

Pathways to equity

Improving welfare, advancing environmental justice

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Berkeley Rausser

College of Natural Resources

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LETTER FROM THE DEAN

It's well established that some communities are suffering greater impacts from the climate crisis than others. People of color, low-income neighborhoods, and fence-line communities near pollution sites or in other vulnerable locations are disproportionately harmed, not only by the effects of climate change itself, but by some of the current approaches to fight it.

These disparate effects on marginalized groups contribute to what is known as the climate gap. There is an urgent need to address these mounting social, economic, and health inequities that are created or compounded by climate change, economic injustice, and the enduring legacies of racism.

This issue of *Breakthroughs* highlights researchers in our community who are tackling these issues head on. Using collaborative, multidisciplinary, and community-engaged approaches, they are advancing environmental justice and climate equity initiatives around the world.

We feature faculty working to ensure an equitable green transition in the US; uncovering the impacts of rare earth metal mining in Tanzania; advising the federal government on how best to direct funds earmarked for vulnerable communities; and many others. We profile just a few of the many College alums who have devoted their careers to improving justice and welfare for others. And we showcase research from some of the outstanding students who have been supported by the Katherine S. and James K. Lau Graduate Fellowship in Climate Equity, which was established at Rausser College in 2021.

We cannot successfully confront climate change without recognizing its intersection with racism, inequality, and environmental injustice. Likewise, we can't confront inequality and discrimination without considering the climate crisis. Our collective global well-being depends on alleviating the climate gap by centering these issues in research and policy decision-making. We hope you are inspired by these stories and will consider supporting our work.

A handwritten signature of David D. Ackerly in orange ink.

David D. Ackerly

Cover illustration
by Daniella Ferretti

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Our 50th anniversary celebrations continue all year long. Scan for stories, events, and our photo contest winners.



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Building better infant formula

Roughly three in four babies worldwide drink infant formula during the first six months of their life, either as a sole source of nutrition or as a supplement to breastfeeding. But this essential product currently doesn't replicate the nutritional profile of human breast milk, which contains approximately 200 human milk oligosaccharides (HMOs), prebiotic sugar molecules that help prevent diseases and support the growth of healthy gut bacteria.

Replicating these sugars has been a significant challenge for manufactur-

ers, but new research led by Plant and Microbial Biology professor **Patrick Shih** may help close that gap. In June, Shih and colleagues reported in *Nature Food* that their team of scientists from UC Berkeley and UC Davis successfully reprogrammed the sugar-making machinery of *Nicotiana benthamiana*—a close relative of tobacco—to produce 11 known HMOs and other complex sugars with similar properties.

Commercial HMO production currently relies on microbial fermenta-

Shades of fear and favor

Around the world, animals that exhibit rare color morphisms—including lighter colored variants with albinism or leucism and dark-colored variants with melanism—are often the subject of both veneration and fear in humans. A recent study by UC Berkeley wildlife biologists is one of the first to explore how human preference for these unusual color variations impacts how animals are perceived and treated.

For the study, which was published in *Human Ecology* this spring, the researchers surveyed news articles and scientific publications for observations of animals with novel

colorations, noting whether they were treated as nuisances or with adoration and protection.

They found multiple places in the US where it's illegal to hunt white stags or albino, white-tailed deer, but not melanistic deer. They also found that both white and black squirrels are

celebrated and protected in parts of the country. Brevard, North Carolina, is a squirrel sanctuary and hosts a White Squirrel Weekend focused on its leucistic squirrels, and in Olney, Illinois, white squirrels get right-of-way when crossing the street. Kent State University's annual Black Squirrel Festival celebrates the campus's black squirrel population, which was imported from Canada in 1961.

While the study found that generally people are more interested in her-



From left: A white fallow deer and a black melanistic squirrel.

tion, but that process is only able to produce two to five simple HMOs at a time. “We made all three major groups of HMOs,” explained Shih, the study’s senior author. “To my knowledge, no one has ever demonstrated that you could make all three of these groups simultaneously in a single organism.” Lead author Collin Barnum, a UC Davis graduate student, also created a strain of plants optimized to produce LNFP1, an HMO that is challenging to produce using existing methods.

Shifting to plant-based formula production would likely be more cost-effective and easier to produce at a commercial scale. The breakthrough could also lead to the development of more nutritious nondairy plant milk for adults. — *Kara Manke*

bivores like deer and squirrels, there were instances of predators benefiting because of their unique color. For example, a black coyote roaming neighborhoods in Atlanta, Georgia—where trapped coyotes are required by law to be euthanized—was instead relocated to a sanctuary.

“Conservation scientists use evidence-based approaches informed by research and literature, but they are still human beings with natural, internalized biases and preferences,” said co-author **Tyus Williams**, a graduate student in the lab of Assistant Professor **Christopher Schell**, which focuses on urban wildlife ecology.

“Critically examining those feelings can help us better inform policies to effectively look after the animals we’re trying to steward.”



Read a full
interview
with
Williams

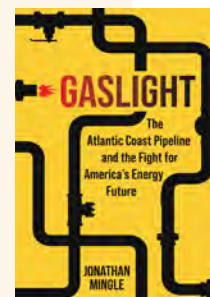
Hot off the press

GASLIGHT: THE ATLANTIC COAST PIPELINE AND THE FIGHT FOR AMERICA’S ENERGY FUTURE

By **Jonathan Mingle, MS ’09 Energy and Resources**

Island Press

Independent journalist **Jonathan Mingle’s** latest book provides a gripping account of the David versus Goliath battle surrounding the Atlantic Coast Pipeline proposed by utility giant Dominion Energy. The book recounts the six-year-long effort of farmers, nurses, scientists, innkeepers, and other rural Virginians to stop the 600-mile-long project. The pipeline’s developers insisted that the pipeline was in the public interest because it would carry natural gas, touted by the industry as a “bridge fuel” to a clean energy future, despite experts’ warnings that it would lock in decades of climate-warming emissions. The grassroots coalition persisted against Dominion’s deep pockets and unparalleled influence over lawmakers and regulators. Eventually they won: Dominion sold most of its gas assets and pivoted to building the country’s largest offshore wind farm. Mingle’s narrative offers insights into the political influence of the utility and gas industries, the risks posed by continued investment in fossil gas infrastructure, and the power of ordinary citizens to shape the decisions that will determine America’s energy future.



RECYCLING CLASS: THE CONTRADICTIONS OF INCLUSION IN URBAN SUSTAINABILITY

By **Manisha Anantharaman, PhD ’15 Environmental Science, Policy, and Management**

MIT Press

In *Recycling Class*, **Manisha Anantharaman** grapples with the complexities of pursuing sustainability in a deeply unequal and exploitative world through a ten-year study of garbage politics in Bengaluru, India. Over the past decade, members of the city’s middle class have developed neighborhood groups to support recycling, composting, and zero-waste lifestyles as solutions to the growing crisis of unmanaged waste. The book details how waste pickers—those who make a living by reclaiming value from discards—organized to obtain inclusion into these decentralized systems. Although these “DIY infrastructures” have created economic and political opportunities for waste pickers, these configurations also continue to reproduce class, caste, and gender-based divisions of labor. Ultimately, the book demonstrates that under the logic of neoliberal, racial capitalism, inclusion without social reform can reproduce unjust distributions of risk and responsibility. Anantharaman argues that urban sustainability transitions and circular economy initiatives must repair past harms and confront their gendered and racialized dynamics to avoid perpetuating existing patterns of exploitation and dispossession.



Blazing premiums

Homeowners across the country are scrambling to keep up with rising property insurance prices, and options for insuring homes in disaster-prone areas are dwindling. Many insurers are raising premiums significantly or leaving high-risk markets altogether.

In California, lawmakers are working to reform regulations that were not designed with the pressures of climate change—like wildfire—in mind. California limits how quickly homeowners’ insurers can increase premiums without a costly and time-consuming public hearing. Insurers argue that these regulations limit their ability to raise rates fast enough to keep up with costs. Consumer advocates, however, insist these guardrails are needed to ensure fair and affordable pricing.

A recent National Bureau of Economic Research working paper co-authored by **Meredith Fowlie**, a professor of agricultural and resource economics, explores the relationship between wildfire risk and insurance prices in the state. The study found that California insurers take very different approaches to pricing wildfire risk and setting homeowners insurance premiums: some look only as far as zip



More on the study



codes to assess wildfire risk exposure, while others use much more granular data.

According to the authors, this finding has two important—and related—implications for California homeowners. First, companies with less granular information price insurance premiums higher because they are worried about “winning” higher-risk homes. Second, insurance availability can decline if companies with less detailed information want to raise premiums but run up against California’s rate increase regulation and instead pull out of high-risk areas altogether.

“There is a very high-stakes conversation right now about regulatory reform,” said Fowlie. “Our work suggests that making it easier for all firms in the market to access more granular, more sophisticated wildfire risk estimates could help improve both the availability and affordability of insurance.” — *Kara Manke*

Empowering equity scholars

A new, year-long, research fellowship is bringing greater focus to issues of equity in the fields of energy and environmental policy and working to cultivate a diverse community of scholars in these fields. Offered by the Energy Institute at Haas and the Opportunity Lab, the Energy and Environmental Economics Mentoring Program gives Berkeley undergraduates a chance to gain research experience by working closely with leading PhD students and faculty researchers.

In addition to direct research, fellows participate in weekly workshops,

receive training in data analysis and programming tools, and benefit from career advising and support. “We designed the program with no requirement for previous research experience,” said **Meredith Fowlie**, a professor in the Department of Agricultural and Resource Economics (ARE) who co-leads the program with **Reed Walker**, an associate professor of economics at the Haas School of Business. “We hope to engage more students, and elevate new perspectives, by making this research opportunity accessible to undergraduate students from a broad range of backgrounds.”

This year’s graduate student mentors include **Kendra Marcoux**,

Sayantana Mitra, **Paula Meloni**, and **Shuo Yu** in ARE; **Hikari Murayama** and **Ari Raphael Ball-Burack** in the Energy and Resources Group; and others from the Departments of Economics and Electrical Engineering and Computer Sciences. Research projects involve topics such as exploring equity in access to public EV charging infrastructure; understanding the effects of incentivizing smallholder farmers in rural India to adopt agricultural practices that improve soil carbon sequestration; and simulating how changes in the demand for oil and gas fuel might increase production of plastics. — *Julie Gipple*

In their own words

Conociendo nuestra cultura

KNOWING OUR CULTURE

From sea-level rise to drought, wildfires, and flooding, climate change's effects are increasing worldwide. With a unique geography and many rural populations, Mexico—a place I hold dear to my heart—is especially vulnerable.

As a part of UC Berkeley's Latinxs and the Environment Initiative, I had the opportunity to travel to Mexico City and Oaxaca for two weeks this summer to learn about agriculture, water management, and how rural communities adapt to climate change and preserve their cultural heritage. Conociendo Nuestra Cultura is a binational program supported by UC Alianza MX, an initiative that connects students from across all ten UC campuses with Mexico by providing funding for research, academic mobility, and other engagement. During the program's first phase, I and nine other participants attended weekly lectures by researchers, government officials, and professors from UC Berkeley and UC Davis.

In Mexico City, we heard from Dr. Luis Zambrano of the National Autonomous University of Mexico (UNAM) about analyzing Mexico City's

water crisis from an urban ecosystem perspective. We learned that groundwater overpumping and continuous urbanization are causing the city to sink. Aquifers and reservoirs can't recharge at the same rate of extraction, and many areas are experiencing flooding and a lack of drinking water.

We also visited the Geoparque Mundial Mixteca Alta, a geopark consisting of nine municipalities within the Mixteca Alta region of the state of Oaxaca. There, we were fortunate to learn from and interact with three rural communities: Santa María Chachoápam, Santa María Suchixtlán, and San Bartolo Soyaltepec. We heard about Santa María Chachoápam's zero waste educational initiative, and how community members built dams and reservoirs to catch rainwater during periods of severe drought. We also met farmers who are adapting by using drip irrigation and crop rotation to preserve water.

At UNAM-Oaxaca, we heard about maize diversity in Mexico from agroecologist and geographer Dr. Quetzalcóatl Orozco. Orozco told us about the evolution of maize's ancestor, teocintle, into what we think of as corn today, and how Indigenous communities around Mexico continue to conserve native corn.

Although I previously visited Mexico to see family in Jalisco, I had not visited Mexico City or Oaxaca. As a Mexican-American, first-generation, low-income



Program participants at the National Museum of Anthropology in Mexico city.

student in academia, I never imagined I would have the chance to study abroad. Even more so, I never expected that I'd be able to study in a country so special to me—the land of my parents, grandparents, and ancestors. This experience allowed me to further connect my research on groundwater and agriculture to my identity and determine ways in which I can contribute to research and movements abroad.

Magaly Santos is a fourth-year student majoring in environmental economics and policy with minors in food systems and Geospatial Information Science and Technology.



The Ticker

Campus's brand-new Helen Diller Anchor House, primarily a housing building for UC Berkeley transfer students, opened in August, with a **state-of-the-art teaching kitchen** for Rausser College's nutritional sciences and dietetics programs.

A study measuring toxic metals in tampons co-authored by postdoctoral researcher **Jenni Shearston** found arsenic, lead, and other contaminants in the feminine hygiene products.

ESPM Professor **Paolo D'Odorico** was awarded the Prince Sultan Bin Abdulaziz International Prize for Water, which recognizes cutting-edge innovation in water research.

Camryn Rogers, BS '22 Society and Environment and Political Economy, won a gold medal for Canada in women's hammer throw at the Paris Olympics in August.



Pioneers of interdisciplinary sustainability

The Energy and Resources Group celebrates 50 years of working toward a sustainable environment and a just society

BY MATHEW BURCIAGA



When the 1973 oil embargo sent shockwaves through global society, few people could predict when—and how—spiking gas prices and fuel rations would end. Those anxieties were compounded by fears that the United States had surpassed its peak oil production and an increasing awareness of how fossil fuels harm the environment.

But even before talk of a crisis began to spread, UC Berkeley faculty were well poised to address it. In 1969,

From top: Michael Cohen (left) and other ERG graduate students during a 2013 visit to a Pacific Gas & Electric substation. A student carries the ERG Program sign as the department moved out of Building T-4 in 1995. ERG is now located in Giannini Hall.

Charles K. “Ned” Birdsall, a professor in the Department of Electrical Engineering and Computer Sciences, began hosting weekly lunchtime seminars for faculty interested in identifying and solving the energy problems of the future. They later recruited Lawrence Livermore National Laboratory physicist **John Holdren** as UC Berkeley’s first cross-campus professor in energy and resources and began developing a proposal for the Energy and Resources Group (ERG): a graduate program that connects students and faculty across the natural and social sciences to address challenges in energy, economics, engineering, and environmental science.

“A great university should have a component that thinks about the integrational pieces,” said Holdren. “We proposed to create that component in the form of a graduate group in energy and resources.”

Since accepting its first graduate students in 1975, ERG has inspired generations of physicists, economists, engineers, and ecologists to reframe ecological and resource issues by incorporating methods and approaches from numerous tradi-



Students and faculty during ERG’s 2018 winter gathering.

tional disciplines. Students have had the opportunity to learn from ERG's core faculty and develop their individualized research focus by making connections with a wide network of affiliates from across UC Berkeley and Lawrence Berkeley National Lab. Many faculty from the College of Natural Resources have been affiliated with ERG since its inception, and in 2011, the graduate group officially joined the College.

ERG has expanded over the last half-century while maintaining its unique culture and learning model. Students and faculty work together as activist-scholars to address questions at the forefront of climate change, social equity, and environmental justice. The program's seminar series helps break down disciplinary silos and provides opportunities to share ideas and perspectives informed by diverse backgrounds and professional skill sets. The impact of ERG's faculty and alums also extends far beyond academics: they have transformed and decarbonized power systems at the local, regional, and global levels; documented the impacts of international development on water and ecological resources; shaped policies that protect clean air and water; and developed economic and computer models that estimate how humans impact the climate and biogeochemical cycles.

"Students and faculty have been very proactive in figuring out what the most pressing problems are today, and then assembling the team and the tools needed to create a more sustainable environment and just society," said **Duncan Callaway**, professor and chair of ERG.

ERG celebrates its graduates at an intimate commencement ceremony, and every master's program cohort selects a recipient for the Spherical Cow Award, a nod to professor emerit **John Harte's** foundational

textbook on environmental problem solving. After graduating, the tight-knit alum community remains engaged and helps organize networking events and mentorship opportunities for current students.

"Going out into the world, it's always impressive to see what other ERGies are doing," said **Chris Hyun**, PhD '20, a leader of the ERG Alumni Network. "They are compassionate about other people and what's happening in the world, and they are looking at the big picture to assess global problems and then move the needle for solutions."

The number of ERG-affiliated faculty at UC Berkeley and beyond now exceeds 150, and updated versions of original core courses like Ecology and Society are still taught today.

ERG's newest core faculty—professors **Meg Mills Novoa**, **Youjin Chung**, and **Paige Weber**—bring fresh perspectives from the social sciences and strengthen the group's ability to address evolving energy challenges.

"I'm grateful that 50 years ago, a group of people on campus recognized the importance of creating a structure like ERG," said Callaway. "That idea has been more successful than people might have possibly imagined."

ERG co-founders Richard Norgaard, John Holdren, and John Harte shared their memories with an oral historian this summer. Visit ERG's 50th anniversary page to listen and join the celebration by sharing your own.



ERG's 50th anniversary



From left: ERG graduate students Jessica Katz, Rachman Setiawan, and Ari Ball-Burack with the solar panels on top of the student union on campus in 2024.



Advancing climate equity around the world

BY MATHEW BURCIAGA

Alums **Katherine Lau** '88 and **James Lau** '81 showed their confidence in UC Berkeley's leadership in climate equity and environmental justice by creating the Katherine S. and James K. Lau Graduate Fellowship in Climate Equity in 2021. The fellowship supports PhD candidates

working on projects that address the adverse impacts of climate change on marginalized communities and confront the underlying causes of inequality. Here we highlight some of the nearly three dozen graduate students the Fellowship has supported.

Chiman Cheung

AGRICULTURAL AND RESOURCE ECONOMICS

Cheung's research explores the impact of informing citizens in Ghana about policy issues to increase their ability to hold political leaders accountable, focusing on artisanal and small-scale gold mining, known locally as galamsey. Key political figures—including

security services, elected members of parliament, and traditional leaders—often support galamsey operations for personal benefit. Cheung collaborated closely with the Ghana Environmental Advocacy Group to organize public documentary screenings in galamsey communities, updating and coordinating community members' beliefs about the health impacts of galamsey.

They believe that this grassroots approach will empower community members to hold elected politicians and traditional leaders accountable through voting or regular interactions. By explicitly including chiefs, the research underscores the importance of incorporating nonstate leaders into environmental management frameworks.

Kendrick Manymules

GEOGRAPHY

For more than a century, swaths of Diné (Navajo) land have been reshaped to support energy infrastructure and development for western states. Manymules argues that much of this transformation has been accomplished through entrenched settler colonialism, which has allowed the US to dominate Indigenous nations and lands without an outright confiscation of territory. Merging archival and ethnographic research with Indigenous research methodologies, Manymules traces how scientific practices emerging from anxieties around soil erosion alongside capitalist development have fundamentally altered the Navajo Nation's relation to the land. This project builds on his earlier work conducted in partnership with the New Mexico-based community organization Earth Care and its youth organizing component, Youth United for Climate Crisis Action.

María Villalpando Páez

ENERGY AND RESOURCES

Villalpando's project explores the combined effects of socioeconomic marginalization, environmental degradation due to climate change, and gender inequality on food systems in southern Mexico's High Mixtec Region. Drawing from feminist political ecology and agroecology, her transdisciplinary work examines Mixtec peasant women's agri-food practices and asks how these contribute to equitable and healthy household food systems. She analyzes the overlap of ecological and social elements of food system change and uses participatory research methods to understand the localized personal and political meanings of food sovereignty among Mixtec peasant communities. Working closely with community members, she hopes to highlight peasant women's ability to access, create, and disseminate their agricultural values and expertise. She collaborates with Mexico's National Autonomous University Geography Institute and UNESCO's Mixteca Alta Geopark.

Cheng-Kai Hsu

CITY & REGIONAL PLANNING

Hsu's research explores the complex interactions between road safety and climate change within Taiwan's evolving gig economy, focusing specifically on the app-based food-delivery sector. Gig workers in Taiwan often ride bikes or motorcycles—which offer little protection from heat and air pollution—and are subject to traffic congestion and delivery deadlines that may exacerbate risky driving behaviors such as speeding, harsh acceleration, and tailgating. Hsu blended focus group responses with thermal, geospatial, and kinematical data from wearable sensors to understand the link between environmental exposures and road aggression among gig workers. His findings point to the urgent need for increased regulatory oversight to safeguard the road safety of this vulnerable group and the general public.

Jesús Alejandro García

ENVIRONMENTAL SCIENCE, POLICY, AND MANAGEMENT

García's work documents the impact of the hydropower boom on the marginalized communities of Colombia's Upper Magdalena River Basin. The project combines archival research and oral histories with first-hand observations to trace how peasant and fisherfolk communities have struggled with these infrastructure projects and how the residual land issues shape their current views on environmental and climate justice. García conducted the research in partnership with different groups of victims of El Quimbo Hydropower Dam that currently lead conversations about achieving a just energy transition within the region. His findings could inform fair and equitable policies for low-carbon energy sources while addressing historical inequalities.

Haley Lane

ENVIRONMENTAL ENGINEERING

Lane conducted an in-depth analysis of urban air pollution, focusing specifically on the disparities in air quality between historically disinvested areas and gentrifying neighborhoods. The project built on an earlier study of the relationship between redlining and air quality to better understand the associations between air pollution and displacement in the San Francisco Bay Area. Much of Lane's initial work was informed by the experiences of the West Oakland Environmental Indicators Project and Groundwork Richmond, two community groups that have advocated for cleaner air and against displacement in the East Bay. Learning from these groups helped Lane devise an analytical framework relevant to community advocacy that could be applied to other affected communities nationwide.



Sheep rancher Gracian Uhalde (right) shows Meg Mills-Novoa an access road on his Steptoe Valley property, which a pumped storage hydropower developer proposed using without consent.



Construction of a geothermal plant in Dixie Valley has halted over concerns for the endangered Dixie Valley toad.

RENEWABLE REPERCUSSIONS

Meg Mills-Novoa's research helps Nevada's rural communities and Indigenous groups navigate a boom of renewable energy production. BY JANET BYRON

On a recent research scouting trip in the Great Basin, **Meg Mills-Novoa** and her colleague Sophia Borgias were “staggered” by the number of lithium claim stakes they saw popping up across the Nevada desert floor.

“We could immediately see the extent and pace of change, with literally hundreds of claims that had clearly been staked in just the past few months,” says Mills-Novoa, an assistant professor in the Department of Environmental Science, Policy, and Management and the Energy and Resources Group.

As California ramps up its decarbonization efforts to combat climate change, a mining and renewable energy boom is underway in the Great Basin—the vast, water-scarce region stretching east of the Sierra Nevada to the Colorado Plateau and from southeast Oregon to Southern California and northern Mexico. The dramatic expansion of infrastructure, however, could have dire impacts on the

Great Basin's scarce water supplies, desert ecosystems, and rural and Indigenous communities.

“We urgently need climate action,” says Mills-Novoa, who leads UC Berkeley's Climate Futures Lab. “But how do we balance the crucial imperative of responding to climate change while not sacrificing vulnerable places and communities? Climate equity is about confronting these challenges, not pretending that they don't exist.”

Mills-Novoa and Borgias are co-principal investigators of a three-year project studying the impacts of the low-carbon energy transition on the Great Basin's water resources and equity implications for the people who live there. The project, which was recently awarded \$700,000 from the Alfred P. Sloan Foundation, combines geospatial analysis, extensive review of regulations and water rights, and in-depth qualitative research.

“The Great Basin is often overlooked as an empty desert, but in fact there's so much vibrance there in terms of both



ecosystems and human communities,” says Borgias, an assistant professor in Boise State University’s School of Public Service.

RISING DEMAND FOR RENEWABLE

The US Infrastructure Investment and Jobs Act of 2021 and Inflation Reduction Act of 2022 spurred a boom in lithium, solar, and geothermal projects, with an estimated \$2.7 billion in decarbonization-related investments in Nevada alone, according to the Department of Energy.

As of mid-2024, nearly 23,000 lithium-mining claims have been staked and 83 lithium mines have been proposed in Nevada, all in service of extracting minerals for the batteries needed to store electrical power from renewable energy sources. Millions of acres have been designated as potential sites for solar farms; some 65 geothermal plants have been leased or are under development; and increasing numbers of pumped-storage projects—which use large volumes of water as a giant battery—are underway.

At the same time, four-fifths of the Great Basin is public lands managed by federal and state governments, which also encompass the traditional lands of dozens of Tribal Nations.

“If you care about public lands in the desert, then renewable energy is your main concern,” says **Patrick Donnelly**, BS ’14 Conservation and Resource Studies, the Great Basin director for the Center for Biological Diversity and a member of a board advising Mills-Nova and Borgias. “Energy storage has become more important recently, and the industry has set its sights on the Great Basin and Mojave Desert.”

Geothermal and lithium extraction require enormous amounts of water and can disturb delicate desert ecosystems and threaten endemic and endangered species such as Tiehm’s buckwheat, Dixie Valley toad, desert tortoise, and dozens of springsnail species.

“Nevada has numerous aquifers and water basins that are in overdraft, meaning that more water is currently being pumped out for agricultural and human needs than is naturally recharged,” Mills-Nova says. “It’s one of our most water-scarce states.”

COMMUNITY CONNECTIONS

As human-environment geographers, Mills-Nova and Borgias study the relationships between people and environments. Longtime collaborators and close friends, they met at the University of Arizona, where they both earned PhDs in

geography and worked together on several climate and water justice research projects in Latin America and the western United States.

In August 2022, the duo facilitated a workshop at the first Great Basin Water Justice Summit, during which community partners coalesced around the need to develop data-visualization tools for critical mineral and renewable energy development and ethnographic, place-based storytelling to highlight potential impacts on the region’s often-ignored and marginalized communities.

“We wanted to build a research program that serves the needs of those folks on the front lines of the green transition and uncovers what tools can be of use to them,” Mills-Nova says.

With seed grants from the Berkeley Economy and Society Initiative and Boise State’s School of Public Service, Mills-Nova and Borgias laid the groundwork for their Great Basin project in 2023, scouting and meeting with stakeholders across Nevada.

Going forward, the project will focus on seven regional case studies, including Clayton Valley, home to the only existing lithium brine operation in North America; Rhyolite Ridge, a proposed hardrock mine at the largest known lithium-boron deposit in North America; Fish Lake Valley, an alkali playa with hundreds of new lithium claims and new road construction for lithium and geothermal exploration; and Amargosa Valley, where local officials are petitioning to prevent lithium exploration due to potential impacts on Ash Meadows National Wildlife Refuge.

The research team will conduct dozens of stakeholder interviews in each area, host workshops in several rural communities, and support two tribal forums on energy transitions and water justice led by advisory board members from the Owens Valley Indian Water Commission and Western Shoshone Defense Project. They will develop an interactive, online map aggregating regulatory and water-rights information from the multitude of state and federal agencies involved; easier access to this information will help communities provide input and secure community-benefit and harm-reduction agreements related to renewable energy development in their backyards. They will also produce story maps—interactive, multimedia websites—focused on each case study area.

“We hope that people can look at this region and the energy transitions that are unfolding with more information about what the implications are,” Borgias says.

Donnelly, who lives in Shoshone, California, near Death Valley National Park, says he’s thrilled to partner with Mills-Nova and Borgias and has already made community connections that will help advance the Center for Biological Diversity’s efforts to protect species and ecosystems in the Great Basin. “Meg and Sophia are getting their hands dirty,” Donnelly says. “They’re working with us and not on us.” **31**

Sophia Borgias



Patrick Donnelly and Mills-Nova on an exploration road in Fish Lake Valley, where prospectors have recently staked hundreds of claims for lithium.



Powering health in Africa

UC Berkeley research is electrifying clinics and hospitals that provide reliable power, Wi-Fi, and water to surrounding communities.

BY JANET BYRON

At least 100,000 of the 170,000 health facilities in sub-Saharan Africa—from rural clinics to hospitals—lack affordable, reliable electricity, which creates critical gaps in health care access and delivery.

In 2021, Professor **Daniel Kammen** was appointed senior advisor for energy, climate, and innovation for the US Agency for International Development (USAID). To begin addressing the health care inequities inherent in unreliable access to electricity, Kammen led a new initiative to collaboratively design renewable energy systems (primarily solar photovoltaics plus battery storage) for health care facilities in sub-Saharan Africa, while transforming those systems into minigrids that provide reliable electricity, Wi-Fi, and potable water for surrounding communities.

“Our goal is to power all of those 170,000 health clinics with sustainable energy, in a sustainable financial model, to enable just access to health care across the continent,” Kammen says. “We work hard on all aspects of that vision.”

Launched in 2023, USAID’s Health Electrification and Telecommunications Alliance—known as HETA or Powering Health—set the ambitious goal of 10,000 new renewable energy systems in its first five years, but progress has been so swift that its new goal is 25,000 systems.

“Imagine that you went to a hospital and the power was out for an hour or two,” says **Laura Kwong**, an assistant professor at the UC Berkeley School of Public Health collab-



Technicians trained through the HETA project install solar panels on the roofs of facilities that UC Berkeley research identified as highest priority.

orating with Kammen and others on HETA. “Without electricity, access to everything from x-rays and vaccines to baby warmers and oxygen machines would be unreliable. The fact that people are trying to provide health care without power is a bit mind-boggling.”

AN INTELLECTUAL HUB

Kammen is now back at UC Berkeley, where his Renewable and Appropriate Energy Laboratory serves as HETA’s chief intellectual hub.

“We do everything,” says Kammen, who retains his title as USAID senior advisor to HETA. “We innovate to have better and more useful sensors, we design the minigrid systems, and we engage with partners from around Africa to integrate the HETA concept into their own ministries of public health. And we do basic materials science research to develop batteries and other systems tailored to the African environment.”

A co-director of the Climate Equity and Environmental Justice roundtable (see pg. 14), Kammen is the James and Katherine Lau Distinguished Chair in Sustainability, with appointments in the Energy and Resources Group, Goldman School of Public Policy, and Department of Nuclear Engineering. He served as science envoy in the US Department of State (2016–2017) and had prominent roles in the Nobel prize–winning efforts of the United Nations’ Intergovernmental Panel on Climate Change.


From early on in his academic career, Kammen has been internationally recognized for his research on cookstoves, health, and gender in Kenya. “Working on HETA was a perfectly natural evolution or extension of what I’ve been doing for decades,” he says.

The countries participating in HETA include the Democratic Republic of the Congo, Kenya, Malawi, Mozambique, Sierra Leone, Tanzania, and Uganda. In a May speech at the Centers for Disease Control and Prevention, President William Ruto of Kenya highlighted HETA as a key initiative for improving the health care of Africans. HETA is supported by the Global Energy Alliance for People and Planet, a multibillion-dollar commitment of funds from the Bezos Earth Fund and the IKEA and Rockefeller Foundations focused on addressing the fragmentation of the renewable energy sector in emerging economies.

Samuel Miles, a PhD student in the Energy and Resources Group (ERG) and recipient of the prestigious Link Foundation Energy Fellowship, is analyzing health data collected from HETA clinics in war-torn regions of the Democratic Republic of the Congo to quantify the relationship between reliable energy and mortality and morbidity.

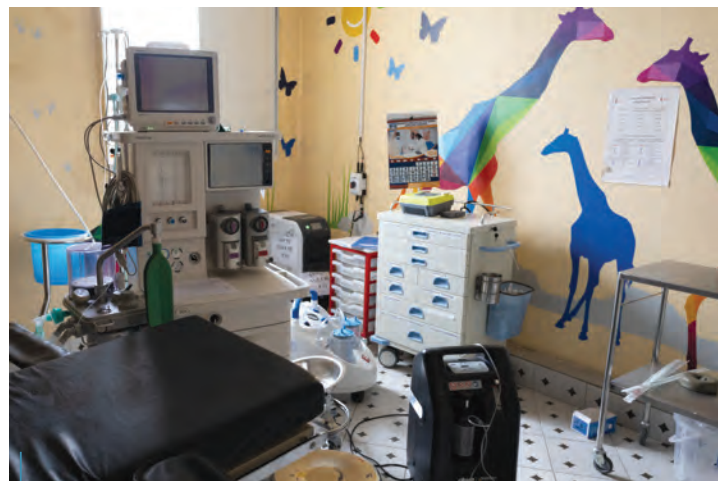
Other Rausser College collaborators on HETA include ERG graduate students **Gbemisola Akinsipe** and **Aline Abayo** and **China Duff**, an undergraduate majoring in environmental economics and policy. Professors **Misbath Daouda** and **Ajay Pillarisetti** in the School of Public Health are also involved, as are numerous students from other departments across campus.

“We are quantifying the impacts of reliable, clean energy on health,” Kammen says. “Our initial data suggests that if you can produce oxygen on demand at medical facilities, you can dramatically increase the survivability of patients.”

Kammen is also energized about the latest step HETA is taking toward health equity in Africa. Earlier this year, USAID launched HETA+, which incorporates the electricity needs of ethnomedicine, herbalists, and traditional healers. “We are working to support the integration of Western medicine and community medicine, because they too can do their jobs better with reliable energy.” 



Samuel Miles and Emery Mbavumoja of the Congolese Rural and Peri-urban Electrification Agency install a sensor that monitors power quality and reliability.



Medical equipment in this pediatric operating room in the Democratic Republic of the Congo is protected from power irregularities through the UC Berkeley-HETA partnership.

Jessica Kersey (2x)

Championing Equity

Grown from the grassroots, the environmental justice movement has gone global—and Rausser College researchers are at the forefront.

BY TOMAS WEBER
ILLUSTRATION BY DANIELLA FERRETTI



In a fall morning in 1991, over one thousand civil rights leaders and environmental activists from all fifty states and beyond made their way to Washington, DC, for a demonstration outside the Capitol. But the event was no mere protest.

Over four days, participants in the First National People of Color Environmental Leadership Summit took part in meetings that transformed the meaning of environmentalism, connecting it to struggles for racial and economic justice. Sponsored by the United Church of Christ, the summit set the foundations for the burgeoning environmental justice movement in the United States.

Today, the movement is flourishing like never before. Environmental justice is at the core of the Biden-Harris Administration's policy agenda, and UC Berkeley scholars are at the vanguard. A multidisciplinary team of researchers affiliated with the campus-wide Climate Equity and Environmental Justice (CEEJ) roundtable is working with impacted communities to address environmental racism, achieve environmental equity, and shrink the climate gap—the disparate impacts that a warming world is imposing on poor people and communities of color.

MOMENTUM OF A MOVEMENT

The movement's roots, though, go back almost half a century. In the late 1970s, civil rights groups such as the NAACP



and the Southern Christian Leadership Conference began grappling with what was, at the time, an overlooked form of racial discrimination. Less visible than segregated campuses or police brutality, environmental harms have long disproportionately affected the most marginalized communities in the country.

A long history of redlining and other actions by lawmakers and city planners has resulted in the ongoing disenfranchisement of people of color. Highways and oil refineries were disproportionately built in Black neighborhoods, creating widespread displacement and exposure to toxic air pollution, and Latinx children are more likely than white kids to attend a school next to a toxic waste dump.

But traditional environmentalists did not usually consider these polluted places part of the *environment*—a word generally used to refer to areas of pristine wilderness that were the focus of predominantly white nonprofits, like the Sierra Club or the Nature Conservancy. At the 1991 summit, the group of mostly Black, Indigenous, and Latinx activists argued that the term should be extended to some of America's most toxic places.

Cancer Alley, the so-called 85-mile stretch between New Orleans and Baton Rouge—home to over 150 petrochemical plants and populated by mostly Black residents—was the environment, they said. So was Afton, North Carolina, where, since the early 1980s, a toxic waste landfill poisoned the soil with cancer-causing polychlorinated biphenyls.

“Our movement redefined environmentalism,” said Robert Bullard during last November's Albright Lecture at Rausser College. Bullard, a sociologist known as the Father of Environmental Justice, revealed in the 1970s that almost all landfills, incinerators, and garbage dumps in Houston were

placed in predominantly Black neighborhoods. “The environment is where we live, work, play, worship, learn, as well as the physical and natural world,” said Bullard, who helped organize the 1991 summit and later created the Bullard Center for Environmental and Climate Justice at Texas Southern University. “Environmental justice embraces the principle that all people are entitled to equal protection of our environment, housing, transportation, energy, health, and civil rights. We are talking about all these things coming together.”

In the years following the summit, the movement snowballed. The first environmental justice centers were created at historically Black colleges and universities, and these centers helped formulate the seventeen principles of environmental justice. They demanded an end to the production of toxic and hazardous wastes and asserted a right for affected groups to participate as equal partners in the planning process at every level of decision-making.

In February 1994, President Clinton, flanked by Bullard in the Oval Office, signed Executive Order 12898, which required every federal agency to make achieving environmental justice part of its mission.

INTEGRATING ENVIRONMENTAL JUSTICE

Since then, California activists and researchers have paved the way. Environmental justice advocates opposed the state's 2006 cap-and-trade program, arguing instead for a carbon tax. But in 2012, environmental justice organizations worked with legislators to mandate that 35% of cap-and-trade monies must be invested to benefit environmentally disadvantaged communities. “They made lemonade out of lemons,” says **Rachel Morello-Frosch**, a professor in the Department of Environmental Science, Policy, and Management (ESPM) and the School of Public Health at UC Berkeley.

Almost \$30 billion has been raised by the cap-and-trade program over the last twelve years, but the funds are only helpful if they flow into communities that need them the most. Morello-Frosch, who co-chairs the CEEJ roundtable, has been working with state and federal government agencies to help pinpoint areas most burdened by pollution.

Morello-Frosch has collaborated with California's Environmental Protection Agency to help develop and update CalEnviroScreen, the nation's first online mapping tool for identifying disproportionately polluted communities. Initially launched in 2013, the tool informs California Climate Investments, the entity that awards grants that fund everything from programs for air pollution abatement and safe drinking water to sustainable farming, tree planting, and high-speed rail.

Rachel Morello-Frosch helps address current and historic environmental injustices as a member of the White House Environmental Justice Advisory Council.





Daniel Kammen is leading efforts to electrify health facilities in Africa and assist underfunded California counties in enacting climate action plans.

environmental justice to majority Black cities in the state—a battle they are still fighting today.

And Morello-Frosch, for her part, is now applying her expertise in mapping areas disproportionately affected by climate change and toxic pollution to the whole country. When President Biden took office in 2021, he signed Executive Order 14008, which asserted an ambition to integrate environmental justice into the administration's efforts to tackle climate change. The result was the Justice40 Initiative, which funnels 40% of the benefits of certain federal climate investments toward disadvantaged communities that suffer from pollution and underinvestment. And the 2022 Inflation Reduction Act unlocked \$369 billion in climate and clean energy investments—and required that \$60 billion be spent on helping communities disproportionately exposed to environmental pollution.

This money is now funding everything from the purchase of electric school buses and the replacement of lead pipes to the protection of low-income households from storms and floods. Morello-Frosch, along with Bullard, sits on the White House Environmental Justice Advisory Council, where she recommends how best to spend the funds and how to measure success.

“We’re helping develop what we call an environmental justice scorecard,” she says. “It’s an accountability tool that tracks and measures how 40 percent of benefits actually flow to the relevant communities.”

Morello-Frosch has also been helping to build the Climate and Economic Justice Screening Tool, a federal version of CalEnviroScreen. She is focused on ensuring the most vulnerable communities are protected from climate change impacts, while “helping to develop accountability and information-sharing structures across agencies that have a commitment to embedding environmental justice and equity in their work,” she says.

Safe water is a particularly urgent need. California’s water is especially vulnerable to climate change, with mountain snowpacks shrinking, frequent drought, and underground aquifers running dry. The predominantly Latinx rural communities along the Central Coast and in the San Joaquin Valley are most vulnerable. These households tend to be reliant on shallow and intermittent backyard wells—which are often contaminated.

“Backyard domestic wells are not regulated under the Safe Drinking Water Act,” says Morello-Frosch. “Many of them are contaminated with nitrates and other pollutants due to agricultural activities, as well as oil and gas development activities in these regions.”

Morello-Frosch has been studying the health impacts of these wells, which include adverse maternal health and birth outcomes. She has also been working with the Community Water Center, a nonprofit water justice organization based in the San Joaquin Valley, to develop the Drinking Water Tool, which empowers affected communities by uncovering threats to local groundwater and providing information on how to get involved in water management decisions.

“Community partnerships have improved the rigor, relevance, and reach of our science,” says Morello-Frosch. “They’ve enabled us to do novel projects in ways we would not have been able to do ourselves. And they’ve ensured that we keep asking relevant questions and guarantee that the science is translated to inform policy and regulatory change in ways that improve the health of the communities that we study.”

Water is also a focus for **Michael Mascarenhas**, an environmental sociologist and professor in ESPM. To research his 2024 book, *Toxic Water, Toxic System: Environmental Racism and Michigan’s Water War*, Mascarenhas worked closely with activists over many years to understand the roots of Michigan’s water crisis. He revealed how community organizers, through a tireless campaign, fought to bring

Michael Mascarenhas is an expert on environmental racism, humanitarianism, and water issues.





Paige Weber uses quantitative methods to understand the trade-offs involved in environmental policymaking.

suited to understand some of the trade-offs involved in environmental policy making. “It’s amazing for the environmental justice field that so many different disciplines are now bringing their tools to the problem,” says Weber. “I want my work to complement the perspectives of other disciplines working on similar questions.”

Weber, an assistant professor in ERG who joined Berkeley last year, digs into environmental policies to uncover potential trade-offs. Could cleaning up a low-income, heavily polluted area cause property prices to rise, forcing residents out? As an environmental economist, Weber attempts to quantify the costs and benefits of environmental policies to understand their short- and long-term impacts, as well as unintended consequences.

Sometimes, Weber points out, crafting policy that advances environmental justice and effectively combats climate change is a balancing act. In 2022, California Governor Gavin Newsom signed SB 1137, requiring all new oil and gas drilling sites to be set back at least 3,200 feet from sensitive sites like homes, schools, hospitals, and parks. But in a paper published last year, Weber and co-authors showed that although setting back wells from vulnerable sites does have the largest health benefits compared with other measures, such as excise and carbon taxes, the policy could not achieve the state’s 90% greenhouse gas mitigation target without additional restrictions.

“We found that setback restrictions are effective in generating health benefits,” says Weber, “but that the state will have to combine it with another policy, like a carbon tax, to get to the greenhouse gas emissions reductions it wants to achieve.”

Environmental trade-offs can have more vicious effects, too. In their rush to extract rare earth metals crucial for the

This unprecedented influx of federal funds requires work at the grassroots level, too. Applying for federal grants can be complicated and time consuming, and the process demands expertise that underserved communities often lack. Last year, **Daniel Kammen**, who leads the CEEJ roundtable with Morello-Frosch, received a \$1.4 million state grant to build tools to help underserved California cities and counties build climate-action plans and limit their carbon emissions. These plans will help disproportionately burdened towns unlock much-needed federal funds.

ACTION-ORIENTED RESEARCH

Environmental justice is growing at Berkeley, too. In 2021, the CEEJ roundtable hired five tenure-track assistant professors to work alongside the campus’s well-established researchers who have long been leaders in the field. These early-career scholars are advancing environmental justice from across diverse fields—ranging from climate migration and engineering to sociology and climate-adaptation design. “They are a remarkable group,” says Kammen, who is the James and Katherine Lau Distinguished Professor of Sustainability in the Energy and Resources Group (ERG). “There’s an amazing community here.”

The growth is necessary. With environmental justice in the public eye like never before, and with billions of dollars now in the mix, it is vital that researchers keep a keen eye on the environmental justice initiatives that are springing up and monitor them for unintended consequences.

Paige Weber, an economist by training, is doing just that. She’s analyzing the equity impact of green policies with a powerful set of quantitative methods, which she thinks are

Youjin Chung’s ethnographic research reveals the impacts of rare earth metal mining on communities in Tanzania.



Matthew Burciaga (Weber); Matthew Locke Wong (Chung)

Peter Nelson collaborates with communities and tribal leaders to support Indigenous approaches that can reduce the risk of megafires and their impacts.

green-energy transition, mining companies risk harming communities and ecosystems around the world. “Projects that aim to do good may end up having inadvertent socio-environmental consequences that negatively affect local communities,” says **Youjin Chung**, an assistant professor in ERG and ESPM.

Although the environmental justice movement began in the US, environmental injustice has no boundaries. Developing countries are on the frontline of climate-change risk while having contributed the least to carbon emissions. “The low-carbon energy transition is an uneven geographical process that has the potential to assign someone else’s landscapes and lives to social and environmental devastation,” says Chung. “It is often framed as: These are the green sacrifice zones that have to be created in the Global South in order for us to achieve sustainability outcomes in the Global North.”

Chung, who focuses on East Africa, is analyzing an ongoing attempt by an Australian mining company to extract neodymium-praseodymium (rare earth elements required for building generator and motor magnets in wind turbines and electric vehicles) from southwest Tanzania. Using ethnographic methods, she is finding that residents of the village where the mine will be built have mixed opinions: while some are excited about the employment opportunities the mine may bring, everyone is worried about pollution and other social costs.

“Water trickles down from the mountain-top mining site to the village,” says Chung. “That’s their source of drinking water and a place of cultural rituals.” As part of the National Science Foundation-supported project, Chung is working with colleagues in natural and physical sciences who are developing more efficient, less toxic methods for processing the metals. As the green transition accelerates, says Chung, it is vital that the quest for critical minerals proceeds in a way that minimizes social and environmental harms.

Moving closer to home, there’s no shortage of well-intentioned but disproportionately harmful environmental policies. Take wildfires. Megafires are becoming increasingly common, and the smoke disproportionately smothers Indigenous communities. Part of the problem, says **Peter Nelson**, an assistant professor in ESPM and the Department of Ethnic Studies, is the exclusion of Indigenous knowledge from forest management decisions.

Nelson, who is Coast Miwok and a tribal citizen of the Federated Indians of Graton Rancheria, studies environmental stewardship at the intersection of environmental science, Indigenous environmental studies, and Native American studies. For thousands of years, Native Californians used controlled burnings to manage land.



But a blanket policy of fire suppression has caused a buildup of vegetation that fuels fires of intense destructive power.

Nelson is now trying to rekindle these traditional practices. Last year, he received a state grant of nearly \$1 million to work closely with tribal entities to expand the use of prescribed fire. By bringing landowners, local communities, and tribal leaders around the table to support Indigenous approaches to fire, he says, we can reduce the risk of megafires and the impacts they cause for everyone.

CLEARING THE AIR—FOR ALL

Morello-Frosch points out that in heavily segregated cities, such as Detroit, Newark, and Memphis, the air is worse overall, for everybody, than it is in less racially divided places. One reason for this is that segregated cities are often more spread out, which means people must drive more to access jobs, amenities, and other services. And in racially divided areas, communities of color have less political power—leading to wealthier white groups from cleaner parts of the city more easily shunting hazards into poorer areas.

“This degrades environmental quality for everyone,” she says. “If we’re not investing in the improvement of air quality or water infrastructure, it affects everybody, even though marginalized groups are disproportionately more impacted.”

Despite progress that has resulted from the environmental justice movement over the past fifty years, it is overwhelmingly disadvantaged groups who are still struggling to breathe. It is this urgent fact, and others like it, that remains at the core of the movement—at Berkeley and beyond. “People of color breathe other people’s air,” says Bullard. Black children, he points out, are four times more likely to die of asthma than white children—and “when you talk about a kid who can’t breathe because of a poor environment,” he says, “people should be mad as hell, in the streets protesting.” **31**



Kristina Yarmolich walking through Kibera with water purified in HNP's water treatment and bottling plant.

PROFILE

Empowering success in Kenya

KRISTINA YARMOLICH, BS '21 CONSERVATION AND RESOURCE STUDIES

BY KRISTIN BAIRD RATTINI

For the estimated one million residents of Kibera, the Nairobi neighborhood that locals refer to as the largest slum in Africa, the overwhelming needs of the present make it extremely difficult to envision a future any different from today. As the USA executive director of the nonprofit Human Needs Project, Kristina Yarmolich develops partnerships and sustainable programs that empower Kibera residents to overcome poverty by providing them with the essential infrastructure they need to succeed. “We’re breaking the cycle of dependency and aid and helping people take charge of their own path,” she says.

MEETING NEEDS UNDER ONE ROOF

The Human Needs Project (HNP) was the inspiration of actor Connie Nielsen, who spent several months shooting the film *Lost in Africa* in Kibera in 2010. Nielsen was deter-

mined to improve the dire conditions there, particularly the lack of clean water, sanitation, and opportunities for advancement. She found the perfect partner and cofounder for the Human Needs Project in **David Warner**, BS '76 Conservation and Resource Studies, owner of Redhorse Constructors Inc. and an expert in sustainability and construction technology.

In July 2014, they opened the Kibera Town Centre. It has a wastewater treatment and filtration system to provide residents with subsidized safe drinking water, toilets, showers, and laundry facilities. Solar panels power the Centre's electricity and Wi-Fi. Over the past decade the Centre has added an urban farming project and a job training program. And HNP's own banking system helps locals, especially women, access loans and gain financial freedom.

“There’s a term called time poverty,” Yarmolich says. “In slum areas, people spend lots of time walking to get water, to access education, to find jobs. There’s so much ineffi-

ciency. The idea behind Kibera Town Centre is to place all these services under one roof, so that people can save their precious time and reinvest it back into themselves, their families, and their community.”

A SOLID FOUNDATION

Yarmolich originally thought she'd focus on waste management when she began her studies at Berkeley. But the multidisciplinary nature of her degree broadened her interests, especially in the areas of sustainability and social justice. A project on food systems for a course with **Kathryn De Master**, a professor of agriculture, society, and environment, resonated deeply with Yarmolich then and reverberates for her today in HNP's urban farming program.

“I'm from Belarus originally, and I spent a lot of time on my grandma's farm,” Yarmolich explains. “If you wanted a salad, you went outside and picked it. The project for Kathryn looked at food supply chains and how most consumers don't really know where their food is coming from. It was really meaningful for me.”

Through a campus connection, Yarmolich went to work for Warner, first as a projects coordinator for Redhorse Constructors before pivoting to the Human Needs Project. “Kristina's experiences at Rausser College of Natural Resources gave her the tools to be incredibly successful in such a demanding role and environment,” Warner says. “Her skillset allows her to organize infrastructure, science, and social justice projects while also working with international institutions like the United Nations to uplift the community of Kibera.”

CULTIVATING PARTNERSHIPS

Rausser College students, alums, and faculty have provided ongoing support for HNP since its inception. Energy Professor **Daniel Kammen** is a board member and has advised HNP on energy, data, and digitization projects. Several students have conducted research for HNP on subjects ranging from microgrids to new revenue streams. And HNP has sponsored more than a dozen Kiberans to attend the College's Beahrs Environmental Leadership Program, including Teresa Nasambu, HNP's operations manager in Kibera.

In addition to working on fundraising and compliance and collaborating with the 40 Kibera staff, Yarmolich focuses on cultivating partnerships with corporations, nonprofits, and agencies around the world. For example, Grundfos, the world's largest water pump manufacturer, supported HNP's

water bottling plant, the first in Kibera. The World Food Programme has provided significant funding for HNP's urban farming project, which generated 20,000 tons of vegetables last year.

Kibera Town Centre is recouping around 40 percent of its operating expenses through these enterprises. “We're creating these systems to be financially independent and sustainable,” Yarmolich says.

Yarmolich was honored to meet Rachel Ruto, the first lady of Kenya, and to nurture a partnership with Ruto's organization, MaMa Doing Good. Together, the organizations plan to build five more community centers throughout Kenya. “It's rewarding to get this level of recognition and have such an amazing partner on our side—someone on the government side to help us execute and expedite things,” Yarmolich says.

She is especially proud of spearheading the Voices of Kibera project, which aims to generate recognition, income, and opportunity for Kiberan musicians. Twenty artists each produced an original song in the Centre's recording studio with guidance from Octopizzo, an award-winning hip-hop artist and humanitarian born in Kibera.

“I'm so fortunate to have David as a mentor to guide me and share his extensive experience,” Yarmolich says. “I'm honored to be able to do this work through such an incredible organization.”



Top: Yarmolich with HNP's cofounder David Warner (right) and marketing director Stella Mwanja at a hydroponic farm supported by HNP. Bottom: Yarmolich and the HNP Kenya team in front of the Centre.

Q&A

Development Economics

INTERVIEW BY JULIE GIPPLE

A multitude of initiatives aimed at reducing poverty and suffering exist around the world. Programs focus on introducing fertilizer or drought-resistant seeds, adding roads and other infrastructure, delivering medicines and electrifying hospitals, and increasing access to information, banking services, or education.

Research in development economics is crucial to informing these efforts and measuring their outcomes. *Breakthroughs* sat down with two leading development economists in the Department of Agricultural and Resource Economics to learn about their work and commitment to improving human welfare and promoting sustainable development.

These conversations have been edited for length and clarity.



Francis Annan

Assistant Professor,
Agricultural and Resource
Economics

What drew you to the field of development economics?

I've always been interested in understanding the stark differences between cities and villages in places like Ghana, where I grew up. Drive only 30 minutes and you will see a remarkable change in quality of life and economic outcomes. I wanted to understand what kind of research can improve welfare, and the developing world is a place of obvious need in that regard. Giving one dollar to someone who is poor is so much more impactful than to someone who is rich. I am interested in not just economic theory but in putting policy and practice at the core of my research to answer questions relevant to changing people's lives.

How do you summarize your work?

I focus on how we can design new markets in low-income environments

where people have historically lacked formal access to safe financial services, and on how to improve government efforts that are working to distribute funds to or scale up programs for poor people.

My work is based on fieldwork: getting to know people, seeing what we call frictions in the market, and then exploring economic approaches that could change those. I often collaborate with Ghana's Ministry of Fisheries; Ministry of Energy; Ministry of Local Government, Decentralization and Rural Development; and other large, commercial providers of financial services for the poor. I also work with local research teams to collect survey responses and use data from the Ghana Statistical Service and other government and commercial data sources. Many of my research questions are influenced by personal experiences and conversations in the field—my research wouldn't be the same without them.

Describe some current projects?

In one project, we're trying to improve the design and effectiveness of the Unified Petroleum Price Fund (UPPF), which is working to redistribute transport costs. If oil companies are allowed to set their prices differentially across geographical regions, they will add transport costs to bring fuel to more isolated locations, which in turn creates higher prices for the people in rural, poor areas. To address this inequality, the government adds a markup to the price of fuel that funds the UPPF, which is then used to pay the oil companies for the cost of moving their product. Rich people buy fuel more often, so they contribute more to the UPPF. In economics we call it the law of one price: trying to ensure that the price is the same across space, with all distortions eliminated in the market.

It's a wonderful program that's been running for about seventeen years, but the monitoring capacity of

the state is poor. Seven years in, it was discovered that oil marketing companies were claiming to have moved fuel farther than they did, ripping off both the government and the isolated poor. Working with the Ministry for Energy through the National Petroleum Authority, I'm exploring the integration of digital monitoring technology to deploy GPS and volumetric trackers on all the tankers that deliver the fuel to prevent fraudulent claims and effectively redistribute transport costs.

Another project focuses on premix fuel, a special blend of fuel intended for boats and canoes that the Ghanaian Government subsidizes for fishing communities. It's fairly easy for economists to determine the optimal subsidy, but it's much harder to ensure that it is delivered appropriately. When fuel arrives in a village, select committees are responsible for selling to the fisherfolk with the discount, but they often sell to others at a higher price and pocket the difference. This issue creates an artificial shortage in the premix market, forcing fisherfolk to the black market to acquire fuel.

I have been working with Ghana's vice president's office through the National Premix Fuel Secretariat in their efforts to solve this issue through automation. Premix fuel stations are being built in villages, and fisherfolk will receive biometric cards to buy fuel at the subsidized price. We are automating around 200 villages and studying the equilibrium impacts, with the goal of increasing the capacity of fisherfolk and ultimately lowering the price of fish—making everyone better off.

I was in one of the villages a few months ago and a fisherman told me that the program is the best thing that has happened to him during his 25-year fishing career. I thought, even if I don't publish a paper from this, it won't matter because I know we've changed lives in a material way.

Can you explain your work in digital financial services?

This stream of my research includes working with banks and commercial providers like Ghana's largest mobile telecommunications company. Poor people have lacked access to financial services for numerous reasons, one being that banks don't have branches in villages because the market there is so thin. We're looking at programs for mobile money in which village corner stores become outlets for retail financial services. Cell phone numbers can become account numbers, and suddenly, it's much easier for people to receive, deposit, and send money across space and time.

Poor people are supposed to benefit from these services, but they are often victimized when retail vendors overcharge for transactions, resulting in people not trusting the financial vendors and less likely to use mobile money services. This phenomenon of vendor misconduct is seen in many



Top: Many fisherfolk dock boats and buy premix fuel at Ghana's Cape Coast Landing Beach. Bottom: Francis Annan visits a new premix fuel station in Elmina, Ghana, where biometric cards and human and camera monitoring ensure that only qualified fisherfolk can access subsidized fuel.

Annan (Cont.)

places, including Ghana, Nigeria, Kenya, Uganda, Bangladesh, and elsewhere and highlights the need for robust interventions to improve market dynamics and trust in digital financial services.

I worked on a program that implemented three distinct, scalable antimisconduct information programs across 130 local markets in Ghana. The interventions yielded a significant reduction in misconduct and improvements across several metrics: consumer trust, market activity, vendor revenue growth, and spillover effects. These findings from markets for mobile money in Ghana offer valuable insights for policymakers and stakeholders aiming to improve market integrity in developing economies, calling for transparent practices and effective monitoring to foster broader financial inclusion.

What role can development economics play in climate change?

Many of today's problems will be exacerbated by large, global, environmental changes. Rising temperatures will have pronounced impacts: farmers will be hit hard and both drought and flooding extremes will increase. Some of my work has looked at these types of problems. For example, I studied the US Federal Crop Insurance Program, a large public-private partnership program, which was designed using now-outdated models that didn't account for climate change. Insured farmers aren't exactly incentivized to adapt to climate change. Why irrigate when the drought is coming? They'll still get a payout if the crops go bad. My work draws on insights from cash transfer programs in developing countries to evaluate alternative market and policy redesigns for climate resilience and adaptation under the US Federal Crop Insurance Program. A lot of research needs to go into rethinking the interaction between the public and the private sector when it comes to engagements to build a society that is resilient to climate change.



Jeremy Magruder

Professor, Agricultural and Resource Economics

What drew you to this field?

There's a general intuition in economics that the value of money declines as you get wealthier. People get a lot of happiness from those first few dollars and a lot less from the thousandth or hundred-thousandth dollar. That idea always seemed powerful to me, and I wanted to try to make an impact by focusing my research on communities for whom increasing the value of dollars they can earn is really meaningful.

People under extreme financial constraints have immediate needs that take priority over all else, and these constraints can distort their ability to make the most profitable decisions. I research how they can make productive decisions.

Summarize your research?

Most of my work evaluates new governmental programs or other initiatives in sub-Saharan Africa. After informal focus group discussions to make sure that I'm finding the right problems and focusing on the most relevant topics, I create surveys that can get samples large enough for statistical analysis.

Recently, I've focused on the implementation of irrigation technologies in Rwanda in collaboration with a team at the World Bank. We have partnerships with the government and a research group called Innovations for Poverty Action. In Rwanda in particular, there's a culture around collecting evidence and designing policies based on evidence, which doesn't exist in a lot of other places. We found that the way the irrigation systems were originally designed makes them very labor intensive. Farmers can make a lot of money by growing vegetables using

irrigation, but it requires an incredible amount of work, and a lot of people just don't do it. Now, the government is finding ways to invest in labor-saving technologies like sprinklers and drip systems rather than the big hoses from the first system. It's exciting to see a direct path between our work and how the government's been pursuing agriculture.

I've also led many projects on how social networks fill the gaps where formal institutions don't exist. In countries where there isn't easy access to banks, for example, people borrow more often from their friends and relatives. I've conducted projects on how job opportunities percolate through social networks in Liberia and what advantages or disadvantages come from that, as well as on how social networks could be useful in determining which individuals would most benefit from direct cash payments.

Most notable career projects?

One project I'm proud of involved understanding how to best spread a new climate-smart agricultural technique in Malawi. We had extension agents training farmers on the benefits of digging pits for maize, which can increase plant yields during drought. We looked at how ideas diffuse through a network to see if we could better pick which partners the agents should work with in each village. We created a network map, which at the time was the largest social network map ever collected.

In some villages, agents picked partners as they always do. In others, we asked them to work with people who knew a lot of different people and would try to spread the information, and in others still, we asked them to work with two people who knew the same people. In the "business as usual" villages, there was little evidence that anyone adopted the new technologies at all. The only



Part of Jeremy Magruder's research focuses on the implementation of irrigation technologies, like this hillside irrigation system in Rwanda.

approach that proved effective was concentrating the information on people right in the middle of the network. Many programs would just try to reach all the stakeholders, and this research showed that a different approach might result in better adoption of helpful technology.

What challenges do you see for development?

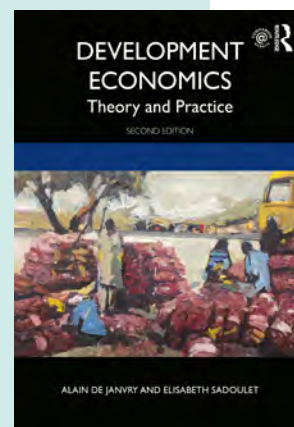
A lot of the programs being tried in developing countries aren't as effective as hoped. Many programs make people's lives a little bit better in different ways, but it is hard to find many cases where a new program suddenly creates meaningful wealth for people. Sometimes programs fail for simple logistical reasons, like the program was designed or implemented ineffectively, but a lot of it is just that people are under a lot of constraints. When you are in extreme poverty, you need to make careful decisions that avoid bad outcomes, so you are less likely to make changes or take risks. It's not that programs are bad, it's just that they are trying to solve really difficult problems.

What's next for your work?

We're currently expanding on the previous work on irrigation in Rwanda. Some farmers who have access to a new irrigation system aren't interested in using it, while others who are interested have plots with no access to the system. Our research shows that nearly all the land rentals and labor

hiring that take place in the villages happens among people who know each other well. It may not sound surprising, but it's not how economists usually think about markets working. If you only do business with people that you know well, a lot of productive transactions can't happen. Our research looks at how best to facilitate land transactions, creating opportunities for interested farmers to rent land from those who don't want to utilize the new irrigation systems.

Professors Emerit **Alain de Janvry** and **Elisabeth Sadoulet** literally "wrote the book" on development economics. Their book, *Development Economics: Theory and Practice*, identifies seven key dimensions of development—growth, poverty, vulnerability, inequality, basic needs, sustainability, and quality of life—and offers a comprehensive history and introduction to current major economic development issues in the world. Now in its second edition from Routledge, the text is used in many development economics classrooms.



Activism as Academics



BHAVNA SHAMASUNDER, PHD '11 ENVIRONMENTAL SCIENCE, POLICY, AND MANAGEMENT

BY CAROLINE CHAMPLIN

At her family's dinner table growing up, Bhavna Shamasunder heard a lot about cancer. Her dad, an oncologist, treated patients across Southern California's Antelope Valley and talked about his work at home. As a budding environmentalist, Shamasunder listened. "As I learned more about environmental exposures, he would tell me what he was seeing in his patients," Shamasunder says.

What he saw was higher rates of breast cancer in some neighborhoods more than others or in workers in specific industries. Shamasunder wondered what caused these disparities, and as she learned more about environmental justice, she started to understand the compounding stress weighing on her family's community.

"It's very low income. People commute into Los Angeles for jobs. There's a lot of pollution," Shamasunder says. "The racial identity of these areas continues to be very complicated—there's a lot of racial tension."

The desire to quantify those factors to understand how they influence the health of a community led Shamasunder to a career focused on environmental justice. She's now a leading expert on cumulative burden—the stacking of environmental risks—and an associate professor and department chair of Urban and Environmental Policy at Occidental College.

Shamasunder's research has covered a range of issues, from chemicals in consumer goods and beauty products to oil wells in residential areas. Her findings were cited in the LA County Board of Supervisors' decision to restrict fossil fuel extraction in the region.

She credits her time in the College of Natural Resources as foundational for learning how to investigate the lived experience of impacted communities with scientifically tested data.

A VOICE THAT SPEAKS THROUGH DATA

Shamasunder knew when it was time for her to pursue a doctorate. She had finished a master's degree at Yale and

was working for an environmental nonprofit, campaigning against a medical waste incinerator in Oakland.

While giving public comment on possible pollutants associated with the facility, she looked across the table and took note of the opposition. “They had someone with a PhD saying pollution wasn’t going to be a problem,” Shamasunder remembers.

She wanted her voice to be just as credible. Going back to school, she hoped, would give her the tools to evaluate and amplify the concerns of disadvantaged communities, like the people living near the incinerator.

Shamasunder chose UC Berkeley because she was inspired by the faculty, especially **Dara O’Rourke** in the Department of Environmental Science, Policy, and Management (ESPM), who was researching global governance and supply chains.

Her thesis was greatly influenced by her advisor, ESPM Professor **Rachel Morello-Frosch**, who introduced Shamasunder to biomonitoring, a tool that can analyze chemicals in people’s bodies. The two still check in regularly.

“Rachel is well known as being a tough-as-nails mentor, but also very gracious and generous with her time,” Shamasunder says. “She made me want to be that kind of a mentor.”

Shamasunder considered herself an activist before she got to UC Berkeley—an identity not always warmly welcomed in academia. She says the College made space for her experience. Mentors encouraged her to investigate her interests scientifically and acknowledge her own biases.

“Berkeley is a good, rigorous place to think about your activism,” Shamasunder says. “You do have to work hard to maintain your public voice as one that comes through the data.”

CHANGING PUBLIC POLICY ON POLLUTION

Over the last decade, Shamasunder has studied the health impacts of oil drilling in Los Angeles. The county currently has over 200,000 active, idle, or abandoned oil wells, and community groups asked Shamasunder whether pollution from those wells could be causing health problems in their neighborhoods.

So, Shamasunder looked for the data. To her surprise, despite oil drilling going back over a hundred years in the city’s history, there were no health studies to start from. “Rachel always said, ‘When there’s no data, it just means there’s no data. It doesn’t mean there’s no problem,’” Shamasunder says.

In this case, there was a big problem. Most of those wells are within 500 meters of sensitive land uses like homes, schools, or parks, and pollutants from the wells were making it harder for people to breathe. By conducting a door-to-door health survey, Shamasunder found that residents living near oil wells in South Los Angeles had higher rates of physician-diagnosed asthma compared with the county population as a whole.



Top: The advisory committee of the Taking Stock Study, which focuses on health impacts of beauty products used by women of color in California and is co-directed by Shamasunder. Bottom: Shamasunder (right) with South LA activists who campaigned against local oil and natural gas extraction.

In a follow-up study, Shamasunder and University of Southern California Professor Jill Johnston measured the lung function of residents living near two drilling sites. They found the closer people lived to wells, the poorer their lung strength and capacity, even when adjusting for other risk factors like smoking, asthma, or proximity to freeways.

With data in hand, Shamasunder could confidently warn the Los Angeles community about the health risks associated with oil wells. That kind of outreach is an essential component of her research process. “We give public comment. We write letters that detail the science. We testify,” Shamasunder says. “A couple of really good studies in the hands of organized community actors are better than a lot of studies that sit on a shelf.”

Shamasunder’s research backed resident stories with data, which led the LA County Board of Supervisors to ban the creation of new oil wells and phase out the ones currently operating over the next 20 years. These legislative efforts remain pending due to court challenges.

“There’s still a long way to go,” Shamasunder says. “We celebrate recent wins and then continue our work to advance environmental justice.”

Disability and environmental repair

PROFESSOR SUNAURA TAYLOR RETURNS TO A DESERT SUPERFUND SITE TO EXPLORE THE CONNECTIONS BETWEEN HUMAN INJURY AND ENVIRONMENTAL HARM



*In the early 1950s, Hughes Aircraft Company and other defense and electronics industries began dumping toxic chemicals in the desert near Tucson's southern border. For decades, the chemicals seeped into the aquifer that supplied drinking water to the city. By the time the pollution came to light in the 1980s, thousands of people had been affected. They include **Sunaura Taylor**, a professor, writer, and*

artist who was born with a disability on Tucson's south side.

*In her book, *Disabled Ecologies: Lessons from a Wounded Desert*, Taylor explores the history of the aquifer through the lens of disability. She documents the tireless work of residents from the south side's largely Mexican American community who organized a successful environmental justice movement in response to the dumping. Along the way, she grapples with the separation between human injury and environmental harm.*

The following is an excerpt from an interview in which Taylor discusses the importance of resisting ableist narratives and bringing disability into environmental movements.

I was raised with the understanding that my disability could likely be traced back to the contamination in Tucson. This book is not a memoir—but my personal story is important because it offered me a way of thinking about disability and the environment together. I understood that disability wasn't just my individual medical problem, but something profoundly political, that can impact a whole community, and that can be caused by systems of harm and exploitation. I also had a visceral understanding that nature isn't separate from us—injury to the environment is injury to people.

City officials in Tucson knew the aquifer had been polluted for decades but didn't investigate who received polluted water. Instead, they blamed community members' lifestyles and diet for the disproportionate levels of serious illnesses the community was facing. These racist, ableist accusations were part of what made the community unite in response, forming an amazing group called Tucsonians for a Clean Environment.

The movement was remarkably successful. Among many other things they won a historic lawsuit against the polluters; secured state-of-the-art treatment for the aquifer; and advocated for a health clinic, which they managed to obtain, even if it didn't last long. These organizers had an expansive vision of justice—one that was directed toward care for the land and the aquifer, and also care for people. That expansive understanding of health and care is what the book is really about.

Why should environmental remediation stop at the threshold of the human body? The idea that our health is inseparable from that of our water and forests is so basic and intuitive, yet I found in my research that it has been legislatively and institutionally severed. Thankfully, environmental justice movements—like the one on Tucson's south side—have worked for decades to bring them together, but there's still much to be done.

We know that people with disabilities are on the front lines of nearly every stage of ecological disaster, and that environmental harm like pollution and climate change causes disability and illness. But disability is also present



▲ **Aquifer losing reach**

Pen and Watercolor on Paper, 11X18

▼ **Aquifer Network**

Pen and Watercolor on Paper, 6X6

beyond the human, both in the stories we tell about environmental harm and the material reality of what’s happening to our environments. What environmentalists and ecologists work toward are healthy ecosystems for healthy people. But what is health and what is a lack of health? What language can articulate what we and our ecosystems are experiencing?

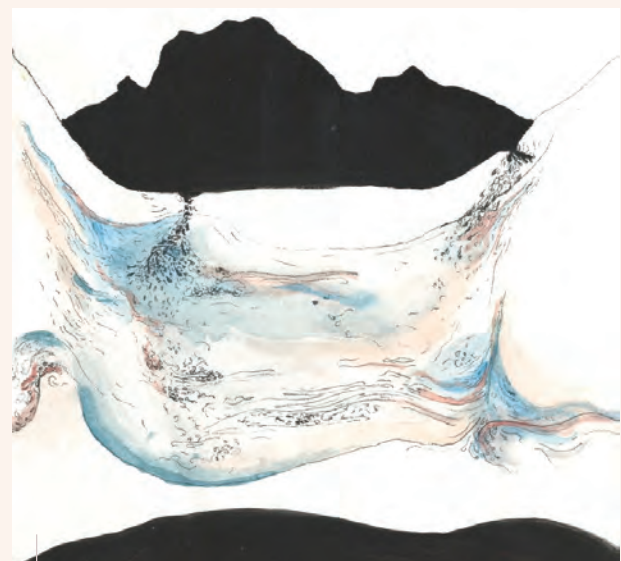
We are living in a moment of mass, multispecies disablement. Whether we are ready for it or not, disability is going to be an increasing part of our environmental reality. I hope this book can give us a language and disability politics to begin grappling with this fact. It is urgent that we bring the insights and work of people who have been living with disability and illness, thinking critically about disability, into our thoughts about and responses to environmental harm.

The fields of ecofeminism, Black ecologies, and Indigenous ecologies have already shown us how social formation and power dynamics shape how we engage with nature and environmentalism. There’s been less work doing the same thing for disability. But disability is already there, and it needs to be politicized.

—Sunaura Taylor



Scan for Taylor’s full interview with Kara Manke at Berkeley News.



Speculative Aquifers

Tucson’s contaminated aquifer became a central character throughout Taylor’s research for *Disabled Ecologies*. She drew her evolving understanding of what an aquifer is, starting with its role as part of human infrastructure and then shifting to its role in ecological systems. “We can gather bits and pieces about where the water, sediments, and contaminants are moving within an aquifer, but so much is inferred because it is inaccessible to us,” Taylor says. “Still, a huge proportion of the population depends on groundwater. Perhaps because aquifers are so hard to imagine we understand them mostly as infrastructure, which benefits those industries that exploit them.”

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