The Center for the Environment

The mission of Discovery Park’s Center for the Environment is to catalyze, support and promote proactive interdisciplinary work addressing important environmental challenges.

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OVERVIEW

Discovery Park’s Center for the Environment is Purdue’s hub for interdisciplinary research on environmental challenges.

With over 185 affiliates hailing from over 35 programs and departments across Purdue, the Center helps promote innovative research while also supporting education and outreach with partners across the colleges as well as from around the state, nation, and the world.

Our faculty affiliates submitted over 60 research proposals in 2018 worth over $40 million, over $5 million more than in 2017. We also secured significant funding for our largest project to date, the Arequipa Nexus Institute for Food, Energy, Water and the Environment. This new signature project has provided funds for 63 Purdue faculty and 27 post-doctoral scholars.

Faculty also received project funding from USDA-NIFA, the Nature Conservancy, Indiana Department of Natural Resources, the National Academy of Sciences, USAID, the National Science Foundation, and Purdue’s Showalter Trust.

In 2018, The Center awarded $102,000 of seed funding to seven new projects that in turn are supporting nineteen post-doctoral scholars and faculty.

The Center supported four undergraduate research projects in summer 2018 and promoted a study abroad program in December 2018. Students also worked with affiliate faculty to conduct research on global sustainability through the DURI program, as featured in our section on undergraduate research.

The end of 2018 marked the beginning of an exciting re-visioning process for the Center. In December 2018, professor Tim Filley, acting director of the Center from fall 2017 and professor in the Department of Earth, Atmospheric and Planetary Sciences, formally began his five-year tenure as director. At the same time, associate professor of anthropology, Laura Zanotti, accepted the role as associate director. In early 2019, the Center hired Lynne Dahmen as the full-time managing director.
In this sesquicentennial year of Purdue’s founding, we have much to celebrate as we look back on 150 years of scholarship, teaching and engagement; this includes Purdue’s long-standing leadership in regional and global environmental research. As we honor our past, we also look to the future and ask, “How can we push the envelope of interdisciplinary environmental research to make our own ‘Giant Leaps’ in the service of society?,” for we are at a time in our history when meeting the needs of a growing population while controlling and reversing environmental degradation are among our most important problems.

I am honored to have been awarded the privilege to serve Purdue’s environmental community as director of the Center for the Environment. Moving forward, I will continue to strive to cultivate an ecosystem where Purdue’s diverse talents, as seen in the expertise of our affiliated faculty and stakeholders, converge to help tackle key environmental challenges.

This past year, the Center has supported exploratory research teams; hosted a series of colloquia, expert panels, and workshops; forged new partnerships; and provided opportunities for student research. In this next year, we will look anew at how the Center can improve and expand our efforts to best support and promote existing, nascent, and future environmental research, education and public engagement. For 2019, with guidance and help from our newly appointed Associate Director, associate professor Laura Zanotti, and our new Managing Director, Lynne Dahmen, we look forward to launching a strategic planning exercise that will engage all corners of the university community. With your continued support, we are confident that more Giant Leaps are to come.

But let’s take a moment to celebrate where we are now. Over the past year, our affiliated faculty, staff, and student researchers have made great strides in the search for solutions to our environmental problems, including: the chemical reactivity of emerging pollutants such as per- and polyfluoroalkyl substances (PFAS); the changing face of farmers; assessing the dynamics of natural and anthropogenic-sourced atmospheric particles; increasing understanding of nutrients and agricultural systems; and many more we describe in these pages.

As you read through this year’s annual report, I hope you will share my extreme pride in the achievements of our community.

- Tim Filley

Director, Center for the Environment
Professor, Earth, Atmospheric & Planetary Sciences
Signature Research Areas in the Center represent topics related to environmental challenges for which multiple disciplinary perspectives come together for productive solutions. Through these areas, the Center supports faculty affiliates in aspects of informal and formal teaming, research project development and relevant programming. In fall 2018, we had three active signature areas: Building Sustainable Communities, Chemical Exposures and Water Challenges.

Each signature research area is led by a faculty convener who shepherds the growth and health of the area and who serves on the Center’s leadership committee. Faculty conveners thus have the opportunity to develop and enhance their own leadership skills as they steward the running of the signature research area during their tenure.

**Building Sustainable Communities**
The world presents us with interconnected global sustainability challenges and “wicked problems.” As communities from different countries and regions consider solutions, decision-makers, stakeholders and resource users are increasingly aware of the complex—yet poorly understood—connections and interdependencies between and among natural, built, and socioeconomic networks and systems. Members of the Building Sustainable Communities signature research area bring with them expertise in areas such as cognitive and motivational biases, cooperation and norms, decision-making, deep uncertainty, equity and justice, moral theory, political ecology, resilience, sustainability science, and socio-ecological systems.

[https://www.purdue.edu/discoverypark/environment/areas/sustainable-communities.php](https://www.purdue.edu/discoverypark/environment/areas/sustainable-communities.php)

**Chemical Exposures**
Modern society has seen an explosion in the commercial use of new chemical compounds. An estimated 80,000 industrial chemicals are in everyday use, but only a small fraction of these has been tested for basic human health effects, and we have even less data about which chemicals people are exposed to on a daily basis. The members of the Chemical Exposures signature research area work to better understand human and environmental consequences of chemical contaminants. The team’s expertise includes multiple chemical exposures, public health implications of these exposures, end-of-life and transport of chemical contaminants in the environment, and remediation technologies.

[https://www.purdue.edu/discoverypark/environment/areas/chemical-exposures.php](https://www.purdue.edu/discoverypark/environment/areas/chemical-exposures.php)

**Water Challenges**
Increasing pressures on freshwater resources lead to difficult trade-offs between water for food production, energy, ecosystems and other uses that water resource managers and other decision makers need to address. The Water Challenges signature research area brings together a large network of Purdue faculty, as well as a larger group of community stakeholders, who work together to conduct varied research to ensure safe and secure water resource-related ecosystems. Areas of strength include agricultural water management, water treatment technologies, protecting water resources, the human dimensions of water, and solutions for under-served communities.

[https://www.purdue.edu/discoverypark/environment/areas/water-challenges.php](https://www.purdue.edu/discoverypark/environment/areas/water-challenges.php)
Arequipa Nexus Institute

PI: Timothy Filley, Earth, Atmospheric and Planetary Sciences

Purdue University and the Universidad Nacional de San Agustín (UNSA) in Arequipa, Peru, are partners in this cooperative technical alliance program begun in 2018 and funded by UNSA. The mission for the Arequipa Nexus Institute for Food, Energy, Water and the Environment is to develop a vibrant research, education, and innovation ecosystem where transformative solutions to the grand challenges faced by Arequipa, Peru, and Latin America are explored and tested. The partnership focuses on co-development of targeted technical and research infrastructure housed in Arequipa to support a network of interrelated, interdisciplinary research projects. Ultimately, the UNSA-Purdue technical alliance aims to include an integrated research and commercialization program modeled on Purdue’s Discovery Park.

For more information, see: https://www.purdue.edu/discoverypark/arequipa-nexus/

Follow on Twitter: @arequipa_nexus

Soundscapes

PI: Bryan Pijanowski, Forestry and Natural Resources

With significant funding from the National Science Foundation and Discovery Park, the Center for Global Soundscapes brings together engineers, social scientists, educators, and musicians who have helped launch a new interdisciplinary science known as soundscape ecology. This field of study is motivated by concerns of preserving our natural soundscapes and studying the impacts that humans have on ecosystems via disruption of natural sounds. The goal is to connect a network of scientists interested in a variety of projects that use natural sound as an indicator of environmental changes, such as shifts in climate, weather patterns, the presence of pollution, or other alterations to a landscape.

For more information, see:
https://www.purdue.edu/discoverypark/environment/areas/soundscapes.php
ENGAGEMENT

Spring 2018 brought together the Center for the Environment, Discovery Park’s Purdue Climate Change Research Center and the Purdue Policy Research Institute in partnership with several colleges to bring to campus a series of speakers and events leading up to Earth Day (April 22). The overall theme was “Toward a Sustainable Environment in a Changing Climate,” and the events featured leading figures within the science, journalism, and activist communities highlighting important topics in the areas of environmental sustainability and climate change.

SPRING

The series included three Discovery Park Distinguished Lecturer events: Dr. Joe Fargione, Chief Scientist for North America with The Nature Conservancy, on January 24th, discussing “Natural Climate Solutions,” and Dr. Ben Santer of Lawrence Livermore National Laboratory, who presented a talk titled “How a Sentence Changed Climate Science,” on March 5. On April 12, Mr. Bill McKibben of 350.org gave a presentation titled, “Hot Times: Reports from the Front Lines of the Climate Fight.” Mr. McKibben’s talk was followed by a facilitated discussion led by Mr. Justin Dearborn, recent CEO of TRONC Publishing.

The Center co-sponsored with the Division of Environmental and Ecological Engineering to host the Distinguished Lecturer conference of the Association of Environmental Engineering and Science Professors. As the keynote speaker, Dr. Pedro Alvarez, the George R. Brown Professor of Civil and Environmental Engineering at Rice University, presented a talk titled “Nanotechnology-Enabled Water Treatment: A Vision to Enable Decentralized Water Treatment and Address Growing Challenges of the Water Energy Nexus.”

Purdue’s own faculty also engaged the campus on a variety of environmental topics. In February, professors Manjana Milkoreit (Political Science) and Bob Marzec (English), and graduate students Kate Haapala, Roberta Weiner and Bi Zhao, led a panel discussion on the Paris Agreement. In April, Purdue professor Leigh Raymond (Political Science) moderated a climate policy panel, “Realistic Climate Solutions: Addressing Climate Change From the Local to the Global Scale,” which brought together California Assembly member Eduardo Garcia, co-sponsor of the bill to renew California’s cap and trade program through 2030; former Congressman Robert Inglis, Executive Director of RepublicEN, dedicated to promoting “free enterprise solutions” to climate change; and former Indianapolis Mayor, Greg Ballard. This theme of sustainability continued with a presentation by Dr. Andrew Light, Professor of Philosophy and Public Policy at George Mason University, who gave a talk on the Paris Agreement and US Climate Policy in the Trump Administration.

Also in April, the Center hosted a film screening and discussion of *The Anthropologist*, a documentary listed on the Indiewire Top 10 Must See Documentaries at DOC NYC. The discussion was led by film creators Dr. Susan Crate and Kathryn Yerogov-Crate. At the core of the film are the parallel stories of two women: Margaret Mead, who popularized cultural anthropology in America, and Susie Crate, an environmental anthropologist currently studying impacts of climate change. Uniquely told from their daughters’ perspectives, Mead and Crate demonstrate a fascination with how societies are forced to negotiate the disruption of their traditional ways of life, whether through encounters with the outside world or the unprecedented change wrought by melting permafrost, receding glaciers and rising tides.

The semester ended with a presentation by Dr. Janet McCabe, Professor of Practice, Robert H. McKinney School of Law, Indiana University, and former assistant administrator of the EPA Office of Air and Radiation, titled “Rolling Back an Environmental Agenda: Will it Stick?”
Purdue University’s 150th anniversary was launched at homecoming in fall 2018 with the theme “Giant Leaps,” inspired by Neil Armstrong’s historic statement on the Moon. As Purdue President Mitch Daniels explained, “The Giant Leaps theme speaks both to Purdue’s contributions of research and action to the expansion of human understanding, and to the countless leaps our graduates have made to successful individual careers and lives.”

One of the four topics for the year-long celebration was “Sustainable Economy and Planet.” Center Director Tim Filley served on the planning committee with co-chair Professor Bernie Engel, head of the Department of Agricultural and Biological Engineering. This was a key topic in light of the reality that, in the last 200 years, our population has grown from 1 billion to 7.6 billion and is projected to be nearly 10 billion by 2050. We will need to adapt to meet the rising demand for food, water and energy. At the same time, rapid, exponential advances in science and technology continue to revolutionize how we live, think and work.

Questions explored included: Can technology, innovation and the marketplace converge to continue to generate economic growth areas in the global economy? Can humankind create a future in which the demands for food, energy, clean water, climate change adaptation and mitigation, biodiversity, and poverty reduction are reconciled?

Events in fall 2018 included a conference organized by the College of Agriculture titled “Innovations in Agriculture: Scaling Up to Reach Millions.” The conference, part of Purdue’s 150th anniversary celebration with its focus on sustainability and the environment, presented effective approaches to grow agricultural technologies and innovations in the developing world. The keynote speaker was Dr. Akinwumi Adesina, president of the African Development Bank Group, 2017 World Food Prize Laureate and alumnus of Purdue’s College of Agriculture.

In October, the Center hosted its fifth annual Environmental Research Expo and Community Mixer, which was dedicated to the 150th anniversary focus on sustainability. Over 150 faculty, students and staff participated in the event.

Sustainability was the focus of several fall talks. The schedule included a McCoy distinguished lecture by Distinguished Professor of Biochemistry and of Horticulture and Landscape Architecture Natalia Dureva, who presented the talk, “Look Who’s Talking: Chemical Language of Plants.” Finally, the “What IF” lecture titled “What if Digital Mapping Could Save our Forests,” was presented by tropical forestry expert Nicolas Picard, an official with the Food and Agriculture Organization of the United Nations, who believes the use of Geographic Information Systems (GIS), can lead to a more sustainable future by improving forest management through the mapping, analysis, and oversight of global forest environments. The event was part of GIS Day Conference.
Tara Grillos (Political Science)

A common strategy for achieving forest conservation in some LDCs (least developed countries) has been to provide monetary incentives to forest users in exchange for conservation behavior. However, it has been hard to gauge the effectiveness of such programs overall, as success depends greatly on specific features of the program design and social context. At the same time, there are important normative reasons to promote the inclusion of women in decision-making bodies. We tend to think it’s fair for people to have some representation in the making of decisions that affect their lives, such as the decisions about group members’ use of shared forest resources. Could there be a win-win in which increasing participation by women in these decisions also leads to better forest conservation outcomes?

Professor Tara Grillos, together with colleagues Krister Andersson and Nathan Cook, from the University of Colorado, have examined this question using a lab-in-the-field experiment. Within a simulated climate-policy intervention, the team randomly assigned a gender quota to half of the participating groups, requiring at least 50% of members to be women. Their findings, published in Nature Climate Change, show that the incentive was more successful at reducing forest degradation in the groups mandated to have a majority female membership. They also found that the majority-female groups distributed the incentives more evenly across all group members, suggesting that gender quotas may improve both the effectiveness and the equity of conservation incentives programs.

The research team continues to examine questions of participation, representation and equity in forest conservation, and has been awarded an NSF DRMS grant for related field-based research in India and Nepal. The new project uses a combination of quasi-experimental methods (in Nepal) and a randomized controlled trial (in India) to examine the effects of institutional changes in forest user groups that aim to increase participation by women and minority ethnic groups.


David Yu (Civil Engineering and Political Science) & Byung-Cheol Min (Computer and Information Technology)

Addressing pressing sustainability challenges in our contemporary world often requires actions at different levels of society; some may include the collective action of individuals (i.e., situations where a number of individuals work together to achieve a common goal) while others derive from the formation of social norms that reinforce desired behaviors. In two Center-funded projects, Purdue faculty David J. Yu and Byung-Cheol Min are investigating the question of how to catalyze bottom-up collective action for community sustainability and resilience.

One of their research questions concerns the phenomena of levee effect or how heavy reliance on structural solutions such as dams and levees for the prevention of short-term flooding events is likely to be associated with increased long-term vulnerability to rarer and larger flood hazards. They are also studying the adaptation effect, in which more exposure to flood events can lead to enhanced long-term resilience to unexpected flood-related disasters. In addition, the team conducted deductive modeling studies and a qualitative case study to investigate the enabling conditions needed for achieving collective action that could lead to the adaptation effect. Yu and Min have published three research articles on their results in Water Resources Research and Ecology and Society.

Their second project focuses on the issue of participatory sensing, i.e., when people use mobile devices to sense and report about distributed environmental phenomena to generate what they call “informational social goods.” In other words, how can we promote people’s collective action towards their sustained participation as human sensors and what are key enabling social and technological conditions for this? This research is currently underway and has led to one PhD dissertation chapter of a participating graduate student. Several more research articles are expected at its completion.


https://rdcu.be/bTWDf
**Sylvie Brouder (Agronomy) & Jeff Volonec (Agronomy)**

Increased crop yields of the last century, including those of the “Green Revolution,” have resulted in large part from greater use of fertilizers containing nutrients like nitrogen (N), phosphorus (P), and potassium (K) applied to crop varieties selected for improved agronomic performance. However, over-application of fertilizers, especially those containing N and P, accelerate eutrophication of surfaces waters; the most notable example is the so-called “dead zone” in the Gulf of Mexico. Other loss pathways for N include the emission of nitrous oxide, a potent greenhouse gas with a temperature-forcing potential that is nearly 300-times that of carbon dioxide (CO2). These environmental problems have led to strategies to improve fertilizer management (e.g., the 4R Nutrient Stewardship Program; see [http://www.nutrientstewardship.com/](http://www.nutrientstewardship.com/)), while simultaneously retaining high crop yields needed to feed our burgeoning global population. A key question for many concerned about global food security is how crop nutrient needs will change as climate changes. The influence of two such factors, i.e. temperature and rainfall/soil moisture, on nutrient use has been well-documented. However, much less is known about the impacts of elevated CO₂ on nutrient use, which is partly due to the inherent challenges in establishing robust facsimiles of future environments as experimental treatments. Sylvie Brouder and Jeff Volonec address this in their work, “Will further increases in atmospheric CO₂ cause previously unobserved phenomena in nutrient cycling and plant-soil feedbacks?” Their analysis suggests that, in general, nutrient loss will scale with yield increases associated with elevated CO₂. However, subtle but potentially important variation in tissue nutrient concentrations and total nutrient uptake are likely to occur. Awareness of these changes is important for devising appropriate nutrient management strategies in a changing climate. This work advances our understanding of drivers of efficient use of inputs including water, radiation, and nutrients.


**Jane Frankenberger (Agricultural and Biological Engineering) & Songlin Fei (Forestry and Natural Resources)**

Accurate quantification of forest aboveground biomass (AGB) is critical to determine how diverse forest ecosystems respond to a changing climate. LIDAR-based statistical models have been used to accurately estimate AGB in large spatial extents, especially in boreal and temperate softwood forest ecosystems. However, the few available models for temperate hardwood and hardwood-dominated mixed forests are low in accuracy due both to the deliquescent or decurrent growth form of hardwood trees and site-to-site variations. Jane Frankenberger (Agricultural and Biological Engineering), Songlin Fei and their team established multiplicative nonlinear regression models that incorporated both LIDAR-derived metrics and soil-based site productivity classes to estimate AGB in temperate hardwood forests. The final model had high accuracy with reliable performance. Their work indicates the importance of including direct or indirect measures of site productivity. In LIDAR-based biomass models, particularly for those applied to temperate hardwood forests, their new model provides a framework that can be used to integrate LIDAR-based structural information and soil-based site productivity to improve AGB estimation.

Land use and climate change impacts on runoff and soil erosion at the hillslope scale in the Brazilian Cerrado.

Summary: Land use and climate change can influence runoff and soil erosion, threatening soil and water conservation. This paper describes the team’s use of the WEPP (Water Erosion Prediction Project) model for different land uses under subtropical conditions in the Cerrado biome in Brazil. Potential climate changes, which here are seen through the increase of rainfall intensities and depths, may increase the variability and rates of runoff and soil erosion. However, these changes did not significantly affect the rates for the four analyzed land uses. Their findings suggest that the soil may attain a sustainable level when land management follows conservation principles.


Evaluation of bioenergy crop growth and the impacts of bioenergy crops on streamflow, tile drain flow and nutrient losses in an extensively tile-drained watershed using SWAT.

Summary: To identify environment-friendly and productive biofeedstock systems, it is important to study biomass production of bioenergy crops and the impacts of these crops on water quantity and quality. This paper describes the team’s work on the impacts of such crops on streamflow, tile flow, erosion and nutrient losses. The study showed that corn stover removal did not lead to significant water quality impacts and that bioenergy crops can offset adverse water quality impacts. In addition, small bioenergy crop areas provided only limited improvements to water quality. Results provide guidance for evaluation of bioenergy scenarios in tile-drained areas.


Defining tipping points for social-ecological systems scholarship—an interdisciplinary literature review. Environmental Research Letters.

Summary: The term “tipping point” has experienced explosive popularity across multiple disciplines over the last decade; however, the diverse uses of the term potentially obscure differences between tipping behavior in natural and social systems. It may also mask issues of causality across natural and social system components. This paper describes the team’s effort to establish a foundation for a discussion within the social-ecological systems (SES) research community about the appropriate use of the term. In their research, they identified 23 distinct features of tipping point definitions and their prevalence across disciplines. Building on the most frequently used features, the team proposes definitions for “tipping point” in general and “social tipping point,” in SES, in particular.


Cultural Evolution of Normative Motivations for Sustainable Behaviour.

Summary: Emerging research on the evolution of culture can offer new explanations for how norms encourage or obstruct sustainable practices. This paper describes the team’s exploration of the concept of normative motivation — internalized desires to follow and enforce norms. They studied the potential utility of this concept and how it could advance two major research agendas in the social and behavioral sciences: first, the impact of motivation on cognition and normative behaviour, and second, the influence of norms on the policy process.

2018 SEED GRANTS

In fall 2018, the Center ran its fourth year of seed grant funding, providing funds of $102,000 to Purdue teams. Teams included affiliates from 10 different departments and colleges.

Visualizing Environmental Research Projects to Enhance Research Management and Collaboration  
Y. Chen, Computer Graphics Technology, and D. Schulze, Agronomy

Distribution of Perfluoroalkyl and PFASs in Indiana Aquatic Ecosystems: Implications for Wildlife Health  
J. Hoverman, Forestry and Natural Resources; R.W. Flynn, Forestry and Natural Resources; L.S. Lee, Agronomy; M. Sepulveda, Forestry and Natural Resources

Monitoring Water Quality by Teachers and Students in Rural Schools and Communities in Developing Countries  
C. Jafvert, Civil Engineering and Environmental and Ecological Engineering; J. Howarter, Materials Engineering and Environmental & Ecological Engineering; L. Payne, Environmental & Ecological Engineering

A Chemical Mixture Conundrum: Leaching and Toxicological Assessment of Drinking Water in Contact with Crosslinked Polyethylene (PEX) Pipes  
C. Ley, Division of Environmental and Ecological Engineering; A. Whelton, Civil Engineering and Division of Environmental and Ecological Engineering; and J. Freeman, Health Sciences

Microbiome Approaches to Detect Contamination in Water Resources to Safeguard Global Rural Populations  
S. Lindemann, Food Science and Nutrition Science, and M. Frisbee, Earth, Atmospheric, and Planetary Sciences

Sustainable Urban Energy-Water Demand Nexus During Heatwaves and Droughts  
R. Nateghi, Industrial Engineering & Environmental and Ecological Engineering; P. Suresh Rao, Civil Engineering and Agronomy; Z. Ma, Forestry and Natural Resources

Mobile Crowd Sensing for Sustainability Challenges: A Behavioral Approach to Inducing User Participation  
D. Yu, Civil Engineering & Political Science, and B.Y. Min, Computer and Information Technology, PPI

**Summary:** Marine sulfate aerosols are critical to the global radiation balance through directly scattering sunlight or forming clouds; however, their feedback effects are poorly quantified because sources and size distributions are unclear. This paper describes the team's investigation of the origins and size distributions of sulfate aerosols from the Southern Ocean as well as at Baring Head, New Zealand. The team's work suggests that marine biological activity is an important factor that controls the amount of sulfate aerosols in remote marine atmosphere, which is of great importance to global climate models.


**Summary:** Invasive species are reaching epidemic proportions, greatly altering global biomes. The role of private landowners in controlling invasive plants in forest ecosystems has been well recognized, although limited research has investigated awareness, actions, needs, and concerns of land managers. This paper describes the team's results of 23 semi-structured interviews with family forest owners and forestry professionals in Indiana, USA. Results suggest that forestry professionals can help motivate family forest owners toward invasive plant management by providing positive psychological reinforcement such as social approval. Further, their results highlight a gap between the recognized importance of cooperative invasive plant management and a lack of on-the-ground practices mainly due to a culture of independence among family forest owners. In addition, private and public actors interpret their responsibilities differently.

[https://doi.org/10.1016/j.landusepol.2018.02.010](https://doi.org/10.1016/j.landusepol.2018.02.010)
New Faculty

**Sa Liu, Assistant Professor of Health Sciences**

Sa’s research focuses on assessing chemical exposure by multiple pathways (inhalation, ingestion and dermal exposure) in both occupational and environmental settings. Sa has recently extended her research into the emerging field of exposome, in which she takes untargeted -omic approaches to assess chemical exposure through biomarkers in human blood. Her current environmental health-related work includes developing collaborations with local agriculture communities to study air quality and environmental exposures in rural Indiana and investigate how social determinants of health may modify these exposures among people with special needs or disabilities. From 2012-2018, Sa was an assistant, then associate, researcher in the School of Public Health at UC Berkeley. Sa is a certified industrial hygienist (CIH).

**Rahim Rahimi, Assistant Professor of Electrical and Computer Engineering**

Rahim’s research has explored development of innovative, scalable, multifunctional, microsystem platforms for medical applications with emphasis on smart wearable and autonomous devices for wound monitoring and therapy. He has also recently pursued work with the development of biodegradable soil sensors including nitrate, phosphate, and microbial activity with the Wabash Heartland Innovation Network. His work has been featured in various news media, including Science Nation, Science360, The Computer World, and Science X. He has led teams on scalable manufacturing processes of flexible electronic devices. Current research is on convergence of advancements in functional polymers and electrical engineering for developing innovative tools and technologies that can be utilized in solving various obstacles in healthcare, agriculture, and the environment.

**David Warsinger, Assistant Professor of Mechanical Engineering**

David’s research interests lie at the nexus of energy, water, and food and he is currently involved with water treatment projects that aim to remove heavy metals and prevent waterborne disease while operating with intermittent renewable microgrids. David came to Purdue after completing his PhD and post-doctoral work with faculty at MIT, Harvard and Yale. Mentoring students is a priority for David, including for undergraduate and graduate students. David is involved with advising, fundraising for, or co-founding several start-up companies in the fields of water treatment and food refrigeration.

Promotions

**Andrew Whelton, Associate Professor of Civil Engineering and EEE**

Andrew is passionate about conducting research to investigate and solve problems that affect our natural and built environments. He brings expertise in polymer science, analytical chemistry, food science, and nanoengineering. Andrew received a BS and PhD in Civil Engineering and an M.S. in Environmental Engineering from Virginia Tech. His honors include a National Research Council Fellowship, National Science Foundation IGERT Fellowship, and an Oak Ridge Institute for Science and Education Fellowship.
**Sara K. McMillan, Associate Professor of Agricultural and Biological Engineering**

Sara's research focuses on how humans impact nutrient and carbon cycling in aquatic and wetland ecosystems. She collaborates with social scientists, and her work integrates field-based research with quantitative modeling approaches to develop solutions that advance the science and practice of ecosystem restoration from site to watershed scales. She is currently looking at restored floodplains in the Wabash River Basin. She and her collaborators are replicating flood dynamics in these complex landscapes using in-field and laboratory experiments and linking these with hydrodynamic modeling. This research will ultimately provide guidance for optimal design and location of restoration to achieve basin-wide water-quality improvements.

**Michael Jenkins, Professor of Forestry and Natural Resources**

Mike's research focuses on the effects of disturbance in forests and the interplay between disturbance and invasive species. Current projects examine the ecological effects of white-tailed deer, the use of fire to maintain and restore oak forests, and the control and effects of invasive shrubs. Prior to being on the faculty in the Department of Forestry and Natural Resources at Purdue, Mike worked for ten years as a vegetation ecologist for the National Park Service in Great Smoky Mountains National Park.

**Venkatesh Merwade, Professor of Civil Engineering & Agricultural and Biological Engineering (courtesy)**

Venkatesh’s research and teaching interests include surface water hydrology with specific focus on flood modeling and mapping. Much of his work has been on improving the simulation of hydrologic processes for flood prediction by using GIS, data-driven techniques, and advances in cyberinfrastructure. He also has interests in water resource issues in developing nations. Some of his recent work includes improved understanding of how sand dams work in East Africa. He teaches both undergraduate and graduate courses in the hydraulics and hydrology areas.

**Tomas O. Höök, Professor of Forestry and Natural Resources**

Tomas is interested in environmental questions at the interface between applied and basic ecology. To address such questions, his team uses an adaptive research approach and employs a variety of research methods (e.g., field sampling, controlled experiments, statistical analysis, simulation modeling). The focus of his research is fish and fisheries ecology in the Laurentian Great Lakes. However, he also studies lower trophic-level organisms and both smaller freshwater and larger marine ecosystems.
NOTES FROM THE FIELD: THE ENVIRONMENT AND DEVELOPMENT OF ORGANIC AGRICULTURE IN SOUTHERN INDIA
By Andrew Flachs, Assistant Professor, Department of Anthropology

I have been learning from South Indian farmers since 2012, when I began research into the impacts of organic regulation on the people who grow these foods and fibers around the world. Organic regulation helps us recognize agricultural products on store shelves everywhere, helping us to vote with our dollars for farmers and their products who we might want to support. Yet, while regulators and consumers need universal symbols to find their products, organic agriculture varies considerably between regional contexts, and even within the same country. India is home to more certified organic farmers than any other country, totaling more than a quarter of all certified organic growers on the planet. However, every crop and production system is different. The search for a good comparison to the ways of learning and managing socio-ecological relationships in dryland cotton brought me to certified organic coffee forests in the Eastern Ghats, a mountain range a few hundred kilometers east of the cotton farms. When I visited Araku’s coffee gardens in summer 2018, organic coffee farmers were still recovering from the Hudhud, a cyclone that devastated forests in 2014. It would have been the perfect moment for skeptical farmers to abandon the project, throwing up their hands at onerous regulations and constant surveillance of watchful project managers. Yet, they didn’t. For some reason, this system passed a real-world test of resilience, and coffee farmers were expecting their first full crop after waiting four years for the forest to regenerate.

These farms are bastions for biodiversity and a diversified local economy. Araku coffee gardens bathe visitors in dark green, reflecting off coffee’s thick, waxy leaves and down from the snakes of black pepper vines above as agricultural plants are grown in accordance with the niches afforded by a forest ecosystem. One typical farm might have pineapple and ginger on the ground, chest-high coffee trees, a mid-level canopy of papaya and banana ten feet above, followed by silver oaks that provide shade and a straight pole for black pepper vines ten feet above that. Interspersed in this forest are mangoes, figs, Pongam oil trees, gooseberries, and other useful crops, to say nothing of hilltop meadows and lowland farms where grains and vegetables grow. Because this habitat is managed without chemical fertilizers or pesticides, it provides space for birds, insects, reptiles, and a wide array of non-economic plants that farmers see no need to destroy. The tree cover traps moisture in the soil while the underbrush drops dew onto our sandaled feet. Instead of fertilizers or manure, this forest is alive with the funk of rotting leaves and humus. In the wake of the cyclone, many coffee trees are new and young, next to decaying stumps. The alternative to replanting is clear when we reach the top of the hill and look across the landscape – forests cut down for timber and mountainsides ripped open for mining.
Although much forested land is owned or claimed by state agencies like the forest service, or the integrated tribal development agency, Adivasi, members of India’s Scheduled Tribe communities, managed these areas long before and after the Indian government and extractive industries took an interest in the bauxite under Araku farmers’ lands. The Eastern Ghats, where Adivasi farmers have lived for generations, received new attention when veins of bauxite, the world’s primary source of aluminum, were discovered under the hills. Adivasi farmers have faced an uphill battle for socioeconomic mobility across India. Displaced from optimal farmland in India’s ancient past, the British colonial government considered many tribal communities to be inherently criminal and restricted their access to land and other rights. After independence, many Adivasi communities fought with the forest service for control over land, timber, and minerals until a series of reforms culminating in the Forest Rights Act of 2006 strengthened their tenure. Growing coffee and staying on the land is one way that Adivasi communities can secure contested territory for themselves, assembling political power and forcing the state to honor regulations that prevent non-tribal landowners from taking forested land and resources.

In India, certified organic cotton agriculture in Telangana and certified organic coffee production in Andhra Pradesh highlight how organic agriculture provides distinct, but parallel, ways for farmers and intermediaries to capture value in these supply chains. These questions are especially pressing in South India, which has struggled to spread the economic development of Hyderabad and coastal Andhra Pradesh to poorer rural areas plagued by suicide and agrarian distress. In a recent article in the journal *Economic Anthropology* and a blog post with the Culture and Agriculture section of the American Anthropological Association, graduate student Sreenu Panuganti at the University of Hyderabad and I explore how organic farmers and intermediaries in South India negotiate the benefits of global ethical supply chains alongside their own aspirations.
While faculty affiliates of the Center for the Environment have always been a driving force of Purdue's international research, education, and outreach programs, 2018 was a particularly exciting year for the Center's sustainability activity in the nation of Peru with the funding of the Arequipa Nexus Institute for Food, Energy, Water and the Environment (The Nexus Institute). Established through a partnership between the Center for the Environment and the Universidad Nacional de San Agustín (UNSA) in Arequipa, Peru, this program is one of the first of its kind in Peru to apply the financial resources from Peru's Mining Canon towards advancing UNSA's technology innovation capabilities through socially responsible projects in Arequipa.

The Nexus Institute has provided transformative opportunities for UNSA faculty through technical workshops, in-field training, new online courses, research laboratory and field station infrastructure projects, a visiting scholars program, and the co-development and co-management of 21 technical and research cooperation projects. These projects, which support 63 Purdue and 74 UNSA faculty, address sustainability challenges of particular importance to the communities of the region who struggle to use their natural resources and want to minimize environmental and societal trade-offs. The projects associated with this new research and technology innovation ecosystem at UNSA were funded in two phases: 10 projects started in March of 2018 and a second cohort of 11 projects started in January 2019. The Nexus Institute provides both UNSA and Purdue students, postdoctoral scholars, and faculty the opportunity to engage in leading-edge, interdisciplinary, convergence research approaches to sustainability challenges that hamper societies, not just in Peru, but across the globe.

An endeavor this large requires efficient and attentive leadership and so in 2018 we were pleased to have Dr. Victor Maqque join the Nexus team as program manager. He came to the Nexus Institute from Purdue's Department of History where he was a Tecumseh Postdoctoral Fellow. Prior to his time at Purdue, Victor was the program developer and instructor at the Kellogg Institute for International Studies at the University of Notre Dame in South Bend, Indiana. Victor received his master's and doctoral degrees from the University of Notre Dame where he studied issues of environmental and social justice among Andean cultures. Victor received his BA and a master's in sociology from the Universidad Nacional del Altiplano, at Puno, Peru.

In August 2018, the Nexus Institute hosted its first pan-Institute technical workshop and symposium at Purdue. Twenty-four UNSA faculty scholars traveled to Purdue for the 10-day event and engaged in project team building and ideation exercises; they also enjoyed numerous social activities designed to enrich both Purdue and UNSA communities and participated in specialized technical training on subjects including: measuring soil health and vulnerability, social science assessment methodologies, applications of environmental sensors, visual analytics for earth sciences, remote sensing, high performance computing, stable isotope and nutrient analysis techniques, and field methods for soil and water sampling. At Purdue, faculty from six colleges, the Libraries, and the USDA National Soil Erosion Research Laboratory designed and led the workshops.

In keeping with the long-term, multi-decadal vision of Purdue's and UNSA's Nexus Institute partnership, a number of collaborative infrastructure projects were initiated this first year. These infrastructure projects included designs for new research and viticulture buildings at the UNSA agricultural research station in Majes (projected construction completion by spring 2020), design and evaluation of existing...
and planned UNSA campus buildings to be modified for net-zero energy goals, and the creation of a new stable isotope monitoring and nutrient analysis geochemistry laboratory on the UNSA campus to support research long into the future.

Throughout the year, Nexus Institute teams worked to support UNSA campus growth in four key programmatic areas that, hopefully, by the conclusion of the Institute’s first three-year phase, will coalesce into aspirational programmatic centers at UNSA that will cultivate and nurture sustainability research for years to come:

1) **The Center for Sustainable Watershed Management** will support projects that work with key stakeholder groups to develop data, simulation models, and decision support tools (DSTs) for watershed management through the use of robust data sets and modeling laboratories, including GIS and remote sensing labs. The DSTs, such as the Soil and Water Assessment Tool (SWAT), will operate on a variety of computing desktop and mobile platforms and help promote efficient food-energy-water management in the region. This year we developed mixed on-line and face-to-face SWAT certificate courses geared for many groups and at various learning levels in Arequipa.

2) **The Center for Agricultural Innovation and Demonstration** will support projects that guide research promoting the sustainable production of profitable crop and animal agricultural products in Peru by using advanced technologies for phenotyping and genetic modification, detailed knowledge of sensor-driven decision making for nutrient and water use, advanced energy-efficient infrastructure, and sound agricultural practices. This year we developed new viticulture and enology programs at the research station and created an on-line mapping program allowing UNSA and Arequipa citizens to explore spatial relationships of soil type, soil chemistry and use, and bedrock geology.

3) **The Center for Social Sciences and the Environment** will promote innovative social science approaches grounded in interdisciplinary socio-environmental research to collect and analyze individual, household, and community data to address pressing socio-environmental challenges related to extractive and agricultural activities, energy use, and food and water security. In this first year of Nexus activity teams investigated how communities across the rural-to-urban gradient perceive water availability and quality in the context of climate change to identify potential strategies for facilitating healthy co-existence between stakeholders and communities.

4) **The Center for Soil, Water and Air Quality** will support projects focusing on the characterization, monitoring, and mapping of the quality and vulnerability of the Arequipa region’s soil, water and air. The research provides the data and tools to support science-based decision making related to sustainable natural resource use, agricultural productivity, and human health. All of these projects are heavily grounded in physical measurements conducted in both the field and laboratory. Projects in this first year focused on aggregating existing environmental data, making new environmental measurements, and providing visual analytics tools to allow UNSA faculty and residents of Arequipa to utilize these resources for education, research, or management.

In 2019 we are looking forward to exciting advances in sustainability and resilience thinking from our teams that will improve the livelihoods of the people of Arequipa. For more information about project progress please see the website - https://www.purdue.edu/discoverypark/arequipa-nexus/en/index.php.

-- Tim Filley, Co-Director of the Nexus Institute
Center for the Environment faculty affiliates lead many of the student environmental programs on campus. Faculty draw from their local and global work to inspire students to engage in a broad range of activities to make a lasting impact on campus and abroad. Here we highlight some academic majors and certificate programs offered at Purdue. For a more complete list of environmental programs with an interdisciplinary environmental focus, see:

https://www.purdue.edu/discoverypark/environment/for-students/undergraduate-certificates-programs.php

Natural Resources and Environmental Science

The Natural Resources and Environmental Science (NRES) program in the College of Agriculture was created in 1970 and is the oldest interdisciplinary environmental science program in the country. This robust program had over 100 students by the end of 2018 and is currently co-directed by professors Linda Prokopy (Forestry and Natural Resources) and Laura Bowling (Agronomy).

Before declaring a major in NRES, students can enroll in the Pre-Environmental Studies (Pre-ES) program, a non-degree option open to first-year students only. The Pre-ES program allows students to explore their options before declaring a major at the end of their first year. At the same time, they take courses in introductory environmental science, biology, and communication to stay on track toward a degree in an environment-related program.

At the end of their first year, Pre-ES studies students can choose the NRES major, which has five concentrations that include: (1) air quality, (2) water quality, (3) land resources, (4) environmental policy and analysis, and (5) emerging environmental challenges. The NRES program also offers two interdisciplinary minors, which are open to students from all majors on campus: Sustainable Environments and Natural Resources and Environmental Science. As an interdisciplinary program, NRES leans heavily on courses offered by other departments but there are a few NRES classes, including Introduction to NRES, Environmental Careers, and Internship Reporting. Over the course of the 2018-2019 academic year, the program took a deep dive into the curriculum, and changes will be made in the next academic year in order to remain at the leading-edge of environmental science programs.

In the past year, you could find NRES students studying in their collaborative work space in the Forest Products Building, attending environmental events like a tour of the ReNEWW house near campus and hiking at Turkey Run State Park with the Environmental Sciences Club, having lunch with alumni who visit campus to speak to the NRES careers class, or visiting local wind farms or the Purdue power plant with the Environmental Sciences Learning Community. A majority of NRES students are engaged in internships or research over the summer in a variety of settings, including the US Forest Service in Oregon, the Natural Resources Conservation Service in Indiana, policy internships in Washington D.C., the Governor’s office in Indianapolis, and environmental consulting firms across the country. Upon graduation, some NRES students continue on to graduate or law school and many enter the labor force directly working for government agencies, NGOs, industry, and environmental consulting firms.

https://ag.purdue.edu/nres/
Environmental and Ecological Engineering

The Division of Environmental and Ecological Engineering (EEE) approaches the management of complex problems with a focus on ecological interactions and resilient designs that take into account complexity and connectivity among systems. Located in the College of Engineering, the EEE curriculum trains engineers to apply their technical understanding of systems engineering, biology, and chemistry to develop strategies to protect human and environmental health. EEE seeks to lead in the education of all disciplines concerning how to incorporate design, practices and processes that are more harmonious with the Earth's ecosystems. EEE is the only degree program accredited in environmental engineering at Purdue University. The EEE student body continues to grow as more students learn of the exciting opportunities within this expanding field. In 2018, there were 140 students enrolled in the EEE degree program. In addition, more than 125 students were on track to earn a minor in EEE, which is open to all majors within and outside of engineering. Many students are interested in engineering because they see that it can make a difference for people as environmental engineering approaches have direct impacts on quality of life. Approximately 60% of EEE undergraduates are women, more than in any other engineering discipline at Purdue University.

Career opportunities for EEE students are excellent with salaries that are competitive with other engineering fields. Many EEE undergraduates choose to attend graduate school and successfully gain admission and financial support at prestigious university programs. More than half of students earning the BS in EEE (BSEE) choose to enter the workforce directly and the program’s job placement rate is typically 100%.

What’s new? Starting in fall 2017 EEE launched a combined degree option, where qualified students are admitted prior to their seventh semester and earn a master’s degree in only two semesters post baccalaureate. The combined degree program is open to select majors within and outside engineering.

https://engineering.purdue.edu/EEE/Academics

Environmental & Natural Resources Engineering

The Environmental and Natural Resources Engineering (ENRE) program, located in the College of Engineering’s Department of Agricultural and Biological Engineering (ABE), focuses on engaging students through teaching, research, and service to protect and restore our world’s natural resources. The global population is growing rapidly and we will need more food, water, energy, and other resources essential for life and prosperity. To meet this challenge, the program focuses on designing solutions that minimize environmental impacts while meeting the needs of society. With current enrollment of 26 students, the program provides ENRE students opportunities to study how water and pollutants move through natural systems and to develop sustainable solutions that use ecosystem processes to conserve natural resources and reduce pollution. Professionals in this area create soil and water conservation systems to support sustainable food and energy production.

Small class sizes and engaged faculty provide mentoring opportunities for the students to develop technical expertise and leadership skills, and the program typically has 100% job placement for graduates. Some career options include environmental consulting, governmental and regulatory agencies, non-governmental organizations (NGOs), and industry. Current examples of what graduates are doing include designing river restoration projects in California, developing nutrient reduction strategies for watersheds in Indiana, and sustainably managing forests in Washington.

New to ABE in 2019, BioEnvironmental Engineering! This new concentration in Biological Engineering builds on the core curriculum to provide students with the necessary biology, microbiology, and process engineering skills to tackle challenging environmental design issues, while adding specialization in environmental and natural resources. There is an increasing demand from industry and regulatory agencies for innovation to meet corporate sustainability goals and comply with increasingly strict governmental regulations. Waste processing and recovery to create value-added products, biological treatment technologies, and sustainable manufacturing are just a few of the gaps this new concentration will fill.

https://engineering.purdue.edu/ABE/academics/undergraduate/enre.html
Environmental and Sustainability Studies Certificate

The Environmental and Sustainability Studies (ESS) Certificate celebrated its second full year with 27 students in the program in 2018. The ESS Certificate is a campus-wide program initiated by the Center for the Environment and the College of Liberal Arts. ESS gives undergraduate students working in disciplines across Purdue’s campus a broad exposure to how environmental and sustainability challenges and solutions are conceived, represented, and researched in the humanities, social sciences, agriculture, and STEM.

Developed by an interdisciplinary committee of faculty from the Colleges of Agriculture, Engineering, Health and Human Sciences, Liberal Arts, and Science, the ESS program introduces students to a wide range of environmental issues. This rich diversity of perspectives gives students a multifaceted skill set, enabling them to better comprehend and evaluate today’s grand and complex environmental challenges. Students must complete the program’s keystone team-taught course, *Interdisciplinary Approaches to Environmental and Sustainability Studies*. Students engage in a series of active learning exercises such as role playing as international leaders in a UN Climate Change Negotiation Simulation, debating the policies of risk management, and encountering biodiversity in an immersive Keystone Species Theater. Students also work together on interdisciplinary projects that include sustainable and urban agriculture, environmental policy, and climate change. At the end of the semester, student teams present their findings and solutions to these Grand Challenges.

In addition, students take 12 credit hours in each of 3 separate areas: social, cultural, economic and political dimensions; stewardship, conservation, and management dimensions; and science, engineering, and technology dimensions. Students also complete an independent capstone. In the past year, student projects included topics such as: The Environmental Impact of the Feminine Care Industry; The Role of Indiana’s Native Plants in Wastewater Management Systems; Energy Policy in Indonesia; The Relationship Between Family Planning and Climate Change; and Restaurant Sustainability: A Local Perspective.

https://www.cla.purdue.edu/students/academics/certificates/environmental.html

Environmental Geoscience Major

The Environmental Geoscience major in the College of Science’s Department of Earth, Atmospheric and Planetary Science, offers an interdisciplinary curriculum that immerses students in the fundamentals of geology, chemistry, atmospheric science, biology, and physics. This coursework prepares our students so they can understand and help solve challenging environmental problems such as climate change, emerging pollutants, shrinking and shifting energy resources, and food production ecology. The Environmental Geoscience major at Purdue is flexible, allowing students to create their own coursework focus based on their particular scientific passion: air quality, soil and sediments, or hydrology. Required research/internships help students gain professional experience.

Graduates develop quantitative problem-solving skills that make them highly competitive for careers or further graduate school studies related to water quality and availability, air pollution and climate, and soil and sediment geochemistry. In 2018, the program had 34 students. Students from this major find success in a variety of professional career areas such as air and water quality monitoring, hydrology, soil and water conservation, environmental consulting, public policy, and climate change.

https://www.eaps.purdue.edu/for_students/undergraduate/environmental-geosciences/index.html
In summer 2018, four undergraduate students undertook research projects with faculty affiliates. These students, their projects and their faculty mentors are listed below.

**Indicators for the Environmental and Ecological Sustainability of the Planet**  
Student: M. Galiana  
Faculty: R. Nateghi (Industrial Eng. & EEE) and I. Hua (Civil Eng.)

**Data Analysis of Heavy Metal Exposure in East Chicago Residents**  
Student: R. O’Connell  
Faculty: E. Wells (Health Sciences)

**Robust Allocation of Funds for Nonstructural Flood Risk Mitigation**  
Student: Z. Richardson  
Faculty: D. Johnson (Industrial Eng. & Political Science)

**Assessing Building Drinking Water Chemical and Microbiological Quality at Home, Office, and School**  
Student: Q. Wang  
Faculty: A. Whelton (Civil Eng. & EEE)

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**DURI PROJECTS FOR 2019**

In Fall 2018, the projects of five Center affiliates were chosen as DURI projects for spring 2019. We look forward to hearing about the results and the experiences of our undergraduate students.

**Directing Sunlight to Meet Local Food, Energy, and Water Needs**  
Peter Bermel (Electrical and Computer Engineering)

**Visual Analytics and Precision-Agriculture to Enable Sustainable Viticulture and Visual Analytics for Milestone Management and Field-Work Coordination**  
David Ebert (Electrical and Computer Engineering)

**Integrated Sensing and Smart Solutions**  
Suranjan Panigrahi (Engineering Technology)

**Big Idea Challenge in Global Food-Water-Energy Sustainability Research**  
Carol Song (Research Computing)

**Energy-efficient Nano-engineered Membrane Distillation Desalination**  
David Warsinger (Mechanical Engineering)

**Kayapo Cinema (CLA Wilke Project)**  
Laura Zanotti (Anthropology)

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The Center for the Environment regularly provides research opportunities to undergraduates to work with affiliate researchers on current interdisciplinary research projects. Working closely with faculty, students experience the excitement, challenge, and power of truly interdisciplinary research that addresses important environmental challenges.

Discovery Park, as a whole, also supports the Discovery Park Undergraduate Research Internship (DURI) program, which is also designed to involve Purdue undergraduates in interdisciplinary research that is the hallmark of Discovery Park.

Both programs provide opportunities for students to work on cutting-edge research projects that involve combining two or more disciplinary strengths.

More specifically, DURI helps additional affiliates of the Center for the Environment to connect with interested students to work on projects relating to the environment and global sustainability.

Students of both programs also get the opportunity to present their research. The Center for the Environment has students present at the annual Research Expo and Community Mixer in the fall, and the DURI program has their poster fair in August or September of each year.
Otto Doering arrived at Purdue on Thanksgiving Day, 1972, in a loaded station wagon with his wife Barbara, two small children, and a border collie who was reluctant to leave New York. Purdue was attractive because of its tradition of public policy involvement. Before Purdue, Otto worked as a legal investigator in the New York City Municipal Courts, as a horse wrangler in the Canadian Rockies, and for the Ford Foundation in Southeast Asia. His career has encompassed public policy issues as seen by someone trained at Cornell and the London School of Economics in government, public administration, and agricultural economics. His training included agricultural policy, energy issues, climate change, and water resource issues.

In Indiana, he began the State Utility Forecasting Group; served on the state’s Energy Development Board, the State Farmland Protection Committee, and the Commission for Higher Education; and was Chair of the State Transfer and Articulation Committee. National service included sabbaticals to serve in the Secretary of Agriculture’s policy group, the Economic Research Service, and the Resource Economics and Social Sciences group in the Natural Resources Conservation Service. He also had sabbaticals at UC Berkeley, Cornell, and North Carolina A&T and advised the Departments of Energy and the Interior. He is currently a member of EPA’s Science Advisory Board, serving as the chair of its Agricultural Science Committee. He was co-author of a number of National Academy studies, served on the Academies’ Water Science and Technology Board, and was a lead author for the Intergovernmental Panel on Climate Change. For over 25 years, he was an evaluator for the NSF’s Industry/University Cooperative Research Centers program. His expertise has always been wide, and he is one of only a few economists to have published in both Speaker Builder magazine and the Bell Journal of Economics.

In terms of teaching, Otto brought Ag Econ 250, the Economic Geography of World Food and Resources, from Cornell to Purdue. Several thousand Purdue undergraduates have been through his class and have learned about the history, economics and geographical importance of why things are done where they are done around the world. For some, his digressions into other issues and personal experiences were more interesting than Ricardian trade theory. In the 1970s, Purdue graduate students worked with Otto to redesign the research methods class he ran, Ag Econ 602. This class stresses the application of research methods to policy problems. The requirement that 602 students attend concerts stems from Otto’s experience as a recording engineer and his concert attendance as a student in London.

Otto’s research contributions were as leader or contributor in multi-disciplinary integrated research efforts that included energy flows in agriculture, the National Hypoxia Assessment, climate change impacts on agriculture, and managing excess reactive nitrogen. He directed several Purdue research centers. His service, outreach, research, and teaching were integrated in the Land Grant tradition. Otto led several professional associations and received numerous awards. Some awards meaningful to him are the IRRI Rice Production Course Certificate awarded by the developers of the Green Revolution’s miracle rice varieties, the “Border Collie Award” for successfully shepherding his last NSF center, and the “Skunk at the Picnic Award” from his colleagues at NRCS “for taking on the status quo, challenging conventional wisdom, and provoking original thought.”