University of Pittsburgh
Mascaro Center for Sustainable Innovation

2025 Summer Research Program
Project Descriptions

Application Link: https://tinyurl.com/summer2025research
Applications Due: February 17, 2025
Program Period: May 12, 2025 – July 18, 2025

Advancing Environmental Justice Through Movement-Engaged Participatory Research
Students will conduct research in collaboration with environmental justice activist groups. This will include identifying and summarizing relevant academic literature, drafting policy briefs and white papers, and working on scholarly manuscripts. Topics of interest include 1) policies to achieve a just transition away from fossil fuels and plastic production, 2) carbon offsets and credits, 3) solidarity and inclusion within the environmental movement ecosystem, and 4) disasters, mutual aid, and social vulnerability, among other topics.
Advisor: Fernando Tormos-Aponte, Sociology

Evaluating Reoccurring Landslides to Design More Sustainable Mitigation
Southwestern PA's infrastructure, both ecological and built, is fundamentally impacted by landslides. This work will leverage the recently completed regional landslide database to evaluate characteristics of landslides occurring in the same location as historical landslides and compare the reoccurring landslides with new landslides in areas without known historical landsliding. This comparison will generate foundational information necessary to design more sustainable and resilient landslide solutions.
Advisor: Daniel Bain, Geology and Environmental Science

Evaluating Urban Soil Metals Along the Eastern Seaboard
The "fertilization" of urban systems with a complicated mixture of trace metals has poorly characterized impacts on urban systems. This work will measure metal concentrations in soil samples collected at sites along the Eastern Seaboard of the United States. The student will be able to place these laboratory results into a rich context provided by data collected as part of the NSF-funded Urban Critical Zone Cluster.
Advisor: Daniel Bain, Geology and Environmental Science

Development of a Reusable Pulse Oximeter Prototype
A comparative life cycle analysis of disposable versus reusable pulse oximeters (manuscript in preparation) showed that the reusable probes have a more favorable environmental profile and 35 times less global warming potential than the disposable probes. We propose using human-centered design principles to address the challenge of implementing reusable pulse oximetry probes in clinical settings. The selected summer intern would work within the SSOE IDEA Lab to address this problem and would also contribute to other ongoing projects within the lab to provide a holistic exposure to the innovation, design, and entrepreneurship process.
Advisor: Kevin Bell, Bioengineering

Nutrition Security & Sustainability
A poor diet is a significant risk factor for chronic diseases. The concept of Food is Medicine (FIM) highlights the crucial link between diet and health. A healthy diet benefits both individuals and the planet. When food is wasted, it generates harmful methane gas in landfills. We will analyze the nutrient content and carbon footprint of the food that is donated through the University of Pittsburgh Food Recovery Heroes to measure the increase in nutrient security and decrease in carbon footprint through sustainable food decisions between UPMC and the University of Pittsburgh.
Advisor: Corey Flynn and Dr. Michael Boninger, Office of Sustainability in the Health Sciences (OSHS)

Filtration properties of binder jet 3D printed porous metals for reusable filter applications
Over the past years, we have worked on printing filters for air and liquid filtration applications that can be reused instead of disposed of after one use. Furthermore, for specific applications, e.g. healthcare, these filters can be made from antibacterial/antiviral copper and are therefore ideal for environments with heavy bacteria and virus exposures. In this project, we want to further enhance filtration capabilities and improve the pressure drop of our 3D printed filters to add even more benefit to these reusable filters.
Advisor: Markus Chmielus, Mechanical Engineering and Materials Science

Developing and Conducting a Scope 3 Greenhouse Gas Inventory
The Center for Sustainability is a newer department at UPMC, so we are in the beginning stages of developing methods for conducting a UPMC systemwide greenhouse gas inventory. 2023 is the first year of a scope 1 and 2 inventory, so 2024 will be the first year with a scope 3 inventory. The student will help with data collection, data analysis, methods creation, and research on other scope 3 calculators to help create a tailored calculator for UPMC.
Advisor: Sydney Crum, UPMC Center for Sustainability

Data Collection and Automatization for Sustainability Teams and Sustainable Business Units
The Center for Sustainability has sustainability teams at each UPMC hospital along with business units that have been recognized for their sustainability contributions. The system to gather data from teams and units is mostly manual at this point. The student will help with data collection, data analysis, and data automation. They can also help with creating and overseeing new sustainability projects with the sustainability teams.
Advisor: Sydney Crum, UPMC Center for Sustainability

Determination of Sustainable and Selective Polystyrene Degradation Mechanisms
Polystyrene is one of the most chemically inert and resilient plastics, but the polymer structure presents significant challenges for recycling. This project aims to develop a more sustainable and selective method of polystyrene degradation using mild reaction conditions, visible light, and green oxidants. Students will apply spectroscopic and computational techniques to fully characterize the oxidation mechanisms responsible for selective polystyrene degradation.
Advisor: Kimberly Carter-Fenk, Chemistry

On the limits of disaster insurance
As our climate changes, so does the frequency and intensity of natural disasters. People insulate themselves (at least financially) from these risks by purchasing insurance. However, as these events become more common, the calculus of insurance policies start to break down and become economically infeasible. For instance, we see such events already occurring in the Florida market for housing insurance. In this project we will explore the limits of these policies and propose modifications. This project will be primarily theoretical/mathematical in nature.
Advisor: Michael L Hamilton, Business Analytics and Operations

Capacity of Dowe-type connections to bamboo
The primary hurdle to broad use of full-culm (pole) bamboo materials in construction is the lack of practical and reliable means of making culm-to-culm connections. Doweled connections are preferred but require significant study in order to optimize their characteristics and design. This study will involve the development of a unique test method intended to permit the assessment of off-axis dowel capacity in bamboo connections. In addition to Prof. Harries, the summer 2025 project will be overseen by a visiting Fulbright Professor.
Advisor: Kent Harries, Civil and Environmental Engineering

Beaver County Art and Design Interventions
This project is supporting art and design projects created in collaboration with Beaver County Awareness Community, an environmental group focused on the health and well-being of citizens in Beaver County. Possible projects include art workshops, events and public art interventions.
Advisor: Aaron Henderson, Studio Arts

Modeling Climate Change Impacts on Insect-Pollination Dependent Crops
This project seeks to evaluate the impact of climate change on insect-pollination dependent crops. We will identify regions and crops most resilient/vulnerable to effects of climate change and identify management strategies for sustainable crop production.
Advisor: Vikas Khanna, Civil and Environmental Engineering

Modeling Climate Change Risks to Food Supply Chains
The overall goal of this project will be to model the impacts of climate change on food supply chains focusing on selected agricultural crops. We will identify combinations of food items and regions most vulnerable to effects of climate change and how these risks propagate across the food supply chain. The findings are expected to provide insights on the sustainability and resilience of food supply chains under varying climate change scenarios.
Advisor: Vikas Khanna, Civil and Environmental Engineering

Using machine learning models to identify wildlife species in field recordings
Our lab uses small, inexpensive acoustic recorders to record soundscapes at field sites across the United States. We are interested in hosting a summer fellow who will work with us on this research. The main tasks will be developing and testing machine learning models to identify species of birds, bats, frogs, and/or insects within long field recordings, but tasks may also include deploying recorders in the field, managing incoming data, and testing new hardware designs.
Advisor: Justin Kitzes, Biological Sciences

Understanding management and services of urban and backyard ponds in Pennsylvania
Our current understanding of aquatic ecology is largely focused on pristine ecosystems. However, many amphibians and aquatic invertebrates live in human-altered habitats under different and unknown management regimes. The student associated with this project will work to contact land managers to understand the management practices (dyes, algicides, etc.), and the services and values that ponds provide to different landowners (golf courses, cemeteries, private residences).
Advisor: Kevin Kohl, Biological Sciences

Gate Driver Circuit Design for Energy-Efficient High-Voltage Power Converters
Energy efficiency in power converters is essential for reducing overall energy consumption and achieving sustainability, especially given the ever-increasing global energy demand. However, designing an energy-efficient gate driver circuit presents a significant challenge, as it requires controlling low-voltage logic while driving the power transistor's gate with high voltage. In this project, the student will research methods for designing high-voltage power converters and their associated gate driver circuits within Application-Specific Integrated Circuits (ASICs) to address these challenges.
Advisor: In Hee Lee, Electrical & Computer Engineering

Detecting low-cost retrofit solutions in homes
This project focuses on identifying air leakage in homes using thermal imaging technology to improve energy efficiency. Thermal cameras detect temperature differentials, highlighting areas where heat escapes or drafts infiltrate through poorly sealed windows, or doors. We will develop a hybrid approach that uses machine learning and building models to automatically detect such anomalies, compensating for potential inaccuracies from low-cost thermal cameras. This cost-effective solution aims to reduce energy consumption and lower utility bills for a wide range of homes.
Advisor: Stephen Lee, Computer Science

Solar Panel Recycling
This project aims to develop new methods to enhance the recycling of solar panels at the end of their life cycle (EOL). While solar energy is a rapidly growing renewable and sustainable power source, around 90% of EOL solar panels currently end up in landfills. This project focuses on improving material separation processes to reduce waste and support more efficient recycling efforts.
Advisor: Paul Leu, Industrial Engineering

Sustainable Glass
This project focuses on creating environmentally friendly glass with high transparency to help combat global climate change. The goal is to produce glass with a lower carbon footprint and reduced melting temperature, while maintaining excellent transparency. These advanced glass materials would be ideal for applications in buildings, infrastructure, solar energy, and consumer electronics, enhancing energy efficiency and promoting sustainability.
Advisor: Paul Leu, Industrial Engineering

Investigation and mitigation of climate change impacts on Pennsylvania regions
In this project, an open data and open model cyberinfrastructure software system (CyberWater) will be used to analyze future climate predictions from complex Earth system models (e.g., CMIP6) under different CO2 emissions scenarios. The project will also explore strategies for better managing the impacts on water resources and energy in Pennsylvania and other regions of the U.S.
Advisor: Xu Liang, Chemical and Environmental Engineering

LEMONTREE: Understanding plant responses to climate variability
In this project, plant responses to climate variability and their impacts on water, energy, and carbon cycles under climate change will be explored through data analysis and model simulations. In particular, the behavior of plant roots will be investigated.
Advisor: Xu Liang, Chemical and Environmental Engineering

Triboelectric effect at water-carbon interface
This project will study how electric charge and current can be generated by flowing electrolyte solution over a carbon substrate (e.g., graphene). The student will receive training in preparing carbon materials, conducting electrical measurements, and using software to analyze large data sets.
Advisor: Haitao Liu, Chemistry

Leveraging Generative AI for Sustainable Knowledge Reuse in Science
This project will focus on using generative AI, large language models such as GPT and LLaMa, for knowledge retrieval and reuse. We will evaluate the tradeoffs between using resources to re-create knowledge vs. retrieving it from dispersed sources and organizing it in a structured format. To examine the tradeoffs, we will use the suite of tools in MeLoDy lab to access LLMs through APIs, collect and organize large amounts of knowledge from published literature, and measure the performance of tools and models.
Advisor: Natasa Miskov-Zivanov, Electrical and Computer Engineering

Using Generative AI to Identify Sustainability Gaps in Healthcare
This project will focus on using generative AI, large language models such as GPT and LLaMa, for retrieving application specific knowledge in the health domain to evaluate the sustainability practices, identify gaps, and propose improvements for these practices. We will use the existing set of tools in MeLoDy lab to access LLMs through APIs and collect large amounts of information and data from articles, organize them in a structured form, and analyze the collected information to generate recommendations.
Advisor: Natasa Miskov-Zivanov, Electrical and Computer Engineering

Advanced Manufacturing of Soft Magnetic Nanocomposite Alloys for Space and Energy Applications
Advanced magnetic materials are critically important for harsh environment applications that also require high electrical efficiency. Magnetic alloys will be processed to generate nanocomposite microstructures using advanced manufacturing methods based upon electrical current annealing. By controlling the heating rate and profiles, a range of nanostructures will be developed, and magnetic properties will be correlated with features such as grain size, volume fraction, and phase identity of nanocrystallites.
Advisor: Paul Ohodnicki, Mechanical Engineering and Materials Science

Fiber Optic Sensing, Modeling, Application and Data Processing for Energy Infrastructure Monitoring
Fiber optic sensing will be applied for monitoring of energy infrastructure such as pipelines and pressurized vessels. Students will have a chance to experimentally work with measurements using fiber optic sensors and/or utilize physics-based modeling of responses to understand how data can be optimally processed and applied.
Advisor: Paul Ohodnicki, Mechanical Engineering and Materials Science

EvolvingSTEM: a three-dimensional laboratory evolution curriculum to increase STEM occupational identity through authentic experiences
Our aims are to assess program impacts on subject learning and STEM attraction in high school biology classes. We will assess high school student attitudes and motivation toward STEM-related careers with established surveys based on the STEM occupational identity survey and focus group interviews. Students will be grouped by starting attitude and evaluated after standard and extended inquiry programs. We will assess student understanding with pre- and posttests based on AAAS Project 2061 and aligned to NGSS

performance expectations, which include a focus on environmental education and sustainability. We will track durability of STEM attraction by longitudinal self-reporting and opinion surveys. We will evaluate the effects of near-peer mentors and curriculum duration on student's identity as researchers.
Advisor: Cassie Quigley, Teaching, Learning, and Leading

My Nature Outing
My Nature Outing examines how we might promote dialogic models of science communication using digital tools to engage youth in inquiry, data collection, and the formation of environmental knowledge. Over the course of a single day, our middle school participants inquire into nature and work with HTML code templates to create a science communication document they can share with others. The program runs 3-5 single-day camps per summer, including a camp focused on Exploring Sustainable Design. Ideally, we would like to connect with schools and existing summer programming to extend these experiences to others.
Advisor: Steven Quigley, English

Data-Driven Analysis of Landfill Greenhouse Gas Emissions through Statistical Modeling and Geospatial Insights
This project aims to analyze greenhouse gas (GHG) emissions from landfills across the United States using statistical modeling and geospatial mapping. The goal is to identify key factors influencing emissions and map geographic trends to support real-time decision-making and targeted sustainability practices. Objectives:
1. Statistical Correlation Analysis: The goal is to assess the relationship between landfill characteristics, such as waste volume, ownership type, equipment suppliers, and GHG emissions. This analysis aims to uncover significant drivers of emissions and provide insights into the effectiveness of reduction strategies.
2. Geospatial Mapping of Emissions: This geospatial analysis seeks to identify high-emission hotspots and regional trends, supporting a clear understanding of emission distributions across the country.
Advisor: Amin Rahimian, Industrial Engineering

Sustainability research project on a selected topic
This project aims to advance sustainability learnings and commitments based on research on a selected topic of student's interest. Student is encouraged to bring a proposal. The project will cover fundamental knowledge on sustainability, guiding principles, and basic approaches for sustainable development. It will explore scientific literature on the selected topic and provide an analysis to highlight the most promising opportunities for further development. The project will elaborate on the most active research centers in the field, sources of publication, current initiatives and tools for analysis. It is aimed to approach a life cycle analysis of the material or process. Student will get training in project management and advancing research on sustainability.
Advisor: Joaquin Rodriguez, Chemical and Petroleum Engineering

Protocol for renewable energy laboratory experiments
Two available lab equipment are in the process to be commissioned for supporting the learning of undergraduate students on sustainability. A solar powered electrochemical cell and a hydrogen fuel cell units are to be used to illustrate and provide basic analysis of the competitive use of alternative energy based on renewable sources. The project consists of testing the equipment, developing lab protocols, and structuring undergraduate lab practices. Student will get experience in lab equipment and instrumentation for sustainability education and research.
Advisor: Joaquin Rodriguez, Chemical and Petroleum Engineering

Electric Vehicle Charging Infrastructure in Pennsylvania: Addressing Barriers to Adoption
This research will examine how the availability and distribution of electric vehicle (EV) charging stations impact the growth of EV market in Pennsylvania. It will explore how strategically placed charging stations can alleviate concerns such as range anxiety, boost consumer confidence, and drive EV adoption. Additionally, the study will address other challenges, including the availability of fast-charging stations, infrastructure affordability, and the sustainability of the energy used. This research aims to evaluate how an optimized, sustainable EV charging network can support Pennsylvania's transition to electric mobility and reduce carbon emissions.
Advisor: Ramin Shabanpour, Civil and Environmental Engineering

Shared Bikes in Pittsburgh: Analyzing Usage Patterns and Environmental Benefits

This project will investigate the impact of shared bike programs on sustainability in Pittsburgh, focusing on usage patterns and their potential environmental benefits. With urban mobility shifting toward more sustainable transportation options, shared bike systems have gained popularity as an alternative to car use, reducing traffic congestion and greenhouse gas emissions. The research will analyze the usage patterns of shared bikes in Pittsburgh, exploring factors such as trip frequency, locations of usage, and demographic trends. The study will also assess the environmental impact of these programs by quantifying reductions in carbon emissions and energy consumption.

Advisor: Ramin Shabanpour, Civil and Environmental Engineering

Using Diatoms to Reconstruct Environmental Change

The major objective of the proposed research is to use previously obtained sediment cores from lakes in Chile and Pakistan to reconstruct climate and environmental change over the Common Era. The student will sample diatoms from sediment cores and identify diatoms to species to indicate past environmental conditions. Hydroclimate variability as indicated by diatoms will be compared with planktonic (water column) diatoms dominating relative abundance during warmer conditions and periphytic (attached) diatoms dominating relative abundance during cooler conditions in Patagonia and the Himalayas. Diatoms will be used to indicate changes in water quality conditions, system tropic status, and lake level.

Advisor: Patrick Shirey, Geology and Environmental Science

Stream Restoration Monitoring in the Churchill Valley Greenway

This is an opportunity to collect stream and wetland monitoring data in the Churchill Valley Greenway, a 151-acre former golf course that is being restored via Acid Mine Drainage remediation and reconnecting of the stream to floodplain wetlands. The Allegheny Land Trust is developing a master plan for the greenway, and our project will provide necessary information on stream and air temperatures, water quality, and the fish and macroinvertebrate community in Chalfant Run, which flows through Environmental Justice communities. The data collected through a Before-After-Control-Impact (BACI) design will help inform future stream restoration efforts in Chalfant Run and Thompson Run watersheds east of Pittsburgh.

Advisor: Patrick Shirey, Geology and Environmental Science

Optimization of traffic signals to reduce fuel consumption and vehicular emissions

This project will give students an opportunity to investigate the impact of various stop penalties (e.g. how many seconds of delay each vehicular stop is worth, from the perspective of consumed fuel) on optimization of traffic signals. Students will use one of the contemporary practical signal optimization tools to test how various stop penalties affect the quality of signal timing plans, which will be measured through associated fuel consumption based on outputs of highly calibrated and validated microsimulation model. The study and results are intended to be submitted for presentation at the 2026 Transportation Research Board conference and the associated journal.

Advisor: Aleksandar Stevanovic, Civil and Environmental Engineering

Validation of Google Eco-friendly routing method

This project will give students an opportunity to validate Google's recently introduced, eco-friendly method where drivers are given the best route not in terms of shortest time to their destination but in terms of the lowest impact on the environment (by suggesting a route which leads to lowest fuel/energy consumption). Students will compare Google's results, for a selected number of routes, to data from a set of highly calibrated and validated microsimulation models to test validity of the proposed routing method. The study and results are intended to be submitted for presentation at the 2026 Transportation Research Board conference and the associated journal.

Advisor: Aleksandar Stevanovic, Civil and Environmental Engineering

Closing the loop: Utilizing low-purity hydrogen streams via chemical looping
Hydrogen is the "Swiss army knife" of decarbonization across many industrial sectors. However, many current hydrogen streams are too low purity to be used industrially, and their purification adds large energy requirements and cost. This project is developing a novel technology that enables use of low-purity hydrogen streams without the need for any further purification via "chemical looping" using hydrogen carrier materials.
Advisor: Goetz Veser, Chemical and Petroleum Engineering

Towards Circular Use of Polyurethanes
Recycling plastic waste is essential to reducing environmental pollution, conserving resources, and minimizing the carbon footprint of polymeric materials. Polyurethanes, widely used as insulation materials, flexible foams for furniture and bedding, coatings, sneakers, and cell phone cases (to name just a few of their many uses!) are particularly important in this context due to the absence of any effective recycling solutions. We are investigating two different approaches towards PU recycling - careful chemical disassembly using targeted catalysts, and robust pyrolysis technology based on using molten metals as novel catalytic reaction media.
Advisor: Goetz Veser, Chemical and Petroleum Engineering

Design spinel ferrite magnetic adsorbents for water purification
In this project, advanced computational methods will be used to predict the capability of a series of spinel ferrites for removing metal ions (such as Pb, As) from industrial wastewater. The outcome of the project is to identify the optimal composition and morphology of spinel ferrite particles to chemically adsorb and remove metal ions from the water.
Advisor: Guofeng Wang, Mechanical Engineering and Materials Science

Can Improved Waterway Quality Enhance Economic Resilience in Coal Communities?
The student will assist with researching the experience of particular communities in coal producing regions of Pennsylvania, some of which have waterways still polluted with mine drainage and some of which have had cleanups. The case studies will focus on understanding the role that cleanups (or lack of them) have played in revitalizing local economies. These case studies will complement more systematic data analysis that the student researcher, if desired, could participate in work on.
Advisor: Jeremy Weber, Graduate School of Public and International Affairs

Advanced manufacturing of high-performance alloys for improved recyclability
This project will work on new alloy development to facilitate alloy recycling efficiency. For example, some aluminum alloys are usually recycled with an excessive metal Fe content from the automobile industry, and thus, they are hard to refine into advanced Al alloys, which require a limited amount of Fe. Instead of developing a new recycling process, this work aims to develop some new alloy compositions that will enhance recyclability. The project will enable the internship students to understand material process-structure-property relationships during advanced manufacturing, including but not limited to cast and 3D printing.
Advisor: Wei Xiong, Mechanical Engineering and Materials Science

Additive manufacturing of nonclassical alloys with multi-principal elements for improved sustainability
The goal of this project is to design and study a nonclassical alloy known as multi-principal element alloys (MPEAs), also referred to as high-entropy alloys. The purpose of this work is to (1) develop a functionally graded alloy with a high entropy composition gradient between traditional alloys and thus enable their functionality, and (2) develop a new composition through computational thermodynamics for improved sustainability. The student can have the opportunity to design a new alloy, in addition, they could also design a co-free cemented carbide to reduce the toxicity of the transitional cutting tool made by this material. The students involved in this project will get a chance to learn the state-of-the-art metal 3D printing techniques as well as the materials characterization.
Advisor: Wei Xiong, Mechanical Engineering and Materials Science

Energy and Smart Data Analytics
Innovative energy research and developing smart dashboards and analytics to inform design making for hospitals and healthcare.
Advisor: Kate Zettl, UPMC Center for Sustainability