UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

29th Annual Environmental Engineering and Science Symposium

April 12, 2024
Urbana, Illinois

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ABOUT THE SYMPOSIUM

2024 marks the 29th Annual Environmental Engineering and Science (EE&S) Symposium at the University of Illinois at Urbana-Champaign (UIUC). This year' s theme as selected by the organizing class is **"Frontiers in Environmental Engineering Research"**.

As always, we aim that the EE&S Symposium brings together researchers from a wide variety of backgrounds and specialties to present their research, ideas, and visions about Environmental Engineering and Science and its role in mitigating the impacts of human activities on the environment and in adapting to environmental changes.

2024 ORGANIZERS

Lillian Burritt

Hanze Dong

Nehal Jain

Oluchi Nweke

Mukesh Pulaganti Venkatappa

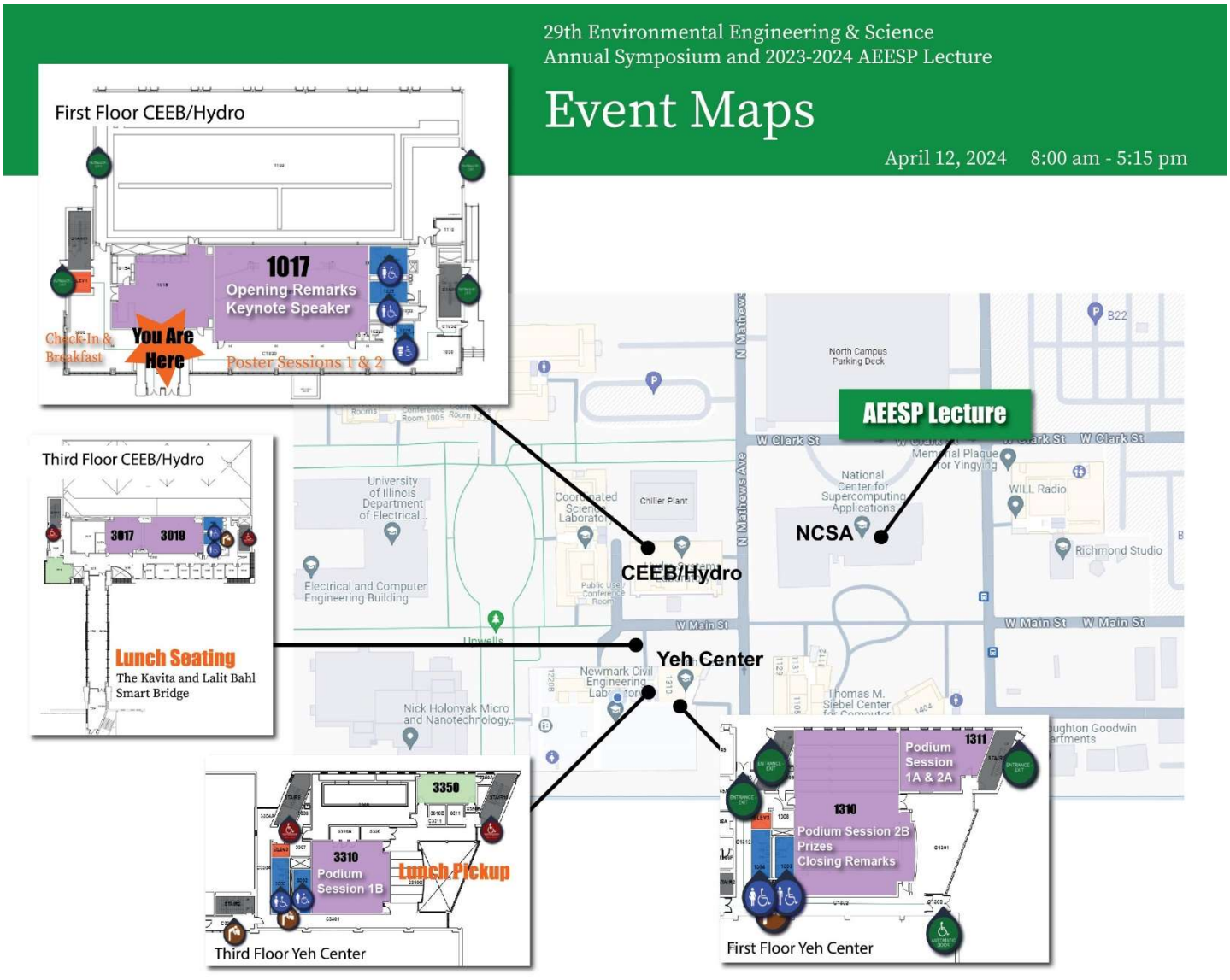
Jeethendra Uppala

The annual EE&S Symposium is traditionally organized and hosted by students in CEE 595G, a professional development seminar course, attended primarily by 1st year MS students.

Advising Faculty: Sotiria Koloutsou-Vakakis

Administrative Support: Suzanne Giesler

CONFERENCE SPACES



SCHEDULE

29th Annual Environmental Engineering and Science Symposium
2024 AEESP Distinguished Speaker Lecture
Schedule – April 12, 2024

Time	Event	Location
8:00 – 9:00 am	Continental Breakfast & Registration	CEEB 1st floor
8:50 – 9:00 am	**Opening Remarks**: Prof. Rosa Espinosa-Marzal	CEEB 1017
9:00 – 10:00 am	**Keynote Speaker[1]:** Distinguished CEE alumnus ***Mr. Damon S. Williams*** (Prof. Roland Cusick introduces)	CEEB 1017
10:00 – 10:50 am	**Poster Session 1**	CEEB 1st floor
11:00 am – noon	**Podium Session 1A (Moderators: Gus Greenwood, Lilian Burritt)** *Air Quality, Indoor Air Quality, Climate Change* 11:00 am **Yoonjoo Seo -** Yeast Surface-Displayed Quenchbody as a Rapid and Simple Biosensor for One-Step Airborne Virus Detection. 11:20 am **Sudheer Salana -** Evaluation of PM2.5 Induced Antioxidant Consumption and ROS Generation as a Proxy for Aerosol Toxicity. 11:40 am **P. S. Ganesh Subramanian -** Oxidative potential and exposure assessment of PM emission from household appliances.	Newmark 1311
11:00 am – noon	**Podium Session 1B (Moderators: Laura Gray, Jeethendra Uppala)** *Emerging Technologies for Water Quality and Processes* 11:00 am **Yurui Li -** Faradaic Rhenium Recovery with Polyvinyl Ferrocene (PVF) Coated Carbon Electrodes. *Artificial Intelligence, Data Science in Environmental Engineering* 11:20 am **Lin Guo -** Probabilistic chemical surrogate modeling with uncertainty quantification using ESINDy. 11:40 am **Renjing Jiang-** "Gold Mining": Machine learning-assisted discovery of 60 plastic-degrading enzymes from 0.1 million hypothetical enzymes.	Newmark 3310
12:00 – 1:00 pm	**Lunch**	CEEB 3rd floor Bahl Bridge
1:10 - 2:30 pm	**AEESP Distinguished Keynote Speaker[1]:** Prof. ***Elisabeth A. Edwards*** (Prof. Wei Na introduces)	NCSA auditorium
2:40 – 3:30 pm	**Poster Session 2**	CEEB 1st floor
3:40 – 4:40pm	**Podium Session 2A (Moderators: Yurui Li, Oluchi Nweke)** *Sustainability and Resource Recovery* 3:40 pm **Quanhui Ye -** Engineering a renewable phytase biocatalyst for phosphate conversion from biorefinery liquid waste. 4:00 pm **Joaquin Yus -** The topography of the substrate affects coral settlement. 4:20 pm **Samuel Aguiar-** Understanding the Influence of Organic Additives on Struvite Precipitation using a Discrete Population Balance Model.	Newmark 1311
3:40 – 4:40pm	**Podium Session 2B (Moderators: Yoonjoo Seo, Nehal Jain)** *Artificial Intelligence, Data Science in Environmental Engineering* 3:40 pm **Manho Park-** A machine-learned advection operator to accelerate air quality modeling without losing spatial details. 4:00 pm **Tahsina Alam -** Application of Machine Learning in Exploring the Synergistic and Antagonistic Interactions among the Inorganic and Organic Particulate Matter Components in causing Oxidative Potential Based on the Dithiothreitol Assay. 4:20 pm **Xiaokai Yang-** Atmospheric chemistry surrogate modeling with sparse identification of nonlinear dynamics.	Newmark 1310
4:50 – 5:10 pm	**Announcement of Awards:** Organizing Committee, Prof. Rosa Espinosa-Marzal confers	Newmark 1310
5:10 – 5:15 pm	**Closing Remarks**: Dr. Sotiria Koloutsou-Vakakis	Newmark 1310

[1] Title and abstract at the Symposium website: https://publish.illinois.edu/2024-uiuc-cee-environmentalsymposium/

Poster Sessions

10:00-10:50 am - CEEB (Hydro) 1st Floor
Poster Session 1 - Presenters 1-21

Air Quality, Indoor Air Quality, Climate Change

1. **Xiao Ran-** A Community-Centric, GIS-Enabled Community Air Pollution Modeling Web Tool for Non-Technical Users.
2. **Oluchi Nweke -** Chemical, Oxidative, and Toxicological Profiles of Fine Ambient Particulate Matter in Alaska.
3. **Shiyuan Wang -** Global disparities in PM2.5 exposure caused by consumption of goods and services.
4. **Qurat ul ain Fatima** - Hyperlocal air pollution prediction using traffic camera footage and computer vision techniques.
5. **Laura Almeida -** Unveiling the True Environmental Cost of Bike-Sharing Systems: A Systematic Literature Review.

Artificial Intelligence, Data Science in Environmental Engineering

6. **Mukesh Pulaganti Venkatappa-** Comparing Investments in Sustainability with Cost Reduction from Waste Due to Lean Construction.
7. **Jialin Liu -** Developing a standard library of symbolic equation-based geoscience algorithms.
8. **Maria Florencia Bianco -** Location models for prioritizing integrated biorefinery deployment opportunities in the United States.

Sustainability and Resource Recovery

9. **Tripta Bhattacharjee -** Rebound Effect of Decarbonization Projects: A comprehensive analysis of reported CDP data.
10. **Alex Deptula-** Increasing control of gel interfaces for more sustainable biomimetics.
11. **Yiming Liu-** Evaluating environmental impacts of historical oil spill incidents in North America.
12. **Wenjun Guo-** Economic and Environmental Sustainability of Sustainable Aviation Fuel Production.
13. **Neha Shakelly -** Towards Sustainable Skies: Evaluating Bio-jet Fuel's Environmental Impact.
14. **Jianan Feng -** Inventory of wastewater treatment plants in the United States and their associated energy usage and greenhouse gas emissions.

Emerging Technologies for Water Quality and Processes

15. **Francisco Montalvo-** Enhancing Water Access and Health in Drought-Affected Regions: A Preliminary Study on Point-of-use Water Filter Intervention.
16. **Will O'Brien - I**ntegrating Non-Sewered Inputs into Centralized Treatment – Preliminary Modeling.

2:40-3:30 pm - CEEB (Hydro) 1st Floor
Poster Session 2 - Presenters 1-21

Sustainability and Resource Recovery

1. **Xuhui Zhang -** Long-range Surface Forces in Salt-in-Ionic Liquids.
2. **Jingyu Li -** The impact of CaCO3-based substrates on the six-month juvenile coral skeletal morphology and composition.
3. **Ma Yongjian -** Influence of polymer-mineral interaction on calcium phosphate mineralization.
4. **Lavanya Kudli -** Sustainability evaluation of azelaic acid production using techno-economic analysis and environmental life cycle assessment.
5. **Junhyung Park-** Advanced Modeling of Carboxylate Production in Anaerobic Digestion Using QSDsan with ADM1 Integration.
6. **Gus Greenwood-** Novel 2D nanomaterial systems for use in sustainable technologies.
7. **Xiaohan Wu -** Comparative Life Cycle Assessment of Copper Production Methods: Pyrometallurgy, Hydrometallurgy, and Bioleaching.
8. **Ming Jun Lee -** Understanding the Interfacial Properties Of Positively Charged Double Network Hydrogels.
9. **Kangdi Sun -** Insight into the assembly of lipid-hyaluronan complexes in osteoarthritic conditions.
10. **Hanze Dong -** The Development and Effects of Sponge City Construction in China.
11. **Binxin Fu -** Interfacial process underlying the environment-dependent friction on calcite single crystals.
12. **Venkat Roy -** Spatializing Life Cycle Assessment to identify Localized Impacts.
13. **Qianlu Zheng -** Impact of Multivalent Cations on Interfacial Layering in Water-in-Salt Electrolytes
14. **Emily Lin -** Spatially Explicit Life Cycle. Assessment and Techno-Economic Analysis of Miscanthus-Derived Biofuel and Bioproducts.
15. **Jeethendra Sai Uppala -** Enhancing Sustainability in Construction Projects with BIM

Emerging Technologies for Water Quality and Processes

16. **Yuqing Mao -** CRISPR-Cas9 modified multiplex target-enriched next-generation sequencing for antibiotic resistance gene detection in environmental samples.
17. **Wanyue Hui -** Electrochemical filtration for emerging contaminant removal.
18. **Amanda M. López-Patiño -** Cost-Effective Water Treatment and Energy Production with Microalgae
19. **Lilian Burritt -** Emerging Technologies and Barriers to Advanced Water Reuse.

17. **Nhung Do -** Wastewater Epidemiological Surveillance in Vietnam: Detection of prevalence of SARS-CoV-2 in neighborhood-scale wastewater-based epidemiology studies. 18. **Arthur Schmidt-** Challenging Conventional Wastewater Sampling Methods. 19. **Jayne Allen -** Modeling novel redox-mediated electrodialysis in the downstream processing of bio-based succinic acid. 20. **Nehal Jain -** The Potential of Dehalococcoides for Sustainable Remediation of Halogenated Pollutants: A Comprehensive Review. 21. **Vineeth Kanteti -** Designing a Methodological Framework: Assessing Economic and Environmental Implications of Centralized Wastewater Sewer Networks Across Diverse Contexts.	20. **Johanna Arita** - Characterizing the potential of decentralized system technologies to advance the sustainability of non-sewered sanitation in a European city. 21. **Ejike Ken-Opurum -** Effects of different concentrations of phosphorus on horizontal gene transfer.

KEYNOTE SPEAKER

9:00-10:00 AM, 1017 CEEB

***Mr. Damon S. Williams**, PE, BCEE, F.ASCE, Managing Member of DSW Water Strategies, LLC*

- BS, Civil Engineering, University of Illinois Urbana-Champaign, 1978
- BS, Physics, Roosevelt University, Chicago, Illinois, 1969
- Registered Professional Engineer in seven states, as well as a licensed water and wastewater treatment plant operator in two states.
- Board-Certified Environmental Engineer (BCEE) of the American Academy of Environmental Engineers and Scientists and a Fellow of the American Society of Civil Engineers.
- A Life Member of AWWA and the American Society of Civil Engineers (ASCE).

"The New Face of Water Research"

ABSTRACT

Today's Environmental Engineers are faced with numerous challenges that are met with innovative approaches and new technologies. This is amply demonstrated in the water sector to address issues of water scarcity driven by climate change and threats to the safety of drinking water brought about by modern industrialization. In the past few decades, water research has shifted from treating drinking water and wastewater as separate domains into embracing the "One Water" concept that includes both.

Moreover, we are recognizing that the limited availability of resources of our planet demand that we look for opportunities to reduce water consumption, reduce wastewater treatment residuals, reuse treated wastewater, and wherever possible, recover resources and energy from wastewater treatment processes.

Mr. Williams will discuss a few representative water projects that demonstrate sustainability on a large scale and his own development as a consulting engineer. He will also discuss some areas he feels would be important to those seeking to pursue a career in consulting environmental engineering.

2023-2024 AEESP DISTINGUISHED LECTURER

1:10-2:30 PM, NCSA Auditorium

***Professor Elizabeth A. Edwards**, Ph.D., P.Eng.*

Department of Chemical Engineering and Applied Chemistry, and Department of Cell and Systems Biology, University of Toronto.

"The complex microbiology of pilot and full-scale anaerobic digestion systems"

ABSTRACT

Anaerobic digestion (AD) is an effective process for converting organic material into methane and carbon dioxide. AD is the result of a beautifically intricate and complex interactive microbial ecosystem. Inexpensive sequencing technology has enabled unprecedented exploration of these ecosystems uncovering thousands of new microbes and putative genes. Yet how can we extract meaningful and actionable data from these microbiological data? We have investigated solid-state anaerobic digestion (SS-AD) as a viable alternative for organic waste disposal, particularly in North America where tipping fees are low, because it minimizes the costs of waste pretreatment, mixing, and subsequent wastewater treatment. We have operated a laboratory SS-AD digester affectionately called "Daisy" for several years. Daisy comprises six 10L leach beds and is fed a mixture of cardboard, boxboard, newsprint, and fine paper, and varying amounts of food waste. The addition of food waste results in enhanced fiber conversion, but is this enhanced conversion explained by microbial community composition? We have also investigated full scale AD systems treating pulp and paper

mill waste streams and tracked the associated microbial communities. These data reveal the importance of time with respect to adaptation of the microbial community and response to perturbations. Appreciating microbial community dynamics, and in particular different processes and metabolic time constants will contribute to improved AD operation.

POSTER SESSION 1

10:00 AM – 10:50 AM, CEEB 1st floor

Air Quality and Climate Change

POSTER 1: XIAO RAN

A Community-Centric, GIS-Enabled Community Air Pollution Modeling Web Tool for Non-Technical Users

Mechanistic air quality models are crucial for assessing air pollution impacts, but their complexity often limits accessibility for non-technical users like local governments and community groups. To address this, we are developing a user-friendly web-based tool that presents the results of the Intervention Model for Air Pollution (InMAP) with interactive features. This tool is designed with input from stakeholder organizations to bridge the gap between their information needs and the technical demands of the model.

The tool utilizes the InMAP Source-Receptor Matrix, corrected with satellite-derived observations for better neighborhood-scale fidelity, and stores data in the Zarr format on AWS cloud for faster remote access. Deck.gl, a WebGL-powered framework, enables exploratory data analysis of large datasets through multi-layered visualization.

We plan to conduct a usability study with key stakeholders to evaluate the tool's effectiveness in simplifying air pollution modeling. Our goal is to democratize access to air pollution modeling by making it accessible and understandable to all stakeholders.

POSTER 2: OLUCHI NWEKE

Chemical, Oxidative, and Toxicological Profiles of Fine Ambient Particulate Matter in Alaska

Alaska's cold climate exacerbates its dire air quality challenges from sources such as vehicular emissions, wood smoke, and industrial activities. However, the oxidative potential (OP) and toxicity of Alaskan fine ambient particulate matter (PM2.5) are relatively understudied. In this study, we quantified the chemical composition and evaluated the toxicity of PM2.5 collected in Alaska during winter using 4 different endpoints [3 acellular; glutathione (GSH) consumption (OPGSH), dithiothreitol (DTT) consumption (OPDTT), and hydroxyl radical generation (OPOH) and 1 cellular (cytotoxicity in A549 cells using crystal violet assay)]. Preliminary results showed that PM2.5 in Alaska had higher organic carbon (OC), water-soluble organic carbon (WSOC), and intrinsic OP and cytotoxicity compared to the Midwest US. Both acellular OP and cytotoxicity were moderately correlated ($r > 0.4$) with OC, elemental carbon (EC), and WSOC, but poorly correlated ($r<0.1$) with metals, indicating that the OC and EC in Alaskan PM may be driving its OP. Our results demonstrate that Alaskan PM may be more detrimental to human health than typical Midwestern ambient PM.

POSTER 3: SHIYUAN WANG

Global disparities in PM2.5 exposure caused by consumption of goods and services

Ambient fine particulate matter (PM2.5) exposure is a major risk factor for human health. Most ambient PM2.5 exposure is caused by emissions that occur in response to economic demand for goods and services, and some of that demand is for exports from other countries. Because PM2.5 pollution has substantial local effects, a country may experience air quality-related social costs from producing exports. We analyze the PM2.5-related mortality caused by global trade and its relationship to wealth and power imbalances among nations. To explore these disparities, we combine economic, geophysical, and epidemiological modeling approaches to quantify the difference between the pollution that people cause by consuming goods and services, and the health impacts resulting from the pollution to which they are exposed. We find that economic demand for exports causes 45% of the over 8 million global annual deaths from PM2.5. For the vast majority (~80%) of countries, the deaths caused by their consumption of goods and services are predominantly felt outside of their borders. The largest exceptions are Indonesia, Brazil, China, and India, which each domestically bear more than 3/4 of the global deaths caused by their consumption. More than 2.4 billion people—primarily in sub-Saharan Africa, Eastern Europe, and Southeast Asia—live in countries with more than half of their deaths from PM2.5 caused by exports to countries with more than double their per-capita economic demand. Overall, our results highlight the interrelated nature of global health, trade, and the legacy of imperialism.

POSTER 4: QURAT UL AIN FATIMAE

Hyperlocal air pollution prediction using traffic camera footage and computer vision techniques

This research focuses on the critical issue of traffic-related air pollution, a significant health hazard with uneven distribution in urban areas. The project aims to develop a novel, cost-effective method for hyperlocal pollution quantification using existing roadway video data. By collecting traffic video alongside pollution measurements in Champaign-Urbana, IL, and Zhejiang, China, we applied deep learning to extract vehicle counts and types and used multiple linear regression to predict pollution levels based on traffic. Our approach, which emphasizes high spatial and temporal resolution, has successfully predicted 28.2% of short-term CO2 variability in Zhejiang based on vehicle dynamics, with articulated and single-unit trucks identified as major pollution contributors. These findings underscore the potential of video-based pollution monitoring to enhance urban air quality management and support environmental sustainability and social equity efforts by identifying pollution hotspots more effectively. Future work will expand measurements and incorporate visual perception techniques to improve pollution inference.

POSTER 5: LAURA ALMEIDA

Unveiling the True Environmental Cost of Bike-Sharing Systems: a Systematic Literature Review

Understanding the environmental impact of bike-sharing systems (BSS) is crucial, given transportation's role as the second-largest emitter of greenhouse gas (GHG) emissions. Despite BSS's global adoption as low-impact alternatives, there is no consensus on whether they decrease or increase GHG emissions. By conducting a systematic literature review enhanced by an AI-assisted screening tool, we found that the emission factor of BSS ranges from 3.04 to 315.06 gCO2-eq/km, with manufacturing and servicing activities (relocation, recharging, maintenance) accounting for between 30% and 91% of emissions. On the net benefit side, more than half of the BSS studied could potentially decrease up to 219 gCO2-eq per kilometer traveled. However, decarbonization advantages are hindered by factors such as low utilization rates, walking and public transport substitution, low service life, oversupply, and inefficient management. These findings underscore the need for strategic improvements in BSS management and regulation to harness their full environmental benefits.

POSTER SESSION 1

10:00 AM – 10:50 AM, CEEB 1st floor

Artificial Intelligence, Data Science in Environmental Engineering

POSTER 6: MUKESH PULAGANTI VENKATAPPA

Comparing Investments in Sustainability with Cost Reduction From Waste Due to Lean Construction

The Architecture- Engineering- Construction industry shows some resistance in certifying (environmental labels) residential projects and applying lean construction practices due to uncertainty of its related costs and benefits. This paper presents a comparative analysis between investments in sustainability and cost reduction due to the reduction of materials' waste. The methodology is a study to (1) quantify the extra costs with sustainable features in a LEED (Leadership in Energy and Environmental Design) residential project and (2) to determine the reduction of construction waste production by comparing the certified project with a similar building built prior the implementation of lean construction practices.

Finally, green features and waste reduction costs impact on the project's final budget. The study results show that the cost of green buildings increased by 1.32 % on the initial budget due to green building certifications. Lean Saving represented a 0.19 % cost reduction in materials' waste.

POSTER 7: JIALIN LIU

Developing a standard library of symbolic equation-based geoscience algorithms

Currently, geoscientific model development typically requires contributors to express scientific concepts in a relatively low-level computing language such as FORTRAN or C++. This has been necessary to achieve suitable computational performance, but makes it difficult to couple models developed by scientists in different disciplines. However, an alternative software paradigm exists where a contributor specifies a model as a system of coupled differential equations and a compiler converts that system of equations into a runnable model. This "symbolic equation-based modeling" has the benefit of allowing scientists to specify models in a manner very similar to how they would appear in a journal article rather than as FORTRAN code. Similarly, scientists from different domains can specify the relationships between model components in equation form, greatly simplifying the process of model coupling. This presentation will cover the history of symbolic modeling, recent developments to make symbolically defined models competitive with traditionally-specified models in computational performance, and our efforts toward building a library of standard model component algorithms which can be flexibly coupled into geoscientific models, focusing on the case of atmospheric chemical transport modeling.

POSTER 8: MARIA FLORENCIA BIANCO

Location models for prioritizing integrated biorefinery deployment opportunities in the United States

Integrated biorefineries capable of transforming a combination of feedstocks into biofuels and bioproducts with novel technologies that seek maximum conversion efficiency and product competitiveness are important in the quest to displace fossil fuels. These new technologies often require significant financial investments and involve high risk. Location modeling is crucial in deciding where to site them but can be very difficult to solve. In this work, a biorefinery siting model was developed in Python with the objective of minimizing total transportation costs. This model was used to locate multiple sweet sorghum and sugarcane biorefineries in the United States. Results to date show possible optimal locations for biorefineries of different sizes in Florida, Texas, and Louisiana (states where both crops are grown). Current work involves using results from this model to assess the financial viability of deploying the biorefineries using indicators such as Maximum Feedstock Purchase Price, and Internal Rate of Return.

POSTER SESSION 1

10:00 AM – 10:50 AM, CEEB 1st floor

Sustainability and Resource Recovery

POSTER 9: TRIPTA BHATTACHARJEE

Rebound Effect of Decarbonization Projects: A comprehensive analysis of reported CDP data

Decarbonization, key to limiting global warming to 1.5°C above pre-industrial level under the Paris Agreement, involves cutting greenhouse gas emissions. To establish a sustainable economy that is in line with this goal, organizations globally record their emissions and reduction strategies using the Carbon Disclosure Project (CDP) framework. The study aims to investigate the rebound emissions resulting from the cost savings derived from these decarbonization initiatives, predicated on the assumption that these savings are reinvested in economic expansion, thereby diminishing the overall benefit of the project. In this study, rebound emissions were quantified through a mathematical model utilizing publicly available CDP reports, which offer data on initiative type, financial savings, payback period, and project lifespan. The preliminary data analysis indicates that initiatives aimed at improving energy efficiency in production processes are the most prone to rebound emission, while projects with a lifespan longer than 11 years are particularly susceptible to it.

POSTER 10: ALEX DEPTULA

Increasing control of gel interfaces for more sustainable biomimetics

A promising approach for controlling wear and friction of gels for biomimetic applications is by incorporating both physical and electrostatic interactions into the network. Responsive behavior for tribological interfaces is an important aspect for wear reduction, but methods of controlling this while maintaining low friction environments are poorly understood. Here, we investigate the structural response and changes in frictional mechanisms of a physically crosslinked poly(methacrylamide-co-methacrylic acid) gel using a combination of in-situ Atomic Force Microscopy and ex-situ characterizations. It was found that there is a frictional transition regime which can be manipulated depending on the surface morphology. Additionally, the adhesive contributions to friction can be controlled by manipulating electrostatic interactions. Implications for future developments with combined electrostatics, dynamic bonds, and hydrogen bonding are relevant areas for understanding how to increase the applicability and long-term use of gels in biomedicine.

POSTER 11: YIMING LIU

Evaluating environmental impacts of historical oil spill incidents in North America

The adverse impacts of extremely large oil spill incidents such as Deepwater Horizon Oil Spill have been widely studied in recent years. Catastrophic oil spill disasters such as Deepwater Horizon Oil Spill have been widely studied. While vast smaller oil spills, which also could result in significant amount of oil release, still lack attention.

This research assessed distributions and environmental impacts caused by historical oil spill incidents in North America. We first analyzed the spatial and temporal characteristics of oil spills. Then the relationship between spillage amount and spill frequency is evaluated via statistical approaches. Last, based on a thorough literature review of environmental, ecological, and economic impacts of oil spill, we proposed a framework to estimate the life cycle impact of oil spill incidents.

POSTER 12: WENJUN GUO

Economic and Environmental Sustainability of Sustainable Aviation Fuel Production

Sustainable aviation fuel (SAF) is being promoted for greenhouse gas (GHG) emissions mitigation in the aviation sector. Among SAF pathways approved by ASTM, cellulosic biomass is a promising renewable feedstock in the alcohol-to-jet (ATJ) pathway. SAF credit has been applied to the qualified SAF since 2023. However, the SAF financial viability taking account of SAF credit remains unclear. To address this question, BioSTEAM, an open-source platform, is leveraged to design, simulate, and evaluate (by techno-economic analysis, TEA, and life cycle assessment, LCA) the biofinery producing SAF from miscanthus and energy cane via preprocessing, pretreatment, fermentation, and upgrading process. Results show that the upgrading energy efficiency is 94.88%; the minimum product selling price (MPSP) is $7.3 gal-1 in the preliminary TEA results.

POSTER 13: HANZE DONG

The Development and Effects of Sponge City Construction in China

In recent years, urban waterlogging significantly impacts ecology and society, in Chinese cities, threatening sustainable urban development and residents' safety, making its resolution crucial. Sponge cities are an approach to addressing urban waterlogging, which has been proposed in China in the past decade. Sponge city construction aims to mitigate water logging by enhancing urban rainwater absorption, storage, purification, and release capacities. I present a review about the development of sponge cities during the past decade and their effectiveness. Key outcomes from the cities where the approach is used include a significant reduction in urban impervious surfaces, improved rainwater utilization rates, and enhanced urban ecological environments. These results demonstrate that sponge city initiatives are an effective way to promote sustainable urban development, improve ecological restoration capabilities, and enhance water resource management efficiency.

POSTER 14: JIANAN FENG

Inventory of wastewater treatment plants in the United States and their associated energy usage and greenhouse gas emissions

Greenhouse gas (GHG) emissions from wastewater treatment plants (WWTPs) account for 2% of CH4 emissions and 5% of N2O emissions in the U.S. However, the facility-level GHG emission information is lacking. This study addressed this gap by compiling an inventory of 15,142 WWTPs, including information on their treatment technologies and energy profiles. Based on this inventory, this work estimated both operational and energy-related emissions from onsite and upstream sources. The total GHG emission was estimated to be 45 million metric tonnes of CO2 equivalent per year, with 20% originating from upstream energy generation. Larger emitters were primarily located in the Midwest and East Coast regions, with the Stickney WWTP being the largest one. Overall, this work provides engineers and policymakers with valuable insights to target dominant GHG emission sources and energy consumers in the WWTP sector. Future work will focus on developing a decarbonization roadmap for WWTPs in the U.S.

POSTER SESSION 1

10:00 AM – 10:50 AM, CEEB 1st floor

Emerging Technologies for Water Quality and Processes

POSTER 15: FRANCISCO MONTALVO

Enhancing Water Access and Health in Drought-Affected Regions: A Preliminary Study on Point-of-use Water Filter Intervention

This collaborative study with the Pan-American Health Organization focuses on developing resilient, decentralized water systems for healthcare in regions affected by extreme weather and climate change. The research objective was to assess current water, sanitation, and hygiene (WASH) conditions in healthcare units with experimental research evaluating POU filter efficacy. Our survey results have revealed several challenges in water quality and infrastructure, highlighting the need for sustainable water treatment solutions. Our experimental results demonstrated a significant reduction in microbial and chemical contamination with reserve osmosis POU filters. The removal of chemicals with activated carbon POU filters are being tested and the feasibility of applying POU systems for the healthcare industry is also being evaluated. This study's approach integrates community participation and governance assessment to ensure effective implementation. The preliminary results underscore the potential of POU filters in improving water access and health outcomes in regions vulnerable to droughts and climate change.

POSTER 16: WILL O' BRIEN

Integrating Non-Sewered Inputs into Centralized Treatment – Preliminary Modeling

As communities worldwide advance their wastewater infrastructure, understating the operations of these systems through modeling becomes increasingly crucial. Gaining knowledge and insight into these processes can not only decrease costs and inefficiencies but also increase the quality of effluent and overall safety. My project focuses on modeling the impacts of additional inputs from non-sewered systems, such as pit latrines, on existing centralized treatment plants. Key analyses include a life cycle assessment, a techno-economic analysis, and simulations of effluent concentrations. Understanding how additional non-sewered loads impact the operations of centralized plants can inform future decisions on how sanitation can be safely managed for developing communities. This modeling is done with QSDsan – an open-source platform that focuses on quantitate sustainable design of sanitation systems.

POSTER 17: NHUNG DO

Wastewater Epidemiological Surveillance in Vietnam: Detection of prevalence of SARS-CoV-2 in neighborhood-scale wastewater-based epidemiology studies

Despite the availability of vaccines since January 2021, Vietnam continues to face challenges from emerging new variants of SARS-CoV-2, leading to high mortality rates and difficulties in monitoring and predicting the pathogen's presence. To address this problem, we propose the installation of autosamplers in neighborhoods to collect wastewater samples weekly. These samples will then undergo analysis using the multiplex digital PCR technique to accurately quantify the absolute copy numbers of SARS-CoV-2 and its variants. The analysis is expected to be completed by May 2024. By that time, the resulting data will be utilized to inform decision-makers in public health implementation efforts, providing valuable insights for combating the spread of the virus. Furthermore, this method can be adapted for monitoring other pathogens, enhancing overall disease surveillance capabilities.

POSTER 18: ARTHUR SCHMIDT

Challenging Conventional Wastewater Sampling Methods

Over the past several years wastewater sampling has increased due to the necessity of wastewater testing to the One Health system. Yet there has been a deficit in literature discussing how samples are collected. One method of collection has become a "pseudo standard", means of collection. However, conventional methods of collection need to be challenged. Our lab looks to improve on standard methods of collection by employing a highly adaptable, two prong approach to wastewater collection. Our methods decrease extremely high costs associated with conventional sampling. While also increasing the collection rate of sampling materials. Over a two-year period of field experiments, our sampling methods have been tested against traditional methods. Allowing for a comparison of the strengths and weaknesses of each and providing insight on where to deploy each system.

POSTER 19: JAYNE ALLEN

Modeling novel redox-mediated electrodialysis in the downstream processing of bio-based succinic acid

Succinic acid is a widely traded platform chemical with high demand in the skincare industry. Sustainable production of succinic acid through biological conversion of sugars from renewable feedstocks has been extensively investigated to replace the barrel of oil used in fossil-based succinic acid production. The cost-intensive production of bio-based succinic acid may be improved through advancements in downstream separation processes. A novel redox-mediated electrodialysis system shows potential for commercial use in sustainable bio-based succinic acid separations with favorable long-term performance by utilization of size- and charge-exclusive and electricity. This work aims to estimate the full-scale performance of the technology (using collaborator bench-scale data) using BioSTEAM Python to perform techno-economic analysis (TEA) and life cycle assessment (LCA) of production plant scenarios under uncertainty. We aim to compare the economic competitiveness (TEA) and sustainability (LCA) of the redox-ED system to more conventional separation processes to inform the prioritization of research efforts.

POSTER 20: NEHAL JAIN

The Potential of Dehalococcoides for Sustainable Remediation of Halogenated Pollutants: A Comprehensive Review

Halogenated compounds are persistent environmental pollutants having adverse effects on ecosystems and human health. With the growing environmental concerns regarding the effective removal of these contaminants, bioremediation is a promising and sustainable approach. Among the wide spectrum of bacteria implemented, Dehalococcoides, a genus of organohalide-respiring bacteria, stands out for its unique ability to catalyse the reductive dechlorination of various chlorinated hydrocarbons. This review offers a thorough look at bioremediation of halogenated compounds, particularly chlorinated aliphatic contaminants. It discusses reductive dechlorination pathways and the key enzymes involved, along with challenges in using Dehalococcoides for remediation and how environmental factors affect the process.

POSTER 21: VINEETH KANTETI

Designing a Methodological Framework: Assessing Economic and Environmental Implications of Centralized Wastewater Sewer Networks Across Diverse Contexts.

In regions where prevailing centralized wastewater infrastructure, including costs, environmental impacts, and space requirements, renders traditional approaches impractical, the urgent demand for alternative solutions becomes evident. In response to this need, this study introduces a comprehensive design methodology aimed at efficiently evaluating centralized wastewater sewer systems, providing valuable insights for informed decision-making. The developed methodology streamlines evaluation by automating life cycle costing (LCC) and life cycle assessment (LCA) of sewer infrastructure systems across different countries. This study integrates both modelling and real-time projects to consolidate research findings on the costs and carbon intensities associated with such systems. Modelling incorporates various industry practices and leverages a range of construction standards to automate evaluation, providing a basis for comprehensive analysis. Furthermore, real-time projects from India enrich cost analysis with practical insights. Offering an innovative approach, this study paves the way for sustainable decisions regarding wastewater infrastructure on a global scale.

PODIUM SESSION 1A

11 AM - NOON, NEWMARK 1311

Moderators: Gus Greenwood, Lilian Burritt

(Air Quality, Indoor Air Quality, Climate Change)

YOONJOO SEO - ***Yeast Surface-Displayed Quenchbody as a Rapid and Simple Biosensor for One-Step Airborne Virus Detection.***

Efficient and cost-effective airborne virus detection is essential to prevent the spread of infectious diseases and safeguard human health. In this study, we developed a new type of whole-cell biosensor by immobilizing VHH-based quenchbody (Q-body) on yeast cells for a rapid, simple, one-step detection of influenza A(H1N1) virus (A/California/04/2009). The biosensor, termed surface-displayed Q-bodies, generated fluorescence signal after 45-minute exposure to the hemagglutinin proteins of the target virus and enabled the selective and sensitive detection in a range from 0.5 μg/mL to 16 μg/mL, with a half maximal concentration of 2.60 μg/mL. The engineered yeast cells were stably stored at 4oC for 28 days, allowing the successful preparation of the biosensor and target detection. Furthermore, the biosensor quantitatively detected real virus particles in a range from 2.4×104 to 1.5×107 PFU/mL. Results from this study provide scientific basis for an innovative whole-cell biosensing platform design for on-site and high-throughput virus detection.

(Air Quality, Indoor Air Quality, Climate Change)

SUDHEER SALANA - ***Evaluation of PM2.5 Induced Antioxidant Consumption and ROS Generation as a Proxy for Aerosol Toxicity***.

Oxidative potential (OP) has emerged as an alternate metric to represent the health effects of particulate matter (PM). Although several cellular and acellular assays have been developed to measure OP, existing studies comparing OP and biological responses provide a contradictory and ambiguous picture. Therefore, in this study we intend to answer two major questions. Is oxidative stress a biologically relevant mechanism to represent aerosol toxicity? And if it is biologically relevant, then do existing OP assays based on antioxidant depletion measurements adequately capture the oxidative stress inducing capability of PM? To answer these questions, we first assess the statistical correlation between different OP endpoints (OPDTT, OPGSH, OPOH, OPAA and cellular ROS) and cytotoxicity in A549 cells for 385 samples collected from different regions of the world. And then study the impact of antioxidant pretreatment on oxidative stress and cytotoxicity. Our results show that cellular ROS is highly correlated with cytotoxicity. Moreover, they validate the relevance of PM induced oxidative stress in cytotoxicity and indicate that our current approach of using antioxidant depletion measurements as a proxy for toxicity may need a rethinking.

(Air Quality, Indoor Air Quality, Climate Change)

P. S. GANESH SUBRAMANIAN - ***Oxidative potential and exposure assessment of PM emission from household appliances. Oxidative potential (OP) has emerged as an alternate metric to represent the health***

Oxidative potential (OP) quantifies the ability of PM2.5 to induce oxidative stress and is a surrogate of PM-induced toxicity. Although people spend over 85% of their time indoors, OP of the PM emitted by household sources is largely unknown. We collected PM emitted by household sources (e.g., candles, incense, cigarettes, ultrasonic-humidifiers, toasters, etc.) in a controlled-environmental-chamber, alongside quantification of chemical composition, particle emission rates (PER), and exposure assessment. OP was quantified using dithiothreitol (OP-DTT), glutathione (OP-GSH), and hydroxyl radical (OP-OH) assays.

Our results indicate following trend for PM emission rates (PER): Toasters> cigarettes > incense. Candles in the presence of a wind-draft showed highest OP-DTT and OP¬OH. Cigarettes showed highest OP-GSH. OP of several sources exceeded (1-6×) those of ambient PM2.5 in US. 24-h exposure to both inhalable PM2.5 mass and OP from several sources were 1-12 times and 1-21 times higher than exposure to ambient PM2.5 in the US, respectively, emphasizing the important role they may have in PM-induced health effects.

PODIUM SESSION 1B

11 AM - NOON, NEWMARK 3310

Moderators: Laura Gray, Jeethendra Uppala

(Emerging Technologies for Water Quality and Processes)

YURUI LI ***- Faradaic Rhenium Recovery with Polyvinyl Ferrocene (PVF) Coated Carbon Electrodes.***

Rhenium, a valuable rare element, is able to be selectively adsorbed by electrodes coated with the redox active polymer polyvinyl ferrocene (PVF). In this study, we elucidate the impact of electrochemical deposition and operation conditions on PVF coating as measured by capacitance, rhenium uptake, longevity, and system cost. PVF films were electrodeposited onto carbon substrate electrode, with all three deposition potential exhibiting excellent Rhenium uptake (350 – 400 mg Re / g absorbent) with high selectivity competing anions. The regeneration improves from 30.78 ± 6.24% at a reduction potential of 0 V to 82.56 ± 9.37 % at -0.8 V. The mechanism of the adsorption and desorption process is explored that relates to formation of ReO4--Fe complex and reduction of ReO4-. Rhenium uptake of the electrodes retaining 69.4% of initial capacity after 15,000 cycles, which contributes to the Re production price of 0.5 $ / g with the experiment setting.

(Artificial Intelligence, Data Science in Environmental Engineering)

LIN GUO - ***Probabilistic chemical surrogate modeling with uncertainty quantification using ESINDy.***

We demonstrate the potential of the Ensemble-Sparse Identification of Nonlinear Dynamics (E-SINDy) framework in uncertainty quantification and enhanced predictions as a surrogate model. We employed a photochemical box model to examine ozone formation, with 3000 2-day training cases and 375 9-day testing cases, the percentage of the 95% confidence interval encompassing the true value is 90.8%. The average R-squared between the calibration of the principal components explaining 96% variance and the perfect calibration is 0.960 and the R-squared for O3 is 0.983, guaranteeing the reliability of the uncertainty quantification. Also, E-SINDy mitigates the overfitting on both generalization and extrapolation and the Ozone testing RMSE is 15.1% of the root mean squared concentration. Extending to 2613 1-week GEOS-Chem simulations, we achieved 13.0% for Ozone testing RMSE along with uncertainty quantification for the model coefficients and trajectory predictions. Future work focuses on replacing the chemical operator of GEOS-Chem with the surrogate model.

(Artificial Intelligence, Data Science in Environmental Engineering)

RENJING JIANG - ***"Gold Mining": Machine learning-assisted discovery of 60 plastic-degrading enzymes from 0.1 million hypothetical enzymes***

Enzyme biocatalysis for plastic treatment and recycling is an emerging field of interest. However, it is time-consuming to identify plastic-degrading enzymes with desirable functionality, given the tremendous number of putative enzymes. There is a critical need to discover the most promising plastic-degrading enzyme candidates from the large pool of putative enzymes. In this study, we developed a four-step "gold mining" framework, through which we identified around 60 top-ranked enzyme/plastic pairs from a pool comprising 0.25 million pairs. The pool, including 0.1 million enzymes and spanning 11 plastic types, was prescreened by analyzing Enzyme Commission numbers, followed by filtering out non-degradable enzyme/plastic pairs using binary classification. Uncertainty estimation was then used to rank the pairs from high to low confidence, and the top 0.5% pairs were further refined to improve confidence. This study demonstrated a new tool to discover and shortlist novel enzymes with high potential for plastic degradation.

POSTER SESSION 2

2:40 AM – 3:30 PM, CEEB 1st floor

Sustainability and Resource Recovery

POSTER 1: XUHUI ZHANG

Long-range Surface Forces in Salt-in-Ionic Liquids

Ionic liquids (ILs) are molten salts under room temperature. They are a promising class of electrolytes owing to low vapor pressures, non-flammability and being universal solvents. Doping ILs with alkali metal salts creates an electrolyte that is of interest for batteries. These salt-in-ionic liquids (SiILs) are a class of super-concentrated, strongly correlated and asymmetric electrolytes. The transference number of the alkali metal cations has been found to be negative, owing to the small but highly negatively charged aggregates which form between alkali metal ions and the anions. Here, we investigate Na-based SiILs with a surface forces apparatus and by atomic force microscopy. We find evidence of confinement induced structural changes, giving rise to unprecedented long-range (non-exponentially decaying) interactions. The long-ranged interactions in SiILs are reminiscent of polymer-like interactions, suggesting analogous high aspect ratio aggregates at the mica interfaces, rather than a purely electrostatic origin.

POSTER 2: JINGYU LI

The impact of $CaCO_3$-based substrates on the six-month juvenile coral skeletal morphology and composition

Coral reefs play a vital role in protecting shorelines from storms and supporting commercial fisheries. They constitute one of the most biologically diverse ecosystems, providing habitats for over 25% of marine life. However, recent human activities are threatening their survival, leading to a rapid decline in coral reef populations. Within the scope of a large collaborative project between several institutions, one of the tasks of our team at UIUC is to design CaCO3-enriched substrates with specific additives that promote coral larval settlement and growth. Among others, we have investigated the impact of the designed substrates on the early stage of juvenile coral skeletons by using a combination of materials characterization techniques. The morphology and composition of coral skeleton has been analyzed by Nano 3DX, scanning electron microscope (SEM), and energy-dispersive spectroscopy (EDS). We have found that the void space in coral skeleton is smaller (greater) when corals grow on substrates containing Mg (Sr) and. SEM images suggest that the voids contain microorganisms, whose role in the early coral life is still under debate. However, the substrate composition, that is, the presence of different additives, does not influence skeleton composition. Future work will include elucidating how microorganisms invade the juvenile coral skeleton and determine their (beneficial or adverse) role.

POSTER 3: YONGJIAN MA

Influence of polymer-mineral interaction on calcium phosphate mineralization

Living organisms employ biomineralization mechanisms to combine organic and inorganic components and thereby to generate unique structures with complex functional properties. Hydroxyapatite plays a critical role in humans' skeletal and dental systems, among others. Using hydrogels as templates for biomineralization has the potential to address the growing need of biomaterials to improve clinical outcomes in regenerative medicine. Here, we discuss the influence of two different polymer networks, polyacrylamide and agarose, on calcium phosphate mineralization kinetics, microstructure, and rheological behavior. Furthermore, we have studied the mineralization pathway of calcium phosphate in the presence of calcium carbonate to simulate early bone formation conditions. Our result indicates that agarose and polyacrylamide networks lead to different polymer-mineral interactions, both during nucleation and crystal growth, and the influence of calcium carbonate is also different in each hydrogel system. As a result, the two hydrogels lead to differences in mineralization kinetics, hydroxyapatite microstructure, and mechanical response.

POSTER 4: LAVANYA KUDI

Sustainability evaluation of azelaic acid production using techno-economic analysis and environmental life cycle assessment

Azelaic acid is a renewable bioproduct and a valuable difunctional monomer with wide ranging industrial applications including lubricants, cosmetics, and pharmaceuticals. It is derived from oxidative cleavage of oleic acid derived from vegetable oils such as high oleic sunflower oil. Conventional ozone-based oxidative cleavage methods for azelaic acid are energy intensive and pose combustion hazards. A more recent oxidative cleavage method utilizes hydrogen peroxide and oxygen as a replacement for ozone as a potentially sustainable alternative. However, significant technological and market driven uncertainties need to be evaluated to understand its potential commercial feasibility and environmental impact. In this study, we leverage BioSTEAM—an open-source platform for design and evaluation of biorefineries— to perform techno-economic analysis and life cycle assessment of hydrogen peroxide and oxygen based oxidative cleavage methods for production of azelaic acid under uncertainty.

POSTER 5: JUNHYUNG PARK

Advanced Modeling of Carboxylate Production in Anaerobic Digestion Using QSDsan with ADM1 Integration

This research advances the modeling of anaerobic digestion (AD) to prioritize carboxylate over methane production, addressing the economic challenges presented by the low cost of natural gas. Utilizing the QSDsan platform, integrated with the Anaerobic Digestion Model No. 1 (ADM1) module, we have developed a sophisticated process model for volatile fatty acid (VFA) production. Data from hybrid bioreactors, inoculated with strained rumen fluid and supplied with glucose at controlled pH, revealed a potential shift towards a valuable mixed acid stream, including lactate, acetate, propionate, and butyrate, while mitigating methane production. This model emphasizes optimizing AD through enhanced fermentation rates, glucose utilization, and tailored carboxylate profiles by refining pH control and analyzing microbial activity. Our approach not only aims to improve the sustainability and economic viability of chemical synthesis from organic waste but also offers a commercially viable alternative to methane, highlighting the potential for significant advancements in bioenergy and bioproducts.

POSTER 6: GUS GREENWOOD

Novel 2D nanomaterial systems for use in sustainable technologies

Complex environmental problems require innovative solutions and one frontier of environmental engineering, nanomaterials (at least one dimension best measured using nanometers), demonstrates unique potential to impact our solutions. Nanomaterials can be used to, for example, reduce energy losses in mechanical systems by controlling friction and wear, remove challenging pollutants from the environment by enhancing membrane and electrochemical separation methods, and control liquid flow through pores and slits. This work describes progress on lab-scale investigations into two relevant two-dimensional nanomaterial systems: graphene nano-slits and van der Waals heterostructures of layered transition metal dichalcogenides. Graphene nano-slits are simulated using the surface forces apparatus, allowing direct experimental investigation of a normally inaccessible system, while heterostructures exhibit "superlattices" of spatially varying mechanical properties, measured here by atomic force microscopy. Challenges of using these materials are discussed, and preliminary results demonstrate proofs-of-concept that are expected to inform how these nanomaterials are leveraged in future technologies.

POSTER 7: XIAOHAN WU

Comparative Life Cycle Assessment of Copper Production Methods: Pyrometallurgy, Hydrometallurgy, and Bioleaching

Copper demand will surge significantly in the context of global renewable energy technology implementation, but its production is an energy-intensive process. It is crucial to choose the best production method to reduce environmental damage in terms of the enormous copper supply. This research develops a multi-criteria life cycle assessment model for the three main copper production routes- pyrometallurgy, hydrometallurgy, and bioleaching. We complied material and energy flow data to assess each route's life cycle greenhouse gas (GHG) emissions, cost, and resource efficiency. Results indicate bioleaching emits the least GHG emissions (4.09 kg-CO2 eq/kg copper) among the three routes. Hydrometallurgy is the most economical production route, costing the least $3.25/kg copper. Nevertheless, hydrometallurgy and bioleaching yield a 75%-95% copper recovery rate, while pyrometallurgy exceeds 98%, establishing it as the most efficient method. This work provides a framework for the decision-making of copper production from the life cycle perspective.

POSTER 8: MING JUN LEE

Understanding The Interfacial Properties Of Positively Charged Double Network Hydrogels

Many natural soft surfaces like human skin, cell membranes, bacteria and microbial surfaces, and insect legs are covered in negative charge. How do these surfaces interact with a countersurface? In this poster, a positively charged double network (DN) hydrogel is used as a model system to investigate the interfacial interactions against a negatively charged countersurface. Techniques like atomic force microscopy will be used to visualize the microstructure and adhesive properties, while streaming zeta potential provides insight into the surface electric potential. The DN hydrogel is made of biocompatible and biodegradable polymers, making it a sustainable way to evaluate the interfacial properties of soft gels. This work could further the understanding of natural soft surface interactions and guide the development of biomimetic and sustainable soft adhesives.

POSTER 9: KANGDI SUN

Insight into the assembly of lipid-hyaluronan complexes in osteoarthritic conditions

Osteoarthritis (OA) is the most common degenerative joint disease which influences millions of people worldwide. Previous studies have shown that in OA-diseased joints, hyaluronan (HA) not only breaks down resulting in a lower molecular weight (MW), but also its concentration is reduced ten times. Here, we investigated the structural changes of lipid-HA complexes as a function of HA concentration and MW to simulate the physiologically relevant conditions that exist in healthy and diseased joints. Taking advantage of several techniques like SANS, DLS and AFM. We infer a significant influence of both MW and HA concentrations on the structure of HA-lipid complexes in bulk and assembled on a gold surface. Our results suggest that low MW HA cannot form an amorphous layer on the gold surface, which is expected to negatively impact the mechanical integrity and longevity of the boundary layer and could contribute to the increased wear of the cartilage that has been reported in joints diseased with OA.

POSTER 10: NEHA SHAKELLY

Towards Sustainable Skies: Evaluating Bio-jet Fuel's Environmental Impact

The aviation sector faces the challenge of reducing its carbon footprint while meeting increasing travel demands. This study examines the environmental sustainability of bio-jet fuel derived from first (1G), second (2G), and third (3G) generation biomass through a comprehensive life cycle assessment (LCA). The focus is on understanding the impact of different biomass sources on greenhouse gas emissions and identifying sustainable pathways for fuel production. Utilizing LCA methodologies, we compare the environmental effects of bio-jet fuels from various feedstocks, including corn, sugarcane, agricultural residues, municipal solid waste, and microalgae. Key findings indicate that 3G feedstocks, especially microalgae, significantly reduce environmental impacts compared to 1G and 2G sources. Additionally, the conversion processes from alcohol to jet fuel play a critical role in the fuel's overall environmental footprint. The results underscore the importance of advancing 2G and 3G technologies to achieve greener aviation, highlighting sustainable feedstock and process choices as pivotal for the sector's environmental improvement.

POSTER 11: BINXIN FU

Interfacial process underlying the environment-dependent friction on calcite single crystals

Abundant in the Earth's lithosphere, calcite-bearing rocks play a crucial role in deciphering fault slips and seismic events. The simplicity of nanoscale measurements on single calcite crystals enables a though insight into various factors that may affect strength of the calcite contacts and, consequently, fault stability. Friction measurements were performed by atomic force microscopy (AFM) with both silica (blunted and colloidal) and calcite tips, and humid vs. aqueous environment. In low humidity, friction increased linearly with velocity, transitioning to a logarithmic regime with blunted silica tips, while colloidal silica tips maintained a linear relationship. Calcite tips exhibited both logarithmic weakening and strengthening regimes, resembling silica probes in dry conditions. Velocity-weakening friction was attributed to contact aging from atomic attrition, and the linear regime to calcite dissolution. In 0M CaCl2 (saturated with CaCO3) solution, the lubrication effects were observed with all tips, and pressure solution at sufficiently slow sliding velocities with colloidal tips. In 3M CaCl2 solution, only logarithmic trends emerged despite no cementation, suggesting water might prevent nanoconfinement cementation. These findings enhance our understanding of interfacial and mechanochemical processes involving calcite, with broad implications for environmental and geochemical systems.

POSTER 12: VENKAT ROY

Spatializing Life Cycle Assessment to identify Localized Impacts

Life Cycle Assessment (LCA) is essential in environmental impact quantification across a product's life cycle, but its conventional applications often overlook spatial details, thus masking localized effects. This study proposes a spatialized LCA method to enhance the delineation of regional impacts. Applied to a case study on lithium extraction from Nevada clays, the approach focuses on Greenhouse Gas Emissions, Freshwater Ecotoxicity, Land, and Water Use. It involves compiling unit processes that contribute to each impact category, attaching location data to principal contributors, and mapping the impacts onto pertinent ecosystems. The spatialized LCA results revealed distinct regional variations in impacts. Notably, while the majority of land and water use impacts were concentrated in Nevada (>90%), a significant portion of freshwater ecotoxicity impacts (>70%) were localized in Arizona's freshwater ecosystems. By identifying the potential ecosystems at risk, this method hopes to aid in informed decision-making for mitigation strategies and developing sustainable alternatives.

POSTER 13: QIANLU ZHENG

Impact of Multivalent Cations on Interfacial Layering in Water-in-Salt Electrolytes

Development of high performing batteries is critical for promoting the use of renewable and sustainable energy. Li-ion batteries are most used nowadays, however, limitation in the availability of raw materials calls for alternative battery chemistries. Multivalent batteries featuring Zn, Mg, Ca, or Al have all been considered. Water-in-salt electrolytes (WiSE) are of interest for use as aqueous multivalent electrolytes due to their potential to address reversibility and passivation concerns common in multivalent batteries. In this work, the impact of addition of multivalent cation salts including Zn(TFSI)2, Mg(TFSI)2, Ca(TFSI)2 and Al(TFSI)3 on the double layer behavior in LiTFSI WiSE is investigated by ultramicroelectrode (UME), surface-enhanced infrared absorption spectroscopy (SEIRAS) and atomic force microscope (AFM). This work shows that cations with a high affinity for water disrupt the ordered interphase present in LiTFSI WiSE, which highlights the important contribution of water as a bridge in layered structures at the interphase.

POSTER 14: EMILY LIN

***Spatially Explicit Life Cycle Assessment and Techno-Economic Analysis of Miscanthus-Derived Biofuel and Bioproducts*.**

Miscanthus is a perennial grass and has attracted great research interests as a promising biofuel and bioproduct feedstock. To project the impacts of miscanthus production on an ecosystem and the sustainability of the generated biofuels and bioproducts, robust and spatially explicit evaluation of the entire field-to-biorefinery value chain is required. The overarching goal of this work is to determine the economic and environmental sustainability of biorefineries with miscanthus as the feedstock. Using ethanol and lactic acid biorefineries as examples, we leveraged the ecosystem model DayCent and the biorefinery simulation tool BioSTEAM for integrated life cycle assessment and techno-economic analysis. We quantified global warming potential and cost of the produced ethanol and lactic acid with location-specific parameters (e.g., climate and soil conditions) across the rain-fed United States.

POSTER 15: JEETHENDRA SAI UPPALA

Enhancing Sustainability in Construction Projects with BIM

The construction industry is increasingly recognizing the importance of sustainability and environmental responsibility in the face of global challenges such as climate change, resource depletion, and environmental degradation. Building Information Modeling (BIM) has emerged as a powerful tool that can significantly contribute to addressing these challenges by facilitating sustainable construction practices. This poster explores the role of BIM in environmental engineering and its potential to enhance the environmental sustainability of construction projects. BIM, as a digital representation of physical and functional characteristics of buildings, provides a comprehensive platform for integrating various aspects of environmental engineering into the construction process. The poster begins by outlining the fundamental principles of BIM and its relevance to environmental engineering. It then delves into the ways in which BIM can be utilized to improve environmental performance, including energy efficiency, water conservation, waste reduction, and material optimization.

POSTER SESSION 2

2:40 AM – 3:30 PM, CEEB 1st floor

Emerging Technologies for Water Quality and Processes

POSTER 16: YUQING MAO

CRISPR-Cas9 modified multiplex target-enriched next-generation sequencing for antibiotic resistance gene detection in environmental samples

The spread of antibiotic resistance genes (ARGs) in the environment is a global public health concern. To date, over 5,000 genes have been identified to express resistance to antibiotics. ARGs are usually low in abundance in environmental samples, making them difficult to detect. Metagenomic sequencing and qPCR, two conventional ARG detection methods, have low sensitivity and low throughput limitations, respectively. To detect a wide range of ARGs with high sensitivity, we propose a CRISPR-Cas9 modified next-generation sequencing (NGS) method to specifically enrich the targeted ARGs during library preparation. In a wastewater sample, 148 ARGs were detected by the CRISPR-NGS method, while only 50 ARGs were detected by the conventional NGS method. Sanger sequencing and qPCR were conducted on the same sample to validate the low possibility of getting false positive results by the CRISPR-NGS method. The CRISPR-NGS method is promising in ARG detection in future wastewater surveillance projects.

POSTER 17: WANYUE HUI

Electrochemical filtration for emerging contaminant removal

Emerging contaminants are frequently detected in both drinking water and wastewater but existing drinking water treatment plants and wastewater plants are not designed to remove them effectively. Electrochemical filtration is a promising technique for contaminant removal but there is a research need for robust and affordable filters for electrochemical applications. The objective of this project was to develop a ceramic electrochemical filter for emerging contaminant removal. The chemical vapor deposition technique was used to grow carbon nanotubes (CNT) on the surface of a ceramic membrane with gaseous phase hydrocarbon passing through a tube-shaped furnace. The electrochemical characteristics of the fabricated CNT-ceramic membrane were tested with an electrochemical analyzer and the results showed that the conductivity of the fabricated was affected by the thickness and heterogeneity of the CNTs on the membrane surface. The developed electrochemical membrane could help contribute to the cost-effective treatment of emerging contaminants.

POSTER 18: AMANDA M. LÓPEZ- PATIÑO

Cost-Effective Water Treatment and Energy Production with Microalgae

The world is facing a water and energy crisis and there is a critical need to develop solutions to treat water and generate renewable energy. The objective of this study was to develop a cost-effective solution to treat water and generate energy with microalgae. Six microalgal-bacterial consortia were isolated from the Ecuadorian Amazon for wastewater treatment. The results showed that their nutrient removal efficiencies were up to 93.78% with average removal rates for ammonia and phosphate being 8.04 ± 1.07 and 6.27 ± 0.66 mg/L/d, respectively. A recently developed biomimetic approach achieved a high efficiency for algal lipid extraction with over 92% energy saving. The feasibility of combining nutrient removal with microalgae for simultaneous water treatment and biofuel production in an integrated system is being evaluated. The coupled nutrient removal and biofuel production with microalgae could contribute to the development of a cost-effective solution for clean water and clean energy.

POSTER 19: LILIAN BURRITT

Emerging Technologies and Barriers to Advanced Water Reuse

As climate change increasingly impacts water supplies and drought frequencies, alternative sources of drinkable water are in high demand. Direct potable reuse (DPR) technology bypasses the need to return wastewater to an environmental buffer, increasing the efficiency in potable water production and reducing discharges from source waters. DPR technologies are advanced in their treatment capabilities but are still met with public and political apprehension due to the "ick-factor" related to drinking wastewater. This poster will highlight emerging technologies and applicable case-studies in DPR that increase its safety, efficiency, and reliability, analyze the prevalence of emerging contaminants that could impact DPR safety, such as pharmaceuticals, and discuss barriers to the increasing implementation of DPR, including public concern and governmental regulation.

POSTER 20: JOHANNA ARITA

Characterizing the potential of decentralized system technologies to advance the sustainability of non-sewered sanitation in a European city

Non-sewered sanitation technologies are a promising alternative to achieve universal access to sustainable sanitation. The 2024 Paris Olympics have led to a billionaire investment in the effort to clean up the Seine River for open water swimming events. This includes the upgrading of centralized facilities, the correction of 35,000 combined sewer connections with the Mon Branchement program, and the construction of new infrastructure such as underground basins. The European commission has published a proposal for a revised Urban Wastewater Treatment Directive where decentralized sanitation is addressed, and by 2030 they are planning to implement EU standards for non-sewered sanitation. However, there is a lack of understanding of how these technologies could satisfy policies. The aim of this project is to understand the nexus between policy and non-sewered sanitation in the European context. This study uses the open-source Python package QSDsan to conduct a techno-economic analysis (TEA) comparing the performance of centralized treatment and non-sewered sanitation using Paris input data.

POSTER 21: EJIKE KEN-OPURUM

Effects of different concentrations of phosphorus on horizontal gene transfer

Horizontal gene transfer (HGT) has been considered one of the factors for the development of antibiotic resistance. Phosphorus can promote microbial growth, but limited information has been available on how the concentrations of phosphorus may affect HGT. The objective of this study was to evaluate the effects of phosphorus concentrations on the rate of resistant gene erm 80. A mating experiment was performed between two bacterial species under different phosphorus concentrations. The results indicated that HGT efficiency was significantly promoted under a phosphorus concentration as low as 0.1 µg/L of phosphorus during the first 36 hours of incubation. The results suggested that trace phosphorus levels may create a selective pressure for HGT, leading to increased rates of antibiotic resistance and public health risks. This study can help us to better understand the relationship between nutrients and HGT and further studies are needed to understand how low level nutrients promote HGT.

PODIUM SESSION 2A

3:40 PM – 4:40 PM, NEWMARK 1311

Moderators: Yurui Li, Oluchi Nweke

(Sustainability and Resource Recovery)

QUANHUI YE - ***Engineering a renewable phytase biocatalyst for phosphate conversion from biorefinery liquid waste***

A critical challenge for phosphate recovery from biorefinery waste is to efficiently convert organic phytate into inorganic phosphate for downstream recovery. Phytase is a natural enzyme that can readily break down phytate to release inorganic phosphate. The present work created a novel surface displayed biocatalyst (named as SDEcP) by expressing the enzyme Escherichia coli phytase (EcP) on the cell surface of Baker's yeast Sacchromycese cerevisiae. Characterization results demonstrated that the SDEcP had efficient phytate hydrolysis activity, fast hydrolysis kinetics, and high storage stability. The stored biocatalyst could be readily regenerated by simple cultivation. The biocatalyst could also be reused with retained functionality. Additionally, the SDEcP biocatalyst could effectively hydrolyze phytate from corn biorefinery liquid waste (e.g., light steepwater). Results from this study provides scientific basis to develop biocatalysis as an efficient approach for organic phosphate hydrolysis from biorefinery waste streams for sustainable phosphate recovery and management.

(Sustainability and Resource Recovery)

JOAQUIN YUS - ***The topography of the substrate affects coral settlement***

The settlement of coral larvae is a critical stage in the life cycle of reef-building organisms, influencing population dynamics and community structure. This study delves into the intricate relationship between substrate topography and coral larvae settlement, shedding light on the ecological significance of this interaction. Through controlled laboratory experiments, we systematically explore how variations in substrate topography, including surface microtextures, influence the settlement preferences and success rates of coral larvae settlement. Our findings show the topography's pivotal role in coral larvae's settlement behavior, providing essential insights into how to shape the novel artificial substrates to speed up this ecological process. Understanding the nuanced connections between substrate topography and coral larvae settlement is crucial for advancing conservation efforts and enhancing our comprehension of coral reef resilience in the face of environmental challenges.

(Sustainability and Resource Recovery)

SAMUEL AGUIAR - ***Understanding the Influence of Organic Additives on Struvite Precipitation using a Discrete Population Balance Model***

In this study we focus on determining the kinetics of struvite precipitation with and without organic additives (Citrate and Aspartate). This work is critical to enhancing Conversion and Yield in full-scale systems at WRRFs. In a batch-mode crystallizer we track the uptake of phosphorus (Ion Chromatography and pH) and change in particle size distribution (Laser Diffraction Based Particle Size Analyzer) over time as struvite forms. Solids are analyzed with SEM and XPS. This data is fit using a discrete population balance model to calculate mechanism specific (nucleation, growth, and aggregation) kinetic constants. Our results indicate organics play two roles in modifying struvite precipitation: 1) Saturation Modification – complexation of organics with free ions reduces overall solution saturation requiring additional magnesium or pH amendment to match the supersaturation of uninhibited solutions and 2) Solubility Reduction – as we increase the concentration of organics more phosphorus is removed from solution indicating the solubility of struvite has decreased potentially leading to faster kinetics. Current work is focused on analyzing the impact of organics on particle size dynamics and determining the physical mechanism(s) behind organic-struvite interactions.

PODIUM SESSION 2B

3:40 PM – 4:40 PM, NEWMARK 1310

Moderators: Yoonjoo Seo, Nehal Jain

(Artificial Intelligence, Data Science in Environmental Engineering)

MANHO PARK- ***A machine-learned advection operator to accelerate air quality modeling without losing spatial details.***

The transport operator (i.e. advection) is the second-most expensive in atmospheric chemical transport modeling. One way to accelerate transport modeling is to decrease spatial or temporal model resolution, but this leads to reduced accuracy. Our previous work focused on spatiotemporal coarse-graining using machine learning for speed up. We implemented the 2-D advection using the learned 1-D solver with a nondirectional splitting mechanism used in GEOS-Chem. Our solver in the coarsest resolution was able to reproduce the output of the finest reference scheme with decent accuracy (r2 = 0.55) and achieved 340 times faster simulation against the high-resolution reference model. One of the limitations of the previous work was that this approach requires the loss of spatial details for dimensionality reduction. In this presentation, we will present our recent effort to accelerate atmospheric advection modeling without spatial coarsening.

(Artificial Intelligence, Data Science in Environmental Engineering)

TAHSINA ALAM ***- Application of Machine Learning in Exploring the Synergistic and Antagonistic Interactions among the Inorganic and Organic Particulate Matter Components in causing Oxidative Potential Based on the Dithiothreitol Assay.***

The objective of this study is to understand the interaction effect of chemical components of particulate matter (PM), particularly PM2.5 in causing oxidative potential (OP). PM oxidative potential originates from the excess generation of reactive organic species (ROS) over the antioxidant capacity in cells. The interaction factors are calculated by measuring OP endpoints of different solutions containing binary mixtures of varying concentrations of Ammonium Sulfate, Ammonium Nitrate, Humic-like Substances, Hydrocarbon-like and Oxygenated Organic Aerosols and metals [Cu (II), Mn (II) and Fe (II)]. The test concentrations of the model species are chosen based on their typical ambient concentrations and conventional filter extraction protocol. The OP is being measured based on dithiothreitol assay (OPDTT). Using different machine learning algorithms like Artificial Neural Network, XGBoost and Random Forest, OP for mixtures containing all components in varying concentrations will be predicted. Combined samples will be tested in the laboratory to validate those predictions.

(Artificial Intelligence, Data Science in Environmental Engineering)

XIAOKAI YANG - ***Atmospheric chemistry surrogate modeling with sparse identification of nonlinear dynamics.***

Modeling atmospheric chemistry is computationally expensive and limits the widespread use of chemical transport models. This computational cost arises 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 has suffered from numerical instability during long-term simulations.

We hypothesize that parsimonious models combined with modern numerical integration techniques can overcome this limitation. Using a small-scale mechanism to explore the potential of these methods, we have created a machine-learned surrogate by (1) reducing dimensionality using singular value decomposition to create an interpretably-compressed low-dimensional latent space, and (2) using Sparse Identification of Nonlinear Dynamics (SINDy) to create a differential-equation-based representation of the underlying dynamics in the compressed latent space with reduced stiffness.