PURDUE UNIVERSITY | Institute for a Sustainable Future

ISF FALL RESEARCH EXPO

2025

ABSTRACT DIRECTORY

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ISF 2025 FALL RESEARCH EXPO ABSTRACT DIRECTORY

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Abstract Number: 1

Research Areas(s):
Biodiversity
Environmental Stressors
Water Challenges

From Leaf to Satellite: Tracking Nitrogen in Short- and Full-Stature Corn hybrids

Author(s): **** indicates presenter(s)***
Agronomy: *Bruno Paulus Scheffer, Leonardo Bosche, Ana Morales, Daniel Quinn
Agricultural and Biological Engineering: Zhiyuan Chen, Kitae Kim, Zhihao Qin, Zhongzhong Niu, Kangyu Ji, Jian Jin

Abstract:
Nitrogen (N) is a critical complex challenge, as both deficiency and overapplication can harm yield and environmental. To address this, this study evaluates the innovative hyperspectral device, LeafSpec, designed for high spatial resolution (SAR; 0.05 mm) and spectral (SER; 400 bands) data under controlled conditions, potently early detecting N stress at the leaf tissue level. Also, we used Unmanned Aerial Vehicle (UAV; 3cm SAR; 6 SER) and satellite (3m SAR; 8 SER). The field trial was conducted at the Agronomy Center for Research and Education in West Lafayette-IN, using two corn hybrids, short-stature (PR111) and full-stature (DKC 62-70). Five N rates (0, 20, 80, 140, and 200 lbs/acre) were applied at V4, plus 40 lbs/acre at planting, except the zero-N control. At V6 and V9 the corn was scanned using LeafSpec, UAV and satellite imagery. As ground truth data, soil sampling was done at the start and end of the trial, and biomass sampling at V6, V9, R1, and harvest. To compare LeafSpec, UAV and satellite, it was used NDVI and the correlation with the ground truth data. Besides, these first-year results aim to calculate the LeafSpec model, decide which model should be used on the next trials and in the future use LeafSpec as ground-truth data for UAV and satellite imagery. The success of this work could potently have a large worldwide impact on how the farmer predicts the corn N uptake and how precisely the N is applied in the field, having potently immense impact on water and soil quality by less N applied. Results will be presented at the conference.

Mentor(s):
Dr. Daniel Quinn, Agronomy

Abstract Number: 2

Research Areas(s):
Circular Economy Systems

Techno-economic Analysis of Integrated Aquaponics Food Production System

Author(s): **** indicates presenter(s)***
*Tosin O. Olanrewaju[1];
Abigail E. Engelberth[1,2]

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Abstract:
Seafood, often referred to as blue food, are nutrient-rich foods derived from aquatic animals, plants, or algae, offering significant health benefits. The U.S. imports approximately 90% of its seafood, contributing to about $17 billion trade deficit. Aquaponics presents a sustainable alternative for localized sea food production but faces systematic challenges such as balancing aquatic and plant systems, high production costs, energy demands, and waste accumulation. This study evaluates the economic viability of an integrated aquaponics system that combines microalgae cultivation, anaerobic digestion, and biorefining to enhance nutrient recycling, produce bioactive compounds, and convert organic waste into biogas and other high-value bioproducts. The nutrient and energy balances within the system were modeled, and a techno-economic assessment was conducted using Aspen Plus and SuperPro Designer software to evaluate the system's performance and economic viability. Results indicate that the greenhouse infrastructure, energy and labor dominate costs, and at small scales, standalone aquaponics is unlike to be profitable. However, integrating anaerobic digestion and microalgae would reduce external inputs and improve profitability. This study aims to develop a zero-waste, grid-independent, and economically viable food production system, fostering local and regional production of nutritious, affordable blue foods while minimizing environmental impact. By doing so, it will contribute to diversifying U.S. agricultural systems and dietary patterns and advancing sustainable food production practices.

Mentor(s):
Dr. Abigail S. Engelberth, Laboratory of Renewable Resources Engineering (LORRE), Agricultural and Biological Engineering

Abstract Number: 3

Research Areas(s):
Environmental Stressors
Water Challenges

CropWISE: A Spatially Explicit and Integrated Multi-Objective Simulation-Optimization Framework for Water Quality, Soil Carbon, and Economic Outcomes in Agricultural Watersheds

Author(s): **** indicates presenter(s)***
*Tang, Yikuan

Abstract:
Modern agriculture faces the dual challenge of increasing food production while mitigating environmental degradation. Addressing these coupled issues requires accounting for hydrologic and nutrient processes as well as soil organic carbon (SOC) dynamics and their economic implications. This study presents CropWISE (Carbon–Runoff–Optimization for Productivity: Watershed Integrity Simulation and Evaluation), a framework integrating simulations with spatial optimization to balance productivity, water quality, and soil health. A hydrologic module was applied to the Wildcat Creek watershed (Indiana, USA) to simulate the impacts of land-use and management scenarios on nonpoint source (NPS) pollution. In parallel, a farm-scale carbon accounting module simulated changes in SOC under different management practices and soil types, enabling the valuation of soil health benefits. These outputs informed the grid-based, stochastic, fractional mixed-integer, multi-objective optimization core of CropWISE to identify spatially explicit optimal management portfolios for each grid cell. This core maximizes agricultural profits and environmental benefits (from improved water quality and carbon credit participation) while minimizing NPS loads, carbon emissions, grey water and total carbon footprint. Results show that the optimized spatial scheme, relative to the status quo, could reduce total nitrogen and total phosphorus loads by 6.35% and 8.39%, while ensuring net soil carbon storage. This comes with an 8.95% reduction in agricultural profit, but monetizing environmental improvements increases total system benefit by approximately 27.90%. These findings underscore the value of grid-scale optimization and economic incentives in aligning farmer profits with watershed ecological goals. CropWISE offers a transferable, spatially explicit approach for integrated watershed management.

Mentor(s):
Dr. Bernard Engel, Agricultural and Biological Engineering

Abstract Number: 4

Research Areas(s):
Environmental Stressors
Risk and Resilience

Characterization of Particulate Matter 2.5 (PM2.5) Including Bioaerosols in a Swine Farrowing Room

Author(s): ***indicates presenter(s)***
*Subin Han [1]
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1 School of Health Sciences
2 Department of Agricultural and Biological Engineering
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Abstract:
Confined Animal Feeding Operations (CAFOs) are modern agricultural facilities that house large numbers of animals, such as swine and cattle, within enclosed environments. The number of CAFOs is significant in the United States because of the advantage of efficiency in production and consistent product quality. However, the growth of CAFOs has raised air quality concerns, linked to adverse health effects on workers and communities. CAFOs are known sources of particulate matter (PM). The swine PM is usually composed of swine feed, feces, mold, pollen grains, insect parts, and mineral ash, which form a complex mix of organic and inorganic materials suspended in the air. A particular concern regarding swine PM is PM2.5 (≤ 2.5 μm), which is small enough to be inhaled, allowing deep respiratory tract penetration and deposition in the lungs. Additionally, CAFO bioaerosols, airborne biological particles, contain diverse microorganisms. In swine operations, these include bacteria such as Pseudomonas, Bacillus, and Lactobacillus species, which can release endotoxins. Studies have shown that endotoxin exposure in CAFOs can lead to both acute and chronic inflammatory respiratory diseases. Given that the large number of animals in CAFOs exacerbates PM2.5 issues, understanding how bioaerosol concentrations shift with changes in animal numbers and activity within the swine facility is important. A comprehensive characterization of PM2.5 and its bioaerosol content is essential for assessing health risks and implementing effective control strategies. This study aims to characterize the size distributions of both PM2.5 and bioaerosols in relation to changes over time during the lactation period.

Mentor(s):
Dr. Jae Hong Park, Health Sciences

Abstract Number: 5

Research Areas(s):
Industrial Decarbonization
Supply Chain Emission

Extending an EEIO Model with Physical Flow Modules: An Iron & Steel Case Study

Author(s): **** indicates presenter(s)***
*Tripta Bhattacharjee
Dr. Heather Liddell, Sustainability Engineering & Environmental Engineering

Abstract:
Tracking how hypothetical energy and product demand scenarios may impact industrial supply chains in the future is crucial for decarbonization and resource planning. The U.S. Department of Energy's Environmentally Extended Input-Output for Industrial Decarbonization Analysis (EEIO-IDA) tool links economic, energy, and environmental data to simulate such industrial technology scenarios. However, like most EEIO models, EEIO-IDA reports emissions intensities in monetary units of kg CO_2e per dollar, making results vulnerable to price changes and awkward for use in life cycle assessment or carbon accounting. To address this, we have compiled a new economy-wide physical production dataset for the United States, consisting of data for 233 goods-producing industries, through primary data collection and estimations from trade records. These new data will enable EEIO-IDA to output energy and emissions intensity results in physical units as well as monetary. Here, we take a step towards validation of this dataset through a case study on iron and steel manufacturing. We systematically compare product-level emissions intensity data from manufacturer Environmental Product Declarations with economy-level estimates implied by our model data. Results show that emissions intensities generally align for this industry, despite some differences in system boundaries. This consistency supports the robustness of our impact intensity estimates for the iron and steel subsector. Future research will include continuing efforts towards validation and refinement of datasets using additional case study industries. Ultimately, we plan to incorporate the fully validated physical flow dataset into new modules for the EEIO-IDA tool to facilitate mass-based effect analysis for enhanced industrial decarbonization modeling.

Mentor(s):
Dr. Heather Liddell, Assistant Professor of Mechanical Engineering and Environmental & Ecological Engineering

Abstract Number: 6

Research Areas(s):
Environmental Stressors

Effects of Artificial Light at Night and Traffic Noise on Tadpole Development and Physiology

Author(s): **** indicates presenter(s)***
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Stiwar A. Cataño[4]
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Abstract:
Urbanization transforms landscapes, exposing species to artificial light at night (ALAN) and traffic noise. These pollutants can disrupt adult morphology and physiology, yet their effects on development are less understood. Research on their combined effects remains limited, despite their frequent co-occurrence. We examined the independent effects of ALAN and the combined effects of ALAN and traffic noise on American toad (Anaxyrus americanus) tadpoles. Glucocorticoid (GC), measured as corticosterone (CORT), regulates immunity, inflammation, and stress resistance making it important to assess how GCs change. To simulate sensory pollution, we used playbacks of traffic noise and white light, creating a "phantom road". To examine the effects of two common sources of light pollution, we tested two spectra of light for ALAN: "white" and "yellow". We hypothesized that these stressors differentially disrupt development resulting in changes in tadpole morphology and physiology. Tadpoles exposed to the white light exhibited higher body weights, whereas yellow light reduced body and tail length, indicating impaired growth. Tadpoles under combined effects were comparable to those under natural conditions. Tadpoles in the control showed strong coping capacity with a stress response and recovery unlike other treatments that had reduced CORT release rates and didn't show recovery. Yellow light alone impairs tadpole growth, while white light can increase body mass without amplifying stress responses. This study provides insights for mitigation strategies in urban environments.

Mentor(s):
Dr. Ximena E. Bernal, Biological Sciences

Abstract Number: 7

Research Areas(s):
Environmental Stressors

Lipid-Mediated Transgenerational Effects of Developmental Pb Exposure on Cognitive Impairments and Anxiety-Like Behavior in Zebrafish Larvae

Author(s): **** indicates presenter(s)***
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Abstract:
Lead (Pb) is a pervasive environmental neurotoxicant that threatens the developing nervous system. Developmental exposure, even at trace levels, has been linked to persistent alterations in cognition, behavior, and cellular homeostasis. This study assessed the multigenerational (F1) and transgenerational (F2) consequences of developmental Pb exposure at environmentally relevant concentrations (0.01, 0.1, and 1 ppb) in zebrafish (*Danio rerio*), integrating behavioral, physiological, and lipidomic endpoints. Zebrafish embryos were exposed to Pb from 1–72 hours post-fertilization (hpf), reared to adulthood (4 months), and bred to generate F1 and subsequently F2 offspring. Behavioral assays were performed in larvae: shoaling and visual motor response tests at 120 hpf, and the open field test at 168 hpf. F1 larvae exhibited marked neurobehavioral impairments, including hypolocomotion, altered anxiety-like responses, reduced social cohesion, and impaired decision-making. These phenotypes correlated with Pb-induced disturbances in sphingomyelins, phosphatidylcholines, and cholesterol esters, suggesting compromised neuronal signaling and membrane stability. In contrast, F2 larvae showed negligible behavioral alterations, indicating no consistent transgenerational inheritance. Pathway enrichment revealed dysregulation of fatty acid transport and mitochondrial energy metabolism, with carnitine–acylcarnitine translocase enrichment in F1 exposed to 1 ppb Pb. Antioxidant analysis indicated a shift toward glutathione-mediated detoxification, with increased GSH-related enzyme activity and reduced catalase, consistent with oxidative imbalance. Together, the findings demonstrate that early-life Pb exposure induces multigenerational neurobehavioral toxicity associated with lipidomic and redox disturbances, but not full transgenerational effects. Pathways related to neuronal energy metabolism and membrane composition highlight the vulnerability of developing organisms to Pb.

Mentor(s):
Dr. Jennifer L. Freeman, Health Sciences

Abstract Number: 13

Research Areas(s):
Environmental Stressors

Assessment of Metal Exposure from Welders and Non-Welders: Toenail Metal Analysis Using a Benchtop X-ray Fluorescence

Author(s): **** indicates presenter(s)***
*Nara Shin, Chang Geun Lee, Aaron J. Specht, Ulrike Dydak, Jae Hong Park
School of Health Sciences

Abstract:
Metal exposure from welding has been linked to neurobehavioral and motor dysfunction. To assess occupational metal exposure, toenail metal analysis has been commonly used. Although inductively coupled plasma (ICP)-based methods are widely used, they require labor-intensive washing and digestion processes of toenails. Therefore, to address these limitations, X-ray fluorescence (XRF) offers a portable, non-destructive alternative and was conceptually compared with ICP-based methods. In this study, a total of 20 welders and 10 non-welders (controls) was recruited and metals in their toenails were evaluated using a benchtop XRF (Epsilon 4, Malvern Panalytical). The collected toenails were washed with surfactant (1% Triton-X100), oven-dried at 60°C for two days, weighed, and analyzed using benchtop XRF. Mean manganese (Mn) concentration was 2.20 ± 1.59 μg/g among welders, 1.34 ± 1.51 μg/g among controls. Mn levels in welders were 1.64-fold higher than in controls. The average iron (Fe) concentration was 42.24 ± 25.41 μg/g among welders. Two-sided t-tests showed significant differences between welders and controls for Mn ($p = 0.17$) and a trend for Fe ($p < 0.05$), though overall differences between welders and controls were not statistically significant yet. These findings suggest that occupational environments may elevate metal exposure even among non-welding factory personnel, highlighting potential co-exposures. This approach can advance industrial hygiene and occupational health by enabling routine, repeated monitoring of metal exposure in workplaces and improving accessibility to exposure assessment in resource-limited settings, thereby supporting early detection and prevention of metal-related health risks.

Mentor(s):
Aaron J. Specht, Health Sciences
Ulrike Dydak, Health Sciences
Jae Hong Park, Health Sciences

Abstract Number: 14

Research Areas(s):
Environmental Stressors

Associations Between Environmental and Biological Metal Concentrations and Self-Reported General Physical and Mental Health Status

Author(s): **** indicates presenter(s)***
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2. Blackford County Concerned Citizens, Hartford City, IN, USA
3. Department of Sociology, Purdue University Fort Wayne
4. Department of Public Health

Abstract

Background and Purpose: Rural populations in the United States face disproportionate environmental health risks due to proximity to industrial sources, limited infrastructure, and reduced access to healthcare. Our prior analyses in Hartford City, Indiana, identified elevated soil and indoor-dust lead (Pb) and copper (Cu) concentrations near a local metal-recycling facility, with levels significantly decreasing by distance based on regression and GIS analyses, indicating localized contamination sources. The purpose of this analysis is to examine whether metal exposures measured in environmental and biological media are associated with self-reported physical and mental health among adult residents of this rural community.

Methods: A community-engaged, cross-sectional study enrolled 80 adults. Soil, indoor dust, and toenail samples were analyzed for metals using X-ray fluorescence and spot urine samples were analyzed for metals by inductively coupled plasma mass spectrometry. Additional data were collected via an online survey. Health outcomes were self-reported physical and mental health in the past 30 days (poor vs good). Multivariable logistic-regression models compared tertiles of metal concentrations with health outcomes, adjusting for age, education, BMI, and urine creatinine.

Results: Mean age was 59.4 years (standard deviation: 14.2); 65% were female. Poor physical health was significantly associated with higher soil arsenic (tertile 3 vs. 1 adjusted odds ratio (aOR): 6.9; 95% confidence interval (CI): 1.35, 35.4), copper (tertile 3 vs. 1 aOR: 7.3; 95% CI:1.35, 35.4), and iron (tertile 3 vs. 1 aOR: 12.3; 95% CI: 2.29, 65.8). The association of poor mental health with soil iron (tertile 3 vs. 1) was also statistically significant (aOR: 22.6; 95% CI: 1.07, 4.77). Other comparisons were not statistically significant.

Conclusions: Findings suggest that localized soil metal contamination may be associated with poorer self-reported physical and mental health among residents living near the metal-recycling facility. However, these results should be interpreted cautiously, as individuals with existing health concerns or heightened awareness of environmental risks may have been more likely to participate or to overreport symptoms, introducing possible perception and selection biases. Nevertheless, this community-engaged study offers valuable insight into an under-studied rural population. Larger, longitudinal investigations integrating objective exposure metrics and biomarker validation are warranted to clarify causal relationships and inform equitable, community-driven environmental health interventions.

Mentor(s):
Dr. Ellen M. Wells, Public Health

Abstract Number: 15

Research Areas(s):
Environmental Stressors

Site-Specific Accuracy of Low-Cost Particulate Matter 2.5 (PM2.5) Monitors in Environmentally Impacted Communities: A Case Study in Northern Lake County, Indiana

Author(s): **** indicates presenter(s)***
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Abstract:
Particulate matter (PM), especially fine particles with diameters equal to or less than 2.5 μm (PM2.5), is a major public health concern, particularly in communities with high industrial activity. Regulatory air quality monitors provide reliable data, but their high operational costs often lead to limited spatial coverage and temporal data gaps. To address these limitations, low-cost PM2.5 monitors utilizing optical sensors can be useful tools. However, their accuracy could vary under different environmental conditions, as optical sensors can be influenced by particle characteristics, humidity and temperature. This study evaluated the accuracy and utility of low-cost PM2.5 monitors (PurpleAir, PA) in industrial Lake County, Indiana. Particle morphology, size distribution, and PM2.5 concentration were measured, and PA data were calibrated and compared with gravimetric samplers (Deployable Particulate Samplers). Raw PA data underestimated PM2.5 concentrations due to irregular particle shapes. Calibrations improved performance, with the US-wide calibration method yielding the best performance (RMSE: 1.40 $\mu g/m^3$; R^2: 0.67). The raw data performed best in Tippecanoe County (RMSE: 0.62 $\mu g/m^3$; R^2: 0.94). Site-specific calibration is recommended to enhance PA reliability in diverse environments. This study demonstrates the potential of low-cost PM2.5 monitors to expand monitoring coverage and the importance of site-specific calibration by considering particle characteristics to improve accuracy and reliability across diverse environments.

Mentor(s):
Dr. Ellen Wells, Public Health

Abstract Number: 16

Research Areas(s):
Environmental Stressors

Real-time Detection and Characterization of Bioaerosols

Author(s): **** indicates presenter(s)***
*Joowon Lee
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Nusrat Jung

Abstract:
The study is to deploy a multi-instrument strategy that samples from a stainless steel chamber environment, integrating chemical, physical, and biological characterization of airborne particles using real-time, high-resolution aerosol instrumentation. Especially, this study focuses on bacteria, and in order to analyze the viability of aerosolized bacteria, several key factors must be carefully considered. First, it is essential to establish a well-controlled chamber environment where the measurements are conducted. To achieve this, the research team constructed a highly sophisticated and precise experimental chamber that meets ISO cleanroom standards. In addition, during the aerosolization process, the biological characteristics of the bacteria were taken into account to create conditions that minimize any impact on their viability. The research presented in this poster includes preliminary experiments that are indispensable prior to a full viability evaluation. Specifically, the suitability of the bacterial broth solution was pre-assessed using multiple instruments, allowing the measured particle number concentrations and fluorescence intensities to be utilized as background reference data for subsequent analyses.

Mentor(s):
Dr. Nusrat Jung, Civil and Construction Engineering

Abstract Number: 17

Research Areas(s):
Environmental Stressors

Assessing Harmful Algal Blooms in Mississinewa Lake: a Current Progress Report with 2025 Bloom Conditions

Author(s): **** indicates presenter(s)***

* Isaac Bradford*, Nileshwari Yewle, Nhu Hoang Van Pham, Sheng Tan, Cary Troy, Melba Crawford, Zhi Zhou, Keith Cherkauer

Abstract:
Cyanobacterial harmful algal blooms (cyanoHABs) pose risks to human and animal health and can disrupt the use of inland freshwater for consumption and recreation. Monitoring these blooms presents significant challenges, but chlorophyll-a (chl-a) is a widely recognized water quality indicator that often occurs with cyanobacterial presence. In this stage of the research, data collected from Lake Mississinewa was analyzed 2023 to 2025, with an emphasis on the 2025 bloom conditions. The project assesses biogeochemical state by measuring microcystin, nitrate, temperature, phosphate, turbidity, dissolved oxygen, conductivity, total solids, total organic carbon, and pH at the selected sites in accordance with EPA standards. Spectral reflectance is measured at each sample site using a handheld spectrometer, and satellite remote sensing imagery. Satellite imagery is clipped in a region around the boat sample GPS location to allow for drift that occurred during the sample collection process. Most of the characteristics used to quantify the biogeochemical state of the water characteristics are not visible to multispectral sensors, so we incorporate supplementary environmental data including topography, land use, precipitation, wind speed and direction, air temperature and water level into our assessment. A general analysis was conducted over chl-a for all three years with an emphasis on the significance of chl-a within spectral signatures. An additional graphic is included to provide insight into possible driving factors of the 2025 Lake Mississinewa bloom conditions. Future models will eventually be used to develop a predictive model of harmful algal bloom risk, incorporating optical properties, land use, and weather information.
Keywords: Harmful algal blooms, chlorophyll-a, cyanobacteria, Indiana, microcystin

Mentor(s):
Dr. Keith Cherkauer, Professor, Agricultural & Biological Engineering

Abstract Number: 18

Research Areas(s):
PFAS

Methodology for Environmental Toxicology: Assessing Feeding and Rearing Strategies in Largemouth Bass (Micropterus nigricans) Larvae

Author(s): **** indicates presenter(s)***
*Amber Hitchins[1]
Hannah McNeese[2]
Deise Cruz[2]
Andrew Todd[2]
Marisol Sepúlveda[2]
Tyler Hoskins[2]

1. Earth, Atmospheric, and Planetary Sciences
2. Forestry and Natural Resources

Abstract:
Poly- and perfluoroalkyl substances (PFAS) are an anthropogenic group of chemicals known for their environmental persistence and potential to bioaccumulate. PFAS can bioaccumulate in largemouth bass (Micropterus nigricans), yet the effects of exposure on bass larvae are unknown. While largemouth bass are raised for aquaculture, techniques for rearing bass enabling controlled experiments at known densities are poorly understood. The objective was to assess different venues (indoors vs. outdoors) and feeding regimes to determine how to raise healthy larvae conducive to PFAS exposure studies.

Four treatment groups were used to assess different combinations of venue and food: (1) indoor tanks with live zooplankton only, (2) indoor tanks with zooplankton and powdered Otohime A fish food, (3) outdoor tanks with a single zooplankton addition, and (4) outdoor tanks with zooplankton replenished daily. Live zooplankton samples were collected from the treatment groups and analyzed using microscopy to assess community composition, relative abundance, and determine size classification. Larval survival, growth, and body condition were assessed with respect to observed densities of zooplankton across treatments.

Analysis did not detect statistical differences between indoor and outdoor rearing ($p = 0.2398$), food density ($p = 0.2233$), or interaction between variables ($p = 0.7392$). However, density dependent growth with statistically significant relationships between outdoor treatment survival and length ($p < 2.2e\text{-}16$), weight ($p = 1.613e\text{-}9$), and body condition factor ($p = 0.04048$) suggest food may have been a limiting factor. Increasing densities of edible zooplankton and conducting exposure studies outdoors appear to be the best approach for exposure studies with early-stage largemouth bass.

Mentor(s):
Dr. Tyler Hoskins, Forestry and Natural Resources
Dr. Marisol Sepúlveda, Forestry and Natural Resources

Abstract Number: 19

Research Areas(s):
PFAS

Understanding PFAS Toxicity: Applying Systems Biology to Investigate Multi-Tissue Lipid Metabolic Alterations in Mice Model

Author(s): **** indicates presenter(s)***
Esraa Gabal[1,2,3,4], Fatema Currim[1], Jason Cannon[1,3,4], Priyanka Baloni[1,3,4]
1 School of Health Sciences, College of Human and Health Sciences
2 Program of Interdisciplinary in Life Sciences (PULSe)
3 Purdue Institute for Integrative Neuroscience
4 Institute for a Sustainable Future

Presenter:
*Kyenret Yakubu Ayuba, PULSe

Abstract:
(Per-)Polyfluoroalkyl (PFAS) substances represent a class of synthetic chemicals, ubiquitous in the environment due to their extensive consumption in several industrial products. PFAS low biodegradability leads to their accumulation in the ecosystems. Based on previous reports, measurable amounts of PFAS were detected in human population, and PFAS exposure has been linked to metabolic dysregulation, including lipid abnormalities, impaired glucose metabolism, and mitochondrial dysfunction. To study the effect of PFAS exposure at systems-level, we used genome-scale metabolic networks (GEMs) to investigate tissue-specific effects in model organisms. In the present study we generated tissue-specific metabolic network of mice liver (iMiceLiver) using the genome-scale metabolic model of mice, iMM1865, as a template. iMiceLiver network contains about 1546 genes, 3926 metabolites, 5467 metabolic reactions, and 82 metabolic pathways. To test the predictive ability of the metabolic networks in identifying metabolic changes, we integrated publicly available transcriptomics datasets in iMM1865 using established computational methods. Using the GEO database, we extracted two transcriptome datasets from mice liver (GSE147331/2 and GSE212294), and one from mice lungs (GSE231602) for integration purposes. In the mice liver study, adult male and female BALB/c mice were exposed to four doses of perfluorinated alkyl substance PFESA-BP2 (Nafion byproduct 2). Our integrated analysis showed that metabolic changes in the samples was sex- and concentration-dependent. Transcriptome analysis showed genes associated with cholesterol metabolism such as Aacs and Acat2 were upregulated in both female and male mice in PFESA-BP2 a concentration-dependent manner. Interestingly, Lcat and Cyp7a1 were downregulated in female mice and upregulated in males following the increase in concentration. The second mouse liver study (GSE212294) focused on the exposure of adult male C57BL/6 wildtype and PPARα-/- mice to PFOA and GenX at two concentrations. Our integrated analysis showed that PFOA exposure caused 419 genes to be differentially expressed (95 upregulated and 324 downregulated). Pathways associated with upregulated genes were sphingolipids, glycosphingolipids, and cholesterol metabolism while fatty acids synthesis, oxidation, and degradation, bile acids synthesis, and eicosanoid metabolism were associated with downregulated genes. GenX exposure yielded in lower number of DEGs (54 in total, with 16 upregulated and 38 downregulated) comparing with PFOA. The pathways associated with GenX-driven upregulated genes were glycosphingolipid and sphingolipid metabolism along with fatty acids oxidation. With GenX-driven downregulated genes, fatty acids oxidation and bile acids synthesis, and glycosphingolipid/sphingolipid metabolism were captured. Our findings demonstrate the power of genome-scale metabolic networks in capturing metabolic alterations due to PFAS exposure. Our ongoing efforts to develop comprehensive tissue-specific metabolic networks aim to lay the groundwork for identification of metabolic

signatures linked to PFAS exposure, providing valuable insights into the systemic impact of these persistent environmental toxicants.

Mentor(s):
Esraa Gabal, Graduate Student Mentor, Health Sciences
Priyanka Baloni, Principal Investigator, Health Sciences

Abstract Number: 20

Research Areas(s):
Water Challenges
PFAS

Foam Extraction for PFAS and Total Fluorine Measurement in Fluorine-Free Foam using High-Resolution Graphite Furnace Molecular Absorption Spectrometry

Author(s): **** indicates presenter(s)***
*Jun Duan 1
Linda S. Lee 1,2
Mahsa Modiri 3
YounJeong Choi 1

1. Purdue University, Department of Agronomy
2. Purdue University, Sustainability and Ecological Engineering, Ecological Sciences and Engineering Interdisciplinary Graduate Program
3. EA Engineering

Abstract:
To investigate the potential impact of PFAS contamination in fluorine-free firefighting foams, this research proposes a fast, simple, and robust method for measuring total PFAS. The method utilizes high-resolution continuum source graphite furnace molecular absorption spectrometry (HR-CS GF MAS), which leverages the high sensitivity and selectivity of the gallium fluoride (GaF) molecule. Fluorine released during sample combustion is complexed with gallium, and the resulting GaF is measured at a wavelength of 211.248 nm.

The optimized method achieved a limit of quantification (LOQ) of 1.1 µg/L (as fluoride, F^-). It was successfully applied to a comprehensive panel of 43 PFAS compounds across 12 chemical groups, demonstrating fluorine recoveries of 70–110% for most analytes. Finally, the method was used to quantify total PFAS in commercial fluorine-free firefighting formulations, enabling effective screening for potential PFAS contamination.

Mentor(s):
Dr. YounJeong Choi, Agronomy
Dr. Linda S. Lee, Agronomy, Sustainability and Ecological Engineering

Abstract Number: 21

Research Areas(s):
PFAS

PFAS Biotransformation Through Composting of Contaminated Animal Carcass

Author(s): **** indicates presenter(s)***
*YounJeong Choi[1]
Linda S. Lee[1,2]

1. Agronomy
2. Environmental and Ecological Engineering

Abstract:
Per- and polyfluoroalkyl substances (PFAS), widely used since the 1950s in products like non-stick cookware, food packaging, textiles, and firefighting foams, have become a major environmental concern. When PFAS-containing materials enter composting facilities, they contaminate compost, which can accumulate in plants and wildlife through biomagnification. This study tested whether composting methods could mitigate PFAS levels and reduce environmental and health risks. In laboratory-scale experiments, compost containers were set up with varying aeration, moisture, and enzyme (laccase with HBT mediator) conditions to promote PFAS breakdown. PFAS degradation was tracked within the compost and in gases captured by granular activated carbon (GAC) filters. Continuous airflow facilitated detection of semi-volatile PFAS in GAC and influenced the release of degradation byproducts. The findings aim to improve understanding of PFAS decomposition during composting of contaminated organic matter.

Abstract Number: 22

Research Areas(s):
PFAS

Robust Ratiometric PFAS Sensing in River Water

Author(s): **** indicates presenter(s)***
*Sydney K. Hardy
Dane C. Wagner
Mobina Masdari
Michael Harrigan
Rebecca B. Clark
Jeffrey E. Dick

Abstract:
Per- and polyfluoroalkyl substances (PFAS) are established environmental micropollutants that need a rapid and robust sensor as a first line of defense. Molecularly imprinted polymer (MIP)-based sensors have shown great promise in electrochemically detecting PFAS. However, like all binding-based sensors, they suffer from interferent effects, especially in the absence of the target of interest. Here, we address this elephant-in-the-room by proposing a ratiometric sensing method. This method uses two MIP-modified electrodes in two different compartments: a compartment in which we know there is no perfluorooctanesulfonate (PFOS) or perfluorooctanoic acid (PFOA), and a compartment in which we add PFOS or PFOA. A sample with the absence of PFOS results in a ratio of electrochemical signals of ~ 1. A sample that contains PFOS or PFOA results in a ratio different from 1. We prove the principal in lab water and river water. This method, grounded in a detailed understanding of binding transduction, is the only way to electrochemically identify PFAS in complex environmental matrices moving forward.

Mentor(s):
Dr. Jeffrey E. Dick, Chemistry, and Electrical and Computer Engineering

Abstract Number: 23

Research Areas(s):
Risk and Resilience

Effect of Social Pressure and Wealth Disparity on Resilience in Post-Disaster Debris and Waste Management

Author(s): ***indicates presenter(s)***
*Seungik Oh, Lyles School of Civil and Construction Engineering
David J. Yu, Lyles School of Civil and Construction Engineering
Makarand Hastak, Lyles School of Civil and Construction Engineering

Abstract:
The impact of natural disasters on communities has been increasing due to climate change. Disasters such as hurricanes, wildfires, floods, and earthquakes generate significant amounts of debris, which require considerable time and effort to remove. In this process, not only is financial input from local governments necessary, but also active participation from local residents. This study employs a dynamic model to analyze the effects of social pressure among residents and the different incentives provided based on socioeconomic disparities by local governments on the recovery process during debris management. Additionally, the study considers the impact of the distance between haulers and communities from waste staging sites. The findings indicate that higher levels of social pressure improve the speed of debris and waste removal, while higher incentives provided by affluent communities enhance the recovery rate. The study concludes by recommending the strengthening of community bonds to accelerate the recovery process of debris and waste after disasters. Furthermore, it proposes the provision of subsidies to economically disadvantaged communities or the strategic placement of waste staging sites to mitigate the disparities in recovery speed caused by socioeconomic differences.

Mentor(s):
Dr. David J. Yu
Dr. Makarand Hastak

Abstract Number: 24

Research Areas(s):
Risk and Resilience

Prediction of Storm Surge and Waves on Evolving Landscapes under Climate Change

Author(s): ***indicates presenter(s)***
*Mohammad Ahmadi[1]
David R Johnson[1,2]

[1] School of Industrial Engineering
[2] Department of Political Science

Abstract:
Storm surges are a major concern for coastal communities, as they can cause significant damage and loss of life. Another factor that must be paid attention to is significant wave height. Significant wave height can contribute to storm surge and exacerbate the coastal flooding. In order to mitigate the impacts of storm surges, and waves accurate prediction of their occurrence and severity is essential. Existing numerical models used to simulate storm surge, particularly high-fidelity are computationally expensive. Because of that, surrogate models for the prediction of storm surges are recognized as great tools for emulating the approximation of storm surges. Once these models are trained, they can be used to cheaply predict surge from other storms not in the training set.

Existing research focuses on accurate prediction of storm surge on a static landscape, with storm parameters such as the track, central pressure deficit and forward velocity used as predictors. In this research, we applied artificial intelligence to storm surge simulations to predict storm surge as a function of storm parameters, geographic location, and landscape data.

The findings of this study show that this approach can produce acceptably accurate results useful for planning studies. Based on the results of this study, it is evident that the developed model has no tendency to overestimate or underestimate storm surges, and it works well in both weak and strong storm events. Our method can be used to generate new landscape scenarios and estimate risk in a larger ensemble of future conditions.

Mentor(s):
Dr. David Johnson, Industrial Engineering and Political Science

Abstract Number: 25

Research Areas(s):
Risk and Resilience

Using Weather and Behavior Data to Predict Heat Pump Energy Demand

Author(s): ***indicates presenter(s)***
*Jiayu Geng; Sustainability Engineering and Environmental Engineering
*Rebecca Ciez; Sustainability Engineering and Ecological Engineering, and Mechanical Engineering

Abstract:
Residential heat pump energy use is driven by occupants' thermal demand and weather dynamics, yet estimating consumption typically requires detailed building physics or extensive submetering. We propose a lightweight, data-driven pipeline that integrates climate scenarios and converts behavior-aware indoor temperature profiles into hourly heat pump energy estimates. First, we apply a building-adjusted internal temperature framework to translate outdoor climate inputs into indoor temperature profiles that reflect season and behavior adjustments. Second, using historical fuel and energy consumption together with weather records, we establish temperature–power functions that translate indoor thermal temperature into heating or cooling power. These functions are integrated into our framework as predictive components for estimating future thermal comfort demand under varying climate scenarios. Then, a variable-speed heat pump performance model was used to estimate the coefficient of performance and electrical power demand as a function of outdoor temperature. This model was used to produce hourly and seasonal energy consumption estimates. The approach requires only weather inputs and heat pump performance specifications, enabling large-scale assessment when detailed building data are unavailable. This framework offers a transparent bridge from weather data to energy use, supporting counterfactual what-if analyses of heat pump adoption in diverse future climates.

Mentor(s):
Dr. Rebecca Ciez, Sustainability Engineering and Ecological Engineering, and Mechanical Engineering

Abstract Number: 26

Research Areas(s):
Risk and Resilience

Towards a Global Conflict Heat Map Caused by Environmental Stressors

Author(s): **** indicates presenter(s)***
*Pragathi Jha
Jason Reinhardt

Abstract:
Climate change has been recognized as an emerging threat to global security, with a rapidly growing body of literature linking it to increased conflict potential. While statistical analyses have identified key drivers, they often lack robust uncertainty characterization, mechanistic modeling, and policy evaluation capabilities. To address these gaps, we present a probabilistic risk framework that integrates climate models with conflict theory, enabling decision-makers to assess and mitigate risks under deep uncertainty.

Our approach leverages Bayesian networks and traditional political-economic contest theory, mapping CMIP6 climate projections to civil conflict likelihoods, producing a dynamic global heat map. This model evaluates how heat stress and other climatic factors influence economic, political, and social instability, offering a systematic way to compare interventions—from solar radiation management to economic policies and infrastructure development. By applying this framework retrospectively to past conflicts, we demonstrate its utility in validating prevention strategies and informing resilient policy design.

This work advances decision-making under deep uncertainty by bridging climate science and conflict risk assessment, providing actionable insights for security and adaptation planning. Policymakers can use this tool to explore trade-offs between mitigation, adaptation, and direct intervention, ultimately reducing climate-driven instability.

Mentor(s):
Dr. David Johnson, Industrial Engineering, Politicial Science
Dr. Jason Reinhardt, Industrial Engineering

Abstract Number: 27

Research Areas(s):
Risk and Resilience

The Importance of Seeds Types for Hurricane Formation in the Eastern and Central Pacific

Author(s): ***indicates presenter(s)***
*Jose A. Ocegueda Sanchez, Earth, Atmospheric, and Planetary Sciences
Daniel R. Chavas, Earth, Atmospheric, and Planetary Sciences
Jane W. Baldwin, University of California Irvine. Department of Earth System Science

Abstract:
Despite progress in understanding the large-scale controls on tropical cyclogenesis (TCG, also known as hurricane formation), a predictive theory for seasonal TC counts remains elusive. Common frameworks, such as the Genesis Potential Indexes (GPIs), fail to capture TCG seasonality and frequency in the Eastern and Central Pacific (ECP). We hypothesize GPIs fail because their limited representation of precursor disturbances ('seeds') overlooks key pathways for genesis. This is particularly significant for the ECP, which has diverse seed sources, including Tropical Easterly Waves (TEWs), monsoon gyres, and ITCZ breakdowns. In this project, we investigate whether seed type affects development favorability by constructing seed-centered composites from ERA5 reanalysis and disturbance databases (1980-2024) for TEW and non-TEW seeds. While non-TEWs dominate the disturbance population (75.7%), half of all TCs originate from TEWs, suggesting a systematic performance difference between seed types for developing TCs. Initially, non-TEW seeds possess more favorable characteristics: stronger low-level circulation, deeper vertical ascent, and a moister environment. This hierarchy flips by the time of TCG. TEW-derived storms develop stronger circulation and generally produce more powerful storms. Our findings demonstrate that seed type significantly impacts development probability in the ECP by modulating key aspects of the precursor structure, its translation speed, and the ambient environment in which they generally live. This work suggests that a more robust framework for TCG, particularly in the ECP, should incorporate the distinct evolutionary pathways of different seed types.

Mentor(s):
Daniel R. Chavas, Earth, Atmospheric, and Planetary Sciences

Abstract Number: 28

Research Areas(s):
Risk and Resilience

What Controls the Expansion of Hurricane Environments? Insights From Past, Future, and Idealized Worlds

Author(s): **** indicates presenter(s)***
*Aaron Kruskie, Earth, Atmospheric, and Planetary Sciences
Daniel Chavas, Earth, Atmospheric, and Planetary Sciences

Abstract:
Do we expect conditions for developing strong hurricanes to expand as the climate warms? If so, how fast, and which regions will be most affected? We explore these questions using an array of different climate models, to try and understand which ocean basins will have the fastest expansion and why. We analyze the expansion of hurricane environments using a combination of observations and future climate models, and find that in the Northern Hemisphere and on the western side of ocean basins, expansion is the quickest. We use a series of idealized ocean and atmosphere climate models to show that the continental setup of ocean basins and their currents are responsible for how fast environments expand. We also compare to models of Earth's past warmer climates to understand how TC environments may change in the future. Our work suggests that future hurricane risk will not be the same across the world, and basins like the North Atlantic and West North Pacific may expand fastest.

Mentor(s):
Dr. Daniel Chavas, Earth, Atmospheric, and Planetary Sciences

Abstract Number: 29

Research Areas(s):
Future Manufacturing
Renewable Energy

Traffic-Aware Grid Planning for Dynamic Wireless Electric Vehicle Charging

Author(s): **** indicates presenter(s)***
*Dipanjan Ghose
Sivaranjani Seetharaman
Junjie Qin

Abstract:
Dynamic Wireless Electric Vehicle Charging (DWC) on electrified roadways is an emerging technology that can reduce EV battery sizes, eliminate charging downtime, and alleviate range anxiety, particularly for long-haul and fleet operations. However, these systems pose challenges for power system planning due to their short-duration, high-power demands (e.g., ≥200 kW in under a minute), which can strain the grid if unmanaged. Since DWC demand depends on vehicle speed, density, dwell time in charging zones, and load profiles along road segments, effective planning requires joint consideration of traffic behavior and EV energy consumption. This work proposes a traffic-aware grid planning framework for DWC corridors. A macroscopic Cell Transmission Model (CTM) is used to estimate real-time, spatiotemporal charging demand. This demand model is then integrated into an AC Optimal Power Flow (AC-OPF) formulation to optimally size a microgrid with solar, energy storage, and grid coupling that supports dynamic charging while minimizing operational costs.
The framework explicitly captures how spatiotemporal traffic patterns influence the utilization and flexibility of grid resources, enabling designs that are both cost-effective and operationally feasible compared to conventional worst-case or microscopic planning approaches. The method is demonstrated on a 14-mile segment of the I-210W highway in California, under multiple traffic conditions including free-flow, congestion, accidents, and natural disasters such as forest fires. Results show traffic-aware planning reduces infrastructure costs by up to 70% compared to worst-case designs, while maintaining charging reliability. This framework also enables flexibility-driven services, such as demand response, in future DWC corridors.

Mentor(s):
Dr. Sivaranjani Seetharaman, Industrial Engineering
Dr. Junjie Qin, Electrical and Computer Engineering

Abstract Number: 30

Research Areas(s):
Future Manufacturing
Renewable Energy

Mapping Electricity Demand Growth Resulting from Decarbonization of the U.S. Steel Industry

Author(s): **** indicates presenter(s)***
*Matthew Ellett

Abstract:
Large scale industrial decarbonization is necessary to avert further damage resulting from climate change. The steel industry specifically is one of the largest emitters, being responsible for 10% of industrial CO2 emissions. Currently, 30% of the U.S. industry runs on blast furnaces and basic oxygen furnaces that emit large quantities of greenhouse gases that result from industrial scale chemical process used to refine iron ore into steel. One of the most promising technologies is the combination Hydrogen Reduction Iron and Electric Arc Furnaces (HRI-EAF). However, these technologies require lots of electricity to create the hydrogen to be used in the HRI process and to run the EAF. As a result, the locations that new HRI-EAF equipment is installed will experience a significant increase in electricity demand. This study uses a database that combines data from the global energy monitor and EPA FLIGHT database to identify the location, production capacity, greenhouse gas emissions, yearly production, workforce size, and production unit. This data can be used to estimate the increase in electricity demand, and where that demand is located, which is required for grid electricity capacity planning. Data shows that the industrial Midwest experiences the largest load growth as blast furnaces are converted to HRI-EAF. Furthermore, data also suggests that the shift to HRI-EAFs from blast furnaces could be accompanied by increases in workforce size.

Mentor(s):
Dr. Rebecca Ciez, Mechanical Engineering, Sustainability and Ecological Engineering

Abstract Number: 31

Research Areas(s):
Future Manufacturing
Risk and Resilience

Integration of LCA systems with VSM to Enhance Sustainability in Industry 4.0 Manufacturing Operations

Author(s): **** indicates presenter(s)***
*Seyi Ogunmodede, Applied Creative and Computing
Samuel Stencel, Engineering Technology
Andrew Morrissey, Mechanical Engineering
Sai Ashish Karanam, Engineering Technology
Heather Liddell, Mechanical Engineering
Nathan Hartman, Engineering Technology

Abstract:
Modern manufacturing desired not only efficiency and effectiveness but also sustainability across the entire value chain. Lean principles have long supported these expectations by reducing waste and ensuring customer satisfaction, with Value Stream Mapping (VSM) emerging as a widely adopted tool for visualizing workflows, identifying bottlenecks, and driving process improvements. However, the drastic transition of the Industry 4.0 era introduces new challenges and opportunities, requiring real-time data integration, machine-to-machine communication, and advanced sustainability assessments. In this context, Life Cycle Assessment (LCA) systems provide an in-depth evaluation of the environmental, social, and economic impacts of manufacturing activities.

This research examines the integration of LCA systems with VSM to enhance sustainability in Industry 4.0 manufacturing operations. With VSM's ability to monitor and optimize production processes and LCA's holistic perspective on the triple bottom line, the study seeks to provide a robust system for advancing sustainable manufacturing practices. A case study on oil pump production in the Purdue Indiana Manufacturing Competitiveness Center (Purdue IN-MAC) will serve as the practical application on three different materials (Aluminum, Steel, and Delran) to compare their various impacts on the TBL. The expected outcome will not only improve operational performance but also strengthen sustainability reporting and decision-making in line with Industry 4.0 capabilities.

Mentor(s):
Dr. Chad Laux, Applied Creative and Computing

Abstract Number: 33

Research Areas(s):
Future Manufacturing

Total Air Emissions from Indiana-based Paper and Fabricated Metal Producers by Zip Code in Pursuit of Air Quality

Author(s): **** indicates presenter(s)***
*Jin Guo, College of Agriculture
*Mark Altman, College of Engineering

Abstract:
This study analyzes total air emissions from paper manufacturing and fabricated metal producers in Indiana using data from the U.S. EPA Toxics Release Inventory (TRI) between 2010 and 2024. Air emissions refer to any pollutants, particles, or gases that are released into the atmosphere due to company-related actions. Emission records were aggregated by zip code to identify patterns and local hotspots across the state. Paper manufacturing and fabricated metal are selected because they are major industrial sources historically associated with PFAS use and emissions, making them relevant for future PFAS-focused research. The findings provide a data-driven view of industrial air pollution in Indiana and lay out the groundwork for assessing pollutant composition and PFAS contributions in subsequent studies.

Mentor(s):
Dr. James Tanoos, Purdue Polytechnic Institute.

Abstract Number: 34

Research Areas(s):
Water Challenges

Pulse Flow Reverse Osmosis IoT Controls System

Author(s): **** indicates presenter(s)***
*John Murray
Dr. Jose Garcia

Abstract:
Household and other small scale reverse osmosis systems often are prone to low efficiencies and low water recovery due to inefficient components and system design (second law efficiency). By applying pulse flow reverse osmosis to a household-scaled model, we can reduce increase water recovery by optimizing the system pressure above the osmotic pressure of the membrane. The proposed system uses control methodologies to achieve the PFRO design. Additionally, the system will demonstrate the use of IoT tools to allow for advanced accessibility and peripheral control management.

Mentor(s):
Dr. Jose Garcia, Mechanical Engineering Technology

Abstract Number: 35

Research Areas(s):
Water Challenges

Nitrogen Release Properties of Urea - Gypsum Cocrystalline Fertilizer

Author(s): **** indicates presenter(s)***
*Vidya Nagaraju

Abstract:
Nitrogen (N) release performance and leaching studies were performed on four urea-based fertilizer formulations: market urea, technical urea, a mixture of urea and gums, and a urea-gypsum cocrystal (URCASU). The urea/gums and URCASU fertilizer formulations were developed in an attempt to reduce the rapid dissolution of urea, thereby controlling nitrate leaching into groundwater and mitigating eutrophication issues. All fertilizer formulations were evaluated for N release performance in clay loam and silty loam soils. Nitrogen release was assessed through a 56-day laboratory soil incubation experiment, with measurements taken on days 1, 4, 7, 14, 28, and 56. On each sampling day, both organic and inorganic forms of N were measured. Two fertilizer placement methods were used: surface application and incorporation into the soil. In addition to N release experiments, flow-cell leaching studies were conducted on samples collected on day 14. The results from the soil incubation studies showed that both urea+gums and URCASU released N significantly more slowly than market urea. Pairwise comparison results indicated that URCASU released significantly less N than market urea in the clay loam fertilizer incorporated, silt loam fertilizer incorporated, and silty loam fertilizer placed on surface. Additionally, the urea+gums formulation performed significantly better than market urea in silt loam (incorporated). However, no significant difference in N release was observed between URCASU and the urea+gums treatment across both soil types and placement methods. In summary, the leaching studies demonstrate the slow release behavior of the enhanced urea formulations in both soil types tested in this study.

Mentor(s):
Dr. Kingsly Ambrose, Agricultural and Biological Engineering
Dr. Carl Wassgren, Mechanical Engineering and Industrial and Molecular Pharmaceutics

Abstract Number: 36

Research Areas(s):
Water Challenges
Risk and Resilience

Characterization of River Discharge and Interaction with Shallow Groundwater Aquifers Along the Wabash River

Author(s): **** indicates presenter(s)***
*Jessica Cyr, Earth, Atmospheric, and Planetary Sciences
Xiaotao Yang, Earth, Atmospheric, and Planetary Sciences
Marty Frisbee, Earth, Atmospheric, and Planetary Sciences

Abstract:
The interaction between the shallow aquifers and local rivers around West Lafayette, Indiana, remains poorly understood. While water levels in the Wabash, as well as some of its tributaries, are monitored through a few stream gauge stations in the local area, groundwater levels and fluctuations are less well documented. Seismometers could play a role in quantifying the role of groundwater on a river's water level and also might provide an alternative way to measure river discharge. Our project utilizes seismic data that has already been recorded and compares increases in amplitude for certain frequency ranges (obtained by computing Fourier transforms on seismic data for 2-hour windows) to USGS stream discharge and precipitation datasets for the same time period. Most of our early efforts have focused on a seismometer that was deployed only about 30 m from the Tippecanoe River, due to its proximity to the river. In this part of Indiana, spring is typically the season with the highest amounts of precipitation, so we chose to focus our initial search for seismic signals that correlate to river discharge from March to June of 2022. In future work, we plan on looking at changes in seismic wave velocity, as this has been tied to fluctuations in groundwater level in previous research on other aquifer systems. We also hope to extend our analysis to a few other seismometers that were deployed at different locations and to look at data collected for all four seasons.

Mentor(s):
Dr. Xiaotao Yang, Earth, Atmospheric, and Planetary Sciences
Dr. Marty Frisbee, Earth, Atmospheric, and Planetary Sciences

Abstract Number: 37

Research Areas(s):
Water Challenges
Risk and Resilience

Daily Newhall Simulation Model for Surface and Rootzone Soil Moisture Estimation

Author(s): **** indicates presenter(s)***
*Moonyoung Lee[1]
Venkatesh Merwade[1]

[1]Civil and Construction Engineering

Abstract:
Soil moisture is a critical variable in the hydrologic cycle that governs processes such as infiltration, evapotranspiration, and runoff. Reliable soil moisture information enables effective water resources management, including flood and drought prediction as well as vulnerability assessment. However, the availability of depth-specific soil moisture data is limited. In-situ measurements are spatially sparse, and satellite products have coarse spatial resolutions and are largely restricted to the surface layer. This study proposes a simple rule-based Newhall Simulation Model (NSM) for depth-specific soil moisture estimation, using only precipitation and temperature as inputs. The monthly NSM was extended to a daily time step by incorporating saturation storage into the available water capacity, adopting the Daily Thornthwaite method to estimate daily potential evapotranspiration, and implementing a one-year spin-up to stabilize initial states. The daily NSM uses depth-specific soil properties from the Gridded Soil Survey Geographic (gSSURGO) dataset. The model was developed and evaluated with U.S. Climate Reference Network (USCRN) daily soil moisture observations at 45 stations from 2010 to 2016. Evaluation results show a strong correlation ($r \approx 0.7$) and a low unbiased root mean square error ($ubRMSE \approx 0.04$) for both the surface and root zone layers, although bias, more pronounced in the root zone, remains. These results demonstrate the feasibility of scaling the daily NSM from point stations to global applications when coupled with gridded meteorological inputs. This Python-based model can provide a practical foundation for depth-resolved soil moisture information in support of sustainable water management.

Mentor(s):
Dr. Venkatesh Merwade, Civil and Construction Engineering

Abstract Number: 38

Research Areas(s):
Renewable Energy

Solar Power: Balancing Contributions to Airport ESG and Mitigating Risks

Author(s): ***indicates presenter(s)***
*Sarah Hubbard, Aviation and Transportation Technology
*Joseph Sobieralski, Embry-Riddle Aeronautical University
*Katherine Sobieralski, JSKS Transportation Consulting LLC

Abstract:
Solar power is a frequently used strategy to support green power generation at airports and near airports. Further, all U.S. airports that published ESG reports included solar power as a strategy. Many of these airports identify solar power as a way to meet UN SDGs. While solar power provides numerous advantages, in the vicinity of airports it can also present potential risks. This was most recently observed at Amsterdam Schiphol Airport, where nearly half of the panels at a nearby solar farm will be removed due to problems with glare affecting pilots on approach. This research investigates the use of solar power at airports to support UN SDGs and explores when solar may not be appropriate near airports, as well as possible mitigation strategies.

Mentor(s):
Dr. Sarah Hubbard, Aviation and transportation Technology
Joseph Sobieralski, Embry-Riddle Aeronautical University
Katherine Sobieralski, JSKS Transportation Consulting LLC

Abstract Number: 39

Research Areas(s):
Renewable Energy

Decarbonizing Indiana's Steel Industry: Hydrogen-Enhanced Electric Arc Furnace Integration and Grid Modeling

Author(s): ***indicates presenter(s)***
*Hanwen Qin, Sustainability Engineering and Environmental Engineering
Anindya Nath, Mechanical Engineering
Abhinand Ayyaswamy, Mechanical Engineering
Navneet Goswami, Mechanical Engineering
Bairav S. Vishnugopi, Mechanical Engineering
Partha P. Mukherjee, Mechanical Engineering
Rebecca E. Ciez, Sustainability Engineering and Environmental Engineering and Mechanical Engineering

Abstract:
In 2022, steel production accounts for over 2% of U.S. emissions, with Indiana contributing nearly half. Decarbonizing Indiana's steelmaking is thus imperative to achieving national climate goals. As the top steel-producing state, Indiana operates 10 steel plants, utilizing both Electric Arc Furnace (EAF) and Blast Furnace-Basic Oxygen Furnace (BF-BOF) technologies. BF-BOF is highly emission-intensive, releasing 1.7 (1.1 – 2.1) tons of CO_{2e} per ton steel in 2022, while EAF is cleaner. Coupled with Hydrogen Direct Reduction (HDR), EAF can further cut emissions by replacing carbon with electrolytic hydrogen, though some emissions remain from fluxes, carbon inputs, and electrode degradation.

Emissions can be categorized as direct and indirect emissions. We assessed direct emissions from an EAF-HDR plant using a mass-based approach, aligned with EPA methods for steelmaking facilities reporting their annual emissions. We found that, by incorporating hydrogen in the steelmaking production, the HDR-EAF plants can nearly get rid of the on-site emissions, with residuals of 0.0675 (0.0220-0.1599) t CO_{2e}/tLS. To capture indirect emissions, which arise from grid for electricity generation, we applied NREL's Regional Energy Deployment System (ReEDS) to model the operation of associated balancing regions, simulating that Indiana's electrifying transition happens instantaneously or in the following ten years, under five grid scenarios (mid, renewables, solar, wind, nuclear) with varying loads. Across scenarios, cumulative emissions through 2050 reach 198.06 (182.66-233.44) $MtCO_{2e}$ under renewables with instantaneous transition and high load. Normalized emissions are 0.36 (0.30 – 0.48) t CO_{2e}/tLS, showing the transformative potential of HDR-EAF.

Mentor(s):
Dr. Rebecca Ciez, Sustainability Engineering and Environmental Engineering, and Mechanical Engineering

Abstract Number: 40

Research Areas(s):
Renewable Energy

Agrivoltaics Implementation in Midwest Agriculture

Author(s): ***indicates presenter(s)***
*Geoffrey Sanchez, Dr. Peter Bermel, Dr. Sylvie Brouder, Dr. Margaret Gitau, Dr. Mitchell Tuinstra, Dr. Rakesh Agrawal

Abstract:
In the world today there are many variables, increased population puts strains on food, energy, and water resources; paired with current technology which requires intensive energy usage, land availability remains constant. The widespread adoption of renewables necessitates finding a suitable land area, and agricultural land has been seen as the most viable location. One of the challenges being faced today is the tradeoff between energy and agriculture. The response to the tradeoff is agrivoltaics, which allows farmers to continue harvesting crops while converting sunlight into energy.

Agrivoltaics is the dual use of agriculture and photovoltaics, with the purpose of maximizing field efficiency. The research at Purdue's ACRE Farm aims to understand the impacts of shadows cast from the solar array on conventional, locally found row crops, corn and soybeans. Data is collected on site using a team of sensors, which measure the microclimate induced by the shadows. Alongside the sensors, physiological and phenological data are also collected to test the long-lasting impacts of shade on crop development and yield.

Field studies were conducted to test whether there was an impact of the agrivoltaic farm on the diurnal and nocturnal temperatures of corn and soybeans. Here, the results will show that proximity to solar arrays at nighttime will increase leaf temperature, shading decreases leaf daytime temperatures, and that the long-lasting effects of shading mean increased soil moisture retention, thus cooler soil temperatures. The relative effects on leaf temperature varied between maize and soybean, however the results remained relatively consistent throughout.

Mentor(s):
Dr. Peter Bermel, Electrical and Computer Engineering

Abstract Number: 41

Research Areas(s):
Renewable Energy
Other: Life Cycle Assessment

Next-Generation EV Batteries: A Life Cycle Assessment of Conventional Lithium-Ion and All-Solid-State Batteries

Author(s): ***indicates presenter(s)***
*Zhu Zhu[1]
Rebecca E. Ciez[1,2]

1. Sustainability Engineering and Environmental Engineering
2. Mechanical Engineering

Abstract:
Lithium-ion batteries (LIBs) dominate today's EV market, but their production is highly energy- and resource-intensive. Recycling can recover valuable materials, yet it also demands substantial inputs. All-solid-state batteries (ASSBs) are emerging as a next-generation alternative, offering higher energy density, improved safety, and greater stability, but their environmental impacts, especially during recycling, remain underexplored. This study develops a prospective recycling process for ASSBs with NMC811 cathodes, lithium-metal anodes, and Li_3PS_4 solid electrolytes, and compares them to LIBs represented by NMC811/graphite cells. We then conduct cradle-to-cradle life cycle assessments (LCAs) with Monte Carlo simulations to compare the energy consumption and greenhouse gas (GHG) emissions of ASSBs and LIBs under varying lifespan scenarios. These assessments allow us to identify environmental hotspots and sustainable designs. Results show that the use phase dominates environmental impacts for both technologies. On a per-cell basis, ASSBs result in higher environmental burdens than LIBs in production and recycling. When normalized by lifetime energy delivered, unit energy use per kWh depends strongly on lifespan: energy use can become statistically significantly higher for ASSBs if their lifespan is half that of conventional LIBs, but when lifespans are comparable or extended normalized energy use for ASSBs is not significantly different from LIBs. In contrast, GHG emissions per kWh delivered do not differ significantly across scenarios, as the variability of grid carbon emissions outweighs smaller battery-level differences. These findings suggest that policymakers should prioritize grid decarbonization, incentivize technologies that extend battery lifespans, and promote recyclable designs to realize the sustainability potential of ASSBs.

Mentor(s):
Dr. Rebecca E. Ciez, Sustainability Engineering and Environmental Engineering, Mechanical Engineering

Abstract Number: 42

Research Areas(s):
Renewable Energy

Foraging Behavior and Social Influence in a Dynamic Traffic Scenario: Developing a Gaming Platform to Study Electric Vehicle Users' Selections of Charging Stations

Author(s): **** indicates presenter(s)***
*Torsten Reimer, Communication and Cognition Lab
Xinwu Qian, Civil and Environmental Engineering, Rice University
Juan Pablo Loaiza-Ramírez, Communication and Cognition Lab
Malhar Sushil Jadhav, Computer Science
Peter M. Todd, Department of Psychological and Brain Sciences, Indiana University
Hossein Gazmeh, Civil and Environmental Engineering, Rice University
Satish Ukkusuri, Civil and Construction Engineering
Omar Faruqe Hamim, Civil and Construction Engineering

Abstract:
This project is embedded in an NSF-grant on Large-scale Planning for Electric Vehicle Public Charging Infrastructure. It has the goal to examine the foraging behavior and social influence among electric vehicle (EV) users in simulated traffic environments. In this phase of the project, a custom-designed gaming platform was developed that was informed by a survey and an experiment modeling human choices of charging stations. In the designed charging game, participants perform simulated tasks involving decisions between multiple charging stations with diverse attributes, mimicking real-world resource constraints. Key variables include access to information, map complexity, variability in station availability, and outcomes influenced by the number of competing participants. The study seeks to identify the primary considerations users rely on when allocating resources, such as reducing waiting times, increasing travel distance, and balancing charging costs. These insights help reveal the interplay between individual preferences and social influence, contributing to our understanding of decision making in dynamic, social environments. This research has practical implications for developing real-world resource distribution systems, such as EV charging networks, by highlighting ways to improve user experience and infrastructure design. It also contributes to broader studies of human behavior in environments where cooperation and competition coexist, offering strategies to enhance resource management in various transportation scenarios.

Abstract Number: 43

Research Areas(s):
Renewable Energy
Other: Decarbonization

Data-Driven Air Sour Heat Pumps Audit: Behavior Undermines Performance

Author(s): **** indicates presenter(s)***
*Hyeongseok Lee, Civil and Construction Engineering;
Panagiota Karava, Civil and Construction Engineering

Abstract:
Air Source Heat Pumps (ASHPs) for residential buildings are fundamental techniques to achieve UN Sustainable Development Goals, especially considering the residential sector accounts for more than 20% of global final energy demand. However, in cold climates, ASHP heating capacity is often insufficient to meet peak demands, requiring less efficient electric resistance backup heating. Minimizing the use of backup heater is important for sustainable energy savings, grid resiliency, and directly impacts on occupant thermal comfort. This study investigates ASHP energy and comfort performance using high-resolution field data from a residential community with 22 houses in Indianapolis, IN. All houses share identical floor areas, construction materials, and local weather conditions. Each house is equipped with a 2-ton single-stage ASHP and a 10kW backup heater. Analysis of winter heating consumption reveals a significant variance, up to three times, in energy use among these identical homes. This variance is directly correlated with different resident interaction patterns with their thermostats, which dictates when and how the backup heater is engaged. The work demonstrates control strategies designed to detect energy-inefficient thermostat interactions, seamlessly improve them into optimized, energy-saving ASHP and backup heater operation, and effectively communicate these changes with residents.

Mentor(s):
Dr. Panagiota Karava, Civil and Construction Engineering

Abstract Number: 44

Research Areas(s):
Renewable Energy
Other: Quality Education, Affordable and Clean Energy

Integrating AI into Engineering Design: Scaffolding Argumentation in Energy-Efficient Housing

Author(s): **** indicates presenter(s)***
*Julian D. Romero;
Alejandra Magana;
Brittany Newell

Abstract:
Engineering technology education is inherently complex due to abstract theoretical foundations and the challenges of applying knowledge to real-world problems. Simulation technologies have long supported this process, and the recent rise of artificial intelligence (AI) offers new opportunities to personalize and enhance these learning experiences. This study reports on an implementation in a first-year engineering technology course where students engaged in a design challenge to improve the energy efficiency of a house affected by shading. The activity required students to weigh technical, economic, and social factors while justifying their decisions through argumentation supported by AI-based scaffolding. By situating learning within an authentic context of energy trade-offs and sustainable design, the intervention fostered not only conceptual understanding but also students' intrinsic motivation and confidence in handling complex engineering challenges. This work demonstrates how AI can be embedded into engineering education to prepare future engineers to navigate the interdisciplinary demands of sustainable innovation.

Mentor(s):
Dr. Alejandra Magana, Computer and Information Technology
Dr. Brittany Newell, Engineering Technology

Abstract Number: 45

Research Areas(s):
Renewable Energy

Investigating PBCV-1 Virus-Induced Lipid Production Enhancement and its Molecular Mechanism for Renewable Energy

Author(s): **** indicates presenter(s)***
*Yoonjung Choi
Amanda Michelle Lopez

Abstract:
Algal lipid production is a promising third-generation biofuel platform offering high photosynthetic efficiency, but large-scale lipid production and recovery remain major bottlenecks. The *Chlorella*-specific lytic virus PBCV-1 that can be easily found in the natural environment has been proposed as a low-energy alternative for lipid recovery through viral-induced cell lysis. Given that microalgae primarily synthesize and accumulate lipids as triacylglycerol (TAG), this study investigated TAG accumulation profiles in *Chlorella* cells infected with PBCV-1 using a high-resolution epifluorescence microscopy and chlorophyll fluorescence. To further understand the molecular mechanisms underlying the lipid enhancement, quantitative polymerase chain reaction (qPCR) was designed to measure changes in the expression of key lipid biosynthetic enzymes during PBCV-1 infection to clarify how viral infection influences algal lipid metabolism and contribute to developing sustainable biotechnological approaches for renewable energy.

Mentor(s):
Dr. Zhi Zhou, Civil Engineering

Abstract Number: 46

Research Areas(s):
Renewable Energy
Other: Environmental Monitoring

A Smarter Way to Watch Over Alpacas in Peru

Author(s): **** indicates presenter(s)***
*Nicolas Rendon-Arias;
*Juyoung Kim;
Elias Salilih;
Walter Daniel Leon-Salas

Abstract:
In the Andean region of Peru, alpacas are more than animals. They are a lifeline for entire families who rely on them. Shepherds, many of whom live in remote mountain areas, spend countless hours watching over their herds.

Without fences or boundaries, alpacas can spread out for miles, sometimes vanishing behind valleys or hills. When this happens, shepherds may spend hours searching for them.

In these high-altitude areas, phone signals are rare, and internet connections are unreliable. As a result, families face stress, lost time, and even financial losses when animals go missing.

At Purdue's Tiny Lab, we focus on designing practical, affordable technologies that meet community needs. For this project, we created a solid geolocation system tailored for alpaca herding in Peru by using LoRaWAN, a communication method that uses low-power, long-range radio signals, sending information over several miles using very little battery power, making it perfect for places with no traditional coverage.

Tiny transmitters are placed on alpacas. Each device sends out signals that include the animal's position; these signals travel wirelessly using LoRa to a receiver device built with a Raspberry Pi. The receiver displays the alpacas' locations, so shepherds can carry this receiver into the field and instantly see where their animals are.

By combining open-source technology, energy efficiency, and community training, we hope to demonstrate that innovation can be simple, practical, and deeply human-centered.

Mentor(s):
Dr. Walter Daniel Leon-Salas, Engineering Technology

Abstract Number: 47

Research Areas(s):
Other

Rethinking AI for Transportation System Optimization: Do Solution Gains Justify the Training Energy Costs

Author(s): **** indicates presenter(s)***
Zhuoli Yin*, Edwardson School of Industrial Engineering Yi Ding, Elmore Family School of Electrical and Computer Engineering Hua Cai, Edwardson School of Industrial Engineering, School of Sustainability Engineering & Environmental Engineering

Abstract:
Artificial intelligence (AI) is transforming decision-making in different disciplines by solving complex problems quickly with good quality, like optimizing travel routes to cut vehicle mileage. However, what is often overlooked is that AI does not come without costs. Training and running AI models consume significantly more energy than traditional computing methods. While researchers have estimated the energy costs of training AI, a crucial question remains: Do the environmental benefits of AI-driven solutions, such as lower vehicle traveled distance, outweigh the energy and emissions from building and operating these models? In this study, we will use the Traveling Salesman Problem (TSP) as a test case to measure the training cost of specialized AI models and quantify how such an AI-driven route optimization can reduce carbon emissions by cutting vehicle travel miles—to determine whether AI's benefits truly justify its energy footprint.

Mentor(s):
Dr. Hua Cai, Edwardson School of Industrial Engineering, School of Sustainability Engineering & Environmental Engineering

Abstract Number: 48

Research Areas(s):
Other

A Conceptual Framework for Structuring the Application of Public Participation GIS

Author(s): **** indicates presenter(s)***
*Zhao, Mingyu

Abstract:
Public Participation Geographic Information Systems (PPGIS) is becoming an influential data collection method to intervene, manage, and govern natural capital. However, the quality, quantity, and accuracy of individual-level data obtained from PPGIS remain subject to criticism. Hence, this paper employs the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) protocol integrated with the Large Language Model (LLM) to review the use of PPGIS in the landscape domain. After a scoping review of 108 studies, we find 3 major groups with 12 subgroups for PPGIS in landscape-related research: (1) methodological approaches in spatial assessment, (2) understanding human values, perceptions, and well-being in landscapes, and (3) applications in environmental and land use planning. Based on the grouping results, we develop a conceptual framework for structuring and streamlining the data collection process conducted by PPGIS to accurately understand the human-environment interactions. Specifically, we proposed three normative propositions to structure the application of PPGIS: (1) Integrate spatial and temporal scales. (2) Ensuring sample size scale alignment and representativeness: local scale (168-478, 95%CI), landscape scale (206-674, 95%CI), regional scale (593-1466, 95%CI). (3) Framing PPGIS as a medium, examiner, and coordinator. The framework was advanced from a technical level to achieve the intervention, management, and monitoring of social capital to natural capital.

Mentor(s):
Dr. Aaron Thompson, Horticulture and Landscape Architecture

Abstract Number: 49

Research Areas(s):
Other: Global Sustainability

Evaluating Community Involvement Efficacy in the Adoption of Airport Noise Mitigation Programs

Author(s): **** indicates presenter(s)***
*Rhea Dutta, Industrial Engineering
*Oleksander Sergey Crowell, Aviation and Transportation Technology
*Joao Pedro Biondo Peres, Aviation and Transportation Technology

Abstract:
The management of noise stemming from airport operations has been at the center of regulatory efforts aimed at balancing airport expansion with both environmental and community impacts. This study evaluates the effectiveness of community involvement in creating and implementing noise mitigation programs. It explored the methods through which airports are adopting federal regulations, established by agencies such as the Federal Aviation Administration (FAA), and implementing initiatives, such as Noise Compatibility Programs (NCPs) and Noise Exposure Maps (NEMs). Specific attention was applied to the community involvement aspects of these processes. Five airports were established as case studies for gaining insights into implemented programs and regulations. The airports, each representing a different airport classification, are Akron-Canton Regional Airport (CAK, Non-Hub); Westover Metropolitan Airport (CEF, Regional-Hub); Fresno Yosemite International Airport (FAT, Small-Hub); Indianapolis International Airport (IND, Medium-Hub); and Seattle-Tacoma International (SEA, Large-Hub). The findings show that noise abatement NCPs, such as preferential runway adoption and noise insulation for schools and residential areas, showed the most efficacy. Furthermore, iterative engagement with communities to evaluate noise procedure effectiveness, through outreach workshops and stakeholders' meetings, has been shown to fuel shared understanding and alignment around noise management strategies.

Mentor(s):
Dr. Caroline K. Marete, Aviation and Transportation Technology

Abstract Number: 50

Research Areas(s):
Other: Sustainable Construction Materials

Surface Treated Wood Wool for Wood Cement Composites as a Sustainable Alternative to Dimensional Lumber

Author(s): **** indicates presenter(s)***
*Akshat Verma, Darien A. Dewar, Jeffrey P. Youngblood
Materials Engineering

Abstract:
Wood wool-cement composites have long been employed in sound and acoustics technology for sound-deafening purposes. Wood wool, also known as excelsior, is a long-sheared fiber of wood and has an organic nature, leading it not to adhere firmly to cement, limiting its application in building structures. Industrially, wood is treated with waterglass to improve its adhesion with cement, but so far, it has not led to the deployment of wood-cement boards as materials for building structures. In this study, wood wool was treated with waterglass, colloidal alumina, colloidal silica, and silica fume. Waterglass was chosen as one of the treating agents due its widespread use in industry as describe above. Colloidal alumina and colloidal silica are nanosols of alumina (~80 nm) and silica (~12 nm), respectively, in water. Silica and alumina are well-known pozzolans for cement, and the presence of nano-silica and nano-alumina adsorbed onto excelsior contributed to cement hydration, forming the high-density calcium silicate phase, improving cement strength and durability. Silica fume is a well known supplementary cementitious material and was grafted onto the surface of excelsior either by electrostatic layer-by-layer assembly with two polyelectrolytes. Single fiber pull-out tests performed with treated fibers showed 50% adhesion improvement with waterglass treatment. Further three-point bend strength testing studies were performed with 75 vol% wood wool content in the compression molded composite. Waterglass treated fibers in the composite showed an increase of 88.88% flexural strength compared to untreated fibers in the molded composite. The use of 75 vol% wood wool assures long-term embodied carbon retention, and minimizes the amount of cement binder, hence lowering the overall carbon footprint connected with cement manufacturing, are some of the environmental benefits of the composite.

Mentor(s):
Dr. Jeffrey P. Youngblood, Materials Engineering

Abstract Number: 51

Research Areas(s):
Other: Plastics and Impact on Environment

Perceptions of the Impact of Plastic Use on the Environment and Health Among Purdue University Students

Author(s): **** indicates presenter(s)***
*Gabriela Da Silva, Pharmacy
*Jasmine Lee, Pharmacy
*Cora Heaston, Pharmacy
Adriana Gardner, Pharmacy
Jasmine Gonzalvo, Pharmacy
Gicella Garcia, Pharmacy

Abstract:
Single-use plastics (SUPs) pose significant environmental, economic, and health concerns. Approximately 400 million tons of plastic waste are produced annually, much of it entering the environment. Plastics do not readily decompose but instead break down into microplastics that persist for centuries, harming wildlife and human health. Initiatives to increase public awareness of the harmful impacts of plastics and strategies to reduce SUP usage are essential. This study aimed to increase awareness of the harmful impacts of plastics and assess Purdue students' perceptions. Study personnel organized an Earth Day event where students were provided an educational infographic. After reviewing, students were asked if they were willing to complete a survey to assess their current knowledge and perceptions regarding plastic usage. Students who completed the survey were awarded a sustainable prize. A total of 177 participants completed the survey. The majority of participants reported making efforts to reduce plastic waste (73%) and recycle at home (75%). The most common items used to reduce SUP waste were reusable water bottles (88%), reusable silverware (70%), and canvas tote bags (60%). Most participants agreed that plastics have a negative environmental impact (88%) and that reducing plastic exposures positively impacts health (89%). When asked about future behavior, 86% of participants indicated they were extremely or somewhat likely to reduce their plastic waste in the next six months. Overall, the Earth Day educational outreach event successfully reached a large number of Purdue students, with survey results indicating that students are open to efforts to decrease SUP waste.

Mentor(s):
Dr. Jasmine Gonzalvo, Pharmacy
Dr. Adriana Gardner, Pharmacy
Gicella Garcia, Pharmacy

Abstract Number: 52

Research Areas(s):
Other: Indoor Air Pollution and Environmental Quality

Significant Nanoparticle Emissions and Exposures from Dry Shampoo Products

Author(s): **** indicates presenter(s)***
*Jordan Cross [1], Jianghui Liu[1], Brian Magnuson[1], Chunxu Huang[1], Satya Patra[1], Brandon Boor[1], Nusrat Jung[1]
[1] Lyles School of Civil and Construction Engineering

Abstract:
Dry shampoos, hair care products marketed for their time-saving features, are potent sources of indoor air pollution as they release significant concentrations nanoparticles (6 to 500 nm) and volatile organic compounds (VOCs) that interact with the indoor atmospheric environment and impact human health. Real-time studies on the emitted aerosols from propellant-based hair care products and associated health impacts remain limited. This study conducted 14 full-scale emission experiments, using five commercially available hair care products in a controlled laboratory environment inside of the Purdue zEDGE Test House. Using a High-Resolution Electrical Low-Pressure Impactor (HR-ELPI+) and a photoionization detector (PID), we measured nanoparticle size distributions and total VOC (TVOC) mixing ratios, respectively, directly from the user's breathing zone during realistic hair care routines. Data analysis revealed that dry shampoos produced airborne nanoparticle concentrations ranging from 75,000 to 650,000 cm^{-3} with most particles ranging between 80 and 200 nm. The TVOC peak concentration found for dry shampoos during source periods were between 2,500 and 4,000 ppb. Interestingly, the only dry shampoo product without label-listed siloxanes, a commonly used VOC in hair care products, displayed the lowest nanoparticle and TVOC concentrations, suggesting that product formulation may have a great impact on aerosol emissions. It is known that prolonged exposure to nanoparticles have potential health outcomes associated with oxidative stress, decreased lung function, heart disease, breast cancer, and prostate cancer. Similarly, long-term exposure to VOCs has been linked to cardiovascular disease, neurological disorders, and risks of cancer. These findings are valuable as they contribute to the body of knowledge regarding indoor air pollution from propellant-based hair care product use and human health that was previously underexamined.

Mentor(s):
Dr. Nusrat Jung, Civil and Construction Engineering
Dr. Brandon Boor, Civil Engineering

Abstract Number: 53

Research Areas(s):
Other: Species Conservation

A Population Viability Analysis (PVA) Approach to Examine the Efficiency of Conservation Strategies in the Critically Endangered Lehmann's Poison Frog

Author(s): ***** ***indicates presenter(s)***
*Abby M. Hagan[1];
Adriana A. Bustos[2];
Ana M. Ospina[1];
Ximena E. Bernal[1,3]

[1] Department of Biological Sciences
[2] School of Life Sciences, Arizona State University, Tempe, AZ 85287
[3] Smithsonian Tropical Research Institute, Apartado 0843-03092, Republic of Panamá

Abstract:
Over the last five decades, wildlife populations decreased by an estimated 73%. Overharvest was the second most significant driver of this decline, which includes the illegal extraction for the pet trade. Poison dart frogs are more abundant in the global pet market than other anurans due to their attractive colors. Many of these species, including Lehmann's poison dart frog (Oophaga lehmanni), have been subject to illegal extraction from the wild into the global pet trade. While these anuran population declines have been attributed to the illicit pet trade, few studies have addressed this problem. Oophaga lehmanni is a critically endangered species found in western Colombia. Here, we aim to predict the future of O. lehmanni by performing a population viability analysis using Vortex10. Based on current knowledge of the life history and demographic traits of this species, we will simulate a baseline scenario that represents the current probability of extinction of protected and unprotected populations. To evaluate the impact of ex-situ supplementation on the probability of extinction, we will simulate various supplementation regimes and contrast those results with current ex-situ conservation efforts by the Zoológico de Cali. We will concurrently simulate these scenarios with low, intermediate, and high yearly harvest rates to account for uncertainty in this parameter and assess its impact on the unprotected populations. This analysis will not only inform future conservation strategies for O. lehmanni but also underscores the need to address the specific challenges that both protected and unprotected populations face.

Mentor(s):
PI: Dr. Ximena E. Bernal, Biological Sciences
Graduate Mentor: Ana M. Ospina, Biological Sciences

Abstract Number: 54

Research Areas(s):
Other: Power System

The Role of Flexible Connection in Accelerating Load Interconnection in Distribution Networks

Author(s): **** indicates presenter(s)***
*Nan Gu, Electrical and Computer Engineering
Ge Chen, Electrical and Computer Engineering
Junjie Qin, Electrical and Computer Engineering

Abstract:
The rapid growth of electrified loads, such as electric vehicles and data centers, is straining the ability of distribution networks to accommodate new connections without costly upgrades. This paper proposes a unified framework for enhancing load-side hosting capacity through minimal flexibility interventions, such as short-term curtailment and delay. We show that even modest flexibility can significantly streamline the interconnection process. We provide theoretical insights that explain when and why these interventions are effective, and validate our findings through realistic simulation studies. Our results offer utilities a scalable and transparent method for evaluating flexible connection potential, while enabling timely integration of emerging loads with minimal operational disruption.

Mentor(s):
Dr. Junjie Qin, Electrical and Computer Engineering

Abstract Number: 55

Research Areas(s):
Other: Healthy Buildings

A Novel Methodology for Rapid Aging of HVAC Filters Using a Synthetic Submicron Aerosol: Effects of HVAC system Operational and Environmental Conditions on Filter Loading

Author(s): **** indicates presenter(s)***
*Chunxu Huang
Nusrat Jung
Brandon E. Boor

Abstract:
Heating, ventilation, and air conditioning (HVAC) filters play a critical role in mitigating indoor air pollution while contributing to HVAC system energy consumption by increasing system airflow resistance as they accumulate particles. Their performance is strongly influenced by aerosol physicochemical properties, particularly the particle size distribution (PSD), which affects filter loading behavior and efficiency. However, standardized test protocols primarily use coarse-mode loading dusts that poorly represent the submicron PSDs characteristic of urban aerosol. This study introduces a novel methodology for aging HVAC filters using synthetic submicron potassium chloride (KCl) aerosol generated by burning salt sticks with a thermal aerosol generator integrated with a full-scale HVAC filter test rig. The loading performance of three minimum efficiency reporting value (MERV)-rated filters – MERV8, MERV13, and MERV14 – was evaluated under varying volumetric airflow rates, salt stick feed rates, and relative humidities (RH). Results show that higher airflow rates accelerate clogging, while lower rates extend loading periods and increase salt stick consumption. The salt stick feed rate had minimal impact on dust-holding capacity, demonstrating the method's robustness for rapid filter performance evaluation. RH strongly influenced loading, particularly for hygroscopic KCl aerosol, where elevated RH slowed loading by enhancing particle adhesion and increasing dust cake porosity. For electret filters, high RH further reduced filtration efficiency by accelerating charge decay on the filter media. Experimental repeatability was confirmed across replicate tests. This methodology provides a realistic, cost-effective, and time-efficient approach to evaluate HVAC filter aging, enabling improved performance assessments of filters in urban environments.

Mentor(s):
Dr. Brandon Boor, Civil Engineering

Abstract Number: 56

Research Areas(s):
Other: Food Security and Urban Agriculture

Beyond Fun, Food, and Fiesta: University Cultural Center's Collaborative Garden Initiatives

Author(s): **** indicates presenter(s)***
*Mukhamad Suhermanto[1,2], Pamela K. Sari, Ph.D.[1], and Jean Paul Gerard Liban[1]

[1]*Asian American and Asian Resource and Cultural Center*
[2]*Environmental and Ecological Engineering*

Abstract:
University cultural centers (UCCs) play an important role for students to engage in a meaningful journey of identity, practice well-being alongside academic excellence, explore the profound dimensions of arts and cultures, and grow professional or global readiness (Maladore, 2024; Patton, 2006, 2010; Museus, 2008; Trieu, 2023; Sari et al, 2023, Kuczajda, 2024). Despite these roles, UCCs at times face a simplistic stereotype as a place for "fun, food, and fiesta." This study follows a journey of the Asian American and Asian Resource and Cultural Center (AAARCC) at Purdue University in reframing the stereotype into a collaborative framework in experiential learning and engaged scholarship to address a particular global or regional challenges. We ask: 1) How can an Asian cultural center engage the complexity of Asian America and share its own mission to weave Asian/American history and lived experiences into campus life for all students? 2) How can the creation of a cultural center garden at a Midwest university allow the center to take part in a land-grant mission and serve as an intentional intervention to reduce food insecurity through community, access, and cultural relevance?

Our journey shows the garden initiative's transformation and growth from a cultural "meeting point" to a comprehensive experiential learning program engaging the issues of food access and food security. A collaborative garden shows how students' buy-ins and agency are central in the efforts well-being to address food insecurity in a college campus. Partnership with other campus units broadens the impact by increasing the quantity and quality of harvest. Focus on container gardens teaches resilience and addresses growing food in a limited space and sparks discussions about the need for more edible landscaping on campus. Creation of a gardening student organization enhances student leadership and networking.

Mentor(s):
Dr. Pamela K. Sari, Asian American and Asian Resource and Cultural Center

Abstract Number: 57

Research Areas(s):
Other: Climate and Weather

Do Extreme Weather Events Occur Randomly in the Midlatitudes?

Author(s): **** indicates presenter(s)***
*Ka Ying Ho, Earth, Atmospheric, and Planetary Sciences
Lei Wang, Earth, Atmospheric, and Planetary Sciences
Edwin P. Gerber, Courant Institute of Mathematical Sciences, New York University
Yi Ming, Earth and Environmental Sciences, Boston College

Abstract:
In late June 2021, a record-breaking heat wave event struck western North America, causing hundreds of deaths across the US and Canada, and severely damaging agricultural yields. In January 2025, extreme drought conditions in California fueled an unexpected winter wildfire that forced hundreds of thousands to evacuate and destroyed more than 18,000 homes and infrastructures. These events were built up by persistent weather patterns over the region, uncoincidentally orchestrated by the same large-scale atmospheric circulation pattern in the eastern Pacific.

The pattern, known as atmospheric blocking, arises from interactions between planetary-scale Rossby wave dynamics and random synoptic-scale eddies. While day-to-day, synoptic-scale weather is inherently chaotic, it remains uncertain whether this persistent, large-scale pattern occur randomly. To address the question, we will study the intrinsic timescale for atmospheric blocking to recur in a given region from observational data and compare it to that of a simple red noise model. We will also investigate what factors affect these return timescales, and how they will change in a warmer climate.

Mentor(s):
Dr. Lei Wang, Earth, Atmospheric, and Planetary Sciences

Abstract Number: 59

Research Areas(s):
Other: Carbon Removal Technologies

Energy Use and CO_2 Capture Estimates Across Operational Cycles of Direct Air Capture Systems

Author(s): **** indicates presenter(s)***
*Jennifer Patterson, Environmental and Ecological Engineering

Abstract:
Achieving global sustainability targets and limiting warming to 1.5 °C will require not only deep emission reductions but also dioxide removal (CDR) technologies to address unavoidable residual emissions from hard to abate sectors such as aviation, agriculture, and heavy industry. The IPCC Sixth Assessment Report (2022) notes that all 1.5 °C scenarios involve some degree of CDR, and that without these technologies, most models cannot generate viable net-zero pathways. Direct Air Capture (DAC) is a promising approach, but large-scale deployment is limited by high energy demands and uncertainties about efficiency under real-world conditions. This study develops a cycle-level modeling framework to evaluate both energy consumption and CO_2 removal performance of DAC systems.
The model quantifies energy requirements across the distinct operational phases: adsorption, vacuum purge, regeneration, and cooling. It also estimates the mass of CO_2 captured per cycle, allowing direct comparisons of carbon removal potential against energy input. Simulating weather conditions demonstrates how ambient temperature, humidity, and pressure influence both energy consumption and capture efficiency. Preliminary results show that energy use is unevenly distributed across DAC phases, with regeneration accounting for the largest share of the demand. Variations in weather conditions also alter capture performance, revealing the importance of plant location considerations.
This cycle-based approach offers a method to assess the tradeoffs between energy input and carbon capture in DAC systems. The modeling framework can be extended to compare different sorbent materials, regeneration strategies, or operational scenarios, ultimately supporting efforts to optimize DAC for sustainable large-scale deployment.

Mentor(s):
Dr. Rebecca Ciez, Mechanical Engineering and Environmental and Ecological Engineering

Abstract Number: 60

Research Areas(s):
Other: Methane

RumenBot: Autonomous Rumen Methane Monitoring for Precision Sustainability

Author(s): **** indicates presenter(s)***
* Juan Soto
*Saru Bharti
*Yuelin Deng
Upinder Kaur, Agricultural and Biological Engineering

Abstract:
Livestock systems are a major contributor to global greenhouse gas emissions, yet remain among the least instrumented components of agriculture. Sustainable management of ruminant livestock requires continuous, non-invasive monitoring of digestion dynamics to reduce methane emissions, optimize feed utilization, and improve animal welfare. Current sensing methods like passive boluses (swallowed sensors that stay in one spot) or external gas sniffers provide only snapshots of data from single locations, missing the dynamic processes happening throughout the four-chambered stomach. To address this challenge, we developed a bio-compatible robot that can swim through a cow's rumen. The system employs an origami-inspired, shape-morphing buoyancy mechanism that enables vertical navigation across rumen layers without propellers or rigid components, minimizing energy use and biological disturbance. By continuously collecting high-resolution spatiotemporal data on fermentation, microbial activity, and gas production, the robot enables data-driven strategies for feed optimization and methane reduction, directly advancing climate-smart and sustainable livestock management. Beyond agriculture, the design principles energy-efficient operation, gentle locomotion, and resistance to biofouling offer a foundation for next-generation bio-integrated robotic systems in environmental monitoring and ecological restoration.

Abstract Number: 61

Research Areas(s):
Other: Animal Ag

Animal Robot interaction

Author(s): **** indicates presenter(s)***
*Ian Noronha
*Juan Soto
Upinder Kaur

Abstract:
Animal-robot interaction (ARI) holds significant potential for advancing sustainable agriculture, yet remains an open challenge as robots struggle to interpret animals' complex, multimodal communication cues such as body language, movement, and vocalizations. Unlike human-robot interaction, ARI lacks the datasets and frameworks needed for reliable, bidirectional understanding. To address this gap, we introduce MBE-ARI (Multimodal Bidirectional Engagement in Animal-Robot Interaction) a comprehensive multimodal dataset capturing natural interactions between a legged robot and cows. The dataset provides synchronized multi-view RGB-D streams annotated with detailed body poses and activity phases, enabling fine-grained behavioral and welfare analysis. We also present a quadruped pose estimation model capable of tracking 39 keypoints with a mean average precision of 92.7%, outperforming existing benchmarks. Together, MBE-ARI and our pose estimation framework establish a foundation for robotic systems that can monitor livestock welfare, optimize resource use, and reduce environmental impact. By enabling perception-driven, adaptive robot behaviors in farm environments, this work contributes to sustainable, data-driven livestock management and precision agriculture practices. The dataset and resources are publicly available at https://github.com/RISELabPurdue/MBE-ARI/

Mentor(s):
Dr. Upinder Kaur, Agricultural and Biological Engineering

Abstract Number: 62

Research Areas(s):
Other: Life Cycle Assessment

Process-Based Life Cycle Assessment of the Manufacturing and Scale Up of Polyethyleneimine-Derived Sorbents for Direct Air Capture

Author(s): **** indicates presenter(s)***
*Ioannis Keroglou - Sustainability Engineering and Environmental Engineering
Rebecca E. Ciez - Mechanical Engineering; Sustainability Engineering and Environmental Engineering

Abstract:
Direct Air Capture (DAC) is a leading negative-emissions technology that removes CO_2 from air via reactions with amines. Solid aziridine-based polyethyleneimine (PEI) sorbents are especially studied for their high amine density and stability under thermal swing cycles. Most Life Cycle Assessment (LCA) studies use a cradle-to-gate boundary focused on DAC operation, offering little insight into sorbent manufacturing. This overlooks process hotspots, differences among sorbent types, and their carbon and energy footprints, gaps that are crucial for scaling DAC technologies. This study conducts a process-based LCA of PEI sorbent production for DAC, modeling aziridine-derived synthesis from lab to industrial scale. It quantifies water use, energy demand, and climate impacts within a gate-to-gate boundary under different PEI loadings and batch sizes. GHG emissions are estimated using U.S. EIA regional grid data, enabling comparison of manufacturing strategies and siting options across the United States. The results reveal a wide variation in energy intensity and corresponding emissions across sorbent types and PEI loadings. Some supports show increasing energy demand and higher emissions with greater PEI loading (e.g., γ-alumina/PEI, silica gel/PEI), others remain relatively stable (e.g., MCM-41/PEI, polyHIPE/PEI), while a third group shows declining energy demand and emissions as loading increases (e.g., MMSV/PEI, SBA-15/PEI). Notably, even sorbents from the same precursor (e.g., silica-based) show different energy-emission trends, reflecting the influence of distinct synthesis routes. Emission analysis also indicates more sustainable prospects in Texas and California, where lower-than-average grid factors align with strong chemical manufacturing capacity to support large-scale PEI sorbent production for DAC.

Mentor(s):
Rebecca E. Ciez - Mechanical Engineering; Sustainability Engineering and Environmental Engineering

Abstract Number: 63

Research Areas(s):
Other: Community Development/Public Health

Health for All: Development of a "Serious Game" to Educate Youth Involved in Poultry Shows on Zoonoses

Author(s): **** indicates presenter(s)***
*Giovanna Vinci Roberto[1], Wendy Beauvais[1], Julia Hüttl[2], Casey Mull[3], Jeffrey G. Pell[4], John Paul Pietrowski[4], Evan K. Perrault[5], Courtney R. Stierwalt[4], Darrin M. Karcher[6], Andrew Patrick Hopkins[7], Geoffrey Lossie[1], Isabel Lechner[2], Wendy Beauvais[1]

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[6]Animal Sciences
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Abstract:
Backyard poultry systems worldwide present significant public health concerns due to zoonotic pathogens. Recent outbreaks, including salmonellosis linked to chick sales, have resulted in deaths, hospitalizations, and economic losses across the USA. Since February 2022, over 166 million birds have died from High Pathogenic Avian Influenza (HPAI), with 929 backyard flocks testing positive. Managing depopulation and traceability is challenging, especially in remote areas. According to the American Pet Producers Association, this year, approximately 11 million U.S. households own chickens, a number that continues to increase. Many states, including Indiana, do not require registration for non-commercial flocks, emphasizing the need for increased biosecurity awareness. This project aims to address knowledge, attitude, and practice (KAP) gaps related to biosecurity among youth engaged with poultry in Indiana, identified through a self-administered survey. Age-appropriate educational materials have been developed for 4-H classes. A class outline employing a serious game approach was provided to increase engagement between students and the learning topic. Additionally, 16 educational sticker designs and a hands-on glitter activity illustrating bacterial and viral transmission were created. These initiatives aim to deliver tailored education that is accessible regardless of location, age, or income, with the goal of increasing youth knowledge and practices, influencing parental behavior, raising awareness, and promoting safe poultry handling practices. Ultimately, these efforts seek to reduce public health risks. The effectiveness of the intervention will be evaluated through pre- and post-questionnaires administered during the 4-H classes.

Mentor(s):
Dr. Wendy Beauvais, Comparative Pathobiology

Abstract Number: 64

Research Areas(s):
Other: Adoption of Sustainable Technologies

Factors Impacting the Additional Electric Vehicle Registration Fee

Author(s): **** indicates presenter(s)***
*Bruno Cesar Krause Moras, Civil and Construction Engineering
Lavan Teja Burra, Civil and Construction Engineering
Arumoy Biswas, Utah State University
Dr. Janette Goodridge, Utah State University;
Dr. Konstantina Gkritza, Civil and Construction Engineering and Agricultural and Biological Engineering

Abstract:
As United States electric vehicle (EV) sales reach record highs, more states are introducing additional EV registration fees. This annual surcharge, imposed on top of the regular registration fee, is designed primarily to compensate for fuel-tax losses caused by transportation electrification. However, discrepancies occur, as several states with high EV penetration rates do not impose such fees, while others charge more than $200 per year. Most previous research focuses only on the link between fee levels and fuel-tax revenue, overlooking factors such as the presence of EV incentives, road conditions, and political context. This study aims to address this gap by using state-level panel data from 2013 to 2023 and estimating a hazard model that investigates factors influencing the adoption of EV registration fees. A logit model assesses the probability of fee adoption in a given year among states that have never adopted the fee before. The results confirm that states more dependent on motor-fuel taxes for roadway funding tend to adopt the fee earlier, and they also reveal that non-fiscal factors, such as political preferences and sociodemographic characteristics, significantly influence the probability of fee adoption. Additionally, the coefficients suggest that other factors, such as gasoline prices and amount of fuel-tax collections, do not affect the adoption of EV fees. This study offers several recommendations for policymakers.

Mentor(s):
Dr. Konstantina Gkritza, Civil and Construction Engineering and Agricultural and Biological Engineering

Abstract Number: 65

Research Areas(s):
Other: Sustainable Tourism

Collaborating for Sustainable Tourism: The Partnership Between Purdue University and Indiana Dunes Tourism

Author(s): **** indicates presenter(s)***
Ailin Fei
*Jonathon Day

Abstract:
As climate change and environmental pressures intensify, destinations must adapt to ensure long-term sustainability and resilience. This research poster presents a collaborative partnership between Purdue University and Indiana Dunes Tourism designed to advance sustainable tourism practices and inform climate action planning in one of Indiana's most valued natural destinations.

The project developed a comprehensive sustainability strategy tailored to the destination's unique environmental, cultural, and economic context. The research team conducted benchmarking of sustainability practices across comparable destinations, identified the key natural, cultural, and economic capitals of the Indiana Dunes area, and performed a marketing audit to evaluate alignment between current promotional efforts and sustainable tourism values. In addition, community engagement was prioritized through surveys with residents and industry stakeholders to assess perceptions of sustainability, tourism impacts, and opportunities for collaboration.

Findings from this initiative provide practical and strategic guidance for enhancing climate resilience, strengthening community engagement, and supporting sustainable economic development. The outcomes also demonstrate how partnerships between academic institutions and destination organizations can bridge research and practice to deliver locally relevant, evidence-based sustainability solutions.

This poster highlights the project's major insights, and recommendations, illustrating how the Indiana Dunes Tourism partnership serves as a replicable model for other Midwest destinations seeking to integrate sustainability and climate action into their tourism development plans.

Mentor(s):
Dr. Jonathon Day, Hospitality and Tourism Management

Abstract Number: 66

Research Areas(s):
PFAS, Other

Improving the stability of PFAS-free firefighting foams with polyurea microcapsules

Author(s): **** indicates presenter(s)***
* Elizabeth Malek* - Materials Engineering Department
Dr. Jeffrey Youngblood - Materials Engineering Department
Dr. Carlos Martinez - Materials Engineering Department

Abstract:
The widespread use of per- and polyfluoroalkyl substances (PFAS) in many applications such as coatings, water-resistant textiles, personal care products , and especially firefighting foams has become heavily regulated in recent years. This strict regulation is a step toward complete removal due to PFAS being linked to harmful effects on human health and environmental persistence. Removal of PFAS in firefighting foam formulations has been achieved in some select commercial formulations; however, in some cases it requires the addition of viscosifying agents to slow drainage and improve foam stability. While the viscosifiers improve stability factors over time, they simultaneously impede the spreadability and extinction time. To combat this, polyurea microcapsules with a viscosifying agent, Carbopol 940, in the core can be produced and incorporated into foam formulations improving foam stability, while decreasing initial formulation viscosity. Different parameters were adjusted to optimize the microcapsules like isocyanate and polyamine concentration, viscosifier concentration, and surfactant concentration. Characteristics of these adjustments like capsule size, shell thickness and permeability, encapsulation efficiency, and ability to improve foam stability were investigated.

Mentor(s):
Dr. Jeffrey Youngblood- Materials Engineering Department
Dr. Carlos Martinez- Materials Engineering Department

Abstract Number: 67

Research Areas(s):
Other

Maple Syrup Cooperatives in North America

Author(s): **** indicates presenter(s)***
* Jean Fritz Saint Preux*, Bindu Paudel, Mo Zhou

Abstract:
The maple syrup industry is a vital part of North America's agricultural landscape. As a highly seasonal and weather-dependent product, maple syrup production presents unique challenges for individual producers, including fluctuating yields and market access difficulties. Cooperative organizations are essential in addressing these challenges by fostering collaboration among individual producers, pooling resources, and offering shared services such as marketing, training, and financial assistance. Other collaborative structures, including industry associations and informal arrangements between landowners and producers, further strengthen the resilience, growth, and sustainability of the industry. Here, we seek to provides an overview of the status quo of maple syrup cooperative structures in the U.S. and Canada. We aim to clarify the distinctions between cooperatives and associations, inventory existing organizations, and explore their services and benefits. We also examine producers' perceptions of cooperatives and associations, and the role of leasing arrangements as an informal cooperative structure and an alternative to land ownership.

Mentor(s):
Dr. Mo Zhou, Department of Forestry and Natural Resources

Abstract Number: 68

Research Areas(s):
Other

Cost and Emissions Impacts of Hybrid High Temperature Heat Pump Systems

Author(s): **** indicates presenter(s)***
* Joseph Tenpenny, Jan Spale, Davide Ziviani, Rebecca Ciez

Abstract:
Process heat is one of the largest drivers of industrial energy demand and greenhouse gas emissions. Here, we consider a spray drying facility case study that requires 6100 kW of heat from 8AM-5PM every day, and examine the potential costs and emissions impacts of adopting a hybrid heating system with a high temperature heat pump (HTHP) over a purely natural gas (NG) boiler system.We generate the NG and electricity demand, accounting for both NG boiler efficiency and the coefficient of performance of the HTHP system, respectively. Using this information about the quantity and timing of NG and electricity demand, we then consider the costs to operate spray drying systems with HTHP and NG boilers.In addition to the costs of operating spray dryer systems, we consider the greenhouse gas emissions of the NG and the electricity used to meet the heat demand.We use these costs and emissions quantities to calculate the levelized cost of heat from each kind of heating system, and the cost of using HTHPs as GHG emissions abatement technology. We find the hybrid system has lower lifetime costs in states where NG boiler heat is \$47/kW_{th} more expensive to produce.We also find that in 14 states, customers see less than 1% increase in levelized cost of heat by choosing HTHP hybrid system over a NG only system. Additionally, the costs of carbon abatement are lower than CCS alternatives for industrial customers in 65 out of 97 grid regions.

Mentor(s):
Dr. Rebecca Ciez, Mechanical Engineering, Environmental & Ecological Engineering