

A wide-angle photograph of a rocky beach at sunset. The sun is a bright, glowing orb on the right side of the horizon, casting a golden light across the sky and reflecting on the water. The sky is filled with soft, wispy clouds. The ocean has gentle waves with white foam washing onto the shore. The foreground is a rocky beach with dark, smooth stones of various sizes.

**ENVIRONMENTAL ENGINEERS:**  
Trailblazing Solutions for a Brighter Tomorrow

# **31st Annual Environmental Engineering and Science Symposium**

April 17, 2026  
Urbana, Illinois

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# ABOUT THE SYMPOSIUM

2026 marks the 31st Annual Environmental Engineering and Science (EE&S) Symposium at the University of Illinois at Urbana-Champaign (UIUC). This year's theme, "**Environmental Engineers: Trailblazing Solutions for a Brighter Tomorrow,**" highlights the critical role of innovation, collaboration, and resilience in addressing today's most pressing environmental challenges.

As in previous years, the EE&S Symposium aims to bring together researchers, students, and professionals from diverse disciplines to share their work, exchange ideas, and inspire forward-thinking solutions. Environmental engineers continue to lead the way in developing sustainable technologies, improving resource management, and shaping a more resilient and equitable future in the face of global environmental change.

## 2026 Committee Members

<b>Executive Committee</b>	<b>Hospitality and Publicity Committee</b>
Mingyue Yu	Juliana Marks Marissa Campobasso Saumitra Rai Wenjun Guo Yuan Fang
<b>Program Committee</b>	<b>Poster Committee</b>
Inas Belkadi Changyi Huang Jingxian Huang Joseph Abi-Karam Kacey Estrella Patrick Alonso Xueming Xu	Lavanya Kudli Elena Cao Yuhui Zhai

The annual EE&S Symposium is traditionally organized and hosted by students in CEE 595G and 595AG, a professional development seminar course, attended primarily by Ph.D. and MS students.

**Advising Faculty:** Sotiria Koloutsou-Vakakis

**Administrative Support:** Suzanne Giesler

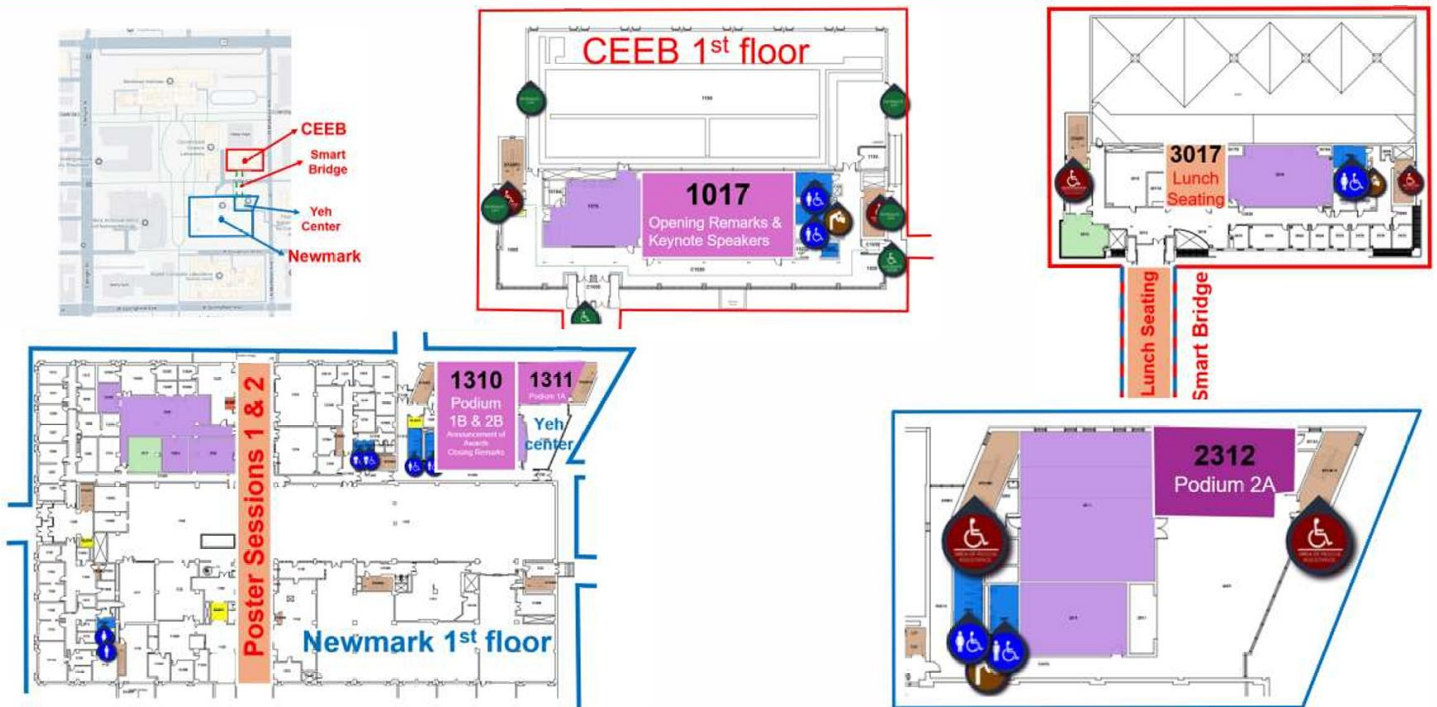
# CONFERENCE SPACES

## Event Maps

CEE 31st Environmental Engineering & Science Symposium (2026)

April 11, 8:00 am – 5:00 pm

Civil and Environmental Engineering Building (CEEB)  
& Newmark Civil Engineering Laboratory (Newmark)



# SCHEDULE

## 31st Annual Environmental Engineering and Science Symposium Schedule – April 17, 2026

Time	Event	Location
8:00 – 8:50 am	Continental Breakfast & Registration	CEEB 1 <sup>st</sup> floor
8:50 – 9:00 am	<b>Opening Remarks: Prof. Rosa Espinosa-Marzal</b>	CEEB 1017
9:00 – 9:50 am	<b>Keynote Speaker: Dr. Katherine McMahon</b> “From environmental engineer to microbiologist and back again.” ( <i>Prof. Ran Mei introduces</i> )	CEEB 1017
10:00 – 10:50 am	<b>Poster Session 1</b>	Crane Bay
11:00 am – noon	<b>Podium Session 1A</b> (Moderators: Marissa Campobasso and Kassandra Estrella) <i>Air Quality, Indoor Air Quality, Climate Change</i>	Newmark 1311
11:00 – 11:20 am	<b>Ganesh Subramanian</b> - Influence of Human Activities and Occupancy on the Emission of Indoor Particles from Respiratory and Nonrespiratory Sources <i>Artificial Intelligence, Data Science in Environmental Engineering</i>	
11:20 – 11:40 am	<b>Xiaokai Yang</b> - Atmospheric chemistry surrogate modeling with sparse identification of mass action dynamics: Toward 3D online integration	
11:40 am – noon	<b>Tahsina Alam</b> - Calibration Data Source Drives Future Root-Zone Soil Moisture Projections in Illinois	
11:00 am – noon	<b>Podium Session 1B</b> (Moderators: Joyce Yang and Buai Shi) <i>Sustainability and Resource Recovery</i>	Newmark 1310
11:00 – 11:20 am	<b>Don Sim</b> - Exploring valorization pathways for thin stillage	
11:20 – 11:40 am	<b>Keroglou Ioannis</b> - Direct air capture sorbent manufacturing: A comparative life cycle assessment of amine-impregnated solid adsorbents	
11:40 am – noon	<b>John Albin</b> - A Tensor-Based Framework for Integrated Economic and Environmental Assessment of Magnet Recovery Pathways	
12:00 – 1:00 pm	<b>Lunch</b>	Bridge and CEEB 3017
1:00 – 1:50 pm	<b>Keynote Speaker: Dr. Ofelia Romero</b> “Perspectives from an EES graduate working in consulting and a regulatory agency.” ( <i>Prof. Helen Nguyen introduces</i> )	CEEB 1017
2:00 – 2:50 pm	<b>Poster Session 2</b>	Crane Bay
3:00 – 4:00 pm	<b>Podium Session 2A</b> (Moderators: Lavanya Kudli and Ganesh Subramanian ) <i>Sustainability and Resource Recovery</i>	Newmark 2312
3:00 – 3:20 pm	<b>Yoonjoo Seo</b> - Engineering a Yeast Whole-Cell Biocatalyst for PET Depolymerization via Cell Surface Display of Humicola insolens Cutinase	
3:20 – 3:40 pm	<b>Rishabh Puri</b> - From Theory to Practice: Data-Driven Insights for Designing and Operating Struvite Recovery Systems	
3:40 – 4:00 pm	<b>Ritvik Kumar</b> - Component-Level Circular Strategies to Reduce the Life Cycle Environmental Impacts of Data Center Rack Servers	
3:00 – 4:00 pm	<b>Podium Session 2B</b> (Moderator: Tahsina Alam) <i>Artificial Intelligence, Data Science in Environmental Engineering</i>	Newmark 1310
3:00 – 3:20 pm	<b>Renjing Jiang</b> - PEZy-Extract: Automated data extraction for enzymatic degradation of plastic from research articles with large language models and prompts <i>Emerging Technologies for Water Quality and Processes</i>	
3:20 – 3:40 pm	<b>Abigail Nason</b> - Aragonite Crystallization Pathways in the Presence of Microplastics <i>Sustainability and Resource Recovery</i>	
3:40 – 4:00 pm	<b>Camila Cassunde</b> - Tiny house and material selection based on life cycle assessment as a sustainable alternative to enhance disaster resilience in the Southwestern U.S.	
4:10 – 4:25 pm	<b>Announcement of Awards: Symposium Student Executive Committee</b>	Newmark 1310
4:25 – 4:30 pm	<b>Closing Remarks</b>	Newmark 1310

## Poster Sessions

Poster Session 1 – 10:00 -10:50 am at Crane Bay	Poster Session – 2:00-2:50 pm at Crane Bay
Poster Presenters 1-22	Poster Presenters 1-21
<p style="text-align: center;"><i>Air Quality, Indoor Air Quality, Climate Change</i></p> <ol style="list-style-type: none"> <li>1. <b>Yuhui Zhai</b> - Assessment of Inter-continental and Seasonal Variability in PM<sub>2.5</sub> Oxidative Potential for Global SPARTAN Samples</li> <li>2. <b>Summer Acker</b> - Satellite-Derived vs. Ground Truth: How Environmental Conditions Modify Their Agreement in PM<sub>2.5</sub> Across the Western United States</li> <li>3. <b>Shiyuan Wang</b> - The Invisible Cost of War: PM<sub>2.5</sub> Emissions and Health Impacts from the 2026 Iran War <i>Sustainability and Resource Recovery</i></li> <li>4. <b>Maria Florencia Bianco</b> - Multi-scale biorefinery deployment for a diversified bioeconomy using spatial feedstock data and surrogate models</li> <li>5. <b>Tuan Anh Mai Nguyen</b> - Evaluating Antimicrobial Resistance in Commensal Escherichia coli Isolated from Fecal and Uterine Samples of Swine in Northern Provinces of Vietnam, 2023-2024</li> <li>6. <b>Kangdi Sun</b> - Electrostatic Balance Tunes the Structure, Mechanics, and Lubrication of Mucin-PEI complexes</li> <li>7. <b>Ming Jun Lee</b> - Properties of Ovomucin Hydrogel Derived From Egg White</li> <li>8. <b>Xuhui Zhang</b> - Interfacial Behavior of Salt-in-Ionic Liquid Electrolytes with [FSI] anions</li> <li>9. <b>Wenjun Guo</b> - Prioritizing early opportunities to enhance carbon efficiency at biorefineries</li> <li>10. <b>Saint Moon Kim</b> - Antibiotic- and Inducer-Free Whole-Cell Biocatalyst for Polycaprolactone Upcycling</li> <li>11. <b>Yuan Fang</b> - Flow-Driven Mass Transfer Shapes Syntrophic Metabolism in Anaerobic Microbial Communities</li> <li>12. <b>Yongjian Ma</b> - Electrochemical Control of Calcium Phosphate Deposition on Gold Interfaces: Effects of Applied Potential and Polymer Additives</li> <li>13. <b>Rourou Ji</b> - Kinetic model of a determinate nodule reveals plant metabolic characteristics for more efficient nitrogen fixation symbiosis</li> <li>14. <b>Saumitra Rai</b> - Economic and environmental implications of sanitation infrastructure transitions in Indian cities</li> <li>15. <b>Xiaozhuo Cao</b> - Electric Double Layer Structuring in Water-in-Salt Electrolytes: Influence of Multivalent Cations and Solvation Structure</li> <p style="text-align: center;"><i>Artificial Intelligence, Data Science in Environmental Engineering</i></p> <li>16. <b>Mukhamad Suhermanto</b> - Development of a Geographical Information System (GIS) Database for Power Grid Infrastructure in Developing Countries: A Case Study of Indonesia</li> <li>17. <b>Song Jiang</b> - A 10-meter resolution informal settlement map for the Global South derived from satellite imagery and open datasets</li> <p style="text-align: center;"><i>Emerging Technologies for Water Quality and Processes</i></p> <li>18. <b>Elena Cao</b> - HRAP-Based Wastewater Treatment with Resource Recovery: LCA Comparison of Biogas and Biofertilizer Routes</li> </ol>	<p style="text-align: center;"><i>Air Quality, Indoor Air Quality, Climate Change</i></p> <ol style="list-style-type: none"> <li>1. <b>Mashiat Hossain</b> - Representing Sub-Grid Wildfire Plume Chemistry in GEOS-Chem: Implications for NO<sub>y</sub> Partitioning and Downwind Ozone</li> <li>2. <b>Anson Regi</b> - Physicochemical and Oxidative Properties of Aerosols Emitted from Aviation Fuel Combustion</li> <li>3. <b>Joseph Abi-Karam</b> - Urban Climate-Energy Coupling Under Extreme Heat Using High-Resolution Climate Modeling <i>Sustainability and Resource Recovery</i></li> <li>4. <b>Haotian Yang</b> - Self-Assembled Protein Nanospheres for Selective Rare Earth Element Recovery</li> <li>5. <b>Lu Cao</b> - From Enzymatic Degradation to Self-Degradable Plastics: New Opportunities for Biodegradable Polymers</li> <li>6. <b>Xueming Xu</b> - Effects of Transient Oxygen Exposure, Light, and Synechocystis on Methanogenesis in a Defined Syntrophic Community</li> <li>7. <b>Marissa Campobasso</b> - Prioritizing R&amp;D for the Harmful Algal Bloom Interception, Treatment, and Transformation System (HABITATS)</li> <li>8. <b>Jingyu Li</b> - How do natural hydraulic lime (NHL)-based substrates influence the growth of juvenile Colpophyllia natans?</li> <li>9. <b>Qianlu Zheng</b> - Sustainable Energy Storage: In-Situ Investigation of Safer Sodium-Ion Battery Electrolytes</li> <li>10. <b>Johanna Arita Mendoza</b> - Rethinking Urban Sanitation in Established Cities: Economic and Environmental Characterization of Non-Sewered Sanitation (NSS) Deployment in Paris</li> <li>11. <b>Genyou Shi</b> - Beyond Lithium: Water-based electrolytes for energy storage</li> <li>12. <b>Buai Shi</b> - Evaluating the economic and environmental potential of valorizing wastewater VFAs using redox-electrodialysis</li> <li>13. <b>Gus Greenwood</b> - Interlayer effects of nanoscale friction on van der Waals heterostructure surfaces</li> <li>14. <b>Zixuan Wang</b> - The potential of thermomechanical and thermochemical processes to enable household non-sewered sanitation</li> <p style="text-align: center;"><i>Artificial Intelligence, Data Science in Environmental Engineering</i></p> <li>15. <b>Juliana Marks</b> - A machine learning approach to elucidating physicochemical drivers of opportunistic pathogen occurrence in drinking water systems</li> <li>16. <b>Qurat ul ain Fatima</b> - Physics-Informed Symbolic Regression Surrogates for Gas-Particle Partitioning in Inorganic Aerosol: Interpretable Emulation of the E-AIM Thermodynamic Model</li> <p style="text-align: center;"><i>Emerging Technologies for Water Quality and Processes</i></p> <li>17. <b>Xiangyi Yang</b> - Electrocoagulation: A Green and Efficient Technology for Wastewater Treatment</li> </ol>

<p>19. <b>Do Nhung</b> - Core resistomes are shared across diverse One Health sources</p> <p>20. <b>Jingxian Huang</b> - Granular Activated Carbon for PFAS Removal in Drinking Water Treatment</p> <p>21. <b>Yang Chen</b> - Environmental Fate and Transport of Contaminants Following the Deepwater Horizon Oil Spill</p> <p>22. <b>Changyi Huang</b> - From Powder to Practical Materials: Macro-Structuring of Metal–Organic Frameworks for Water Treatment</p>	<p>18. <b>Kassandra Estrella</b> - Assessing Performance and Scalability of Low Chemical Addition with Membrane Filtration for Harmful Algal Bloom (HAB) Mitigation</p> <p>19. <b>Paul Lee</b> - Substrate-specific microbial responses during proteinaceous biomass degradation in a deep-sea sediment enrichment</p> <p>20. <b>Inas Belkadi</b> - Detection and Removal of Microplastics in Wastewater Treatment Plants: Current and Emerging Methods</p> <p>21. <b>Thando Mawasha</b> - Evaluation of Bacterial Inhibition by KDF Media in Zero Water Point-of-Use Filters</p>
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# KEYNOTE SPEAKER

9:00-9:50 AM, CEEB 1017



## **Dr. Katherine (Trina) McMahon**

Professor of Bacteriology and Civil and Environmental Engineering at the University of Wisconsin–Madison.

Professor Katherine (Trina) McMahon received her BS in Civil Engineering and MS in Environmental Engineering from the University of Illinois at Urbana Champaign in 1995 and 1997 respectively. Her MS thesis advisor was Dr. Lutgarde Raskin, currently at Yale University. McMahon earned her PhD in Environmental Engineering at the University of California at Berkeley in 2002. She joined the faculty in the Civil and Environmental Engineering Department at the University of Wisconsin Madison in 2003 and became cross-appointed with the Bacteriology Department in 2008. She was promoted to Associate Professor with tenure in 2008 and professor in 2013. Her research interests span multiple dimensions of the “water microbiome” including wastewater treatment and freshwater quality. She has a special interest in wastewater treatment bacteria that sequester phosphorus using an enigmatic physiology. She is heavily invested in the North Temperate Lakes Long Term Ecological Research site and directs the NTL Microbial Observatory. Finally, she is passionate about future faculty professional development and has served as Co-Faculty Director of the Delta Program in Research, Teaching, and Learning at UW-Madison since 2011. She was elected as a fellow in the American Academy of Microbiology in 2018.

As an undergraduate at UIUC, McMahon received the following awards:

- David Owens Scholarship, National Association of Water Companies (1995)

- Grant H. Flint Scholarship, Solid Waste Association of North America (1995)
- Melih T. Dural Undergraduate Research Award, Civil Engineering Dept., UIUC (1995)
- Ira O. Baker Prize, Civil Engineering Department, UIUC (1995)
- A. Epstein Award, Civil Engineering Department, UIUC (1995)
- Langlier Scholarship for Achievement in the study of water and wastewater treatment, Civil Engineering Department, UIUC (1994)
- Sandberg Scholarship, Civil Engineering Department, UIUC (1994)
- Barry M. Goldwater Excellence in Education Scholarship (1993-1995)
- Morrow Award, Civil Engineering Department, UIUC (1993)

## ***"From environmental engineer to microbiologist and back again"***

### **Abstract**

Most modern academics would claim to engage in some degree of "interdisciplinary" activity. But what does it mean to be interdisciplinary in a culture that values deep expertise and independent contributions as a measure of scholarly achievement?

Beyond academia, the concept of having interdisciplinary skills is even more important. How do we cultivate the right level of interdisciplinary in ourselves, combined with sufficient depth, in order to be successful (and for our students to be successful). I will talk about my own passion for working across multiple disciplines in a way that brings me joy while stimulating my academic creativity and motivation. As an undergraduate and as a master's student at UIUC in the CEE Department, I actively sought out research projects that exposed me to topics that were NOT covered in my coursework. I've continued this pursuit for more than 30 years and look forward to reflecting on what has gone well, and what has gotten me into trouble. Hopefully I can convince you that it is possible to find balance between disciplinary depth and interdisciplinary work.

# KEYNOTE SPEAKER

1:00-1:50 PM, Newmark 1017



## **Dr. Ofelia Romero**

Senior Engineer at the California State Water Resources Control Board, Division of Drinking Water.

Dr. Ofelia Romero-Maraccini is the Senior Engineer overseeing the Yosemite District for the California State Water Resources Control Board (SWRCB) Division of Drinking Water (DDW). In her current position, Dr. Romero oversees 132 public water systems in Tuolumne County and Yosemite National Park. Previously with the SWRCB, Dr. Romero was the acting Senior Engineer for the Water Arrearage Team, which distributed over \$300M to provide relief to community water systems for unpaid bills accrued during the COVID-19 pandemic, for which Dr. Romero received a Superior Accomplishment Award.

Dr. Romero graduated from the University of California Berkeley with a Bachelor's Degree in Civil and Environmental Engineering, and the University of Illinois at Urbana-Champaign with a Master's and PhD in Civil and Environmental Engineering under the direction of Dr. Helen Nguyen. Thereafter, Dr. Romero was a Life Science Research Associate with the Center for Ocean Solutions at Stanford University, then an Engineer at Water Quality & Treatment Solutions, Inc. (WQTS), a company founded by University of Illinois graduate Issam Najm. With WQTS, Dr. Romero investigated and resolved water quality and treatment challenges pertaining to the operation, performance, and regulatory issues for multiple California water utilities.

***"Perspectives from an EES graduate working in consulting and a regulatory agency."***

**Abstract**

Ofelia Romero Maraccini earned both her MS and PhD from the UIUC EES program, graduating in 2014, working under the guidance of Professor Helen Nguyen. She will be speaking with us about her professional journey since graduation.

Right after completing her degree, Ofelia joined the Center for Ocean Solutions at Stanford University as a research associate. She later transitioned into engineering through a temporary environmental engineering role with the Alameda County Water District (ACWD). That six-month position opened the door to a full-time consulting engineer role with WQTS in Los Angeles, California. After five years at WQTS—and welcoming two daughters—Ofelia moved to the State Water Resources Control Board- Division of Drinking Water (DDW) in Fresno, CA. She began in 2020 as a staff engineer in the Tulare District, then in 2021 joined DDW's Arrearages Unit, which distributed more than \$300 million to public utilities during COVID to help offset customer non payment. In 2022, she served as acting senior for the Arrearages Unit through 2023. A few months later, Ofelia became the District Engineer for the Yosemite District, where she now oversees all public water systems in Tuolumne County and Yosemite National Park.

# POSTER SESSION 1

10:00 AM – 10:50 AM, Crane Bay

## Air Quality, Indoor Air Quality, Climate Change

### POSTER 1: Yuhui Zhai

#### *Assessment of Inter-continental and Seasonal Variability in PM<sub>2.5</sub> Oxidative Potential for Global SPARTAN Samples*

The oxidative potential (OP) of atmospheric fine particulate matter (PM<sub>2.5</sub>) is a critical toxicological metric for assessing particle-induced oxidative stress and its associated adverse health effects. However, comprehensive evaluations of PM<sub>2.5</sub> OP and its linkage to chemical composition across diverse global regions and seasons remain limited. This study utilizes data from the Surface Particulate Matter Network (SPARTAN) to systematically evaluate the inter-continental and seasonal variability of PM<sub>2.5</sub> mass concentrations and their corresponding OP metrics. Specifically, we analyze mass-normalized (DTT<sub>m</sub>) and volume-normalized (DTT<sub>v</sub>) dithiothreitol activity. By integrating experimentally measured OP with detailed SPARTAN chemical composition profiles, this research investigates the spatiotemporal distribution of aerosol toxicity across multinational urban environments. Our analysis characterizes the regional and seasonal disparities in particulate toxicity and evaluates the primary chemical components driving these OP metrics globally. The merged dataset enables a robust assessment of how varying emission sources and atmospheric processes influence the intrinsic toxicity of PM<sub>2.5</sub> in different continental contexts. Ultimately, this work provides critical empirical evidence for understanding the global distribution of PM<sub>2.5</sub> health risks, underscoring the necessity of incorporating both chemical speciation and biological activity metrics into comprehensive, health-oriented air quality management strategies.

## **POSTER 2: Summer Acker**

### ***Satellite-Derived vs. Ground Truth: How Environmental Conditions Modify Their Agreement in PM<sub>2.5</sub> Across the Western United States***

Fine particulate matter (PM<sub>2.5</sub>) strongly impacts human health, yet surface monitoring networks provide limited spatial coverage. Satellite-derived products extend observations globally, but agreement with monitors varies with environment. We quantify distributional agreement between biweekly satellite-derived and monitored total and speciated PM<sub>2.5</sub> across the western US and within specific environments from 2021-2023, applying Jensen-Shannon divergence (JSD) as a measure of distributional similarity. Total PM<sub>2.5</sub> shows strong agreement (JSD = 0.006;  $r = 0.833$ ) throughout the West. Distributional agreement worsens in mountain, desert, and high wildfire risk regions with JSD increasing by 1.6x, 11.3x, and 2.6x, respectively. Pearson correlations are less affected, with relative decreases of 0.6%, 18.2%, and 6.6%. Desert JSDs are the worst across species and organics show consistently better JSDs than inorganics across environments; Pearson  $r$  shows no consistent pattern. These results identify where satellite products may fall short, motivating ongoing modeling work exploring factors that drive agreement changes.

## **POSTER 3: Shiyuan Wang**

### ***The Invisible Cost of War: PM<sub>2.5</sub> Emissions and Health Impacts from the 2026 Iran war***

This study proposes a framework to estimate the air-quality and public health impacts of military activities during the Iran–Israel conflict. Armed conflicts can generate substantial air pollution through explosions, infrastructure destruction, and fires at fuel and industrial facilities, releasing particulate matter and toxic gases into the atmosphere. We will construct a spatially explicit emission inventory of PM<sub>2.5</sub> by combining conflict event datasets, satellite observations, and available information on military activities. These emissions will be allocated to conflict locations and integrated with a reduced-complexity (e.g., InMAP) and machine learning based air-quality model (e.g., EarthSciML) to estimate changes in ambient PM<sub>2.5</sub> concentrations. The resulting exposure fields will be coupled with population data and concentration–response functions to estimate premature mortality attributable to conflict-related air pollution. Because detailed military activity and damage data are often incomplete or unavailable during active conflicts, the analysis will rely on multiple data sources and scenario-based assumptions. This framework aims to provide a systematic approach for quantifying the environmental and health externalities of armed conflict.

# POSTER SESSION 1

10:00 AM – 10:50 AM, Crane Bay

## Sustainability and Resource Recovery

### POSTER 4: Maria Florencia Bianco

#### *Multi-scale biorefinery deployment for a diversified bioeconomy using spatial feedstock data and surrogate models*

Strategic siting of biorefineries is critical for enabling a cost-effective and sustainable bioeconomy, yet planning is challenging because fuels and specialty bioproducts operate at very different production scales and rely on spatially dispersed biomass. This work develops a spatial optimization framework to coordinate multi-product biorefinery deployment using surrogate models trained on process simulations, feedstock logistics, and geographic data. The approach is applied across rainfed U.S. regions using miscanthus as a representative emerging feedstock and evaluates alternative planting densities. Results show that minimum selling prices remain relatively insensitive to feedstock density despite large changes in transportation distance and sourcing patterns. Meeting combined fuel and biochemical targets requires modest land relative to current agricultural use, with large-scale fuel pathways driving most land demand. Overall, findings indicate that dispersed biomass production can support flexible refinery siting and near-term expansion of a diversified bioeconomy without widespread land conversion.

## **POSTER 5: Tuan Anh Mai Nguyen**

### ***Evaluating Antimicrobial Resistance in Commensal Escherichia coli Isolated from Fecal and Uterine Samples of Swine in Northern Provinces of Vietnam, 2023-2024***

Antimicrobial resistance (AMR) in food-producing animals threatens animal health, food safety, and public health. Commensal *Escherichia coli* is widely used as an indicator organism for AMR surveillance; however, comparative data across anatomical sites in swine remain limited in high-antimicrobial-use settings such as Vietnam. This study characterized phenotypic resistance and multidrug resistance (MDR) in 211 *E. coli* isolates (96 fecal and 115 uterine) collected from swine in Northern Vietnam during 2023–2024. Antimicrobial susceptibility was determined using the Kirby–Bauer disk diffusion method following CLSI guidelines across five antimicrobial classes. Resistance was highest to ampicillin (96.7%) and tetracycline (95.7%), with substantial resistance to gentamicin (80.1%), sulfamethoxazole/trimethoprim (80.1%), and enrofloxacin (73.5%). Fecal isolates exhibited higher resistance levels and more frequent MDR profiles than uterine isolates. Logistic regression demonstrated significantly higher odds of resistance among fecal isolates for selected antimicrobials. Fecal isolates exhibited significantly higher resistance levels, suggesting that the intestinal tract may serve as an important reservoir of multidrug-resistant *E. coli* in swine production systems in Northern Vietnam.

## **POSTER 6: Kangdi Sun**

### ***Electrostatic Balance Tunes the Structure, Mechanics, and Lubrication of Mucin–PEI complexes***

Mucins play a critical role in boundary lubrication in biological systems, including joints and mucosal surfaces, where impaired lubrication is associated with diseases such as osteoarthritis and dry-eye syndrome. However, how mucin molecular architecture governs interfacial mechanics and friction remains unclear. Here, we compare porcine gastric mucin (PGM) and bovine submaxillary mucin (BSM), as well as their complexes with polyethyleneimine (PEI), using a combination of dynamic light scattering, quartz crystal microbalance with dissipation monitoring, atomic force microscopy, and colloidal-probe friction measurements. PGM forms soft, weakly charged nanofilms, whereas BSM forms stiffer, more highly charged films. Although PEI produces smoother nanofilms in both systems, it induces opposite mechanical effects, stiffening PGM films while softening BSM films. Consequently, PGM-based films exhibit high friction dominated by deformation-mediated dissipation, whereas native BSM films display the lowest friction coefficients. PEI disrupts the intrinsic stiffness of BSM films, leading to impaired lubrication performance. These results demonstrate that effective mucin lubrication is governed by intrinsic film mechanics rather than surface smoothness alone, and highlight the importance of electrostatic balance in designing biomimetic lubricating systems and understanding lubrication failure in disease.

## **POSTER 7: Ming Jun Lee**

### ***Properties of Ovomucin Hydrogel Derived From Egg White***

Mucus is a natural, gel-like material secreted onto the epithelium to protect many biological surfaces. It helps to trap and remove bacteria, lubricate food through the digestive tract, and ensure smooth sliding of the eyelids, for example. Performing these functions requires a unique combination of physical properties including low shear modulus, suitable adhesion force, and low sliding friction coefficient. Patients that suffer from mucus-related diseases like cystic fibrosis experience hardening of mucus, preventing it from performing its anti-inflammatory functions, resulting in harm to the patient. Introducing mucus extracted from other humans may help to alleviate these symptoms but the process will be costly and complex. Development of synthetic mucus derived from natural sources may present a cost-effective alternative. The poster will demonstrate extraction and identification of ovomucin component via electrophoresis from egg white, followed by characterization of its viscoelastic properties via oscillatory rheology. Tribological properties will be evaluated in gemini interface via triborheology. The goal is to develop ovomucin hydrogels and establish fundamental knowledge towards relationships between microstructure-rheology and interfacial properties.

## **POSTER 8: Xuhui Zhang**

### ***Interfacial Behavior of Salt-in-Ionic Liquid Electrolytes with [FSI] anions***

Ionic liquid (IL)-doped alkali-metal salts, commonly known as salt-in-ionic liquids (SiILs), have drawn attention over recent years as electrolytes in batteries. SiILs are a class of highly concentrated, strongly correlated, and asymmetric electrolytes, with low volatility, low flammability, and extraordinary thermal and chemical stability. In this work, we focused on the interfacial structure and behavior of Na-based SiILs on charged surfaces. Sodium bis(fluorosulfonyl)imide (NaFSI) and 1-ethyl-3-methylimidazolium bis(fluorosulfonyl)imide ([EMIM][FSI]) have been selected as the alkali-metal salt and the IL, respectively, and systematically mixed at different molar ratios. An extended Surface Forces Apparatus (eSFA) and Atomic Force Microscopy (AFM) were employed for probing structural features such as the arrangement of ions at charged surfaces, while Wide Angle X-ray Scattering (WAXS) was used to explore the bulk structure of the SiILs. We have found that the interfacial force profiles of SiILs transition from long-range to short-range during approaches, indicating fundamental structural changes with time and concentration. We aim to provide insights to design materials for the next-generation batteries beyond Li-based chemistries to improve energy resilience.

## **POSTER 9: Wenjun Guo**

### ***Prioritizing early opportunities to enhance carbon efficiency at biorefineries***

To reduce reliance on fossil resources, biorefinery development should prioritize strategies that enhance carbon use efficiency while preserving economic viability. Here, we evaluate integration of CO<sub>2</sub> capture and utilization into a commercial-scale cellulosic ethanol biorefinery using process simulation, techno-economic analysis, and life cycle assessment under uncertainty. Results show integrating CO<sub>2</sub>-to-methanol synthesis increased feedstock carbon use efficiency. However, environmental and economic outcomes were highly configuration dependent. Fossil-based electricity and hydrogen undermined carbon mitigation benefits, whereas renewable-powered pathways substantially increased system overall carbon use efficiency from ~0.3 to ~0.7 while achieving comparable cradle-to-grave carbon intensity to base cases. Economically, all integration configurations elevated ethanol production costs, with renewable electricity and hydrogen prices identified as critical bottlenecks linked to future net-emission targets. Carbon utilization credits provided modest cost-parity improvements but were insufficient to fully close the gap. Overall, these findings highlight meaningful biorefinery decarbonization requires coupling CO<sub>2</sub> conversion with low-cost clean energy and supportive policy frameworks.

## **POSTER 10: Saint Moon Kim**

### ***Antibiotic- and Inducer-Free Whole-Cell Biocatalyst for Polycaprolactone Upcycling***

Polycaprolactone (PCL) is a biodegradable polyester widely used in biomedical and packaging applications, yet its increasing use raises concerns regarding plastic waste management. Adipic acid is an important industrial chemical and a key precursor for the production of nylon-6,6 and other polymers. In this study, we developed an antibiotic- and inducer-free whole-cell biocatalyst capable of depolymerizing PCL and converting the resulting intermediates into adipic acid in a single microbial system. By integrating extracellular polymer degradation with intracellular metabolic conversion, the engineered strain enables a one-pot biological process for plastic waste upcycling. This work provides a sustainable strategy for transforming polyester waste into value-added chemicals.

## **POSTER 11: Yuan Fang**

### ***Flow-Driven Mass Transfer Shapes Syntrophic Metabolism in Anaerobic Microbial Communities***

Syntrophic degradation of volatile fatty acids (VFAs) is a key process in anaerobic ecosystems, which requires extremely efficient transfers of electron carriers such as hydrogen and formate between cells. Yet microscale mass transport limitations that may constrain interspecies electron transfer remain poorly understood. Here, we investigate how hydrodynamic conditions regulate syntrophic metabolism by altering mass transfer and local reaction thermodynamics. Using batch cocultures operated under different mixing intensities, we developed a mass-transfer-constrained model to estimate hydrogen and formate concentrations at the cell surface and calculate local reaction energetics ( $\Delta G$ ). The results show that changes in flow can substantially shift the energetic window of syntrophic reactions. Transcriptomic analysis further reveals corresponding changes in the expression of key hydrogenase and formate dehydrogenase genes. Together, these results reveal that hydrodynamic transport links physical mass transfer to reaction thermodynamics and gene expression, thereby shaping syntrophic metabolism in anaerobic microbial communities.

## **POSTER 12: Yongjian Ma**

### ***Electrochemical Control of Calcium Phosphate Deposition on Gold Interfaces: Effects of Applied Potential and Polymer Additives***

Hydroxyapatite (HAP) mineralization plays an important role in environmentally relevant processes, including phosphorus recycling, contaminant immobilization, and interfacial biomineral formation. Understanding and controlling mineral growth at solid–liquid interfaces is critical for advancing environmentally responsive technologies. In this study, we investigate how applied electrochemical potential regulates HAP deposition on gold surfaces. Using electrochemical quartz crystal microbalance (EC-QCM), atomic force microscopy (AFM), and surface-sensitive spectroscopy, we evaluate how electrical conditions influence mineral growth kinetics and interfacial behavior. Moderate negative potentials enhance growth kinetics and improve surface uniformity. In contrast, more negative potentials increase overall mass deposition while producing more heterogeneous films. Although HAP forms under both open-circuit and applied potential conditions, electrochemical control significantly alters growth dynamics. These findings demonstrate that applied potential provides a promising strategy for regulating interfacial mineralization, with implications for environmentally driven mineral processes and electrochemically assisted resource recovery.

## **POSTER 13: Rourou Ji**

### ***Kinetic model of a determinate nodule reveals plant metabolic characteristics for more efficient nitrogen fixation symbiosis***

While synthetic nitrogen fertilizers are widely used in agricultural production, their application entails significant environmental and energetic costs. In contrast, some crops are less dependent on synthetic nitrogen fertilizer because they engage in symbioses with nitrogen-fixing bacteria that provide ammonium to the plant in exchange for carbon. Different crops vary in the efficiency of this carbon-for-nitrogen exchange, which raises the possibility of engineering it to further reduce these crops' need for fertilizer. Such engineering efforts would be greatly facilitated by accurate, quantitative models that can predict the changes to the underlying metabolism most likely to improve the efficiency or rate of nitrogen fixation. In this work, we build a kinetic model of the metabolic network in determinate root nodules, shedding light on underlying interactions towards improved biological performance. Using this model, we quantitatively identify enzymes and kinetic parameters that could potentially improve nitrogen fixation efficiency and rate. We show that the enzymes phosphoenolpyruvate carboxylase and pyruvate kinase have a particularly marked effect on the rate and efficiency of nitrogen fixation.

## **POSTER 14: Saumitra Rai**

### ***Economic and environmental implications of sanitation infrastructure transitions in Indian cities***

Rapid urbanization in India has outpaced expansion of centralized sewer networks, leading to widespread reliance on non-sewered sanitation (NSS) while many wastewater treatment plants (WWTPs) operate below capacity. High capital costs and uneven network coverage limit scalability of centralized systems. Hybrid sanitation systems that combine centralized treatment with NSS technologies represent an important transition pathway, yet their economic and environmental tradeoffs remain poorly understood.

This study evaluates cost and GHG implications of sanitation infrastructure pathways using systems level TEA and LCA. National sanitation and WWTP capacity datasets are integrated with process modeling of two illustrative WWTPs in Bengaluru and Pune. Results show that centralized sewer infrastructure creates a fixed cost baseline, while NSS technology choice drives variation in both cost and emissions. High capital anaerobic systems increase costs and methane emissions, whereas low emission options such as composting toilets perform similarly to centralization.

## **POSTER 15: Xiaozhuo Cao**

### ***Interfacial Structure and Electrochemical Properties of Au/Salt-in-Ionic Liquid Interfaces***

Understanding interfacial structure at electrified solid–liquid interfaces is essential for advancing electrochemical energy systems. Here, we investigate the Au/ionic liquid interface using atomic force microscopy (AFM) and electrochemical techniques. Atomically smooth Au surfaces were prepared via a template-stripping method, achieving sub-nanometer roughness suitable for high-resolution imaging. Using a NaFSI-based salt-in-ionic liquid system, AFM results show that the electrolyte does not significantly alter surface morphology over time, enabling reliable probing of interfacial structures. Electrochemical measurements, including cyclic voltammetry and impedance spectroscopy, reveal distinct behavior compared to conventional electrolytes, reflecting the unique electric double layer structure in ionic liquid environments. This work provides insight into interfacial ion organization and highlights the importance of model surfaces for studying complex electrochemical interfaces.

# POSTER SESSION 1

10:00 AM – 10:50 AM, Crane Bay

## Artificial Intelligence, Data Science in Environmental Engineering

### POSTER 16: Mukhamad Suhermanto

#### *Development of a Geographical Information System (GIS) Database for Power Grid Infrastructure in Developing Countries: A Case Study of Indonesia*

A Power Grid Infrastructure GIS database serves as a valuable tool for enhancing energy planning, management, and sustainability efforts in both developed and developing countries. Unlike in developed countries, developing countries often do not have accessible GIS databases which in turn becomes hurdle in research, energy planning, management, and other endeavors. In the case of Indonesia, the government seems reluctant to share the database for public therefore requires rigorous steps to obtain the GIS database despite of the data is shared in PDF format. This research is aimed at yielding a GIS database using PyPSA processed in Python coupled with ArcGIS Pro. The data used in PyPSA are from publicly available database such as openstreetmap and is crossmatching with governmental data such as the Ministry of Energy and Mineral Resources and 2021-2030 Indonesian Electricity Plan. This technique can assist other comparable developing nations in generating pertinent data to promote research

## **POSTER 17: Song Jiang**

### ***A 10-meter resolution informal settlement map for the Global South derived from satellite imagery and open datasets***

Over 1 billion people currently live in informal settlements—self-identified and spontaneous locations often inhabited by asylum-seekers, refugees, or internally displaced people. These areas frequently lack basic services and are highly vulnerable to climate-related risks, posing challenges to achieving the Sustainable Development Goals (SDGs). However, the absence of large-scale spatial data on informal settlement boundaries limits quantitative research and effective risk assessment. Here, we develop an efficient and scalable framework that integrates satellite imagery with publicly available datasets to generate a 10-meter resolution map of permanent informal settlements across the Global South. Validation using random samples shows an overall accuracy of 96%. Results indicate that nearly 80% of informal settlements are concentrated in tropical and arid climate zones, where exposure to extreme heat, heavy rainfall, and drought is high. This high-resolution dataset provides a new foundation for global monitoring of vulnerable populations and supports climate risk assessment and SDG implementation.

# POSTER SESSION 1

10:00 AM – 10:50 AM, Crane Bay

## Emerging Technologies for Water Quality and Processes

### POSTER 18: Elena Cao

#### ***HRAP-Based Wastewater Treatment with Resource Recovery: LCA Comparison of Biogas and Biofertilizer Routes***

High-rate algal ponds (HRAPs) offer a low-energy alternative for wastewater treatment while enabling resource recovery via harvested microalgal biomass. This poster summarizes a cradle-to-grave life cycle assessment (functional unit: 1 m<sup>3</sup> treated water; 20-year lifetime) comparing two HRAP configurations for small communities: (i) energy recovery through anaerobic digestion of algal biomass to biogas with combined heat and power, and (ii) nutrient recovery by converting algal biomass into biofertilizer. Both HRAP options are benchmarked against a conventional small-scale activated sludge system. Results indicate that the biogas pathway performs better in climate change, ozone depletion, photochemical oxidant formation, and fossil depletion, driven by avoided electricity/heat and fertilizer substitution. In contrast, the biofertilizer pathway can reduce eutrophication and metal depletion impacts under warm, high-radiation conditions. Biomass composition (nutrients and heavy metals) strongly influences acidification, particulate matter, and toxicity impacts, highlighting the importance of site-specific design and downstream management.

## **POSTER 19: Do Nhung**

### ***Core resistomes are shared across diverse One Health sources***

#### Introduction

The environmental dissemination of antimicrobial resistance (AMR) is a global health priority; however, many clinically relevant antibiotic resistance genes (ARGs) remain undetected in complex environmental samples due to their low abundance. This study utilizes a "One Health" framework to determine whether clinically-relevant ARGs previously found mainly for humans circulate across human, animal, and water compartments.

#### Aim

We investigate the distribution of resistant markers, especially targeting OXA beta-lactamases and co-occurring genes across clinical human settings, wastewater treatment plants (WWTP), and migratory Canada Geese (*Branta canadensis*) in Illinois, US.

#### Methods

We employ an improved CRISPR-NGS enrichment approach to overcome the limitations of standard metagenomics in detecting low abundant ARGs. Then, qPCR assay is used for resistant markers quantification. These two complementary methods provide quantitative information of the co-occurrence for clinically relevant ARGs in these One Health matrices.

#### Results

The CRISPR-NGS approach significantly broadens the detectable resistome revealing a diverse array of *Acinetobacter*-associated OXA variants and associated MDR genes. In addition, we identified a conserved core resistome resistant to tetracyclines, cephalosporins, fluoroquinolones, and aminoglycosides that was consistently present across clinical, wastewater, and avian samples.

#### Conclusion

The overlap in resistance to four major antibiotic classes indicates that anthropogenic resistance markers have become established in the environment and underscores the role of migratory species as recipients and carriers of ARGs.

#### Public health relevance

By using an innovative methodology consistently across a diverse set of One Health samples, we found evidence of shared OXA beta-lactamase families in geese environmental fecal samples, demonstrating that these migratory species pick up dangerous ARGs, and may play an important role in sharing them across One Health environments.

## **POSTER 20: Jingxian Huang**

### ***Granular Activated Carbon for PFAS Removal in Drinking Water Treatment***

Per- and polyfluoroalkyl substances (PFAS) are persistent synthetic chemicals widely detected in drinking water sources due to their extensive industrial and commercial use. Their strong carbon–fluorine bonds make them highly resistant to natural degradation, leading to long-term environmental persistence and potential health risks. Among the available treatment technologies, adsorption using granular activated carbon (GAC) has become one of the most widely applied methods for PFAS removal in drinking water treatment plants. GAC removes PFAS primarily through adsorption mechanisms driven by hydrophobic interactions and electrostatic forces between PFAS molecules and the porous carbon surface. This technology is particularly effective for long-chain PFAS compounds such as PFOA and PFOS, which are more readily adsorbed onto activated carbon. However, the removal efficiency can be influenced by factors such as water chemistry, the presence of natural organic matter, and the chain length of PFAS compounds. In addition, short-chain PFAS are generally more difficult to remove using GAC. This study reviews the adsorption mechanisms, treatment performance, and operational considerations of GAC systems, highlighting their role and limitations in current drinking water treatment strategies.

## **POSTER 21: Yang Chen**

### ***Environmental Fate and Transport of Contaminants Following the Deepwater Horizon Oil Spill***

The Deepwater Horizon oil spill released massive quantities of crude oil and chemical dispersants into the Gulf of Mexico, causing long-term environmental damage. This study examines the environmental fate and transport processes of major contaminants, including hydrocarbons, heavy metals, and dispersant chemicals. Key transport mechanisms include advection, diffusion, volatilization, and sediment sorption, while chemical and biological processes such as photo-oxidation and microbial degradation influence contaminant persistence. Course-based environmental transport models were applied to conceptualize pollutant distribution and exposure pathways under simplified assumptions. Results highlight the complexity of large-scale marine contamination and emphasize the importance of integrating physical, chemical, and biological processes in spill assessment and remediation planning. This case study demonstrates practical applications of environmental engineering principles to real-world pollution events.

## **POSTER 22: Changyi Huang**

### ***From Powder to Practical Materials: Macro-Structuring of Metal–Organic Frameworks for Water Treatment***

Metal–organic frameworks (MOFs) are promising adsorbents for water treatment, due to their high adsorption capacity, tunable structures, and potential for more environmentally friendly and cost-effective pollutant removal compared to conventional materials. However, their use is limited by their powder form, which leads to poor mechanical stability and challenges in separation and flow applications. This work reviews how macro-structuring strategies can improve the practical performance of MOF materials, focusing on ZIF-8. Recent approaches, including pellets, monoliths, membranes, and gel-based materials such as aerogels and hydrogel beads, are compared. The relationships between fabrication methods, structural properties, and adsorption performance are analyzed. Results show that macro-structuring enhances material stability, improves mass transfer, and enables reusability, although trade-offs in surface area and performance may occur. Overall, this study highlights how structural design can bridge the gap between laboratory-scale MOF powders and real-world water treatment applications.

# PODIUM SESSION 1A

11 AM - NOON, NEWMARK 1311

Moderators: Marissa Campobasso and Kassandra Estrella

**Air Quality, Indoor Air Quality, Climate Change**

**Ganesh Subramanian**

***Influence of Human Activities and Occupancy on the Emission of Indoor Particles from Respiratory and Nonrespiratory Sources***

In this study, we examined the relationship between human activities and emission characteristics of CO<sub>2</sub> and particles in three indoor settings: a clean environmental chamber, a café, and a musical club. We determined CO<sub>2</sub> and particle emission rates (CER and PER) across various human activities (sitting, reading, and exercise) in both masked (N-95) and unmasked scenarios, as well as scenarios involving normal and clean-room clothing (CRC) in the clean environmental chamber. Masking reduced PER only during the exercise (~11%), indicating that respiratory sources constitute a tiny fraction of the total particle emissions during passive activities (e.g., sitting and reading). In contrast, wearing CRC reduced the PER by over 55% for all activities, demonstrating that clothing and skin-shedding constitute a dominant fraction of particle emissions from humans. Results from the café and club measurements showed that the CO<sub>2</sub> and particle number concentrations were mostly driven by human occupancy. Collectively, the results from the controlled lab and field environments demonstrate that nonrespiratory emissions (e.g., clothing and skin-shedding) from humans outnumber respiratory emissions in an indoor environment, emphasizing the need to better quantify the contribution and evaluate the potential role of nonrespiratory emissions from humans in the airborne transmission of infectious diseases.

# PODIUM SESSION 1A

11 AM - NOON, NEWMARK 1311

Moderators: Marissa Campobasso and Kassandra Estrella

## Artificial Intelligence, Data Science in Environmental Engineering

**Xiaokai Yang**

***Atmospheric chemistry surrogate modeling with sparse identification of mass action dynamics: Toward 3D online integration***  
***Tahsina Alam - Calibration Data Source Drives Future Root-Zone Soil Moisture Projections in Illinois***

Modeling atmospheric chemistry is computationally expensive and limits the widespread use of atmospheric chemical transport models. This computation cost arises mainly from solving high-dimensional systems of stiff differential equations. Previous work has demonstrated the promise of machine learning (ML) to accelerate air quality model simulations, but ML chemical solvers which can be used in 3D simulations under a wide range of conditions remain elusive. We hypothesize that neural-network overfitting and the use of time-integration techniques ill-suited for stiff systems—both of which tend to result in numerical instability—are main bottlenecks to further progress, and that the creation of parsimonious models combined with modern numerical integration techniques can overcome this limitation.

In this work we will present the results of our recent work to create such models. In particular, we will describe updates to our Sparse Identification of Mass Action Dynamics (SIMADy) system for representing the chemical dynamics in a compressed latent space, as well as a new method for determining the composition of the compressed latent space based on the Controllability Matrix (a concept from control theory) of the chemical mechanism we are attempting to emulate. Finally, we will describe efforts to leverage our recently-developed Earth Science Machine Learning (EarthSciML) framework to generate realistic training datasets and evaluate our trained surrogate models in 3D simulations.

**Tahsina Alam**

***Calibration Data Source Drives Future Root-Zone Soil Moisture Projections in Illinois***

Soil moisture regulates land–atmosphere interactions, agricultural productivity, and hydrologic extremes, yet projections remain highly uncertain. We examine how calibrating a single-column root-zone water balance model with different calibration data alters model parameters and propagates into future projections for Illinois. Using the Python-based Water Balance Model (pyWBM), we calibrate eight sites with ground-based measurements and satellite- and model-derived products. Calibrated parameters are combined with downscaled meteorological projections to generate daily soil moisture projections for 2016–2100. In-situ calibration produces systematic shifts in parameters like available water capacity and wilting point. All projections indicate drying relative to historical conditions. However, simulations calibrated with in-situ data retain consistently higher growing-season soil moisture than those calibrated with satellite products. Projected distributions closely track their calibration source, indicating that dataset choice induces persistent climatological shifts. Calibration selection thus represents a structural uncertainty with direct implications for drought risk, irrigation demand, and regional water planning.

# PODIUM SESSION 1B

11 AM - NOON, NEWMARK 1310

Moderators: Joyce Yang and Buai Shi

## Sustainability and Resource Recovery

**Don Sim**

***Exploring valorization pathways for thin stillage***

This study evaluated alternative valorization pathways for thin stillage using process modeling, techno-economic analysis, and life cycle considerations. Full process models were developed for anaerobic digestion, including methane production followed by either biogas upgrading to renewable natural gas or combined heat and power generation. A parallel fermentation-based pathway was also modeled, where methanogenesis was intentionally suppressed to enable recovery of high-value volatile fatty acids (VFAs) as the main product. The pathways were compared in terms of production cost, utility demand, capital and operating costs, and coproduct credits. Under baseline parameters, the VFA recovery pathway with electrodialysis had the lowest net production cost at 1.04 USD/gal, followed by the base-case scenario at 1.61 USD/gal, biogas upgrading at 1.74 USD/gal, and CHP at 1.94 USD/gal. These results suggest that redirecting carbon toward intermediate products rather than complete methane formation can substantially improve the economic viability of thin stillage valorization.

## **Keroglou Ioannis**

### ***Direct air capture sorbent manufacturing: A comparative life cycle assessment of amine-impregnated solid adsorbents***

Direct Air Capture (DAC) is gaining attention as a promising pathway to achieving net-zero emissions by 2050 by removing carbon dioxide directly from ambient air. Amine-functionalized solid sorbents, particularly aziridine-based polyethyleneimine (PEI), are widely used due to their high amine density and stability under thermal swing cycles. This study presents a comparative life cycle assessment of amine-impregnated solid sorbent manufacturing for DAC applications. A process-based modelling framework is developed to quantify gate-to-gate energy consumption across multiple sorbent types and PEI loadings, identifying energy-intensive synthesis steps and trade-offs among PEI production, support synthesis, and amine impregnation stages. The framework enables the development of high-resolution life cycle inventories (LCIs) for DAC sorbents that are currently unavailable in LCA databases and literature. These inventories are used in a cradle-to-gate LCA to quantify climate change, fossil resource depletion, and water depletion impacts, providing new insights into the carbon footprint of sorbent manufacturing relative to the overall life-cycle emissions of DAC systems.

## **John Albin**

### ***A Tensor-Based Framework for Integrated Economic and Environmental Assessment of Magnet Recovery Pathways***

Permanent magnets are essential components in modern technologies like electric vehicles and wind turbines, but recovering them at end of life remains technically and economically challenging. Current evaluation methods typically analyze economic cost and environmental impact separately, which makes it difficult to compare recovery routes and identify the most sustainable options. Inefficient recovery strategies can increase both resource demand and environmental burden as the demand increases. We developed a mathematical framework that integrates economic and environmental assessment of magnet-recovery pathways within a single analytical structure. Process data—including material-flows, energy use, emissions, and costs—are organized into a multidimensional data-structure that enables consistent evaluation across recovery methods and regions. Using this approach, economic costs and environmental impacts are calculated simultaneously through systematic mathematical operations. The results demonstrate clearer comparison between recovery routes and improved transparency in decision-making. This framework provides a structured tool for guiding sustainable magnet-recovery strategies.

# POSTER SESSION 2

2:00 AM – 2:50 PM, Crane Bay

## Air Quality, Indoor Air Quality, Climate Change

### POSTER 1: Mashiat Hossain

#### *Representing Sub-Grid Wildfire Plume Chemistry in GEOS-Chem: Implications for NO<sub>y</sub> Partitioning and Downwind Ozone*

Nitrogen oxides (NO<sub>x</sub>) emitted from wildfires play an important role in regulating air quality and tropospheric oxidant chemistry. A fraction of emitted NO<sub>x</sub> rapidly transforms within fresh smoke plumes, forming longer-lived reactive nitrogen species (NO<sub>y</sub>) such as peroxyacetyl nitrate (PAN). Because this chemistry occurs at spatial scales smaller than those resolved by chemical transport models (CTMs), it introduces uncertainty in simulated NO<sub>y</sub> partitioning and subsequent ozone production. Here, we will develop a plume-informed framework that uses a pseudo-Lagrangian box model driven by the native GEOS-Chem mechanism, to simulate plume chemistry during the first few hours after emission. An ensemble of simulations will then be used to train an emulator that represents NO<sub>y</sub> partitioning as a function of environmental conditions. By accounting for sub-grid plume chemistry within a global CTM framework, this approach aims to improve predictions of downwind ozone formation and air quality under increasing wildfire activity across North America.

## **POSTER 2: Anson Regi**

### ***Physicochemical and Oxidative Properties of Aerosols Emitted from Aviation Fuel Combustion***

Aerosols generated during the combustion of aviation fuels contain non-volatile particulate matter (nvPM) with complex physicochemical characteristics. These particles can generate reactive oxygen species (ROS), contributing to oxidative stress in biological systems. This study aims to assess physicochemical properties, such as particle size (mobility diameter,  $D_m$ ), elemental and organic carbon fractions, metallic content, and oxidative properties, i.e. the capability of PM to generate ROS, and investigate the relationship between these two properties. The experimental protocol involves generating aerosols using a lab-scale swirl combustor for different aviation fuels, and analyzing their oxidative potential using the dithiothreitol (DTT) assay. In-situ measurements include using an SMPS and OPS to determine  $D_m$ , while offline characterization is being conducted on particles collected onto quartz filters. Current results indicate that sustainable aviation fuels (SAFs) exhibit higher oxidative potential than Jet A under fuel-rich conditions. Ongoing analyses aim to elucidate the underlying physicochemical drivers of this behavior.

## **POSTER 3: Joseph Abi-Karam**

### ***Urban Climate–Energy Coupling Under Extreme Heat Using High-Resolution Climate Modeling***

Under climate change, extreme heat events are expected to increase in both frequency and intensity, placing growing stress on energy systems. Sustainable energy planning is therefore particularly important in urban environments, where air-conditioning use releases anthropogenic heat into the urban canopy layer. This waste heat can enhance local warming, creating a feedback that intensifies cooling demand during extreme heat. Previous studies have examined the relationship between extreme heat and urban cooling demand using global climate models, typically at coarse spatial resolution. Using high-resolution ( $25 \times 25$  km) output from the Community Land Model (CLM) urban model, we quantify the response of urban air-conditioning energy flux to extreme heat by analyzing cooling demand above the local 98th percentile temperature ( $T_{98}$ ) and computing both the increase in cooling flux  $\Delta Q(AC)$  and its temperature sensitivity  $\Delta Q(AC)/\Delta T$ . We generally find that urban air-conditioning energy flux increases nonlinearly with temperature, with particularly strong increases occurring at higher temperature ranges. These findings underscore the importance of explicitly accounting for urban air-conditioning energy use in future climate and energy planning strategies.

# POSTER SESSION 2

2:00 AM – 2:50 PM, Crane Bay

## Sustainability and Resource Recovery

### POSTER 4: Haotian Yang

#### *Self-Assembled Protein Nanospheres for Selective Rare Earth Element Recovery*

Rare earth elements (REEs) are essential for many modern technologies, yet their selective and sustainable recovery from complex aqueous systems remains challenging. In this work, we explore a protein-based recovery platform using lanmodulin (LanM), a rare earth-binding protein, together with the IC-tag/muNS-Mi self-assembly system, where IC-tagged proteins are specifically recruited onto self-assembled protein nanospheres. By fusing LanM with the IC-tag, we designed a one-step immobilization strategy that avoids external carriers and reduces purification steps. Preliminary results support the feasibility of assembling LanM on muNS-Mi nanospheres and suggest potential advantages in selective adsorption, material recovery, and reuse. Overall, this study highlights a simple and scalable biomaterial design for rare earth recovery and provides a promising foundation for sustainable metal recycling.

## **POSTER 5: Lu Cao**

### ***From Enzymatic Degradation to Self-Degradable Plastics: New Opportunities for Biodegradable Polymers***

Biodegradable plastics (BPs) have emerged as promising alternatives to conventional plastics and offer significant potential to mitigate growing environmental pollution. Enzymes such as cutinase, lipase, protease, and esterase produced by microorganisms play a critical role in BP degradation by breaking polymers into low-molecular-weight oligomers or monomers, thereby enabling degradation, recycling, and value-added utilization. Compared with traditional chemical methods, enzymatic catalysis offers advantages such as high efficiency, environmental friendliness, and operational safety, making it an attractive approach for environmental remediation and circular plastic economies. This study reviews recently reported enzymes involved in the degradation of representative BPs, particularly polylactic acid (PLA) and polycaprolactone (PCL). In addition, the strategy of embedding degrading enzymes directly into BP materials to create self-degradable plastics is discussed. Current research progress, potential applications, and the key challenges for future development are also highlighted.

## **POSTER 6: Xueming Xu**

### ***Effects of Transient Oxygen Exposure, Light, and Synechocystis on Methanogenesis in a Defined Syntrophic Community***

Methane production in anaerobic systems is highly sensitive to brief oxygen exposure, yet some microbial communities may tolerate short micro-oxygenation events. This study examines how oxygen, light, and the cyanobacterium *Synechocystis* affect methane production in a defined community containing *Pelotomaculum* and *Methanospirillum*. Batch serum-bottle incubations used pyruvate as the sole carbon source under controlled light-dark conditions, with a single low-dose O<sub>2</sub> pulse applied to test disturbance response. Headspace gases were measured by gas chromatography. Preliminary results showed methane accumulation in all biotic treatments, with the highest production in dark cocultures without *Synechocystis* and lower production when *Synechocystis* was present. Bottles receiving low-dose oxygen still produced methane over time, suggesting partial recovery after disturbance. These findings indicate that both light conditions and *Synechocystis* influence methane production, while a one-time oxygen pulse suppresses but does not completely stop methanogenesis.

## **POSTER 7: Marissa Campobasso**

### ***Prioritizing R&D for the Harmful Algal Bloom Interception, Treatment, and Transformation System (HABITATS)***

Harmful algal blooms (HABs) significantly affect water quality through toxin release and hypoxia, impacting public health, recreation, fisheries, and tourism. The Harmful Algal Bloom Interception, Treatment, and Transformation System (HABITATS) developed by the US Army Engineer Research and Development Center (ERDC) intercepts algae using floating weir skimmers, removes it from the water via Dissolved Air Flotation, and transforms it into biocrude using Hydrothermal Liquefaction. After extensive field testing, recent work has focused on characterizing the costs of HABITATS deployment for HAB removal and nutrient recovery at relevant design scales. A scenario analysis is being conducted to understand the financial and performance implications of algae distribution in the water column, spillway flowrates, and related parameters under uncertainty. A sensitivity analysis will be conducted using the Spearman's Rank Order Correlation to determine which parameters have the largest impact on the life cycle cost, with the goal of guiding future investment in HABITATS.

## **POSTER 8: Jingyu Li**

### ***How do natural hydraulic lime (NHL)-based substrates influence the growth of juvenile *Colpophyllia natans*?***

Coral reefs play a vital role in protecting shorelines from storms and supporting commercial fisheries. However, increasing anthropogenic activities are threatening their survival, resulting in a rapid global decline in coral reef populations.

As part of a large collaborative, multi-institutional project, our team at UIUC is designing natural hydraulic lime (NHL)-based substrates with targeted additives to promote coral larval settlement and growth. Among others, we have investigated how these engineered substrates influence early-stage (1 week – 6 months) biomineralization in juvenile corals. The morphology and microstructure of the coral skeleton were characterized using a combination of complementary analytical techniques. We have found that NHL-based substrates induce higher skeletal porosity and substrate composition significantly influences skeletal development in *C. natans*. Incorporation of Mg into the substrate led to skeletal decalcification after 1 month but increased the abundance of early mineralization zones (EMZs) in the skeleton. In contrast, Sr incorporation significantly slowed calcification and resulted in the formation of larger EMZs at one month of age.

## **POSTER 9: Qianlu Zheng**

### ***Sustainable Energy Storage: In-Situ Investigation of Safer Sodium-Ion Battery Electrolytes***

To enhance energy resilience, developing safe energy storage technology is critical. While lithium-ion batteries dominate, their dependence on scarce resources and flammable organic solvents poses significant environmental and safety risks. Sodium-ion batteries using Ionic Liquids (ILs)—low-temperature molten salts with negligible volatility and high thermal stability—offer a safer, earth-abundant alternative. However, battery performance hinges on the "Solid Electrolyte Interphase" (SEI)—a complex passivation layer that protects electrodes. This study employs in-situ Atomic Force Microscopy (AFM) and Surface-Enhanced Infrared Absorption Spectroscopy (SEIRAS) to investigate how sodium ions and ILs organize at the electrified interface. By probing SEI formation in real-time, we reveal the fundamental mechanisms governing ion transport and interfacial stability. These insights bridge the gap between molecular-scale interactions and macroscopic device safety, guiding the rational design of next-generation non-flammable beyond-lithium electrolyte chemistry.

## **POSTER 10: Johanna Arita Mendoza**

### ***Rethinking Urban Sanitation in Established Cities: Economic and Environmental Characterization of Non-Sewered Sanitation (NSS) Deployment in Paris***

Access to sanitation remains a global challenge due to urbanization, population growth, and aging infrastructure, even in high-income cities. In Paris, poor water quality in the Seine River prompted major investments through the Plan Baignade, including correction of 23,000–35,000 sewer connections discharging household wastewater to the river. The Mon Branchement program subsidizes these corrections but requires costly upgrades to existing sewer networks. This study evaluates non-sewered sanitation (NSS) as an alternative using the NEWgenerator system. A Quantitative Sustainable Design (QSD) framework was applied to compare the economic and environmental outcomes of centralized, hybrid, and decentralized sanitation deployment for a residential block in Ivry-sur-Seine and four additional blocks across Paris. Results show that when more than 43% of the properties in the block require sewer corrections, NSS can become economically beneficial. However, centralized treatment had a lower carbon intensity across all correction levels. These findings suggest that decentralized sanitation can provide cost advantages in areas requiring extensive sewer rehabilitation while increasing infrastructure flexibility.

## **POSTER 11: Genyou Shi**

### ***Beyond Lithium: Water-based electrolytes for energy storage***

Water-in-salt electrolytes (WiSEs) are a promising route to safe, water-based energy storage by fundamentally reshaping solvation and interfacial electrostatics at extreme concentrations. Here we use NaTFSI as a model WiSE and examine how adding a small amount of Zn(TFSI)<sub>2</sub> (6 m NaTFSI + 0.5 m Zn(TFSI)<sub>2</sub>) alters both bulk transport and interfacial structure. Surprisingly, Zn<sup>2+</sup> addition increases bulk conductivity relative to NaTFSI alone, consistent with a redistribution of TFSI<sup>-</sup> coordination that frees more Na<sup>+</sup> to remain water-hydrated. At the interface, electrochemical AFM reveals pronounced layering and potential-dependent surface clustering, indicating amplified ion-solvent organization under bias. Potential-dependent SEIRAS further suggests reduced water adsorption at positive potentials upon Zn<sup>2+</sup> addition, accompanied by measurable EDL modifications (capacitance changes), while negative potentials show Zn plating/stripping signatures. These results highlight multivalent-enabled tuning of WiSE transport and interphases for next-generation aqueous energy storage.

## **POSTER 12: Buai Shi**

### ***Evaluating the economic and environmental potential of valorizing wastewater VFAs using redox-electrodialysis***

Volatile fatty acids (VFAs) are versatile platform chemicals predominantly produced from petroleum. Wastewater-derived VFAs produced via arrested methanogenesis offer a sustainable alternative, but their recovery from dilute and chemically complex streams remains energy- and cost-intensive using conventional separation methods. Redox-electrodialysis (redox-ED) has demonstrated up to 80% energy reduction relative to conventional ED by replacing water electrolysis with reusing a redox couple. By coupling with polyelectrolyte membranes, redox-ED also improves selectivity against organic impurities such as lactic acid.

In this study, we developed a process model for VFA recovery from a 10-MGD wastewater treatment plant with anaerobic digestion. The process includes centrifugation, microfiltration, pH adjustment, and redox-ED. Process modeling was integrated with techno-economic analysis (TEA) and life cycle impact analysis (LCA) to evaluate costs, power and chemical demand, and associated environmental impacts. Simulated fluxes of redox-ED at 0.8 volts for C3, C4, and C6 VFAs were 25.59, 22.17, and 16.69 ×10<sup>-7</sup> mol<sup>-1</sup> • m<sup>-2</sup> • s<sup>-1</sup>, consistent with experiments. Preliminary TEA and LCA results for the centrifugation alone indicate energy use dominates operational cost and life-cycle greenhouse gas emissions.

## **POSTER 13: Gus Greenwood**

### ***Interlayer effects of nanoscale friction on van der Waals heterostructure surfaces***

Technologies like membranes, energy storage solutions, and micro- and nanoscale components of advanced manufacturing systems are dependent on nanoscale interactions at surfaces. Surface processes like friction, adhesion, and wear are more important than at larger scales due to the inherently large surface area to volume ratio of nanomaterials, and understanding these processes allows new and better ways to design high performing technologies that fail less often. Here we use atomic force microscopy to measure nanoscale friction and other forces, in ambient environment, at the surface of transition metal dichalcogenide (TMD) van der Waals (vdW) heterostructures, stacked layers of two-dimensional materials with unique properties (e.g. moiré superlattices) due to interactions between layers. We explore the effects of these properties on the friction at the top surface of the heterostructures, varying the TMDs used and their stacking order to link interlayer effects to the measured friction.

## **POSTER 14: Zixuan Wang**

### ***The potential of thermomechanical and thermochemical processes to enable household non sewered sanitation***

Thermomechanical and thermochemical approaches could enable household-level sanitation, yet their economic and environmental potential remains unclear. We assessed two prototype household reinvented toilets (HRTs), with either pasteurization mechanical dewatering (PMD) and supercritical water oxidation (SCWO) treatment processes, using integrated process simulation, techno-economic analysis, and life cycle assessment under uncertainty. The total annualized expenditures are 1.41–1.87 (5th to 95th percentiles) and 1.85–2.45 USD·cap<sup>-1</sup>·day<sup>-1</sup> for PMD and SCWO, respectively, placing both at the high end of global centralized treatment prices. The life cycle greenhouse gas emissions span 321–452 and 362–520 kg CO<sub>2</sub>-eq·cap<sup>-1</sup>·year<sup>-1</sup> for PMD and SCWO, respectively, with the grid electricity contributing 87–90% in both HRTs. In the short term, optimizing a few levers can significantly reduce cost and emissions. In the long term, operating at maximum efficiency reduces both cost and emissions by approximately 70%, positioning HRTs as viable advanced decentralized sanitation options in specialized settings.

# POSTER SESSION 2

2:00 AM – 2:50 PM, Crane Bay

## Artificial Intelligence, Data Science in Environmental Engineering

### POSTER 15: Juliana Marks

#### *Application of a machine learning approach to elucidate physicochemical drivers of opportunistic pathogen occurrence in drinking water systems*

Opportunistic pathogens (OPs) in drinking water systems can cause severe illness, but effective OP control and risk mitigation requires an understanding of the complex environmental parameters influencing OP growth. This study applies machine learning (ML) to elucidate relationships between physicochemical parameters, OPs (*Legionella* spp., *Pseudomonas* spp., and *Mycobacterium* spp.), and the free-living amoeba *Vermamoeba vermiformis*. Using datasets collected from premise plumbing and drinking water distribution systems, three models (eXtreme Gradient Boosting, Random Forest, and Support Vector Regression) were trained to predict *Legionella* spp. concentrations based on environmental parameters. Shapley Additive exPlanations were employed to interpret the influence of each parameter on model output. Results indicated that free chlorine, pH, and temperature were the strongest drivers of *Legionella* spp. occurrence, with effective control requiring high free chlorine concentrations and pH below the pKa of hypochlorous acid. Overall, this study demonstrates the potential of ML frameworks to inform effective OP control strategies.

## POSTER 16: Qurat ul ain Fatima

### ***Physics-Informed Symbolic Regression Surrogates for Gas-Particle Partitioning in Inorganic Aerosol: Interpretable Emulation of the E-AIM Thermodynamic Model***

Gas-particle partitioning of inorganic aerosol species governs fine particulate matter formation and atmospheric nitrogen cycling, yet the thermodynamic models required for accurate simulation, such as the Extended Aerosol Inorganic Model (E-AIM) are computationally expensive and difficult to embed within large scale atmospheric models. In this work, we develop symbolic regression (SR) surrogate models to emulate thermodynamic predictions of the gas-particle partitioning fractions of  $\text{HNO}_3$  and  $\text{NH}_3$  across atmospherically relevant ranges of temperature, relative humidity, and inorganic aerosol composition. Unlike neural network emulators, symbolic regression produces compact analytic expressions that retain physical interpretability while approximating the behavior of the underlying thermodynamic model. The framework combines physics informed feature engineering, including neutralization ratio, base availability, and competition between nitric and hydrochloric acid, with a logit transformation of the partitioning fraction to stabilize regression. Candidate equations are discovered through evolutionary search and selected using a validation RMSE based Pareto criterion balancing predictive performance and model complexity. This approach provides a pathway toward interpretable, computationally efficient emulators of aerosol thermodynamic partitioning.

# POSTER SESSION 2

2:00 AM – 2:50 PM, Crane Bay

## Emerging Technologies for Water Quality and Processes

### POSTER 17: Xiangyi Yang

#### ***Electrocoagulation: A Green and Efficient Technology for Wastewater Treatment***

Wastewater often contains suspended solids, organic matter, nutrients, and metal ions that are difficult to remove efficiently with conventional treatment alone. This presentation examines electrocoagulation as a sustainable treatment and pretreatment strategy for complex wastewater systems. Based on a literature review, I explain how sacrificial metal electrodes generate coagulants in situ, destabilize colloids, and promote floc formation for pollutant removal. The reviewed studies show that electrocoagulation treats diverse wastewaters, including textile, oily, mineral-processing, and municipal streams, often achieving pollutant removal above 85%; for municipal wastewater, chemical oxygen demand removal can reach 92%. In addition, coupling electrocoagulation with oxidation or membrane filtration improves downstream performance by lowering pollutant loads and reducing membrane fouling. Overall, electrocoagulation is a promising low-chemical platform, especially as a pretreatment step, although electrode passivation, anode consumption, and sludge handling remain important challenges.

## **POSTER 18: Kassandra Estrella**

### ***Assessing Performance and Scalability of Low Chemical Addition with Membrane Filtration for Harmful Algal Bloom (HAB) Mitigation***

Harmful Algal Blooms (HABs) occur due to excess nutrients in waterways and may lead to ecological, health, and economic damage. Current mitigation chemicals to address symptoms, but membrane filtration could remove the nutrient rich biomass from the water column. This study presents pilot-scale evaluation of the effect of Aluminum Chloralhydrate (ACH) dose upstream of a microfiltration membrane system. The membrane system achieved high removal of Chlorophyll A, phycocyanin, turbidity, and nutrients, though it is dependent on dose. Fouling analysis shows a non-linear relationship between ACH dose and filtration resistance, with an optimal ACH dosage of 10 mg/L. When scaling to a 100 million gallons per day (MGD) treatment system, a hybrid configuration could reduce physical plant footprint by 66% and chemical costs by 44% compared to conventional methods. Membrane filtration is an effective and potentially scalable solution for physical removal of algae and intracellular nutrients from water for HAB mitigation.

## **POSTER 19: Paul Lee**

### ***Substrate-specific microbial responses during proteinaceous biomass degradation in a deep-sea sediment enrichment***

Microbial biomass is a major organic carbon pool, yet the microorganisms that actively degrade proteinaceous biomass in deep-sea sediments remain poorly resolved. We hypothesized that this degradation is partitioned among distinct microbial populations, with some responding preferentially to more complex cell-associated material and others to simpler soluble compounds released during degradation. To test this, we spiked fresh samples from a deep-sea sediment enrichment community with biomass-derived substrates ranging from more complex forms (freeze-thawed cells and protein extracts) to simpler forms (protein hydrolysates and amino acids). By combining genome-resolved metagenomics with metatranscriptomic profiling, we examined substrate-specific microbial activity. Preliminary analyses indicate distinct transcriptional responses across treatments, with some metagenome-assembled genomes (MAGs) showing strong treatment-dependent expression patterns that are not fully predicted by metagenomic potential alone. These results suggest that proteinaceous biomass degradation may be mediated by specialists targeting different forms of biomass rather than by a single generalist population.

## **POSTER 20: Inas Belkadi**

### ***Detection and Removal of Microplastics in Wastewater Treatment Plants: Current and Emerging Methods***

The widespread use of plastics has led to increasing concerns about microplastic contamination in aquatic environments. Wastewater treatment plants (WWTPs) represent a significant pathway through which microplastics enter water systems. This study reviews current and emerging methods for the detection, transport, and removal of microplastics in wastewater treatment processes. A literature review was conducted to examine detection techniques and reported removal approaches across various treatment stages. Conventional processes such as filtration, coagulation, and sedimentation can remove a substantial fraction of microplastics, yet these methods face limitations in capturing smaller particles. Membrane filtration technologies may offer improved removal but are often constrained by cost and operational challenges. Emerging approaches, including AI-driven image analysis for detection, advanced oxidation processes, and electrocoagulation, show potential for improving microplastic monitoring and treatment. Understanding the fate of microplastics in wastewater treatment systems is essential for developing strategies to mitigate their release into aquatic environments.

## **POSTER 21: Thando Mawasha**

### ***Evaluation of Bacterial Inhibition by KDF Media in Zero Water Point-of-Use Filters***

Point-of-use filters (POU) drinking water filters are used in households to improve water quality and remove contaminants. However, microbial regrowth within filters can occur over time and may affect water quality by creating conditions that promote the growth of waterborne pathogens. (Wu et al., 2017) Because of this, the materials within the filtration system are important for maintaining water safety.

The Zerowater filters are used to reduce contaminants in drinking water. Unlike most filters, the ZeroWater filter contains Kinetic Degradation fluxion (KDF) (copper-zinc), which can inhibit bacterial growth through redox reactions and the release of metal ions. (Wu et al., 2021)(Lemire et al., 2013).

Although microcibal growth in POU filters has been studied, there are gaps that remain in understanding how the zerowater media influences bacterial growth under different conditions, including exposure times, water sources, temperatures, and after repeated filter use. In this study, the media from the ZeroWater filter will be evaluated for its ability to inhibit bacterial growth.

# PODIUM SESSION 2A

3:00 PM – 4:00 PM, NEWMARK 2312

Moderators: Lavanya Kudli and Ganesh Subramanian

## Sustainability and Resource Recovery

**Yoonjoo Seo**

***Engineering a Yeast Whole-Cell Biocatalyst for PET Depolymerization via Cell Surface Display of Humicola insolens Cutinase***

Microbial cell surface display techniques offer significant potential for industrial-scale enzymatic plastic degradation, providing economic benefits through low production cost and reusability. In this study, we created yeast cell-surface-displayed *Humicola insolens* cutinase as a novel biocatalyst platform for PET depolymerization. The engineered biocatalysts yielded approximately 6 mM of total degradation products from PET plastics at 40 °C over 14 days, achieving a depolymerization efficiency comparable to that of commercial HiC. Long-term storage stability and reusability of the engineered biocatalysts were then evaluated to demonstrate their economic feasibility compared to the single-use commercial enzyme. Furthermore, critical genes related to the heat stress response of yeast cells were regulated via synthetic biology approaches to enhance the overall thermostability of the engineered biocatalysts and thus improve PET depolymerization performance. Overall, this study presents an engineered yeast whole-cell biocatalyst platform that enables efficient plastic depolymerization, contributing to sustainable plastic recycling.

## **Rishabh Puri**

### ***From Theory to Practice: Data-Driven Insights for Designing and Operating Struvite Recovery Systems***

Phosphorus management is shifting from removal to recovery, but full-scale process control remains challenging. We present a practical workflow that converts routine SCADA and laboratory data into operational guidance. Two systems are analyzed: Metro's Mag-Prex (biosolids-side sequestration) and Nine Springs' Ostara Pearl process (fertilizer-grade struvite recovery). Prophet models are used to capture seasonal and diurnal patterns that complicate set-point control. Supervised learning is applied to rank the most influential operational levers (e.g., pH/alkalinity, Mg dosing, and recycle rates). Equilibrium screening is used to identify conditions approaching washout or scaling, enabling preventive operational adjustments. Together, these components aim to produce clear operational rules for recycle control and Mg/NaOH dosing while maintaining product quality. The study was further extended to include an uncertainty-aware techno-economic analysis (TEA) and life cycle assessment (LCA), providing insights into the costs and emissions associated with struvite recovery alongside the process findings.

## **Ritvik Kumar**

### ***Component-Level Circular Strategies to Reduce the Life Cycle Environmental Impacts of Data Center Rack Servers***

Rapid growth in artificial intelligence, cloud computing, and digital services is increasing demand for data centers and the rack servers that power them. While improving operational energy efficiency has received significant attention, the environmental impacts associated with manufacturing server components remain substantial and are often overlooked. This study evaluates whether circular end-of-life strategies for server components can reduce these impacts. A comparative life cycle assessment model is developed for a representative rack server, considering manufacturing and end-of-life stages. Two scenarios are evaluated: a conventional recycling approach and a component-level circular strategy that includes processor reuse and enhanced recovery of materials from storage drives. Results show that manufacturing impacts are dominated by processors and storage devices. Implementing the circular strategy reduces greenhouse gas emissions by about 36% and significantly lowers other environmental impacts. These findings highlight the importance of component level recovery strategies for improving the environmental sustainability of data center infrastructure.

# PODIUM SESSION 2B

3:00 PM – 4:00 PM, NEWMARK 1310

Moderator: Tahsina Alam

## Artificial Intelligence, Data Science in Environmental Engineering

**Renjing Jiang**

***PEZy-Extract: Automated data extraction for enzymatic degradation of plastic from research articles with large language models and prompts***

Automated data extraction is emerging as a cutting-edge technology to replace manual extraction of data from research articles. In this work, the PEZy-Extract pipeline was proposed to fully automate data EXTRACTION from the field of Plastic EnZYmatic degradation, using an advanced conversational large language model (LLM). PEZy-Extract consists of a set of engineered prompts applied to a conversational LLM that screen for articles relevant to the topic, extract the containing data, assure the data's correctness, and generate a structured output that can be directly used for downstream applications. Finally, a database for enzymatic degradation of plastic is developed using PEZy-Extract. Due to the simplicity and accuracy of PEZy-Extract, similar approaches are likely to be transferrable and become powerful tools for automated data extraction in other fields.

# PODIUM SESSION 2B

3:00 PM – 4:00 PM, NEWMARK 1310

Moderator: Tahsina Alam

## Emerging Technologies for Water Quality and Processes

**Abigail Nason**

### ***Aragonite Crystallization Pathways in the Presence of Microplastics***

Microplastics are emerging as a pervasive threat to marine ecosystems, yet their interactions with mineralization processes critical to reef-building corals remain poorly understood. In this work, we investigate how microplastic chemistries influence the nucleation and growth of calcium carbonate crystals, with a focus on aragonite, the dominant polymorph in stony coral skeletons. Using a model seawater system, aragonite was precipitated in the presence of polyethylene terephthalate (PET), polyethylene (PE), and polypropylene (PP) microfragments under controlled laboratory conditions. Scanning electron microscopy (SEM), powder X-ray diffraction (XRD), and thermogravimetric analysis (TGA) revealed differences in nucleation pathways and resulting crystal microstructures. These findings highlight how microplastics can redirect mineralization, with potential implications for coral skeletal integrity and reef resilience under increasing plastic pollution. By distinguishing the roles of microplastic presence and chemistry, this study provides mechanistic insight into how anthropogenic particles perturb biomineralization. Understanding these pathways will be critical to predicting and mitigating the long-term impact of microplastics on coral reef health.

# PODIUM SESSION 2B

3:00 PM – 4:00 PM, NEWMARK 1310

Moderator: Tahsina Alam

## Sustainability and Resource Recovery

**Camila Cassunde**

***Tiny house and material selection based on life cycle assessment as a sustainable alternative to enhance disaster resilience in the Southwestern U.S.***

Sustainable, constructive materials could be used in communities with high environmental risk to mitigate the social and economic impacts of weather-related disasters. This study focuses on tiny house design, combined with life cycle assessment (LCA) and material selection charts, to support decision-making and mitigate the consequences of natural disasters on the housing sector. A tiny house (TH) was designed for the Southwestern United States and used as a functional unit for the LCA. To identify the best material combination, this method reviews the physical properties and environmental impacts of materials to determine the best materials in the early design stages. The results indicate that compressed earth blocks (CEB) lightly stabilized with cement (10%), settled with polymeric mortar, with frames in wood, would be the recommended material combination to resist a wildfire scenario and offer the highest resilience to future disasters while generating the least environmental impacts.