UC SANTA BARBARA
Bren School of Environmental Science & Management

Symposium Schedule

This symposium will have short (3 minutes) and long (12 minutes) oral presentations, with one short break (30 minutes).

1:00-1:10pm Welcome remarks,
Kelly Garvey,
Chair, PhD Symposium Committee

Bruce Kendall,
Bren School Associate Dean

The Bren School expresses its sincere gratitude to the sponsor of the PhD student symposium.

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Symposium Schedule

(CONTINUED)

ORAL PRESENTATION I

1:10 – 1:25 pm: Zoe Sims, Risa Lewis, and Renae Marshall
"Beyond Monoculture: Understanding Impacts and Enabling Conditions for Intercropping in the United States"

1:25 – 1:40 pm: Wen-Tien Wang
"*Air Quality, Health, and Equity Outcomes of Decarbonizing Petroleum Refining in the United States"*

1:40 – 1:45 pm: Paxton Ridgway
"Drivers and Management of Changing Sediment Regimes in California's Rivers"

1:45 – 2:00 pm: Olivia Ross
"Investigating Fire-Drought Interactions in the Sierra Nevada"

2:00 – 2:05 pm: Fatiq Nadeem
"Satellites vs Farmers: Evidence from Strategic Evasion in South Asia"

2:05 – 2:20 pm: Aidan O'Neil
"From Climate Help to Hindrance? An Analysis of Combined Heat and Power Systems in the US Industrial Sector"

2:20-2:25 pm: Ojas Sarup
"Comparing Ecohydrological and Climate Resilience Outcomes of Forest Management in India"

2:25 – 3:05 pm: Refreshment Break

Symposium Schedule

(CONTINUED)

ORAL PRESENTATION II

3:05 – 3:20 pm: Michelle Mohr
"Novel Fire-Disease Interactions May Buffer Forests Under Climate Change"

3:20 – 3:35 pm: Jaenna Wessling
"Life Cycle Carbon Footprint of Global Apparel"

3:35 – 3:40 pm: Emma Rigatti
"One Species, Many Strategies: How Plant Hydraulic Traits Shape Divergent Water Use in Coast Live Oaks"

3:40 – 3:55 pm: Trace Martin
"Safer Swimming: Innovating Microbiological Water Quality Testing"

3:55 – 4:00 pm: Eleanor Thomas
"From Smokestacks to Power Plants: Does Industrial Electrification Reduce or Relocate Air Pollution Burdens?"

4:00 – 4:15 pm: Anna Pede
"Agreeing on Conservation? Forests and Land-Use Consensus in Peru"

4:15 pm: Closing Remarks

4:20 pm: Reception in the Michael J. Connell Memorial Courtyard

Symposium Abstracts

In order of appearance

Zoe Sims, Risa Lewis, and Renae Marshall

Title: Beyond Monoculture: Understanding Impacts and Enabling Conditions for Intercropping in the United States

Summary: Row crop production in the United States drives land use, nutrient pollution, greenhouse gas emissions, and harm to human health as a result of agrochemical inputs. In agronomic experiments, these environmental problems are reduced, per unit of food produced, by growing more than one crop intermingled within a field: a practice known as intercropping, which increases land and input efficiency relative to monocultures. Yet intercropping is extremely rare in the United States, and the costs which constrain its expansion, as well as the motivations and benefits experienced by the few farmers who have adopted it, have not been studied. We characterize methods, motivations, and costs of intercropping adoption among the small population of practitioners of mechanized, harvested row crop intercropping in the U.S. Through semi-structured interviews with U.S. farmers (n = 17), we identify three distinct ways that farmers grow crops together: 1) planting corn in strips alongside soybeans or forage crops, 2) planting wheat or rye first and then adding soybeans to the same field later, and 3) growing mixtures of grain, legume, or oilseed crops together. These adopters universally articulated motivations linked to on-farm environmental benefits, including enhanced soil biological activity, reduced erosion, and human health benefits of reducing chemical inputs. Contrary to suggestions in the literature, appropriate field machinery is not the only - or even the primary - factor limiting intercropping adoption across these systems; crop insurance, harvest separation equipment, and market availability are major challenges. Using the insights from farmer interviews, we are developing an economic model to quantify benefits and costs of intercropping for farmers and characterize potential profitability and uptake at scale.

Acknowledgements: H. William Kuni Bren Research Award

Wen-Tien Wang

Advisor: Ranjit Deshmukh

Title: Air quality, health, and equity outcomes of decarbonizing petroleum refining in the United States

Summary: The petroleum refining industry is the third-largest source of global greenhouse gas (GHG) emissions from stationary sources and a major source of air pollutants, including particulate matter, sulfur oxides, nitrogen oxides, volatile organic compounds, and metals. Previous studies have shown the significant impact of air pollution from refineries on neighboring communities that are disproportionately people of color and low-income households. With increasing electrification of transportation and a shift towards renewable liquid fuels like renewable diesel and sustainable aviation fuel in the U.S., the demand for petroleum refined products is likely to decline. U.S. refineries could (a) reduce their production of petroleum refined products in tandem with demand, (b) continue production at historical levels and increase exports, or (c) undergo conversions to produce renewable fuels or chemical feedstocks for other industries. How refinery production responds to changing demand for refined products will have significant impacts on air pollution exposure and health across communities.

In this study, we develop a modeling framework to analyze refined petroleum production pathways for U.S. refineries, their associated air pollution and impact on premature mortality, and the distribution of those impacts across different demographic groups. We first develop a refinery production model to simulate gasoline, diesel, and jet fuel production, exports, and refinery conversions and retirements in response to transportation fuel demand projections under different decarbonization scenarios and refinery retirement strategies. Using three different reduced-form air pollution models to account for model uncertainty, we estimate pollution exposure and associated premature mortality across census tracts. We then quantify health benefits of decarbonization by estimating avoided premature mortality in comparison to historical production levels. Lastly, to assess equity outcomes of decarbonization of the refinery sector, we compute the distribution of monetized health benefits by disadvantaged community status, income, and race.

Paxton Ridgway

Advisor: Rafael Schmitt

Title: Drivers and Management of Changing Sediment Regimes in California's Rivers

Summary: Wildfire activity has intensified in recent decades, reshaping sediment regimes in mountain watersheds and threatening downstream infrastructure and water security. Within river systems, geomorphic responses increasingly reflect the compounding effects of wildfire disturbance and climate-driven shifts in hydroclimatic forcing. Although substantial research has examined the mechanics of discrete post-fire events such as debris flows, the longer-term cascading effects of sediment through river networks remain less well understood. Improving our understanding of how these interacting drivers alter the balance between water and sediment is critical for improving hazard forecasting and supporting resilient river management in a changing climate.

Olivia Ross

Advisor: Joan Dudney
Co-authors: Katherine Siegel (University of Colorado, Boulder), Kathy Baylis (Department of Geography, UC Santa Barbara)

Title: Investigating Fire-Drought Interactions in the Sierra Nevada

Summary: Upward trends in size and severity of wildfires coupled with climate change pose unprecedented challenges for forest ecosystems. Although high severity fires lead to extreme tree mortality, post-fire climate conditions hinder the ability for forests to recover by interrupting mechanisms of tree regeneration. Limited forest recovery may result in a conversion to an alternate ecosystem type such as a shrubland or grassland–referred to as a forest transition. Consequently, forest transitions result in loss of biodiversity and ecosystem function. Such concerns are prominent in California's Sierra Nevada, where evidence suggests that forests are transitioning following high severity fires. In this empirical study, we assessed forest recovery following high severity fires with varying post-fire drought conditions. We aim to understand how the timing or severity of drought following a fire impacts the rate of long-term forest recovery. Here, we present our preliminary findings from the first field campaign of this study, where we surveyed five fires across three National Parks and Forests in the southern Sierra Nevada. Identifying where forests are most vulnerable to transition is critical to support future management efforts and forest restoration strategies.

Acknowledgement: NSF GRFP

Fatiq Nadeem

Advisors: Robert Heilmayr, Kathy Baylis
Co-author: Kathryn Baragwanath (University of Melbourne)

Title: Satellites vs Farmers: Evidence from Strategic Evasion in South Asia

Summary: When enforcement relies on satellite detection, monitored actors may adapt their behavior to evade observation rather than reduce the underlying activity. We examine this phenomenon in the context of agricultural residue burning in Northwestern India and Pakistan, where enforcement is explicitly linked to fire detections from the Visible Infrared Imaging Radiometer Suite (VIIRS), a polar-orbiting satellite with a single afternoon overpass. Combining VIIRS data with high-frequency observations from GEO-KOMPSAT, a geostationary satellite providing hourly coverage, and burn scar imagery from Landsat, we document systematic temporal evasion: farmers in monitored districts increasingly burn outside VIIRS's observation window. While official fire counts declined by approximately 30% between 2015 and 2024, ground-level $PM_{2.5}$ concentrations show no corresponding improvement, and burn scar evidence confirms continued burning activity. We find that this evasion emerges through a combination of social learning among farmers and tacit collusion with local enforcement agents who benefit from appearing effective while avoiding confrontation. Our results highlight a fundamental challenge in remote-sensing-based regulation: when penalties depend on detection, strategic adaptation can render monitoring systems uninformative about actual behavior. These findings have implications for the design of environmental monitoring systems and suggest that single-sensor enforcement architectures may be particularly vulnerable to gaming.

Aidan O'Neil

Advisor: Eric Masanet
Co-authors: Eleanor Thomas (UC Santa Barbara), Colin McMillan (Industrious Labs), and Eric Masanet (UC Santa Barbara)

Title: From Climate Help to Hindrance? An analysis of combined heat and power systems in the US Industrial Sector

Summary: Combined heat and power (CHP) has been a sustainable and energy efficient solution employed by the U.S. manufacturing sector for the past 100 years. However, CHP also accounts for roughly 19% of industrial onsite greenhouse gas emissions. As policies like the Inflation Reduction Act and state level legislation begin exploring decarbonization of the industrial sector, research must be conducted to understand the environmental and human health impacts of locked-in CHP systems. This work aims to fill that research gap through two approaches: (1) develop a first-principles model to compare CHP to traditional generation of heat and electricity, and (2) build a methodology that compiles a CHP dataset with unit level emissions limits, technological specifications, and operating conditions. First, we use the Onsite Energy Installation dataset by Oak Ridge National Laboratory and construct a first-principles energy model to conduct both a fleet-wide analysis. We find that although CHP may have previously been an emissions saving technology, it may now be contributing to excess greenhouse gas emissions and air pollution. We further explored Clean Air Act Operating Permits in two case studies to find that emission benefits of CHP can range dramatically depending on operating conditions. Discrepancies across CHP data sources underscore the need for improved transparency and reporting from industrial operators. Future research and policy must account for these uncertainties to effectively achieve net-zero manufacturing goals.

Acknowledgement: NSF GRFP

Ojas Sarup

Advisor: Naomi Tague

Title: Comparing ecohydrological and climate resilience outcomes of forest management in India

Summary: In Global South countries, approximately 49% people still live in rural areas and source 28% of household income directly from the environment – especially forests. Most of this rural population consists of smallholder farmers who, in addition to producing food for urban areas, heavily depend on subsistence agriculture for their food security. Many of these communities live near or within forests and depend on ecosystem services enabled by these forests and the catchments in which they exist. The resilience of forests against the effects of climate change therefore is an important factor for determining the socioeconomic resilience and adaptive capacity of human communities in the coming decades. However, forests in most parts of the Global South are under human use and management - India is no exception to this. Forest management in India is complex, with governance and management split between bureaucratic institutions, local communities, and joint management setups. The objective of this research will be to compare the climate resilience of forests to climate change under these different regimes by modelling biophysical variables through time and space. Management methods will be translated to model inputs for comparable forest stands, and the response of the forest will be analysed for three IPCC RCP scenarios for each intervention. The results of this study should provide policy makers, scientists, practitioners and communities with forward-looking simulations of forest resilience, crucial for climate resilience planning.

Michelle Mohr

Advisor: Joan Dudney
Co-authors: Jennifer Cribbs (UC Davis), Andrew Latimer (UC Davis), Allison Simler-Williamson (Boise State University), Emily Sorenson (UC Santa Barbara), Joan Dudney (UC Santa Barbara)

Title: Novel fire-disease interactions may buffer forests from invasive disease impacts

Summary: Climate change is shifting disturbance regimes in California's Sierra Nevada. A combination of extended droughts, invasive disease spread, and increases in fire extent and severity threatens California's mixed-conifer forests. Shifts in individual disturbance regimes may also increase the likelihood of their spatial overlap, leading to more frequent and sometimes novel disturbance interactions. For example, historically fire did not have a strong influence on white pine blister rust (WPBR caused by *Cronartium ribicola*) in the southern Sierra Nevada, but this relationship may shift with increases in the extent of high-severity fire patches. To test this hypothesis, we surveyed 56 burned and unburned plots in Yosemite National Park. Crews carefully evaluated 1,473 live sugar pine, *Pinus lambertiana*, (PILA) to detect signs and symptoms of WPBR. We found that 48.2% of the plots had WPBR and infection rates decreased as fire severity increased. We identified three mechanisms that likely explain this negative fire-disease effect: 1) reductions in the number of infected sugar pine hosts, 2) limited sugar pine recruitment following high severity fire, and 3) shifts in local environmental conditions that limit pathogen reproduction. These results suggest that shifting fire regimes may increasingly impact forest tree diseases, which has important implications for forest restoration.

Jaenna Wessling

Advisor: Roland Geyer
Co-author: Roland Geyer

Title: Life Cycle Carbon Footprint of Global Apparel

Summary: Over the past two decades, fast-fashion business models have doubled global garment production. Current annual garment production is estimated between 32 - 64 million tonnes, and is projected to continue to rise to 102 million tonnes by 2030. Due to its large magnitude, the global apparel industry releases large amounts of greenhouse gases (GHGs) that contribute to climate change, not only from the production of garments, but across its entire life cycle, including the use phase habits of global consumers, and at the end of the garments' useful lives. Quantifying the GHG emissions of global apparel is crucial, yet global studies assessing the full life cycle are missing, and existing global assessments of individual life cycle stages vary widely in scope, methodology, assumptions, and thus results. Therefore, this research aims to generate a comprehensive cradle-to-grave life cycle GHG assessment to identify global apparel hotspots. This research combines material flow analysis and process-based, attributional life cycle carbon footprinting to assess the entire life cycle of all global apparel produced from seven fiber types in 2016. The life cycle stages investigated include production, consumer use, transportation, and end-of-life management. The preliminary results of this study found that the production phase contributed the greatest carbon footprint for every fiber type investigated. Within the production phase, the fabric and fiber production phases produced the largest carbon footprints. The use phase produced the second largest carbon footprint, with drying contributing the greatest. Compared to previous literature, the total result of this study proved to be within the middle to lower range of the literature. This research is significant as it is the first complete life cycle carbon footprint assessment of global apparel, and the first to assess this by fiber type. The results of this study will be shared to inform future research, policy, and businesses of where to target efforts to reduce apparel emissions. Moving forward, this research can be expanded to other environmental impact categories, such as water consumption, land use, and eutrophication impacts, to better understand a wide range of global impacts and potential tradeoffs.

Emma Rigatti

Advisor: Kelly Caylor

Title: One Species, Many Strategies: How plant hydraulic traits shape divergent water use in Coast Live Oaks

Summary: Terrestrial vegetation mediates the hydrologic cycle, transporting more than half of the water that moves between the land-system and the atmosphere. Given that this water movement is tightly coupled to landscape-level energy and carbon cycles, understanding plant water transport is essential for understanding ecosystem function, especially under drought conditions. In particular, California's ecosystems are increasingly vulnerable to water stress, and understanding mechanisms underlying plant responses to drought has applications for agriculture, land management, and forest conservation. Yet, recent studies demonstrate that these mechanisms, such as the coordination of plant drought-tolerance traits, are poorly understood. For example, empirical studies often find that plants of the same species can show distinct water-use patterns under identical stressors due to differences in drought-tolerance traits. This propagates to land-surface modeling frameworks that exclude plant drought-tolerance traits, leading to large uncertainties in gross primary productivity, and drought-induced mortality. We therefore lack a quantitative framework describing how plant drought-tolerance traits yield divergent water use behavior under water stress, and the implications for ecosystem function and resilience. This research therefore seeks to 1) quantify how individuals of the same species use water differently across a California dryland, 2) characterize the role of drought-tolerance traits in mediating functional responses, and 3) synthesize findings into a mechanistic model to predict vegetation responses to future drought.

Trace Martin

Advisor: Arturo Keller

Title: Safer Swimming: Innovating Microbiological Water Quality Testing

Summary: Ocean water is determined “safe to swim” for recreators such as swimmers and surfers based on quantities of the water quality indicator bacteria, Enterococcus spp., but the current standard method of analysis takes 24 hours in the laboratory to achieve results. Beach management decisions, such as posting advisories to inform the public, are thus delayed by at least a day meaning people could unknowingly be exposed to unsafe water. While faster molecular-based methods have been explored, many of these methods produce results different from the standard culture-based method and aren’t directly comparable to established health risk thresholds. This research seeks to innovate the standard culture-based laboratory method by incorporating microfluidics, the technology of manipulating fluids at the microscale, to create a device capable of achieving faster results that are directly comparable to the standard method. Although microfluidic technology imparts many advantages, microfluidics are generally not well suited for environmental samples, so a sample pretreatment method will need to be developed to be able to apply this technology to ocean water.

Eleanor Thomas

Advisors: Eric Masanet and Roland Geyer
Co-authors: Antoine Merlo (UC Santa Barbara), Guillermo Terrén-Serrano (UC Santa Barbara), Sanjay Poudel (UC Santa Barbara), Ranjit Deshmukh (UC Santa Barbara), Eric Masanet (UC Santa Barbara)

Title: From Smokestacks to Power Plants: Does Industrial Electrification Reduce or Relocate Air Pollution Burdens?

Summary: The industrial sector is responsible for one-quarter of U.S. greenhouse gas emissions, increasing to one-third when scope 2 emissions from the grid are included. Approximately half of industrial energy use is for heating applications, much of which occurs at low-to-medium temperatures (<300°C) suitable for electrification using industrial heat pumps and electric boilers. While electrification can reduce net greenhouse gas emissions even with today's grid, the health impacts of criteria air pollutants (CAPs) depend critically on where emissions occur. When plants electrify, CAP emissions shift from industrial facilities to power plants, but the net health impact depends on: (1) the location and emissions intensity of marginal electricity generation sources, (2) existing equipment and emissions controls at industrial facilities, and (3) proximity to vulnerable communities. This spatial dimension has been largely overlooked in electrification analyses. Using hourly heat demand modeling and unit- and facility-level emissions data, this study quantifies how CAP emissions change spatially when food and beverage facilities in California electrify process heat. We analyze current and future grid scenarios to identify conditions under which industrial electrification improves local air quality and assess distributional health impacts. Results will inform industrial decarbonization policies that prioritize both climate and environmental justice goals.

Anna Pede

Advisor: Robert Heilmayr
Co-authors: Yifan (Flora) He (Georgetown University), Mark Buntaine (UC Santa Barbara), Marco Millones (University of Mary Washington), Stuart E. Hamilton (East Carolina University)

Title: Agreeing on conservation? Forests and land-use consensus in Peru

Summary: Literature on the governance of common-pool resources (CPRs) predicts that clearly defined boundaries and community consensus on resource use rules will promote effective governance of natural resources. However, empirical evidence directly testing this hypothesis is scarce. We investigate how community-level consensus on territorial boundaries and spatial land use rules are associated with forest conservation and conversion using original survey and participatory mapping data from 70 Indigenous communities in the San Martín region of Peru. We conducted an innovative mapping exercise in which community participants independently mapped their understanding of permissible land uses across their territory. Our analysis of these maps reveals two key findings: (1) areas with higher consensus on forest conservation designation exhibit significantly lower deforestation rates, while (2) areas with stronger consensus on agricultural use face greater forest loss. Our findings highlight how consensus about the rules governing land use is strongly associated with forest outcomes. This finding suggests that interventions should be deployed to help communities achieve consensus about how to use communal lands.

The 2026 Bren PhD Student Symposium Committee

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