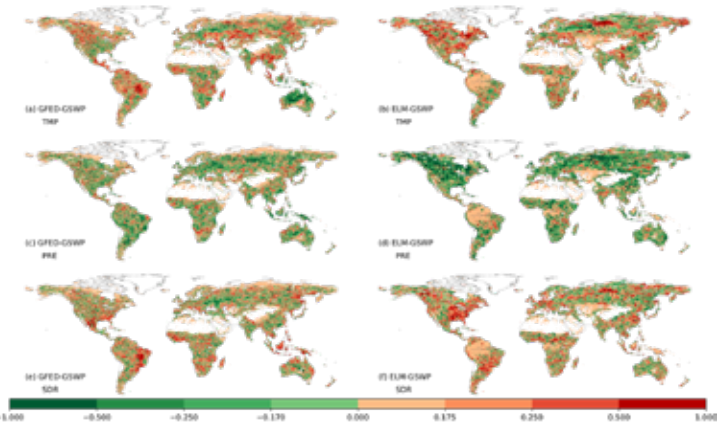
The team has developed the desired soil moisture data sets (1970–2016, monthly, 0.5, 0–10 cm, 10–30 cm, 30–50 cm, 50–100 cm) and published the results in an open-access journal (Wang et al., 2021). Using the developed data sets, detection and attribution analysis was conducted on zonally averaged global Standardized Soil Moisture Index, and the results were written up in a submitted manuscript. The results showed that human forcings, mainly greenhouse gas emissions, had significant impacts on historical changes in soil moisture. The impacts featured drying in the northern mid-latitudes and the southern hemisphere, and wetting in the northern high-latitudes in spring and in the northern subtropics, and were projected to continue in the 21st century. The surface soil layer dried more rapidly than the root-zone (0–100 cm) layer. The contributions of temperature, precipitation, vegetation, and snow cover changes to these changes in soil moisture were quantified. The developed soil moisture data sets were added into the ILAMB package, enabling rapid benchmarking of soil moisture simulations by Earth system models using standard metrics (e.g., bias, root mean squared error). The team will add more advanced benchmarking metrics for soil moisture in the ILAMB package, and will explore the relationship between soil moisture changes and processes in the terrestrial carbon cycle.



left: Example benchmarking graph using one of the developed soil moisture data set, showing global mean monthly soil moisture time series over the four soil layers. Gray–benchmarking data set. Red–BCC-CSM2-MR historical simulation. Top to bottom: 0–10 cm, 10–30 cm, 30–50 cm, 50–100 cm.

Wildfires

PIs: Yaoping Wang, Mingzhou Jin, Jiafu Mao, Yulong Zhang, Joshua Fu



Spatial distributions of partial correlation coefficients between burned area IAVs and different climate factors from 1997 to 2012 (Tang et al., 2021)

Understanding historical wildfire variations and their environmental driving mechanisms is key to predicting and mitigating wildfires. Using recent satellite-derived wildfire products and simulations from version v1.0 of the land component of the US Department of Energy's Energy Exascale Earth System Model (E3SM land model [ELM] v1) driven by three different climate forcings, we investigated the interannual variability (IAV) and its climatic sensitivity of the burned area globally and across nine biomes from 1997 to 2018. We found that (1) the ELM simulations generally agreed with the satellite observations in terms of IAV magnitudes, regional contributions, and covariations with climate factors of the burned area, confirming the robustness of the ELM to the usage of different climate forcing sources; (2) tropical savannas, tropical forests, and semi-arid grasslands were primary contributors to the global burned area IAV, collectively accounting for 71.7%–99.7% of the global wildfire IAV estimated by both the satellite observations and ELM simulations; (3) precipitation was a major fire suppressing factor and dominated the IAVs of global and regional burned area, and temperature and shortwave solar radiation were mostly positively related with burned area IAVs; and (4) noticeable local discrepancies between the ELM and remote-sensing results occurred in semi-arid grasslands, croplands, boreal forests, and wetlands, likely caused by uncertainties in the current ELM fire scheme and the imperfectly derived satellite observations. Our

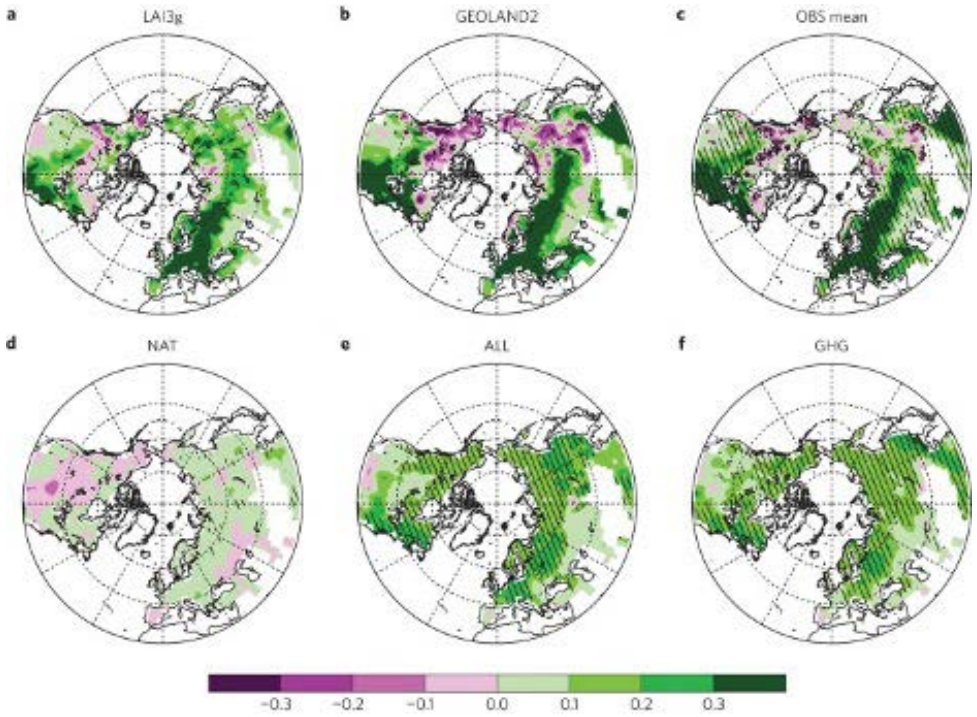
findings reveal the spatiotemporal diversity of wildfire variations, regional contributions, and climatic responses, and can provide new insights for wildfire modeling, prediction, and management.

Vegetation

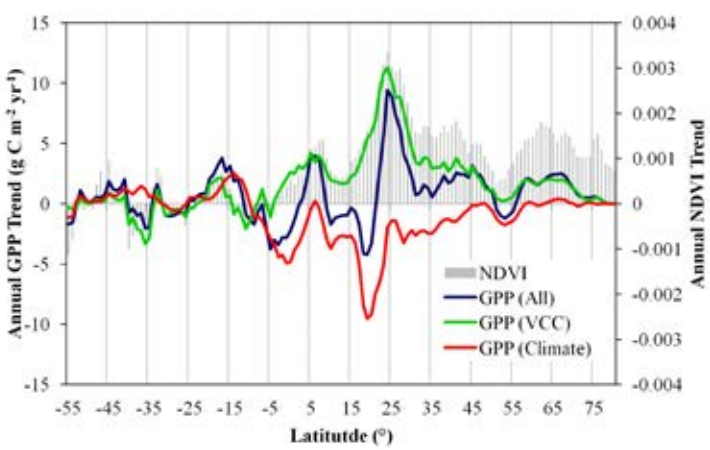
PIs: Yaoping Wang, Mingzhou Jin, Jiafu Mao, Yulong Zhang, Joshua Fu

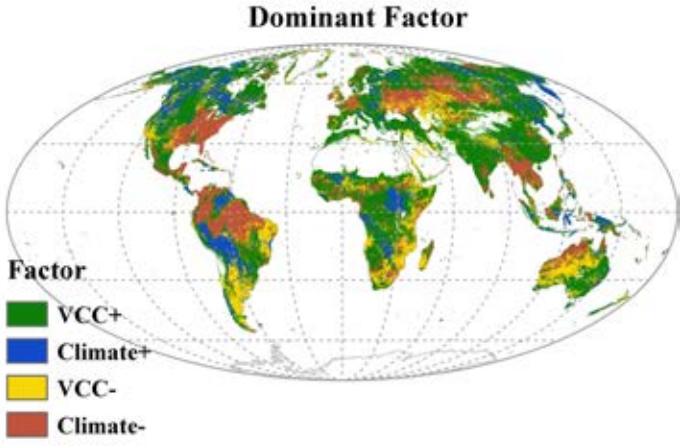
The terrestrial biosphere on Earth is breathing continuously by inhaling carbon dioxide from the atmosphere (a process known as "photosynthesis") and exhaling water vapor into the atmosphere (a process known as "evapotranspiration"). These 'invisible' gas exchanges are key drivers of global carbon and water cycles, serving important roles in regulating climate system. We have worked on modeling and understanding these dynamic processes at the global scale based on remote sensing, ecological modeling, and ground observations. Specific research are related to eco-hydrological model development, Earth's greening, El Niño-Southern Oscillation, and climate drying and land use/cover change.

below: Spatial distribution of the linear trends in the growing season (April–October) LAI (m2 m−2 per 30 yr) (Mao et al., 2016)



below: Spatial pattern of global GPP trend and its dominant factors from 2000 to 2015 (Zhang et al., 2019)



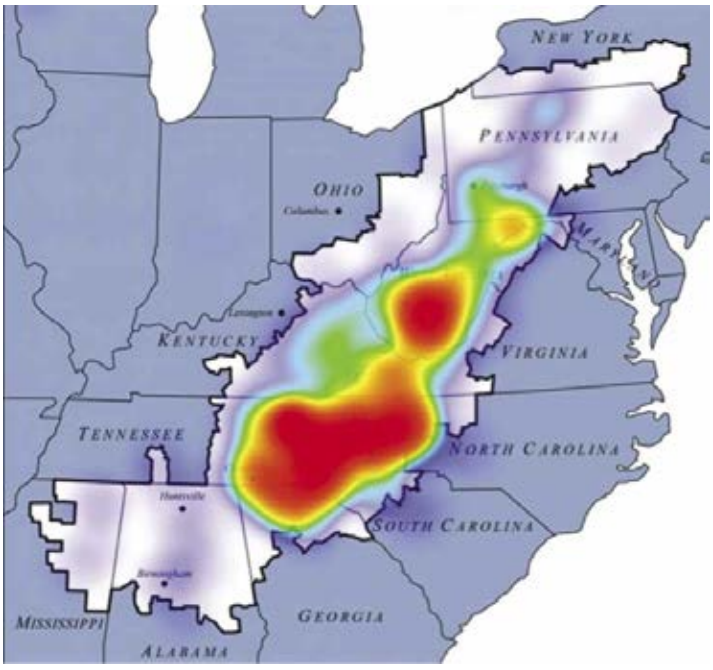


Regional Sustainability

Sustainable regional systems are connected urban and rural systems that work together for equitably advancing the well-being of people and the planet in a sustainable way. As a THEC center, ISSE is committed to the sustainable development of the State of Tennessee and surrounding areas with its research, education and outreach.

Appalachian Studies: Increasing Economic and Entrepreneurial Opportunities by Promoting Outdoor Recreation Among Underrepresented Visitor Groups
Tim Ezzell, PI
From 2017-2020 researchers from ISSE led the largest and most comprehensive study of Appalachian tourism, a $60 billion industry. They were joined by Dr. Stefanie Benjamin from UT's Retail, Hospitality, and Tourism Management program and Bruce Decker, president and founder of Collective Impact, LLC, a consulting firm located in Huntington, WV. Their research, which covered all aspects of this rapidly changing industry, included detailed site visits to a dozen established and nascent communities across the thirteen-state region, The work resulted in significant findings and recommendations, which are detailed in the final report, Extending Our Welcome, Trends and Strategies for Tourism in Appalachia, which was released in February 2021.

Sustainability of Urban Water
John Schwartz, PI



Heat map of visitor destinations in Appalachia

Urban water demand is expected to increase significantly in the next several decades, and as these demands increase conflicts over use of this most vital human resource will surge without adequate integrated planning. Conflicts will cross jurisdictional boundaries and into the rural communities where watersheds largely provide the higher-quality resource supply. Resolving conflicts and achieving resource sustainability through integrated planning are constrained by many regulations and governed by multiple agencies. Regulations may have different directive or overlaying directives among agencies, and multiple levels of governance. Dr. John Schwartz and his team are developing a new framework for integrated water resource planning to achieve sustainably recognizing all system needs and socioeconomic interdependencies among the urban and rural communities, suggesting policy for more effective governance, and formulate the technologies to advance current water management planning procedures. To fully stress test regions and their water needs and infrastructure, advanced technology in terms of database management and watershed modeling will be required. Population growth is inferred as one stressor with increased future demands in urban centers, though incorporating the impacts from climate change on the regional hydrologic processes are equally important to expose system vulnerabilities and supply risks.

Water Research

The Tennessee Water Resources Research Center (TNWRRC) is a federally designated state research institute supported in part by the U.S. Geological Survey and the Environmental Agency. It serves as a primary link among water-resource experts in academia, government, and the private sector, and the diversity of its staff in terms of background and expertise enhances flexibility and positions the Center to establish productive partnerships.

TDEC: Tennessee Stream Quantification Tool Training
John Schwartz, PI
The goal of this project is to strengthen the stream compensatory mitigation regulatory program by refining and validating success criteria the TN Stream Quantification Tool (TN SQT) version 1, and provide statewide stakeholder education and outreach on the use and implementation of the TN SQT to review functional loss and lift of §401 Water Quality Permits and compensatory mitigation projects. In August 2020, a working group was formed to review the existing TN SQT, meeting monthly. The working group consisted on seven

The Urban Water Cycle, image coutesty National Science Foundation. Credit: Nicolle R. Fuller, Sayo-Art LLC

consulting firms, a mitigation in-lieu fee program, TDEC staff, and US Army Corps of Engineers staff in Nashville and Memphis. With the aid from the Water Center, TDEC will work with the state's Interagency Review Team, consultants, and stakeholders to develop and provide statewide education for practitioners and regulators on how to use the TN SQT to increase the success of compensatory mitigation projects and prevent functional loss from 401 Water Quality permits. In April 2021, a final review by the working group was completed, and now graduate student Grace Long is working through the proposed revision of the metrics to assess how they influence the SQT condition scores. It is a work-in-progress, with the final aim to develop a training course for the practitioners estimating loss on functional condition from some near stream activity and preparing requests for mitigation credits through stream restoration projects.

Development of the Urban Waters Report Card

John Schwartz, PI

Development of the Urban Waters Report Card (UWRC) is sponsored by several municipal stormwater programs in the state of Tennessee, including Nashville Metro, City of Memphis, City of Chattanooga, and Shelby, Hamilton, and Knox counties. The UWRC will provide for tracking of improvements for streams that failed to meet their designated uses and are on the list of impaired waters. The UWRC grade scale spans from A to F, a structure that is simple and intuitive for the public to understand. Members from this state-wide working group have been meeting since 2020, and this year the working group has made progress identifying metrics that will be assessed for the final version of the UWRC. Metrics have been selected from four categories: water quality, watershed hydrology (connectivity), stream corridor, and community value. A presentation on the UWRC development was given at the Tennessee Stormwater Association annual

conference by John Schwartz and Karina Bynum in October 2021. A beta version of the UWRC will be finalized early next year and beta tested spring 2022. A web site for the UWRC have been created at http://tnurbanwaters, and is a work-in-progress.

USGS Water Resources Program 104b Funds FY2021

John Schwartz, PI

The Tennessee Water Resources Research Center (TNWRRC) is the state representation to the National Institute of Water Resources (NIWR), associated with Section 104 of the Water Resources Act with annual funding from the US Geological Survey (USGS). The TNWRRC serves as a primary link among water resource experts in academia, government, and the private sector across the state of Tennessee. Though 104b Program funds from the USGS, the TNWRRC supports competitive grants awarded annually to university researchers state-wide. For this year's round of call for proposals we asked for organization/agency to provide us their water resources research priorities. We obtained priorities from the Tennessee Department of Environment and Conservation, Tennessee Department of Agriculture, Tennessee Department of Transportation Environmental Division, Tennessee Valley Authority, The Nature Conservancy, and the USGS Nashville Science Center. We received nine proposals and funded four, in which funds were awarded in September 2021. Research topics included: validation of the Tennessee nitrogen budget model for secondary-treated reclaimed water, improved remoted sensing imaginary techniques to identify riparian corridor characteristics in headwaters, auto-depuration due to stream bar hyporheic exchange, and identifying patterns of water scarcity for Tennessee under climate change and urban growth. The institutions funded were UT Institute of Agriculture, University of Memphis, and University of Tennessee Knoxville.

Impacts of Acid Deposition on Water Quality and Aquatic Biota *(a cooperative agreement between National Park Service and UT)*

John Schwartz, PI

For decades, acidic air pollutants from regional and local sources have been transported by prevailing wind currents and deposited onto high-elevation watersheds in the Great Smoky Mountains National Park (GRSM) on the Tennessee/North Carolina border. To investigate the potential effects of acid deposition on stream water quality, the GRSM began a Water Quality (WQ) Monitoring Program in 1991 consisting of: 1) detailed hydrologic and biogeochemical monitoring at Noland Divide Watershed (NDW), a high-elevation forested site, and 2) Park-wide stream survey monitoring for spatial mapping and temporal trend analysis of stream acidification. In addition to the routine monitoring, special studies are conducted to investigate questions that remain on the fate, biogeochemical transformation, and transport of acid/base ions and dissolved metals. Two special studies are on-going: 1) a sulfate isotope analysis to quantify the mass flux of sulfate generated from the high-elevation Anakeesta pyritic shale formation in comparison to acid deposition inputs; and 2) a throughfall chemistry mapping, which has been over 15 years since the last GRSM effort by Dr. Kathleen Weathers at Cornell University. We work with Dr. Charles Driscoll at Syracuse University, where his research team developed and uses the BGC-PnET model for estimating critical loads in the GRSM.

One of the most interesting investigations is the observed responses in deposition and stream chemistry due to emission reductions from local and regional coal-fired power plants. Many geochemistry parameters of wet/dry deposition at the monitoring site show strong and direct responses to emissions reductions: measured deposition amounts decreased, precipitation pH and ANC increased, and nitrogen speciation in precipitation samples shifted; all within the same 2008-2009 time frame. Through fall sulfate deposition has declined from above 1,500 eq/ha/yr before 2007 to approximately 500 eq/ha/yr after which. However, the changes in deposition have not yet translated to significant changes in stream sulfate concentrations or annual mass exports. It appears the lack of response in stream sulfate is influenced by the biogeochemistry in associated with the nitrogen cycle dynamics, base cation availability, and carbon-sulfate dynamics.

Hydrologic Connectivity Using Regenerative Stormwater Conveyance

Jon Hathaway, PI

In Powell, Tennessee at Collier Preserve, a public park needs a remediation method for the erosive flows produced at a stormwater outfall bringing offsite drainage through the property. Implementing an RSC in this area will protect the park's trails, increase water quality of the receiving waters, and serve as a public attraction. The watershed routing to the site is 5.06 ha of predominantly field and forested land. The site itself consists of two 1.07 m diameter pipes that spill onto 61 m of previously unmanaged forest until discharging into a swale connected to Beaver Creek.

Earlier this year, Dr. John Schwartz, director of the Tennessee Water Resources Research Center, and Dr. Jon Hathaway received a grant from the Environmental Protection Agency to

right: Graduate student Gillian Palino working in an urban culvert for the Regenerative Stormwater Conveyance project.

study the loss of headwater wetlands that have resulted from the Southeast region's rapid and explosive urbanization. Efficient drainage systems route water quickly to local streams, bypassing floodplains and drying once vibrant wetlands. New techniques studied by the University of Tennessee show promise in restoring hydrologic connections allowing wetlands to be reestablished in these environments. The goals of this project are 1) to demonstrate the possibilities that Regenerative Stormwater Conveyances offer for recreating wetlands in urban environments and 2) to identify and document best practices for design of these systems.

3D Dynamic Evolution of Pore Water-Air Interaction within Saturated Sheared Sand

Khalid Alshibli, PI

Many foundation systems are supported by water-saturated sand deposits. At the micro-scale, the voids between sand grains (pore space) are filled with water. The sand resists applied foundation loads through friction and interlocking between particles, which is known as the shear strength of sand. The presence of air within the pore space in addition to water introduces new forces and fundamentally changes the shear strength of sand. Alshibli's preliminary experiments show that standard procedures to saturate laboratory sand specimens may suffer from a major shortcoming despite decades of use and wide acceptance by the geotechnical community. The goal of this research is to monitor the evolution of sand-water-air interaction using fast dynamic synchrotron microcomputed tomography imaging at 6-micron resolution under shear loading conditions. This research will (i) investigate the influence of particle morphology and gradation on the degree of saturation of sheared sand; (ii) monitor local water- air interaction within pore space of sheared sand under drained condition; and (iii) evaluate the effects of specimen density on the change of degree of saturation of sheared sand. The following fundamental questions will be answered: (1) what is the minimum value of pore water pressure to maintain the same degree of saturation in sheared sand; (2) does the sand specimen remain 100 percent saturated when it is sheared; (3) if air bubbles develop; how they will evolve and what are the factors that affect their onset and growth. 3D probing of dynamic particle-water-air interaction is expected to offer unique measurements to support the development of a new particle-scale theory that better describes the behavior of saturated sheared granular materials.

Sustainable Food Systems

Responding to the second UN Sustainable Development goal of ending hungers and achieving food security, ISSE studies food sustainability in the United States and world, using analytic models and pursuing systematic solutions. We assess the sustainability and resiliency of the global food systems by carefully considering socioeconomic, policy, and climate scenarios.

Food Loss & Waste

PIs: Mingzhou Jin, Scott Zheng, Yaoping Wang, Andrew Muhammad, Joe Zhuang

Quantification of food loss and waste (FLW) generation is a vital step to FLW reduction, recycling, and recovery. Working with Oak Ridge National Lab, we estimate the mass flow and FLW according to the real weight of commodities at each stage of the Food Supply Chain (FSC) and evaluate the management of U.S. FLW through nine management pathways. In 2016, 572.9 MMT of food materials were harvested for human food consumption, while 40.8 MMT of food materials were planted/raised but unharvested (i.e., failed to enter U.S. FSC), pulsing 302.8 MMT (52.8% of the food materials entered FSC; including water evaporated during food manufacturing) entered but left the FCS ended as recovered/recycled products or disposed of via landfilling, incineration, and wastewater treatment. Among the total of 343.6 MMT of FLW, 63.7 MMT (18.5%) is the weight reduction due to water evaporation during the manufacturing process of some food commodities (e.g., sugar), 193.7 MMT (56.4%) is recycled or recovered, and 77 MMT (22.4%) is disposed of via landfill, incineration or wastewater treatment (LWI).

In addition, the management of on-farm animal-related FLW (8.8 MMT; 2.6%) is left as unknown due to the data limitations. The Consumption stage is the worst contributor to FLW disposed via LWI (51%). Conversely, even though U.S. food manufacturing contributes the most FLW (i.e., 208.5 MMT; 60.7% of total FLW), this stage demonstrates a high level of circular economy: only 4.6 MMT, 2.2%, of manufacturing FLW was landfilled or incinerated, 63.7 MMT (30.4%) is the weight reduction due to water evaporation which cannot be considered as waste, and the remaining was recycled or recovered (i.e., 140.2 MMT, 67.4%). However, U.S. food manufactures can contribute to a sustainable FSC by influencing the downstream stages, since the products with high demand and perishability contribute the most FLW and manufactures can contribute to FKW reduction by extending products' shelf-life. along the U.S. FSC.

Sustainability of Global Crop Supply Chain

PIs: Mingzhou Jin, Scott Zheng, Yaoping Wang, Andrew Muhammad, Joe Zhuang

The largest challenges for global food systems are the spatial and temporal mismatches of their supply and demand. The crop supply chain (SC) helps relieve the two mismatches through transportation, trade, and storage. However, long-distance shipment consumes a lot of energy. Water, as a critical resource for crop production, is unevenly distributed across regions and seasons. The interaction as a Food, Energy, and Water System (FEWS) and spatial and temporal heterogeneity require a systematic and coupled method to study the global crop SC, which includes production, storage, transportation, distribution, and consumption. Funded by the National Science Foundation, we are developing a scalable framework that models decision-making in the global crop SC as embedded in the water resources and energy, socioeconomic, and policy environments and as affected by prices and climate factors. The framework will be applied to assess the sustainability and resiliency of the global crop SC as a FEWS under carefully designed socioeconomic, policy, and climate scenarios using the global soybean and wheat SCs as a case. Key performance indicators will be developed to measure individual and corporates utility, societal welfare, and environmental sustainability and identify technical, societal and policy solutions.

New Sponsored Research

NSF Planning Grant for Sustainability in Central Appalachia

ISSE has been awarded an NSF planning grant that will prepare an interdisciplinary team based in Central Appalachia to develop and submit a quality Track-1 proposal to create a research network. Participating institutions include The University of Tennessee, Knoxville as the lead, Virginia Tech, Western Carolina University, University of Kentucky, West Virginia State University, Morehead State University, and Appalachian State University.

The goal of this research network is to produce a *People-Centric, Integrated Assessment Model for Regional Sustainability* with stakeholders in the Central Appalachian region. The research is expected to answer these questions: 1) What are locally-relevant sustainability indicators for people in the Central Appalachian region? 2) What are the relationships among economic development, health, education, infrastructure, and environment? 3) How can people's behaviors be modeled? 4) How can the model couple all subsystems within the region and integrate them with other regions? 5) How can the model balance complexity, local relevance, actionability, and scalability? and 6) How can the model balance the responses to long-term trends and potential short-term shocks?

A wide range of disciplines will build the foundation for this research network: public health, political science, social science, public policy, economics, geography, environmental engineering, regional planning, agriculture, geology, and others.

Hathaway Wins NSF Research Undergrad Experience Grant

Green Infrastructure for Sustainable Urban Environments (GI4SUrE) Research Experience for Undergraduates (REU) is a 10-week summer program designed to expose and immerse undergraduate students to unique green infrastructure (GI) research. GI is a way to build better infrastructure, as a part of the National Academy of Engineering's Grand Challenge, to restore and improve urban infrastructure. This program lets students perform field, laboratory, or modeling studies to explore how GI can mitigate the effects of urban runoff on surface water quality and hydrology. This research will affect not only eastern Tennessee, but any area that deals with urban stormwater runoff. Students will also dive into a professional and social atmosphere that will develop their fundamental research methodologies and critical thinking skills.

DOE funds EMPOWER Workplace Charging project, ISSE to manage project and design data

On Nov. 1, 2021, the U.S. Department of Energy Vehicle Technologies Office announced the winners of the FY21 "Low Greenhouse Gas Vehicle Technologies Research, Development, Demonstration, and Deployment" competition. The Columbia-Willamette Clean Cities Coalition's EMPOWER proposal (Equitable Mobility Powering Opportunities for Workplace Electrification Readiness) won in the topic area of Electric Vehicle Workplace Charging. Leveraging their experience with the Drive Electric USA program, ISSE-based East Tennessee Clean Fuels (ETCF) will provide administrative support and project management guidance for the EMPOWER program.

The project aims to reach upwards of 2,000 employers and secure at least 650 employer commitments to install and support workplace charging programs. One goal is to obtain at least 20% of commitments from diverse employers in qualified opportunities zones that benefit underserved communities and people of color and increase career pathways in the EV charging industry for underrepresented communities.

"We are looking forward to engaging directly with unrepresented and overburdened communities through this project," said Jonathan Overly, ETCF Director. "We will listen to and consider fully what these communities have to say about electric vehicle infrastructure in their communities."

The project team will receive $3,970,539 in federal funds. The team has secured $1,000,000 in cost share from non-federal sources. The Institute for a Secure & Sustainable Environment (ISSE) has a major role in the EMPOWER project. The ISSE team includes Director Mingzhou Jin, Yulong Zhang, and Nawei Liu, along with ETCF Director Overly.

The UTK/ISSE team will oversee data planning and help design all data that will be aggregated through the project and determine the types of analyses that can be performed. These data will inform future EMPOWER users to accelerate adoption of workplace charging across the participating states. Analysis results will show the project's success and identify areas for improvement.

The integrated data and analysis results will be shared with national labs to inform research and development of modeling tools related to workplace charging.

Besides UTK and East Tennessee Clean Fuels, leadership-level partners include Cadeo Group, Louisiana Clean Fuels, ICF International, Shift2Electric, Smart Electric Power Alliance, National Rural Electric Cooperative Association, Electric Vehicle Infrastructure Training Program, Cerritos College, Washington State Department of Commerce, American Lung Association, Pacific Northwest National Laboratory and Oak Ridge National Laboratory.

The project's charging provider partners include Siemens and Chargepoint and these diverse utilities: ComEd, Alabama Power, Entergy, Eversource, Memphis Light Gas & Water, OK Gas & Electric, Northern Indiana Public Service Company, Green Mountain Power, Baltimore Gas & Electric, Tennessee Valley Authority, Avangrid, Electric Power Board of Chattanooga, Pepco Holdings, Western Farmers Electric Cooperative, Central Maine Power, Knoxville Utility Board, Rocky Mountain Power, Burlington Electric Department, Portland General Electric, Southwestern Electric Power Company, and Kentucky Power.

AOP for Wastewater

This project, funded by Aramco Services Company, is being led by Dr. Qiang He. Wastewater generated in large volume during oil and gas extraction contains substantial amounts of toxic contaminants, presenting an urgent industry-wide issue of environmental stewardship and regulatory compliance. These contaminants, including hydrocarbons and sulfide, have to be removed from the produced water. However, current treatment technologies lack technical robustness and economic feasibility. This project aims to test advanced oxidation processes for the selective removal of BTEX, oil, and other organic pollutants in the wastewater, enabling field deployment with high technical implementability and economic feasibility.

Land Freight Lifecycle Impact Project

This project is the research and development of a comprehensive life-cycle impact tool for planners of freight transportation infrastructure. ISSE research has identified and calibrated twenty-eight social, environmental, and economic externalities that constitute the full-lifecycle impact from freight infrastructure projects. These lifecycle impacts, which result in numerous negative externalities, are typically absent from freight transportation infrastructure impact studies today.

This research project and resulting tool development will enable planners, developers, and even the general public to have a complete 360° view of the lifecycle impacts of their transportation infrastructure projects and compare different transportation modes for freight movements. This will inform the design, location, and scope of new freight infrastructure, ensuring investment is prioritized toward projects which make the most environmental, social, and economic sense.

Why this tool is so important

Investments in major freight transportation infrastructure are vital to economic prosperity. Billions of dollars of public and private capital are pumped into new projects each year across North America. The fact that the majority these projects have no full-lifecycle impact assessment during the scoping, location, or design phase is damaging. Freight transportation has a significant, and growing, environmental and social impact. Currently accounting for more than 10% of all the continent's carbon emissions, freight transportation is the fastest growing contributor to greenhouse gases in North America. With shipments of goods in the US projected to grow by a further 45% by 20401 action is needed now to reduce its impact.

To meet the increased demand in shipping goods North America is witnessing a period of large and rapid development of new freight infrastructure, such as warehouses, loading facilities, container ports, and highway widening projects. The Land Freight Lifecycle Impact Project is crucial to ensuring the full impacts of these and future projects are understood and lead to informed planning and design decisions which optimize environmental protection, community benefit, and the overall commercial returns on investment.

The right solution for the moment

The best approach to ensure full-lifecycle impacts are considered for planned new freight infrastructure projects is to apply an appropriate, empirically researched, impact assessment tool. Currently there are no tools available in the US which provide a balanced and comprehensive analysis of current-dollar impacts across economic, social, health, and environmental lifecycle factors. The Land Freight Lifecycle Impact Project addresses this need by applying data driven, research methodology to create a comprehensive inventory of the impacts of freight transportation infrastructure. The project establishes a decision framework which forms the basis of a groundbreaking full-lifecycle impact tool for project sponsors, developers, and consultants to analyze the full impacts of their freight infrastructure investment plans.

Seed Grants

2022 ACTIVE SEED GRANTS			
PI	*Sponsor*	*Title*	*Start*
Khalid Alshibli	ISSE	Geochemical Interaction between CO2 and Caprock for Safe Carbon Sequestration	Continued
Qiang He	ISSE	Environmental Health Risk Management	Continued
Scott Lenaghan	ISSE	Brioengineering of the Duckweed Plastid Genome	Continued
Kelsey Ellis	ISSE	Beat the heat: Building adaptive capacity of vulnerable populations	7/1/2021
Frank Loeffler	ISSE	Microbrial transformation and degradation of PFAS	7/1/2021
Jie Wu	ISSE	Socioeconomic inequalities and drinking water quality	7/1/2021

Geochemical Interaction between CO2 and Caprock for Safe Carbon Sequestration, PI: Khalid Alshibli

This project was developed to understand the chemical reaction between Carbon dioxide (CO2) and rocks when it is stored deep into the ground for safe storage (sequestration) of CO2. CO2 emission into the atmosphere from human and industrial processes continues to pose a major environmental and health threat to public health worldwide, and many governments have launched initiatives to reduce the impact of CO2 emission. According to a report by the Intergovernmental Panel on Climate Change (IPCC), United Nations (2005), about 13,466 MT/ year of CO2 is emitted from fossil fuels and biomass where power plants and cement production are the top sources for CO2 emission. Some technologies can capture 85%-95% of CO2 processed in a capture plan (IPCC 2005). Carbon dioxide capture and storage (CCS) is a process of separating CO2 from industrial facilities and other point sources and injecting it in deep geological formation for long-term storage. Deep saline aquifers, depleted gas and oil fields, and coal mines are good potential places to store CO2.

CO2 needs to be injected deep into porous rocks, deeper than 3000 feet, at a pressure higher than 3000 psi. To prevent the upward flow of CO2, which is caused by its low density, it must be trapped below a thick, low permeability rock such as limestone, shale, or salt rock (caprock). There are many challenges associated with CCS that include potential leaks of CO2 into the atmosphere and groundwater through natural/ reactivated faults or man-made operations (e.g., abandoned oil wells). CO2 pressure can be a source for seismic damage and fracture of the caprock. A chemical reaction could occur between CO2 and the caprock, which may compromise the integrity of the caprock and result in the leak of CO2 back into the atmosphere. The overall aim of the project is to characterize CO2-caprock geochemical interaction at micro and nano-scales. The research team will use world-class analysis tools at the Advanced Photon Source (APS), IL to image specimens of limestone samples collected from a depth of 800 ft from East Tennessee before and after exposing them to CO2 at 3000 psi pressure at a temperature similar to field temperature for a long duration. Nanoscale changes of the pores within the limestone may occur and can potentially cause a clogging (desirable) or dissolution of the rock. The dissolution of the rock will open channels for CO2 to flow upward back to the earth's surface.

Environmental Health Risk Management, PI: Qiang He

Humans are exposed to numerous chemical, physical, and biological factors, such as microorganisms and particulates, in the environments, collectively defined as the human exposome. The exposome plays important roles in human health, particularly in the development and progression of diseases such as cancer, infectious diseases, and chronic inflammatory diseases. The ongoing COVID-19 pandemic has exposed disparities in environmental exposure as individual transmission risks have been shown to correlate with one's socio-economic determinants. Thus, monitoring and understanding the exposome is particularly valuable to develop strategies to reduce environmental inequity and manage health risks. However, precision management of environmental health risks requires personalized monitoring of the exposome, which until now is conducted exclusively at the population level. Therefore, it is of great importance to develop methodologies feasible for personalized exposome monitoring to reduce exposure risks and mitigate environmental inequity.

During the first half of the project period, the project team has developed a sampling device for personalized exposome

monitoring and sampling. The sampling device can be operated with an autonomous mode, enabling deployment even under COVID-19 restrictions. As a proof-of-concept, the sampling device has been used for the monitoring of exposure to indoor microbiomes. The airborne microbiome is sampled with the device by actively capturing airborne particulates on a 25-mm sterile filter (0.22-μm pore size) followed by determination of the quantity and composition of the airborne microbiome according to protocols established in the PI's laboratory, including DNA extraction, high-throughput sequencing, and bioinformatics analysis. Preliminary results indicate that human exposure to indoor microbiome exhibited significant temporal changes during a four-month period. Indoor microbial exposure experienced rapid changes during the first 6 weeks but stabilized during the last 6 weeks, coincided with the changes in cleaning and disinfection practices during the monitoring period. These results demonstrated the utility of the personalized exposome sampling device developed during this project.

The project team will continue with efforts to 1) publish results from this seed project to strengthen the track record in the research area of environmental exposomes, which is essential for developing competitive research proposals; and 2) expand the research scope to other health outcomes associated with environmental exposure, including asthma, allergy, and infectious diseases, particularly those associated with airborne transmission. Preliminary results from this seed project can be readily leveraged to support proposals in these extended research topic areas.

Bioengineering of the Duckweed Plastid Genome, PI: Scott Lenaghan

The complete chloroplast genome for Lemna minor L. has been sequenced, along with comparative genomics of other duckweed species. Recently, PI Lenaghan published a modular cloning plastid engineering (MoChlo) kit for assembly of plastid transformation vectors. Using this kit and the available plastomic information, the team will synthesize homology arms for four insertion sites for homologous recombination in the native plastome of duckweed. The MoChlo kit contains 95 plastid regulatory sequences that can be used to control expression of transgenes in duckweed, as most plastid regulatory sequences are highly conserved and function in a variety of species. Thus, the kit's available resources provide a facile entry point for developing methods for plastid engineering in duckweed using existing resources with minimal gene synthesis. At the same time, the team will develop a method for automated duckweed tissue culture and chlorophyll analysis, using the robotic platform in PI Lenaghan's lab.

Previously, researchers at CASB have automated high-throughput protoplast isolation, transformation, and screening in switchgrass, corn, rice, tobacco, and soybean. We will use this expertise to develop an automated protocol for vegetative propagation of duckweed, which will enable more rapid screening of compounds to select for transplastomic duckweed. Since plastid engineering requires biolistics to physically insert gold-DNA nanocomplexes, it is not anticipated that adapting biolistics to duckweed will represent a significant challenge. Further, genetic similarities between the

plastid genome of Lemna minor and species used in development of MoChlo suggest high vector compatibility. It will also be possible to apply constructs and selection strategies that are currently being tested in an existing DARPA-funded project to plastid engineering in duckweed. These strategies include toxin/antitoxin systems, positive selection for photoautotrophic growth, novel antibiotics that affect prokaryotic polymerases, pathways for essential amino acid synthesis, and the control spectinomycin selection. Quantum Yield (QY) is a relationship of the variable fluorescence (Fv) to the maximum fluorescence (Fm). QY reflects the efficiency of PS II and can be related to overall plant health. Aminoglycosides such as spectinomycin and kanamycin inhibit protein synthesis by binding at the ribosome, interfering with translation. Photosystems are large protein complexes, requiring 20 plus subunits. Inhibiting protein synthesis leads to diminished complex turnover thus a breakdown of photosynthesis.

Pulse Amplitude Modulated (PAM) fluorescence measurements allow for relatively non-intrusive, in-vivo monitoring of plant health as related through photo-efficiency. Preliminary work has already been conducted to determine several selection agent parameters, kanamycin and spectinomycin in Lemna minor and Spirodela. In addition to the strategies themselves, the regulatory elements driving expression of the genes play a significant role in success or failure of a selection strategy. In this way, this seedling project represents an ideal platform to demonstrate the high throughput potential of duckweed, while also demonstrating for the first time, stable monocot transplastomics. This research will open the door for a variety of applications targeting molecular farming, protein production, and phytoremediation. Specifically, following establishment of a homoplastomic transformation protocol, altered oxalate synthesis (improve human consumption), and Cs accumulation will be investigated.

Microbrial transformation and degradation of PFAS, PI: Frank Loeffler

This project's overarching objective is to challenge the paradigm of "forever chemicals" and demonstrate that sulfonated PFAS are susceptible for biotransformation by specialized bacteria.

Project Summary. Per- and polyfluoroalkyl substances (PFAS) are global contaminants linked to a variety of humans diseases. The proposed research will use the soil isolate Pseudomonas sp. strain 273, which harbors an unusually high number of 22 alkanesulfonate monooxygenase (ssuD) genes, to demonstrate that naturally occurring bacteria can transform and defluorinate perfluorosulfonic acids, including perfluorooctanesulfonic acid (PFOS). The research will generate evidence for the existence of a natural attenuation process for a major class of PFAS, which would have far-reaching implications for fate and transport modelling, sensible regulatory frameworks, and possibly enhanced remedies.

PFAS comprise thousands of synthetic chemicals produced since the 1950s for use in various industrial applications, diverse consumer products, and as components of aqueous film forming foam (AFFF) formulations for fire suppression. PFAS have emerged as global contaminants that can be detected in every person on the planet Earth and are linked to metabolic disruption, obesity, diabetes, immune suppression, and cancer in humans. Deemed "forever chemicals", some evidence is now emerging suggesting that naturally occurring microbes can transform PFAS 7. A major group of PFAS in AFFF are perfluorosulfonic acids with the general structure CnF2n+1-SO3H and various precursors with the general structure CnF2n+1-SO2R. Sulfonated PFAS and its precursors are pervasive groundwater contaminants originating from AFFF applications, landfill leachate, and wastewater treatment plants 10, but also from nonpoint sources, predominantly urban stormwater runoff.

Beat the heat: Building adaptive capacity of vulnerable populations, PI: Kelsey Ellis

This project has three integrated parts, including analysis of climate data, examining vulnerabilities to heat, and building a community stakeholder task group. Temperature data were collected inside the homes of a dozen volunteers and near locations where unhoused individuals are known to sleep in August 2021. Some of the data are shown in Figure 1, demonstrating the variability of heat exposure among residents during the data collection period. These data will be analyzed in conjunction with an upcoming survey about air conditioning use and perceived heat exposure.

We have pulled together a number of data sources to examine the vulnerabilities to the effects of urban heat island, including data from the Centers for Disease Control and Prevention, the US Census Bureau, the Tennessee Department of Health, and others. This includes data sources examining heat-related, socioeconomic, and health-related vulnerabilities. Using these data, we have identified a number of neigh-

left: close-up of Lemnoideae, commonly known as Duckweed.

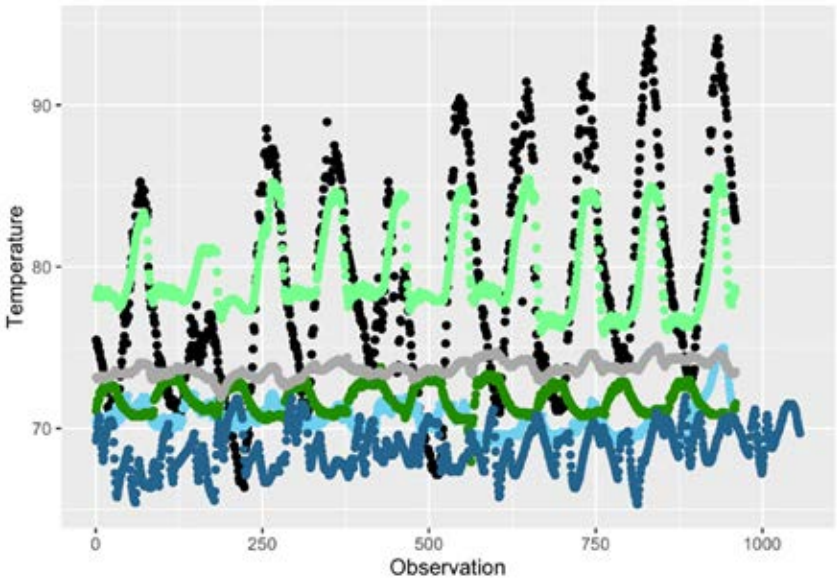


Figure 1: Examples of the data collected in the first two weeks of August 2021. Each set of observations represents a different home, with the black dots being the observations near a large homeless encampment.

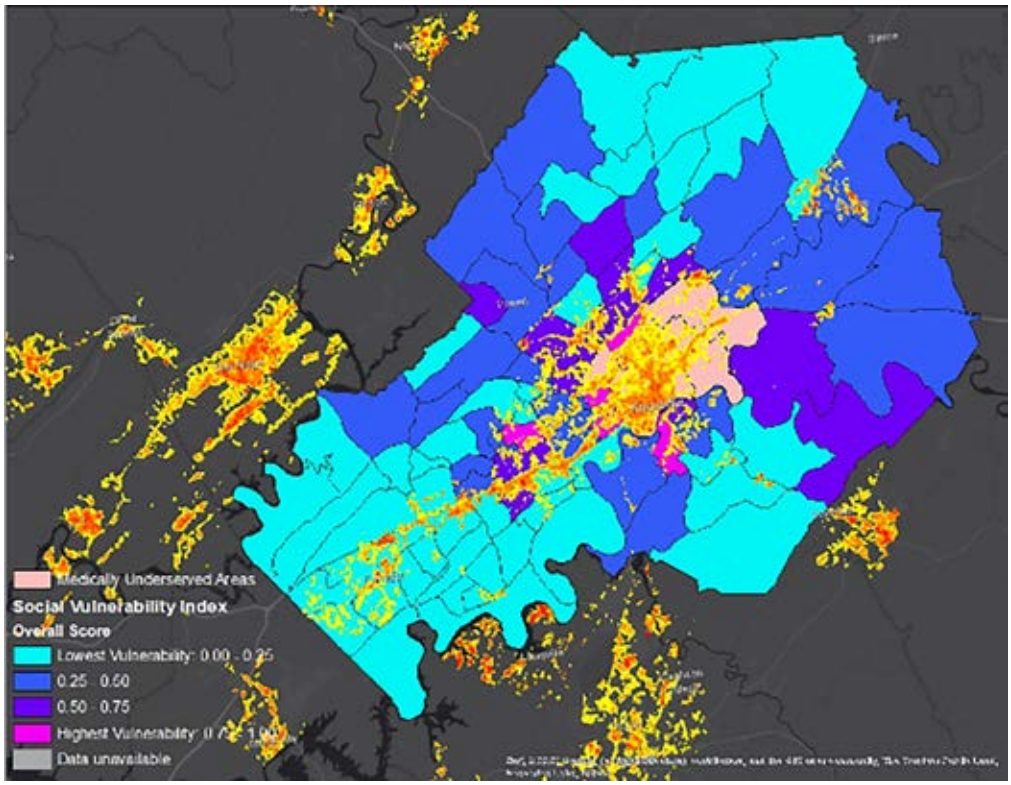


Figure 2: Knoxville's heat vulnerability and exposure, and medically underserved areas.

borhoods in Knox County that are at greatest risk for harmful effects and negative outcomes for heat and climate impacts. We are developing a public-facing dashboard and story map of these data sources. Figure 2 identifies the areas and neighborhoods in downtown Knoxville with high social vulnerability that are also considered medically underserved areas and experience higher temperatures than surrounding areas due to the urban heat island.

We have developed a community stakeholder task group, the Knoxville Heat Equity Coalition (KHEC), which includes members from Knoxville city government offices, community organizations, environmental justice advocates, and researchers. KHEC is working to develop solutions and build a critical social infrastructure to advance heat equity and environmental justice issues in Knoxville. Stakeholder organizations, city government offices, and institutions involved include:

- Knoxville Office of Sustainability
- Knoxville Office of Homelessness
- Knoxville Office of Diversity and Inclusion
- Three3
- Sustainable Future Center
- Community Action Committee Offices of Weatherization, Aging
- YOVEMENT
- Empower Knox
- East Tennessee Clean Fuels
- UT: Social Work, Public Health, Geography

Socioeconomic inequalities and drinking water quality, PI: Jayne Wu

Arsenic (As) contamination in water poses a severe threat to a broad spectrum of living organisms. It is a carcinogen, highly toxic, and widely present in many aquifers around the world. It is estimated that globally about 150 million people are at risk because of arsenic contamination. The most common As exposure pathway is consumption of groundwater containing arsenic. Particularly in certain agricultural communities, irrigation and drainage would enhance arsenic releases from geogenic sources with high evapotranspiration rates further concentrating arsenic in surface water and shallow groundwater to elevated levels. This dire situation is expected to be exacerbated by climate change in these vulnerable communities. Inorganic arsenic in the form of arsenic cations (Asn+), i.e., As(III) & As(V), has long been an Environmental Protection Agency (EPA) priority pollutant, setting its maximum contaminant level (MCL) for public water supplies at 10 parts per million (ppb), or 10 µg/L. The EPA limits are set for the aggregate of As(III) and As(V). As(III) is 60 times more toxic than As(V). Therefore, it is critical to distinguish these two forms of toxic As, which is limited by long turnover time and high costs with currently available techniques. There is a great need to develop rapid and affordable As sensing techniques for the monitoring of As in disadvantaged communities where inadequate water quality monitoring and treatment have persisted.

Timely detection of traces of active arsenic (As3+) is imperative to addressing the presence of arsenic in water, and a simple and low-cost arsenic sensor is urgently needed to protect the community health. From a broader perspective, there is evidence suggesting that arsenic exposure is not uniform across all communities, and low-income and minority communities could face disproportionately high pollutant exposures, due to the structural inequality ingrained in land-use patterns, facility siting, and local regulatory policies. So far, nationwide assessments of arsenic exposure or other contaminants in community water systems and possible correlation with socioeconomic disparities are yet to be available.

Our objectives are 1) to develop a simple, low cost and sensitive biosensor for the detection of arsenic in community water systems; 2) to obtain preliminary data on arsenic levels from selected communities with diverse racial/ethnic or socioeconomic backgrounds; and 3) to identify possible correlations between the arsenic levels and socioeconomic status. The outcome of this project will eventually yield an arsenic detection device readily available to all walks of life, the identification of the U.S. population subgroups disproportionately exposed to elevated water contaminants, which in turn will lead to informed decisions on public health interventions and regulatory action needed to eliminate exposure inequalities.

left: Graduate student Cortney Myers collects water samples to test for arsenic.

EDUCATION

Training & Education

ISSE focuses on innovative educational and environmental projects that employ the latest technologies (or explore the use of such technologies) to resolve problems and explore complex issues. Most projects combine the resources of private and governmental sectors with the expertise of University staff, faculty, and students through team agreements.

Tennessee Water Resources Research Center Training, Tim Gangaware

Since October 1, 2021, TNWRRC has offered eight different courses: Levels 1 and 2 of Tennessee Erosion Prevention and Sediment Control (TNEPSC) Training Program for Construction Sites plus a Level 1 and Level 2 TNEPSC Recertification courses; Tennessee Hydrologic Determination Training and its corresponding Recertification course; and the Storm Water Control Measure Inspection and Maintenance Workshop and Recertification Course. TNWRRC has offered a total of 30 course sessions and trained 2,000 professionals in these workshops. The courses were a combination of virtual, online and in person training.

TNEPSC offers three training workshops for developers, contractors, engineers, and other professionals, inspection personnel, and enforcement officials responsible for all aspects of preparation and implementation of Storm Water Pollution Prevention Plans for preventing erosion and controlling sediment at construction sites one acre or more in size.

Tennessee Hydrologic Determination Training is a course for conducting hydrologic determinations. Successful completion of the training course is one of the requirements for certification as a Qualified Hydrologic Professional.

Storm Water Control Measure Inspection and Maintenance Workshops are available to design engineers and architects as well as plan reviewers and other local municipal program personnel. They provide insights on avoidance and minimization approaches to site layout, design guidance on specific permanent stormwater control measures, and experience using tools developed to assist designers and plan reviewers with implementation of runoff reduction and pollutant removal requirements.

Worker Health & Safety Training at DOE Facilities, Sheila Webster

The training is funded by a grant from the National Institute of Environmental Health and Sciences (NIEHS) and administered by the Partnership for Environmental Technology Education (PETE). The use of HAZWOPER ONLINE (developed by AWARDEES CCCHST and PETE) started transitioning to Roane State Community College (RSCC) in September 2020. Vol State incorporated HAZWOPER ONLINE with numerous OSHA and related Safety and Health courses that are offered on a regular basis.

ISSE's primary role was to obtain feedback and determine workplace impact of HAZWOPER ONLINE training. ISSE analyzed data for surveys for end of course and workplace follow up provided by Roane State Community College. ISSE also conducted follow up interviews to determine how training is applied in the workplace and how it is benefits the employee and the employer. ISSE observed classroom training and continues to with RSCC as they maintain the online training. Staff continued to attend virtual meetings including, training sessions offered by NIEHS, quarterly meetings hosted by PETE and the annual PETE Advisory Committee meeting.

right: Worker safety course participant takes part in a field exercise.

above: UT's PIPES and ASPIRE programs are designed to improve educational prospects for youth in rural Appalachia.

STEMM Programs in Appalachia, National Institute of Health & National Science Foundation, Timothy Ezzell

Dr. Ezzell assists with two established STEMM programs at UT: **PIPES**–Possibilities in Postsecondary Education and Science among Rural Appalachian Youth and **ASPIRE**–Appalachian Students Promoting the Integration of Research in Education. These programs are designed to help bring underrepresented population into STEM fields, at all levels. In particular, they work to help create opportunities for young people in rural Appalachian communities in East Tennessee.

PIPES: Possibilities in Postsecondary Education and Science among Rural Appalachian Youth, is funded by the National Institute of Health (NIH), provides opportunities for tenth- and eleventh-grade students in two Appalachian counties, Monroe and Campbell, to explore STEMM careers (science, technology, engineering, math, and medical science) and to promote college awareness.

ASPIRE: Appalachian Students Promoting the Integration of Research in Education, is funded by the National Science Foundation (NSF) and build on PIPES success by providing scholarships to academically talented Appalachian high school seniors majoring in STEM and STEMM fields. Aspire also creates a learning community for participating students and assists Appalachian students, and their families, in making the transition to college life.

Watershed Management Course, John Schwartz

Students in the Watershed Management course offered in the Department of Civil and Environmental Engineering are producing a watershed plan for Turkey Creek in Farragut, Tennessee. Along with the instructor Dr. John Schwartz, the students are working with stormwater program staff at the Town of Farragut and Knox County including Lori Saal, Kait Klema, and Quinn Cypher to develop the watershed plan. The plan the students are producing will be a §319 EPA-approved watershed plan, in which these two municipal stormwater programs can then apply for grant money to fund green infrastructure and stream restoration projects.

The photo showing Dr. Andrea Ludwig and Sam Jurek installing a flow monitoring station is used to measure stream discharges at 30-minute time intervals. Data is used to estimated typical flows during the day and also the flood flows after significant rainfall. This data allows the students in the class to develop hydrology models and design criteria for future stream restoration projects. The students are engaged in a class project that directly helps the Town of Farragut community to improve water quality in Turkey Creek.

right: Graduate student Sam Jurek and faculty member Andrea Ludwig working with Town of Farragut and Knox County to develop a watershed plan for Turkey Creek.

Outreach & Partnerships

Drive Electric TN/East TN Clean Fuels
Daniel Siksay, Jonathan Overly

East Tennessee Clean Fuels is the project lead on a 2020 DOE-funded project that works with 14 states to build their statewide 'Drive Electric' programs. The project's priority areas include developing branded websites, hosting outreach events, and creating social media campaigns; educating consumers and developing state chapters; planning electric vehicle (EV) charging infrastructure; reaching out to local and state government officials; engaging car dealers; and creating fleet partnerships for EV adoption.

In Year One, efforts began on all priority areas and the participating coalitions started assembling their branded programs. Coalitions began building partnerships around their state and developing a program logo as a part of their statewide plan development. Chapter development, building utility relationships, and dealer and fleet planning are other significant tasks underway in year one.

Before project completion, Drive Electric Tennessee (DET) will develop long-term funding approaches and expand the program to include additional states beyond the original 14. During summer 2021, the project added four states (Indiana, Kentucky, Connecticut, and New York) and discussions are currently underway with another dozen Clean Cities Coalitions. Additional states will be able to use all materials developed from the project to help establish their initiatives.

A cooperative partnership with Tennessee Technological University expanded to include a second, multi-state project that will bring a medium-duty electric truck ("eTruck") to fleets across Tennessee, where they will be able to borrow the truck for up to two months to vet its use in fleet operations. Data from fleet use will not only help the fleets understand their potential applicability to electric truck use but also feed an information system to better understand various fleets' needs and desires with EVs.

DET efforts expanded to include further chapter development and to hold more Ride & Drive events in various areas across Tennessee. The "Appalachian Highlands Chapter" of DET, which covers the northeastern part of the state, ramped up in April 2021. Two events were held including the first-ever Ride & Drive in Bristol, Tennessee that brought together about 25 local EV owners and reached nearly 100 citizens during the day with information about how EVs work and where you charge them. Attendees were able to drive EVs such as the Ford Mustang Mach-E, the Tesla Model 3, and the Nissan Leaf.

TNWRRC Information Transfer Program
Tim Gangaware

The major emphasis of the information transfer program during the FY 2021 grant period was on technical publication support, conference planning and development, and improvement in the information transfer network. The primary purpose of the program was to support the objectives of the technical research performed under the FY 2021 Water Resources Research Institute Program. During the FY 2021 grant period, information transfer activities included staff participation in planning and implementing several statewide conferences and training workshops.

As an ongoing sponsor, TNWRRC helped plan and implement the 30th Tennessee Water Resources Symposium, which was held virtually on April 14-16, 2021. The goals of the symposium are: (1) to provide a forum for practitioners, regulators, educators and researchers in water resources to exchange ideas and provide technology transfer activities, and (2) to encourage cooperation among the diverse range of water professionals in the state. Dr. Andreas Fath, Furtwangen University, Germany, delivered the keynote presentation, "Plastic Cocktails in Rivers." As with previous symposia, the 30th Symposium had more than 200 attendees and approximately 59 papers and 33 student posters were presented in the two-day period.

TNWRRC was a co-sponsor of the 2021 Tennessee Stormwater Association Annual Conference, "Together Again," held on October 19-21, 2021 at Montgomery Bell State Park. Over 243 persons attended the live in-person conference. Attendees, including staff from MS4 communities, state and federal government agencies, and engineering consulting companies from across the state participated in the three-day event. The conference included over 54 presentations and a special half day workshop on design of bioretention SCMs.

Timothy Gangaware, TNWRRC Associate Director, received the Dr. Bruce Tschantz Lifetime Achievement Award (2021) at the Tennessee Stormwater Association's Annual Conference. This award is TNSA's highest honor for outstanding, longtime stormwater professionals with a minimum of 20 years of service. These individuals' long-term contributions have made a measurable impact on stormwater management efforts in the State of Tennessee.

UTK's Appalachian Leadership Institute team: Tim Ezzell, Cat Wilt, Lexi Webster, Katie Cahill

Appalachian Leadership Institute
Tim Ezzell, Katie Cahill, Catherine Wilt

The Appalachian Leadership Institute, a program of the Appalachian Regional Commission, conducted a graduation ceremony for its second class of fellows in Washington in July. The UT ALI team, and its partners, welcomed the new class of 40 fellows in October. As always, this class is learning from experts and peers about several topics, include economic opportunities, natural and cultural resources, and critical infrastructure. While this program has been largely virtual for the past two years, the ALI team is excited to resume in-person activities at the March session in Huntington, WV. The ALI team will also be launching a new leadership alumni program, which will create new networking and learning opportunities for our growing cohort of ALI graduates. The first session of this program will be held on the UT Knoxville campus in late April.

PUBLICATIONS

Publications & Presentations

Publications

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Presentations

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Ash, K. T., Y. Li, D. C. Joyner, D. E. Williams, I. Alamilla, P. McKay, B. Green, C. Iler, F. Kara-Murdoch, C. Swift, F. Löffler, and T. C. Hazen. Contributed. Miles Away From Ordinary: Raw Wastewater Surveillance For The Novel SARS-CoV-2 Virus On The University of Tennessee - Knoxville Campus. World Microbe Forum, Online, June 20-24, 2021. American Society for Microbiology and Federation of European Microbiological Societies. World Microbe Forum

C. K. Ku and M. Jin, Retailer Inventory Counting Policy, May 2021.

Campa, M. F., J. C. See, L. Unverdorben, O. Wright, K. A. Roth, J. M. Niles, D. Ressler, E. Macatugal, A. Putt, S. M. Techtmann, T. C. Hazen, and R. Lamendella. Contributed. Geochemistry, land coverage, and multiomics data differentiate streams in Pennsylvania based on unconventional oil and gas activity. World Microbe Forum, Online, June 20-24, 2021. American Society for Microbiology and Federation of European Microbiological Societies. World Microbe Forum

Chakraborty, R., X. Wu, D. C. Joyner, T. C. Hazen, R. G. Malana, A. P. Arkin and P. D. Adams. Invited. Applying Stable Isotopes for Source Fingerprinting of Dissolved Organic Nitrogen in Groundwater. February 23-26, 2020. Washington, DC. 2020 Genomic Sciences Program (GSP) Annual Principal Investigator (PI) Meeting. ORAU www.orau.gov › gsp2020.

D. M. Vance, C. Price, S. Nimbalkar, T. Wenning and M. Jin, Selecting a Smart Manufacturing Maturity Model, IISE Annual Conference, May 2021.

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Ellis, K. N. Variability in Knoxville's urban heat and residential exposure. Social Inequality in Energy, Environment, and Technology Workshop. University of Tennessee. 13 August 2021.

Fukai, I., and T. C. Hazen. 2021. Germ Anti-Warfare: Evaluating Microbial Biosensors for Nuclear Arms Nonproliferation. 9th Annual Oak Ridge Postdoctoral Association (ORPA) Research Symposium, Oak Ridge, TN, July 28–29, 2021.

Fukai, I., and T. C. Hazen. Contributed. Evaluation of Microbial Biosensors With Applications In Nuclear Arms Nonproliferation. World Microbe Forum, Online, June 20-24, 2021. American Society for Microbiology and Federation of European Microbiological Societies. World Microbe Forum .

Fuqai, Isis and T. C. Hazen. 2020. Biosensors for Detecting Nuclear Production Activity in the Environment. March 12, 2020. Ann Arbor, MI. MTV, University of Michigan.

Griffiths, Z., A. Putt, M. Campa, D. Joyner, J. Miller, O. Pelz, N. GaraJayeva, P. Gardinali, and T. C. Hazen. Contributed. Observing the Indigenous Microbial Community Response to Crude Oil Amendment in Aerobic and Anerobic Conditions. World Microbe Forum, Online, June 20-24, 2021. American Society for Microbiology and Federation of European Microbiological Societies. World Microbe Forum

Gushgari-Dolye, S., A. P. Arkin, L. M. Lui, R. Chakraborty, T. C. Hazen and X. Wu. Contributed. Functional Diversity of Arthrobacter Strains Across the Dynamic Capillary Fringe and Adjacent Sediment Zones. December 16, 2020, San Francisco, CA. AGU Fall Meeting.

Gushgari-Doyle, S., M. O. Yee, J. V. Kuehl, H. J. Smith, M. P. Thorgersen, X. Ge, A. E. Otwell, T. L. Lie, K. A. Hunt, M. W. W. Adams, E. J. Alm, N. S. Baliga, J.-M. Chandonia, A. M. Deutschbauer, D. A. Elias, M. W. Fields, T. C. Hazen, T. R. Northen, A. Mukhopadhyay, G. E. Siuzdak, D. A. Stahl, P. J. Walian, J. Zhou, R. Chakraborty, A. P. Arkin, P. D. Adams. Invited. Targeted Isolation Using Field-Informed Approaches. February 22-24, 2021. Washington, DC. 2021 Genomic Sciences Program (GSP) Annual Principal Investigator (PI) Meeting. ORAU www.orau.gov › gsp2021.

H. Kose and M. Jin, Planning and Scheduling for a Single Additive Manufacturing Machine Using Multi-material Types, May 2021.

H. Sun, Y. Sun, R. E. Wagner, M. Jin, W. Tate, and J. Zhuang, Food losses and waste challenges for the food-water-energy nexus in the United States, AGU Annual Conference, December 2020

Harik, A.-M., T. C. Hazen, D. C. Joyner, and S. Rafie. Contributed. Imaging and Analysis of Methanotroph Induced Bioaggregation in Sand. World Microbe Forum, Online, June 20-24, 2021. American Society for Microbiology and Federation of European Microbiological Societies. World Microbe Forum

Hazen, T. C. Invited Webinar. Exxon Valdez vs. Deepwater Horizon and Considerations for Peru Repsol Spill. Online. Lima, Peru. January 27, 2022. Pontificia Universidad Católica del Perú.

Hazen, T. C. Invited Webinar. Repsol Oil Spill in Peru. Online. Lima, Peru. February 8, 2022. National Service of Protected Areas (SERNANP) from the Ministry of Environment (MINAM).

Hazen, T. C. Invited. After Chat June 21 3:45-4:30PM. "Environmental Systems Biology: The Whole is Greater than the Sum of its Parts – Team Science" ASM Environmental Microbiology Award. World Microbe Forum, Online, June 20-24, 2021. American Society for Microbiology and Federation of European Microbiological Societies. World Microbe Forum

Hazen, T. C. Invited. Biosensors for Detecting Nuclear Production Activity in the Environment (Consortium for Monitoring, Technology, and Verification (MTV)). September 8-10, 2021. Office of Defense Nuclear Nonproliferation Research and Development, University Program Review (UPR) 2021 Meeting.

Hazen, T. C. Invited. Careers in National Labs. U Mass Amherst online, 5/16/21.

Hazen, T. C. Invited. Environmental Systems Biology: The Whole is Greater than the Sum of it's Parts – Team Science. Online, August 6, 2021. Louisiana Tech Environmental Class.

Hazen, T. C. Invited. Environmental Systems Biology: The Whole is Greater than the Sum of it's Parts – Team Science. World Microbe Forum, Online, June 20-24, 2021. American Society for Microbiology and Federation of European Microbiological Societies. World Microbe Forum

Hazen, T. C. Invited. Lessons Learned from the Deepwater Horizon Oil Spill Response and Omics. Online, December 13, 2021. Louisiana Technical University CEE Departmental Seminar.

Hazen, T. C. Invited. Wastewater Based Epidemiology during the Covid-19 Pandemic at the University of Tennessee, Knoxville. September 16, 2021. Charlotte, NC. Global ENVIRO Summit https://www.envirosummit.com/

Hazen, T. C., E. R. Kelly*, A. Putt, K. Walker, D. C. Joyner, I. Fukai, K. Lowe, M. Rodriguez Jr, M. W. Fields, R. Chakraborty, X. Wu, D. Stahl, T. Lie, M. W. W. Adams, F. Poole, P. J. Walian, J. Zhou, J. V. Nostrand, T. R. Northen, J.-M. Chandonia, A. P. Arkin, and P. D. Adams. Invited. Cone Penetrometer 3-D Characterization of Y-12 Site to Determine the Hydrological, Geological and Biogeochemistry Best Sites for ENIGMA Subsurface Observatories. February 22-24, 2021. Washington, DC. 2021 Genomic Sciences Program (GSP) Annual Principal Investigator (PI) Meeting. ORAU www.orau.gov › gsp2021.

Hazen, T. C., I. Fukai, A. P. Arkin, E. Alm, and H. Dulai. Invited. Environmental Surveillance for Biological Traces of Radionuclide Sources. MTV Monthly Seminar, online, 15 May 2021. University of Michigan.

Hunt, K. A., A. E. Otwell, S. Bowman, S. D. Wankel, K. F. Walker, E. R. Dixon, M. Rodriguez, K. A. Lowe, D. C. Joyner, A. Carr, L. Lui, T. Nielsen, N. S. Baliga, T. C. Hazen, D. A. Stahl, A. P. Arkin, P. D. Adams. Invited. Resolving Biotic and Abiotic Controls of Nitrous Oxide Flux in a Subsurface Site Contaminated with High Nitrate Concentrations. February 22-24, 2021. Washington, DC. 2021 Genomic Sciences Program (GSP) Annual Principal Investigator (PI) Meeting. ORAU www.orau.gov › gsp2021.

Hunt, K. A., A. V. Carr, K. F. Walker, E. R. Dixon, M. R. Jr, K. A. Lowe, D. C. Joyner, A. E. Otwell, S. D. Wankel, N. S. Baliga, T. C. Hazen, D. A. Stahl, A. P. Arkin and P. D. Adams. Invited. High nitrous oxide emissions from a nitrate contaminated subsurface indicate significant metabolic activity. February 23-26, 2020. Washington, DC. 2020 Genomic Sciences Program (GSP) Annual Principal Investigator (PI) Meeting. ORAU www.orau.gov › gsp 2020

J. Hale and M. Jin, Monitoring Additive Manufacturing Machine Health Using Partially Observed Markov Decision Process and a Witness Parts Framework, IISE Annual Conference, May 2021.

J. Overly, "ETCleanFuels – Actions & partnerships for Success", ISSE Advisory Board Meeting, December 2020, Knoxville, TN.

J. Overly, "Innovative, Diverse EV Applications for Your Fleet", Presented virtually in partnership with the Quebec Government Office in Atlanta, April 2021.

J. Overly, "Renewable Energy in Transportation – Actors & Opportunities for Fleets in Tennessee", Tennessee City Management Association Spring 2021 Conference, April 2021, Murfreesboro, TN.

J. Overly, "Statewide Action & Rural Alt Fuels Leadership – Examples of Success in Tennessee", TDOT RPO Virtual Conference, October 2020.

J. Wu, Socioeconomic inequalities and drinking water quality: Assessing arsenic concentrations in community water systems by novel field deployable biosensors, Social Inequality of Energy, Environment and Technology Workshop, University of Tennessee, August 6

Jarrar, Z. A., Al-Raoush, R. I., Alshibli, K. A., and Jung, J-W (2020). "Dynamic 3D Imaging of Gas Hydrate Kinetics using Synchrotron Computed Tomography", 2nd International Conference on Energy Geotechnics (ICEGT-2020), Published online 18 November 2020, E3S Web of Conferences 205, 11004, https://doi.org/10.1051/e3sconf/202020511004

Jarrar, Z. A., Al-Raoush, R. I., Alshibli, K. A., and Jung, J-W (2020). "Dynamic Imaging of Hydrate Specific Area Evolution during Xenon Hydrate Formation", International Conference on Civil Infrastructure and Construction (CIC2020), Feb. 2-5, 2020, Doha, Qatar, http://dx.doi.org/10.29117/cic.2020.0081

Jarrar, Z. A., Al-Raoush, R. I., Alshibli, K. A., Hannun, J. A., and Jung, J-W (2019). "Hydrate Surface Area Measurements During Dissociation using Dynamic 3D Synchrotron Computed Tomography". The 3rd European Association of Geoscientists and Engineers (EAGE) WIPIC workshop: Reservoir Management in Carbonates, 18-20 November 2019, Doha, Qatar.

Joyner, D. C., and T. C. Hazen. Contributed. Managing Your Graduate Career: Guidelines for Success. World Microbe Forum, Online, June 20-24, 2021. American Society for Microbiology and Federation of European Microbiological Societies. World Microbe Forum .

Kalina Scarbrough Real-Time Sensor-Based Prediction of Soil Moisture in Green Infrastructure: Case Study, Maintenance of Stormwater Control Measures, March 2022 (under review)

Kalina Scarbrough, Identifying a Minimal Set of Real-Time Sensors to Predict Soil Moisture in Green Infrastructure, 1794 Scholars Showcase, University of Tennessee, Spring 2020

Kalina Scarbrough, Identifying a Minimal Set of Real-Time Sensors to Predict Soil Moisture in Green Infrastructure, 2020 IISE Annual Conference, Virtual, May 30-June 2, 2020

Kalina Scarbrough, Identifying a Minimal Set of Real-Time Sensors to Predict Soil Moisture in Green Infrastructure, Poster presentation, EUReCA, University of Tennessee, Spring 2020

Kalina Scarbrough, Real-Time Sensor-Based Prediction of Soil Moisture in Green Infrastructure: Case Study, 2021 IISE Annual Conference, Virtual, May 22-25, 2021

Kalina Scarbrough, Real-Time Sensor-Based Prediction of Soil Moisture in Green Infrastructure: Case Study, 2021 IISE U.S. Mid-Atlantic Region Conference, Virtual, March 27, 2021

Larsen, D., and Waldron, B., 2020, Low-level soluble chloride extraction in soil: MethodsX, v. 7, 100967, https://doi.org/10.1016/j.mex.2020.100967

Larsen, D., Bursi, J., Waldron, B., Schoefernacker, S., and Eason, J., 2020, Recharge pathways and rates for a sand aquifer beneath a loess-mantled landscape in a humid region: Journal of Hydrology, Regional Studies, v. 28, 100667, https://doi.org/10.1016/j.ejrh.2020.100667

Li, Y., K. Ash, D. C. Joyner, D. E. Williams, C. Iler, I. Alamilla, P. McKay, B. Green, F. Kara-Murdoch, C. Swift, F. Löffler, and T. C. Hazen. Contributed. Decay of SARS-CoV-2 and Pepper Mild Mottle Virus (PMMoV) RNA in raw wastewater to inform application in wastewater-based epidemiology of the University of Tennessee student residential buildings. World Microbe Forum, Online, June 20-24, 2021. American Society for Microbiology and Federation of European Microbiological Societies. World Microbe Forum

Lui, L. M., H. J. Smith, F. V. Netzer, K. B. D. León, E. L.-W. Majumder, J. V. Kuehl, F. Song, A. Sczesnak, T. Nielsen, M. P. Thorgesen, X. Ge, F. L. Poole, B. P. Bowen, S. M. Kosina, C. J. Paradis, K. F. Walker, K. A. Lowe, D. C. Joyner, J. M. Rodriquez, B. A. Adams, D. Williams, J.-W. Moon, J. D. V. Nostrand, D. Ning, Y. Fu, W. Shi, Y. Li, D. J. Curtis, Y. Fan, L. Wu, R. Tian, G. M. Zane, A. B. Aaring, X. Wu, A. E. Kazakov, J.-M. Chandonia, P. S. Novichkov, P. J. Walian, R. Chakraborty, M. W. W. Adams, J. Zhou, T. R. Northen, J. D. Wall, D. A. Stahl, D. A. Elias, T. C. Hazen, M. W. Fields, A. P. Arkin and P. D. Adams. Invited. Core Values: Spatial Variation in Microbial Function, Activity, and Community Assembly in Groundwater and Sediment from a Contaminated Subsurface Aquifer. February 23-26, 2020. Washington, DC. 2020 Genomic Sciences Program (GSP) Annual Principal Investigator (PI) Meeting. ORAU www.orau.gov › gsp2020.

Lui, L. M., T. Nielsen, H. J. Smith, F. V. Netzer, E. L.-W. Majumder, J. V. Kuehl, F. Song, A. Sczesnak, M. P. Thorgesen, X. Ge, F. L. Poole, C. J. Paradis, K. F. Walker, K. A. Lowe, D. C. Joyner, D. Ning, J. M. Rodriquez, A. B. Aaring, B. A. Adams, D. Williams, J. D. V. Nostrand, G. M. Zane, M. W. W. Adams, J. Zhou, R. Chakraborty, J. D. Wall, D. A. Stahl, T. C. Hazen, M. W. Fields, A. Arkin and P. Adams. Invited. A Method for Circularizing Microbial Genomes from Metagenomics Data. February 23-26, 2020. Washington, DC. 2020 Genomic Sciences Program (GSP) Annual Principal Investigator (PI) Meeting. ORAU www.orau.gov › gsp2020.

Lui*, L. M., E. L.-W. Majumder*, H. J. Smith*, H. K. Carlson, F. V. Netzer, N. Nielsen, M. Peng, X. Tao, A. Zhou, M. Price, J. V. Kuehl, A. J. Hendrickson, V. Trotter, S. Gushgari-Doyle, J. Valenzuela, A. Otwell, K. Hunt, A. Carr, K. Walker, E. Dixon, F. Poole, M. Thorgersen, X. Ge, M. W. W. Adams, E. J. Alm, N. S. Baliga, J.-M. Chandonia, A. M. Deutschbauer, D. A. Elias, M. W. Fields, T. C. Hazen, T. R. Northen, A. Mukhopadhyay, G. E. Siuzdak, D. A. Stahl, P. J. Walian, J. Zhou, R. Chakraborty, A. P. Arkin, and P. D. Adams. Invited. Mechanism across scales: integrating laboratory and field studies for microbial ecology as illustrated by the ENIGMA SF. February 22-24, 2021. Washington, DC. 2021 Genomic Sciences Program (GSP) Annual Principal Investigator (PI) Meeting. ORAU www.orau.gov › gsp2021.

M. Galbreth, and M. Jin, Should OEMs Authorize Third-Party Remanufacturers? INFORMS Annual Conference, November, 2020.

M. Jin, Remanufacturing and Supply Chain Managements: Dynamics between Dynamics between Original Equipment Manufacturers and Third Part Remanufacturers, PRES'20, August, 2020.

Miller, J. I., S. M. Techtmann, J. Fortney, N. Mahmoudi, D. C. Joyner, J. Liu, S. Olesen, E. Alm, A, Fernandez, P. Gardinali, N. GaraJayeva, F. S. Askerov and T. C. Hazen. Contributed. Potential for rapid microbial biodegradation of petroleum hydrocarbons in hypoxic marine environments. San Antonio, TX. October 7-9, 2019. International Petroleum Environmental Conference Annual Meeting.

Miller, J. I., Z. Griffiths, S. Techtmann, J. Fortney, N. Mahmoudi, D. Joyner, J. Liu, S. Olesen, E. Alm, A. Fernandez, P. Gardinali, N. GaraJayeva, F. S. Askerov, O. G. Brakstad, O. Pelz, M. Kuijper and T. C. Hazen. Contributed. Microbial Community Structure and Oil Biodegradation in a Hypoxic Marine Environment. May 6, 2020. Dublin, Ireland (online). SETAC SciCon SETAC Europe 30th Annual Meeting.

Needham, D. M., A. Zhang, J.-M. Chandonia, D. Chivian, L. M. Lui, W. Zheng, S. Zhao, Y. Yin, D. A. Weitz, T. C. Hazen, P. S. Novichkov, J. Zhou, E. J. Alm, A. P. Arkin and P. D. Adams. Invited. Integrating data and algorithms from the ENIGMA project into KBase. February 23-26, 2020. Washington, DC. 2020 Genomic Sciences Program (GSP) Annual Principal Investigator (PI) Meeting. ORAU www.orau.gov › gsp2020.

Ning, D., Y. F., L. M. Lui, J. P. Michael, Y. Fu, J. D. Van Nostrand, R. Tian, Y. Wang, K. F. Walker, E. R. Dixon, A. D. Putt, D. E. Williams, D. C. Joyner, K. A. Lowe, F. L. Poole, X. Ge, M. P. Thorgersen, M. W. W. Adams, R. Chakraborty, X. Wu, D. A. Elias R. L. Wilpiszeski, J. Zhou, M. W. Fields, T. C. Hazen, A. P. Arkin, and P. D. Adams. Invited. Physical size matters in groundwater bacterial community assembly. February 22-24, 2021. Washington, DC. 2021 Genomic Sciences Program (GSP) Annual Principal Investigator (PI) Meeting. ORAU www.orau.gov › gsp2021.

Palino GM, Thompson J, Schwartz J, Hathaway J. 2021. Urban floodplain reconnection through regenerative stormwater conveyances. Tennessee Water Resources Symposium. Web. April 15.

Parker, C. and Kintziger, K. Identifying medically vulnerable areas in Tennessee. Summer Undergraduate Research Internship Program, Discovery Day. University of Tennessee. 31 August 2021.

Pineda, P., I. Alamilla, A. Salim, A. Putt, and T. C. Hazen. Contributed. Comparison of Bacterial DNA Extraction from Stream Water. World Microbe Forum, Online, June 20-24, 2021. American Society for Microbiology and Federation of European Microbiological Societies. World Microbe Forum

Putt, A., P. Pineda, I. Alamilla, A. Salim, A. P. Arkin, P. D. Adams, and T. C. Hazen. Contributed. Response of Filterable Microbes to a Beta-Cyclodextrin Injection. World Microbe Forum, Online, June 20-24, 2021. American Society for Microbiology and Federation of European Microbiological Societies. World Microbe Forum

R. Li and M. Jin, Defect Detection on Additive Manufacturing Parts with Machine Learning Informed by Discrete Mean Curvature Measures, IISE Annual Conference, May 2021.

R. Zhou, Z. Li, and M. Jin, Techno-economic Analysis of CO2 Conversion to Jet via Ethanol, IISE Annual Conference, May 2021.

Rafie, S. A. A., K. P. Hoyt, M. R. Schubert, M. T. Kerr, L. R. Blentlinger, A. M. Faiia, A. Szynkiewicz, J. F. Franklin, S. P. Horn, and T. C. Hazen. Contributed. Soil bacterial response to prescribed fires in a southern Appalachian clear cut with fuel manipulation. World Microbe Forum, Online, June 20-24, 2021. American Society for Microbiology and Federation of European Microbiological Societies. World Microbe Forum

Salehi, M., Aghilinasrollahabadi, K., Salehi Esfandarani, M. (2020). An Investigation of Stormwater Quality Variation within an Industry Sector Using the Self-Reported Data Collected under Stormwater Monitoring Program. Water, 12(11), 3185

Salehi, M., Salehi Esfandarani, M. Evaluate the Industrial Facilities Stormwater Pollution Prevention Plan Using the Self-Reported Stormwater Quality Data, A Case Study in West Tennessee, USA. In Preparation Manuscript

Salim, A. A., A. Putt, and T. C. Hazen. Invited. Learning and growing as a Scholar : My Experience as an Undergraduate Researcher. April 14, 2020. Knoxville, TN. 1794 UTK Annual Scholars Showcase one of 20 finalists.

Salim, A. A., P. Pineda, I. Alamilla, A. Putt, and T. C. Hazen. Invited. A Novel approach for Characterizing the Ultra-Micro Size-Fraction Community. April 13, 2020. Knoxville, TN. EURēCA Undergraduate UTK Annual Research Meeting.

Serrano Matos, Y., A. Gonzalez, A. Rivera, D. Williams, T. C. Hazen, and G. A. Toranzos. Contributed. Prophage and CRISPR Sequences Detected in Enterococci Isolates From Soils and Waters with Low Anthropogenic Disturbances. November 20-24, 2019, Anaheim, CA. Annual Biomedical Research Conference for Minority Students (ABRCMS) 2019.

T. Cokyasar, W. Dong, M. Jin and O. Webas, Optimization Methods for Innovative UAV Applications, INFORMS Annual Conference, November, 2020.

W. Dong and M. Jin, Travel Time Models for Tier-to-tier SBS/RS with Different Storage Assignment Policies and Shuttle Dispatching Rules, IISE Annual Conference, May 2021.

Walker, K. F., E. R. Dixon, D. C. Joyner, K. A. Lowe, F. L. Poole, X. Ge, M. P. Thorgersen, D. Ning, Y. Fan, J. P. Michael, Y. Fu, R. Tian, Y. Wang, J. D. V. Nostrand, L. M. Lui, X. Wu, K. J. Davis, M. W. W. Adams, R. Chakraborty, D. A. Elias, R. L. Wilpiszeski, J. Zhou, M. W. Fields, T. C. Hazen, A. P. Arkin and P. D. Adams. Invited. Spatiotemporal Dynamics of Groundwater and Sediment: Geochemistry, Microbial Communities and Activities in a Contaminated Aquifer. February 23-26, 2020. Washington, DC. 2020 Genomic Sciences Program (GSP) Annual Principal Investigator (PI) Meeting. ORAU www.orau.gov › gsp2020.

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right: Members of the ISSE EMPOWER team
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