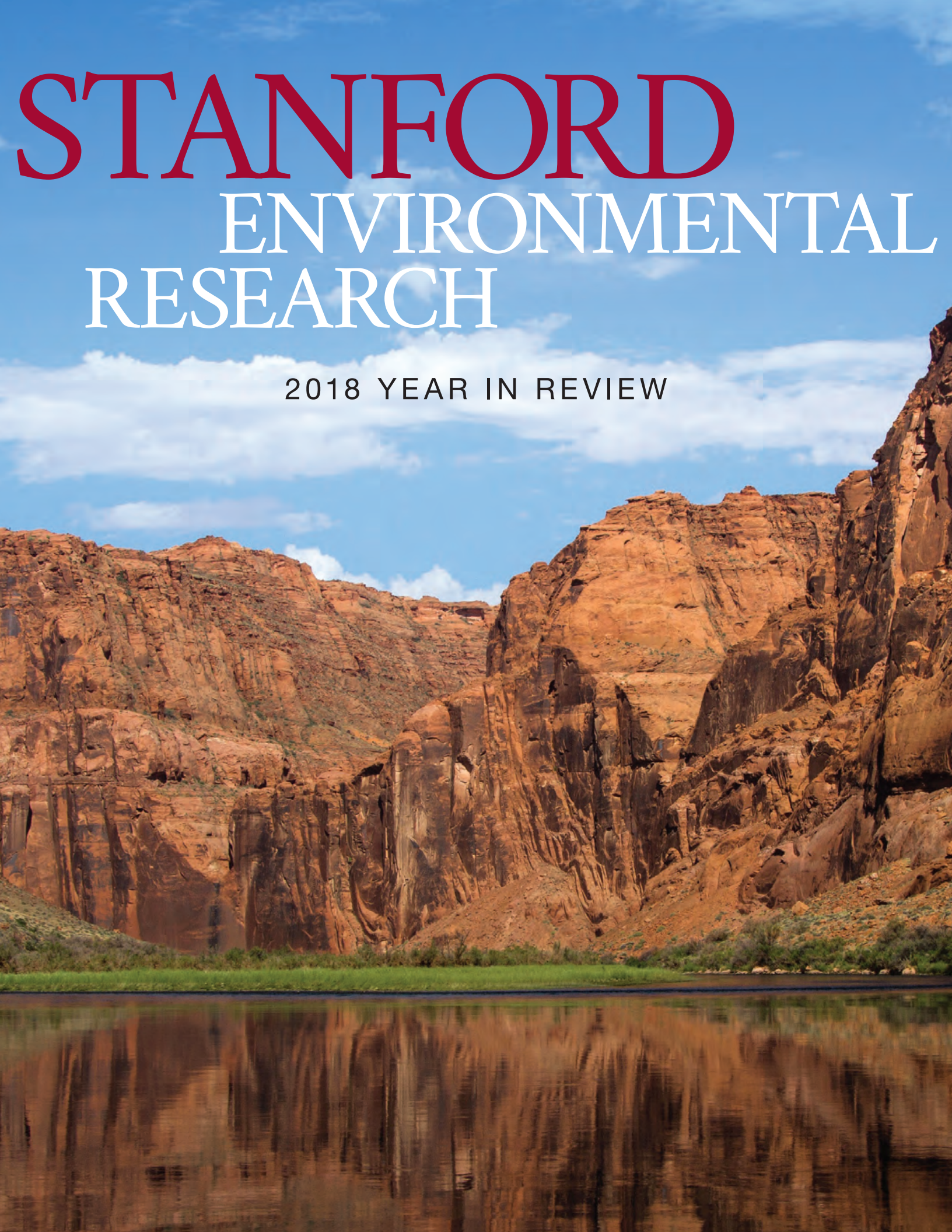
STANFORD ENVIRONMENTAL RESEARCH

2018 YEAR IN REVIEW



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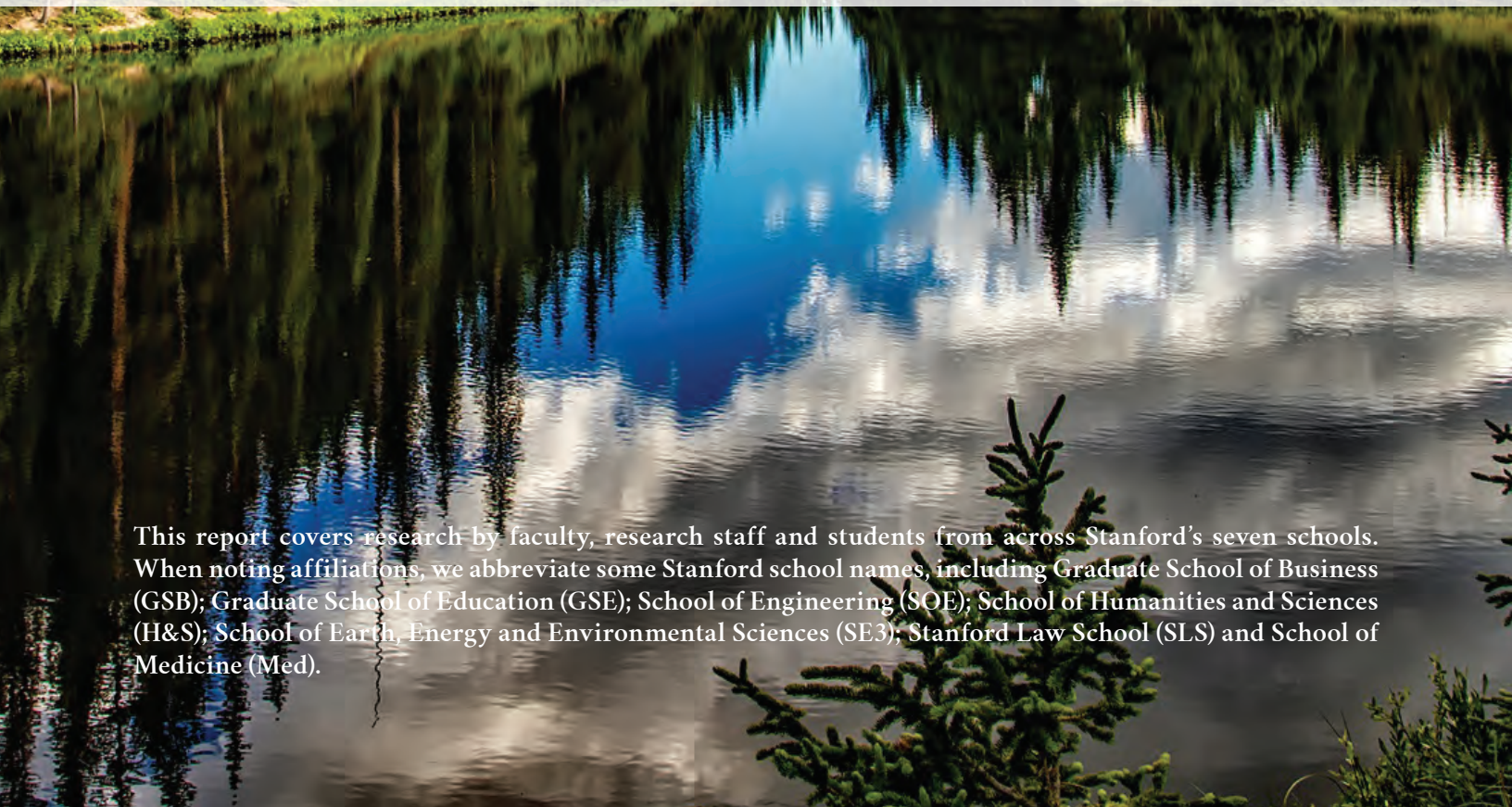
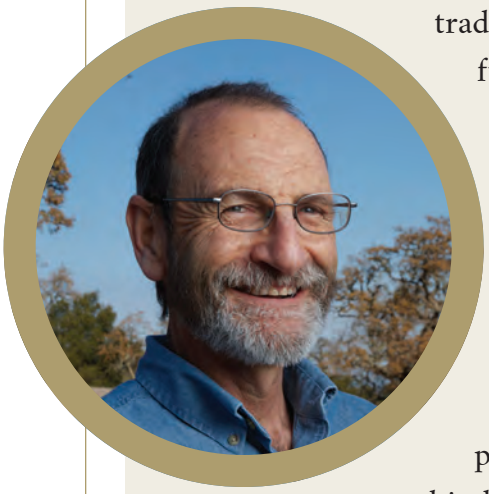


This report covers research by faculty, research staff and students from across Stanford's seven schools. When noting affiliations, we abbreviate some Stanford school names, including Graduate School of Business (GSB); Graduate School of Education (GSE); School of Engineering (SOE); School of Humanities and Sciences (H&S); School of Earth, Energy and Environmental Sciences (SE3); Stanford Law School (SLS) and School of Medicine (Med).

DIRECTOR'S NOTE

The Stanford Woods Institute for the Environment is dedicated to generating knowledge and solutions to sustain people and the planet. It's a goal that requires engaging with decision-makers and practitioners from the local to the international levels who can pursue policies and implement solutions at scale to confront our intractable environmental challenges. The unique role of the institute as an interdisciplinary hub for environmental research at Stanford enables fellows, affiliates, researchers, and their students to transcend traditional disciplinary boundaries to produce use-inspired, fundamental knowledge required to guide policy and action.



This year, that body of knowledge includes studies at the intersection of agriculture with groundwater geochemistry; biological oceanography with fluid dynamics; business practices with forest and marine conservation; and climate change with policy, health, water resources, environmental justice, and the muskrat population decline. These are just a few examples of the kinds of leadership in environmental research that the Stanford community provides. Stanford is a global thought leader in nearly every field required to chart the course to a more sustainable future. It's my privilege as the director of the Woods Institute to help our world-class faculty and students imagine how their expertise and efforts in their home domains can be brought to bear on the immense challenges facing our planet.

Chris Field

Chris Field

Perry L. McCarty Director

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RESEARCH AWARDS FOR ENVIRONMENTAL SOLUTIONS

Major environmental problems are too complex to be solved by any one discipline alone. Since 2004, Stanford researchers across all seven schools have collaborated on solving such problems with support from Environmental Venture Project (EVP) grants offered by the Stanford Woods Institute for the Environment. In 2015, the Institute expanded opportunities for Stanford researchers to collaborate on solutions by created the Realizing Environmental Innovation Program (REIP), which provides additional funding resources needed to show how solutions can be brought to scale.

Priority for both programs is given to projects with the potential to make significant strides in addressing such multifaceted challenges ranging from long-neglected tropical diseases to dwindling groundwater supplies to drought-fueled wildfires.

Since the EVP and REIP programs began, the Stanford Woods Institute has awarded more than $14.5 million in grants to 94 research teams representing all seven of Stanford's academic schools. The Institute awarded ten EVP and REIP grants in 2018.

ENVIRONMENTAL VENTURE PROJECTS

EVP grants support interdisciplinary, high-risk research projects that identify and develop real-world solutions. The projects selected for 2018 will each receive grants ranging from $21,085 to $200,000 over the next two years:

Tracking Parasite Hotspots: Schistosomiasis is a devasting parasitic disease affecting 250 million people worldwide. Detecting parasite-carrying snails can assist decision makers in managing risk and controlling the disease, but traditional monitoring techniques are costly and labor intensive. Stanford researchers propose a novel approach to assess schistosomiasis risk across large spatial scales, integrating field data on vegetation and snail distribution with high-definition satellite and drone imagery, artificial intelligence and disease dynamics modeling. The goal will be rapid, cost-effective assessments of transmission hotspots. Giulio De Leo (Biology) and Eric Lambin (Earth System Science)

Monitoring Drought with Forest Radar: Droughts can cause dramatic increases in large-scale tree mortality and fire fuel aridity in forests. To manage risk, forest managers need to know the water content of tree canopies, but related remote sensing data is either unavailable or at too poor a resolution. Stanford researchers will test an upward-facing ground-based radar system – previously used to monitor ice sheets – at the Jasper Ridge Biological Preserve to see if it can measure water content. This technology could eventually be used for distributed monitoring networks operated by the U.S. Forest Service or other organizations to better understand fire risk. Alexandra Konings (Earth System Science) and Dustin Schroeder (Geophysics)

Building Solar-Powered Water Treatment: Contamination of drinking water is a huge challenge. Chlorination is the most common method of disinfection, but it produces carcinogenic byproducts and undesirable taste and odor. An alternative disinfectant, hydrogen peroxide (H2O2), leaves only water and oxygen as byproducts. However, cost and safety concerns make H2O2 inaccessible to a large percentage of people who need it the most. This project will design, build and test a prototype solar-powered water treatment system. The system will electrochemically convert water and oxygen to produce levels of H2O2 sufficient to remove pathogens, odors and metals from water. Xiaolin Zheng (Mechanical Engineering) and Jens Norskov (Chemical Engineering)

Mapping Intersection of Water, Climate and Disease Transmission: Understanding the relationship between water resources, climate change and mobility can help us better understand disease transmission. This project will combine detailed ethnographic and epidemiological fieldwork with remote sensing of water resources to create simulation models exploring future climate change scenarios. This effort will create maps to help government ministries and nongovernmental organizations develop combined economic and epidemiological interventions for communities in Africa. James Holland Jones (Earth System Science), Alexandra Konings (Earth System Science) and Jeff Koseff (Civil and Environmental Engineering)

Controlling Wildlife Disease: Canine distemper virus (CDV) is distributed globally and causes fatal disease in domestic and wild carnivore species. There is no cure, and the mortality rate is 50 percent in adult dogs and 80 percent in pups. Epidemics have caused 30 percent declines in Serengeti lions, 45 percent declines in Yellowstone wolves, and 95 percent declines in island foxes. This project will bridge understanding of the genetic variations of the disease with models of how, where, when, who and why the disease can be transmitted to improve CDV control in wildlife, particularly in threatened and reservoir populations. Dimitri Petrov (Biology) and Elizabeth Hadly (Biology)

Sonifying the Sea: This project will develop, test and deploy novel methods of displaying complex data through sound. The researchers will focus on interpreting and communicating oceanic data to understand the processes affecting rich and complex ecosystems such as giant kelp forests and coral reefs. Auditory display using musical principles can provide effective translations of many cyclical factors that impact the health and survival of these ecosystems, ranging from the dynamic patterns of biomes, to the effects of climate and other anthropogenic factors. Jonathan Berger (Music) and Stephen Palumbi (Biology)

Evaluating Water Safety: Although New Zealand has the reputation of maintaining a pristine environment, 26 percent of its rivers are no longer swimmable due to waterborne pathogens, and high concentrations of contaminants such as nitrogen, phosphorous and pesticides. With these concerns in mind, Stanford researchers will develop a pilot freshwater sustainability policy evaluation model for the watershed containing Auckland. This work, in collaboration with academics and government scientists in New Zealand, has the ultimate goal of extending the model to the entire country. Steven Gorelick (Earth System Science) and Kate Maher (Earth System Science)

REALIZING ENVIRONMENTAL INNOVATION PROGRAM

REIP is intended to forward projects from the solution discovery phase of research to the validation phase and toward adoption by end users. The projects selected for 2018 will each receive grants ranging from $130,000 to $200,000 over the next two years:

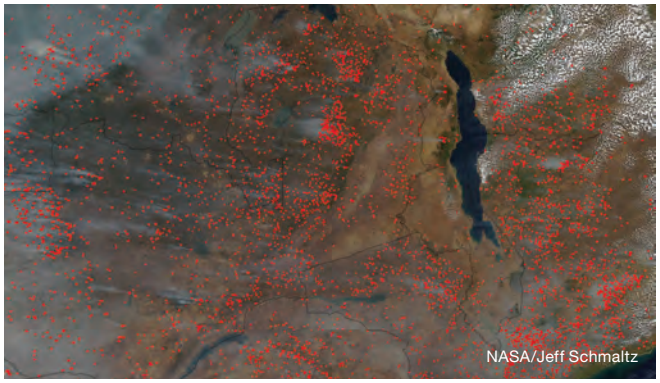
Optimizing Groundwater Recharge: Increasing groundwater recharge is critical to our water future. Spreading basins (ponds with high percolation rates) can help, but many cities don't consider how innovative urban water sources, such as recycled water and spreading basins can augment recharge. Stanford researchers have developed a computational tool called AquaCharge that facilitates planning augmented spreading basin systems by optimizing technical designs. This project will apply AquaCharge to case studies of California's Santa Clara Valley and the Central Valley city of Fresno, comparing insights to draw general lessons about planning these systems. Richard Luthy (Civil and Environmental Engineering) and Amin Saberi (Management Science and Engineering)

Reducing Coastal Risk: Understanding the increasing risk posed by coastal floods and erosion and the benefits of natural defenses, such as reef and wetland restoration, is critical to governments and private industry. This project will develop fragility curves, which denote the expected extent of damage to structures by extreme events. This data will allow risk managers to describe the long-term effectiveness of coastal habitats, transfer information to industry models and tools and help unlock funding for the conservation and restoration of natural defenses. Jenny Suckale (Geophysics) and Jack Baker (Civil and Environmental Engineering)

Preventing Wildfire: Wildfires can cause billions of dollars in damages and drain the U.S. Forest Service of financial resources that would otherwise be available for conservation investments. Many of the human-caused fires originate in the same hotspots such as mountain passes and highway sections. Unfortunately, there is no environmentally-safe prophylactic fire-retarding treatment available for use in fire prevention. However, Stanford researchers have developed an environmentally-benign cellulose-based hydrogel that can retain polyphosphate fire retardants on target fuels for up to several months following application with common spraying equipment. In collaboration with Cal Fire, the Desert Research Institute, and the U.S. Forest Service, this project will pilot, optimize and validate the technology. Eric Appel (Materials Science and Engineering) and Craig Criddle (Civil and Environmental Engineering)

Glenn Beltz/Flickr

Poor Air Quality Leads to Infant Mortality in Sub-Saharan Africa



Heft-Neal, Sam; Burney, Jennifer; Bendavid, Eran; Burke, Marshall. (2018). Robust relationship between air quality and infant mortality in Africa. *Nature*, 559(7713), 254.

In 2015, exposure to particulate matter in sub-Saharan Africa led to 400,000 otherwise preventable infant deaths, according to a Stanford study published in the journal Nature. The study, funded by a 2016 Environmental Venture Project grant, showed even modest improvements in air quality could lead to substantial reductions in infant mortality in developing countries.

Led by Sam Heft-Neal, a research scholar at Stanford's Center on Food Security and the Environment, the research team combined 15 years of survey data on nearly 1 million births across sub-Saharan Africa with satellite-based measurements of particulate matter.

"The results were sobering," said Burke. "We find that mortality rates are substantially higher for infants exposed to higher levels of particulate matter."

> We find that if countries in Africa could achieve reductions in particulate matter exposure similar to wealthy countries, the benefits to infant health could be larger than nearly all currently used health interventions, such as vaccinations or food and water supplements.
>
> *— Marshall Burke, Professor of Earth System Science*

The researchers found that high particulate matter concentrations were responsible for 22 percent of infant deaths from 2001 to 2015, about three times larger than existing estimates.

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Research Brief

Air Pollution and its Health Impacts in Africa

Overview

Poor air quality is a known health hazard, especially for infants and children. However, the extent of related health effects in the developing world is largely unknown due to a lack of monitoring and data collection of particulate matter levels (PM2.5). Using satellite-based measurements to overcome this challenge, a Stanford research team determined that air pollution was responsible for nearly a quarter of all infant deaths in sub-Saharan Africa from 2001 to 2015

Key Takeaways and Points for Policymakers

- Current estimates of infant deaths caused by air pollution are significantly underestimated.
- Even a modest reduction in air pollution in developing countries could lead to larger improvements in infant health than almost any other known health intervention, including vaccines and nutritional supplements.
- An improvement in air quality comparable to that achieved by the U.S. Clean Air Act could have reduced infant mortality by 4.6% and avoided 40,000 infant deaths in 2015 in Africa.
- Wealthy households and poor households are affected similarly by exposure to dirty air. This finding contradicts the common premise that wealth insulates households from environmental harm. One possible explanation is that the pollutant is small enough to penetrate buildings, meaning even wealthier households cannot escape exposure.

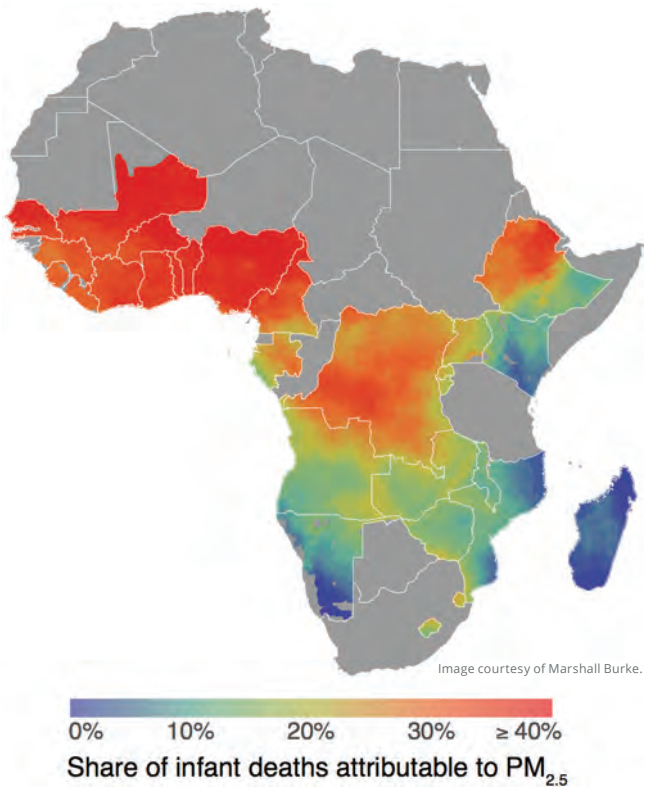


Image courtesy of Marshall Burke.

Stanford scientists calculated the amount of infant deaths due to high particulate matter concentrations in 31 sub-Saharan African countries.

Jerry Yang & Akiko Yamazaki Environment & Energy Building | MC 4205 | 473 Via Ortega, Stanford, CA 94305 | woods.stanford.edu

Background

Although there have been numerous studies on the human health effects of poor air quality in developed countries, the same is not true for developing countries. To craft appropriate policy responses and allocate aid funding effectively, a deeper understanding of air pollution and health linkages in the developing world is imperative. This remains challenging due to lack of data. For instance, in sub-Saharan Africa, only two countries have air pollution monitoring stations that report to global databases, and most countries do not have the vital statistics common in developed nations.

The research team's findings indicate that poor air quality affects child health in sub-Saharan Africa much more severely than previously understood and suggests adopting air quality policies could yield immense health returns. In regions where human activities such as industrial activity or biomass burning are important sources of air pollution, experience elsewhere suggests that policy can improve air quality. However, in regions such as West Africa, where air quality is particularly bad and a substantial proportion of particulate matter derives from non-human dust sources, policy should also support adopting approaches or technologies that limit exposure to dirty air.

Looking Ahead

Additional research is needed to determine the optimal portfolio of health interventions and related costs to best protect people—especially infants and children—in developing countries from the effects of poor air quality.

About the Researchers

Marshall Burke is a fellow at the Center on Food Security and the Environment, the Stanford Woods Institute for the Environment, the Freeman Spogli Institute for International Studies, and the Stanford Institute for Economic Policy Research.

Jennifer Burney is a fellow at the Center on Food Security and the Environment and an assistant professor at the University of California, San Diego, School of Global Policy and Strategy.

Eran Bendavid is an associate professor of medicine at Stanford, a member of the Child Health Research Institute and an affiliate of the Stanford Woods Institute for the Environment.

Sam Heft-Neal is a research fellow at the Center on Food Security and the Environment.

This research brief is based on the *Nature* article "Robust relationship between air quality and infant mortality in Africa," published June 27, 2018.

Climate Changes Driving Muskrat Decline

Ward, Ellen M; Gorelick, Steven M. (2018). Drying drives decline in muskrat population in the Peace-Athabasca Delta, Canada. *Environmental Research Letters*, 13(12), 124026.

Muskrat populations are in decline across North America including in the Peace-Athabasca Delta in Canada, part of a World Heritage Site. A new study by Ellen Ward, a doctoral candidate in Stanford's School of Earth, Energy & Environmental Sciences working with Steven Gorelick, Professor of Earth System Science, uses 46 years of satellite imagery to show that since the 1970's, the Delta has been drying out, reducing muskrat habitat.

The study, funded through an Environmental Venture Project grant, links this loss in habitat to the decline in population of semi-aquatic muskrats.

The semi-aquatic muskrat serves as an indicator species for ecological health and is very sensitive to changes in hydrologic conditions. These muskrats build "houses" out of vegetation in small water bodies in areas susceptible to drying out. The researchers were able to map the counts of these structures using Landsat satellite images and found that suitable muskrat habitat declined 32 percent since 1972.

"Our result is timely because this UNESCO World Heritage Site is currently being considered for designation as a wetland with "in danger" status," said Gorelick.

> The ecological impacts are not limited to muskrat – they extend far beyond that. These results suggest that maybe the widespread continental scale decline in this animal is actually being driven by a large scale loss in wetland and aquatic habitat.
>
> *— Ellen Ward, doctoral student in Earth System Science*

Previous research suggests the drying of the Delta is primarily caused by climate change. If the muskrat continues to decline, it will impact other species down the food chain as well as Indigenous communities in the area that rely on muskrat for hunting, fishing and trapping.

"I hope that this paper shows hydrologists that looking at viable habitat through a water lens can actually tell you a lot about environmental change as it affects animals – traditionally, hydrologists have stayed away from that area," said Ward.

Tom Koerner/USFWS

RESEARCH HIGHLIGHTS

Virtual Reality as an Environmental Education Tool

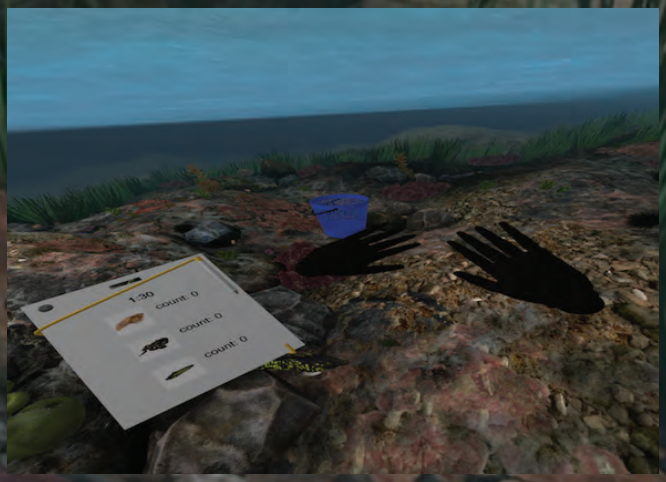
Markowitz, D. M., Laha, R., Perone, B. P., Pea, R. D., & Bailenson, J. N. (2018). Immersive Virtual Reality Field Trips Facilitate Learning About Climate Change. *Frontiers in Psychology*, 9.

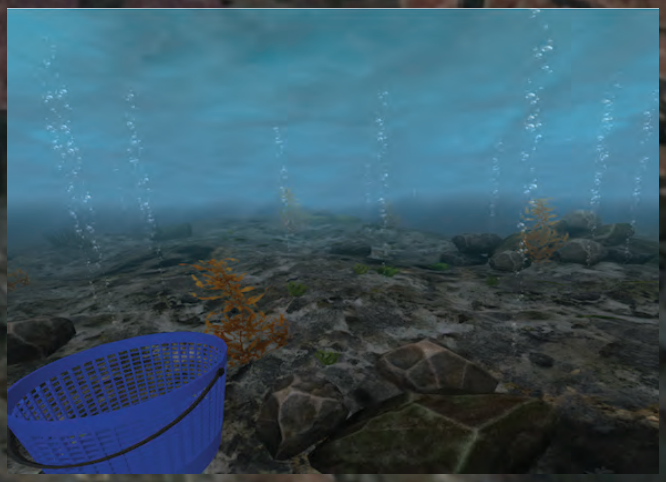
Researchers at Stanford and the University of Oregon discovered that experiencing a virtual reality (VR) simulation of ocean acidification's effects spurred meaningful gains in people's understanding of the issue.

Working with co-author Roy Pea, Professor of Education, Jeremy Bailenson, Professor of Communication, and his team brought the "Stanford Ocean Acidification Experience" to more than 270 high school students, college students and adults. Bailenson and his team also brought their demonstration to Washington, D.C., on several occasions, giving Congressional staff and ocean policy decisionmakers, including Senator Whitehouse, a chance to get a better understanding of the issue and the impact of VR.

After the simulation fast-forwards to what the reef will look like at the end of this century, the brilliantly varied and colorful species have disappeared, replaced by algae and the silver Salema Porgy – a fish that will likely thrive in more acidic waters. The simulation is based on the work of Fiorenza Micheli, Professor of Biology at Stanford.

> We don't know whether a VR experience results in more learning compared to the same materials presented in other media What we do know is that it increases motivation – people are thrilled to do it, much more so than opening a textbook – and because of the richness of the data recorded by the VR system, you can tweak the learning materials in real time based on how well someone is learning.
>
> *— Jeremy Bailenson, Professor of Communication*





Photos: Stanford VHIL

Overpumping Groundwater Leads to Arsenic Threat

Smith, Ryan; Knight, Rosemary; Fendorf, Scott. (2018). Overpumping leads to California groundwater arsenic threat. *Nature communications*, 9.

Decades of groundwater pumping has caused significant subsidence in California's San Joaquin Valley, damaging infrastructure. A new study by Ryan Smith, a recent graduate in Geophysics working with Rosemary Knight, Professor of Geophysics, suggests that as pumping makes the ground sink, it also allows arsenic to move into groundwater aquifers that supply drinking water for 1 million people and irrigation for expansive crops and farmland.

> Arsenic in groundwater has been a problem for a really long time. But the idea that over-pumping for irrigation could increase arsenic concentrations is new.
>
> — *Ryan Smith, Geophysics Graduate*

When pumping draws too much water from the sand and gravel areas, the aquifer compresses and land sinks. Arsenic-rich water then starts to seep out and mix with water in the main aquifer. "We're just starting to recognize that this is a danger," said Scott Fendorf, Professor of Earth System Science and co-author on the study.

The research shows that remote sensing can contribute to better water monitoring by looking at potential threats to human health from contamination of groundwater.

"Instead of having to drill wells and take water samples back to the lab, we have a satellite getting the data we need," said Knight. "You're never sampling a well frequently enough to catch that arsenic the moment it's in the well. So how fantastic to have this remote sensing early warning system to let people realize that they're approaching a critical point in terms of water quality."

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Research Brief

California Water: Quantity, Quality and Public Health

Issue Overview

Maintaining a safe drinking water supply is a top priority for California citizens and policymakers alike. Multiple layers of federal and state laws set strict limits on the levels of pollutants deemed safe for human consumption. However, through agriculture, industry and resource extraction, we have inadvertently created new causes of water pollution. This brief is based on recent findings detailing how human activities create pathways for cancer-causing contaminants, arsenic and chromium, to enter California's groundwater supply.

Points for Policymakers

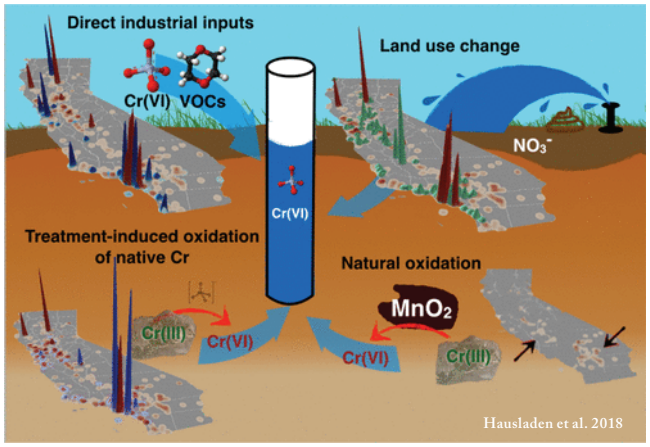
- The naturally occurring and benign form of chromium (chromium-3) can be transformed into the toxic, carcinogenic form of the metal (chromium-6) through human activities. This is significant for groundwater management as the prevalence of chromium-3 affects a far greater area, involving more wells and a larger population throughout California than any industrial sources of chromium-6;
- Analyzing California groundwater data has shown there is widespread transformation of chromium-3, particularly around the coasts and Central Valley, that corresponds to groundwater pumping and agricultural activity; "hotspots" of chromium-6 are found around industrial areas of Los Angeles and throughout the San Francisco Bay Area;
- Arsenic is commonly found in many underground aquifers and poses a risk of contamination when those aquifers are pumped for drinking water;
- Over-pumping in the San Joaquin Valley has resulted in land subsidence and a significantly increased probability that groundwater is contaminated with arsenic two to three times greater than World Health Organization standards. However, aquifers can recover to normal levels if over-pumping is stopped.

Photo: CA DWR

Jerry Yang & Akiko Yamazaki Environment & Energy Building | MC 4205 | 473 Via Ortega, Stanford, CA 94305 | woods.stanford.edu

Background

Water quality is strictly monitored and controlled at the state and federal levels by setting maximum contaminant levels for chemicals, metals and other toxic substances. Chromium and arsenic are both commonly occurring elements that, if ingested, can pose human health risks, especially bladder, liver and other forms of cancer. Hexavalent chromium (or chromium-6) became infamous through Erin Brockovich's fight for the rights of residents in Hinckley, California, where drinking water was contaminated by the compound. Largely in response to that case, California set a state drinking water standard to limit allowable levels of chromium-6 below the EPA standard.



While water quality has been closely regulated in California, water quantity – especially the extraction of groundwater – had been largely unregulated until the 2014 passing of the state's Sustainable Groundwater Management Act. Groundwater supplies approximately 40 percent of water usage in California, and is likely to play a much larger role in the future. Understanding aquifer management will become increasingly critical as the state continues to balance future needs with sustainable water quantity and quality.

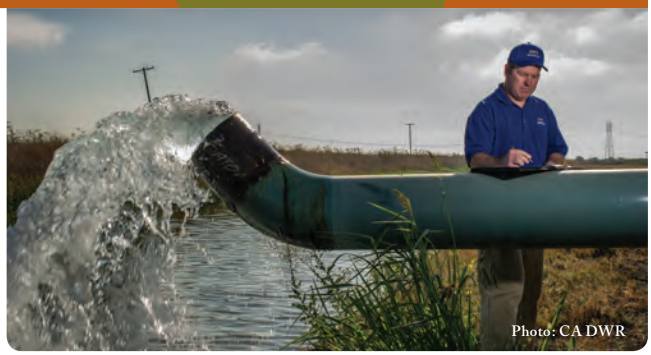


Photo: CA DWR

The connection between water drawdown, specifically as it applies to groundwater quality, is just beginning to be understood. Additional research in this area is necessary, but there is evidence that pumping of groundwater that leads to land subsidence also opens pathways for toxins such as chromium-6 and arsenic to enter the water supply.

About the Authors

Ryan Smith received his Ph.D. in geophysics from the School of Earth, Energy & Environmental Sciences and is now an Assistant Professor at Missouri University of Science and Technology.

Scott Fendorf is the Terry Huffington Professor and Senior Associate Dean for Academic Affairs in the School of Earth, Energy & Environmental Sciences; and a senior fellow, by courtesy, at the Stanford Woods Institute for the Environment.

Rosemary Knight is the George L. Harrington Professor in the School of Earth, Energy & Environmental Sciences; and affiliated faculty at the Stanford Woods Institute for the Environment.

This brief is based on the papers *Overpumping leads to California groundwater arsenic threat* by Ryan Smith, Rosemary Knight and Scott Fendorf in the journal *Nature Communications* and *Hexavalent Chromium Sources and Distribution in California Groundwater* by Debra Hausladen, Annika Alexander-Ozinskas, Cynthia McClain and Scott Fendorf in the journal Environmental Science and Technology.

Hope for Pikas Hit by Climate Change

Solari, K. A., Ramakrishnan, U., & Hadly, E. A. (2018). Gene expression is implicated in the ability of pikas to occupy Himalayan elevational gradient. *PloS ONE*, 13(12), e0207936.

As the climate changes and their habitat warms, pikas – small, mountain mammals highly sensitive to heat – must move to higher elevations to stay cool, but those more comfortable temperatures come at the price of less oxygen. A study by Katie Solari, a postdoctoral scholar working with Elizabeth Hadly, Professor of Biology, suggests a key to withstanding that lower oxygen may already be in the pikas' genes.

Solari hiked up and down India's Mount Kanamo in Spiti Valley, live-trapping pikas, putting them to sleep and taking blood samples before returning them safely to their daily routine. The research revealed that as low-altitude pikas outrun climate change, they may be able to dial certain genes up or down to make better use of what little oxygen is present in their new, higher-elevation home.

> We're used to thinking about genetic adaptation taking thousands of years to occur in a species, but what's exciting about this work is that this flexibility in gene expression could give at least the lower-elevation pika populations a better chance than we thought of being able to adapt to climate change on these short timescales.
>
> *— Elizabeth Hadly, Professor of Biology*

The team is now working on a follow-on project testing pikas from the Minnesota Zoo in a chamber designed for high performance athlete training that can mimic higher elevation pressure and oxygen levels.

"Once we understand more about which genes can help animals adapt, we will know which species are likely to thrive and which species lacking those genes are less likely to survive as their environments change," said Hadly.

Katie Solari

Carbon Capture and Financial Opportunity

Sanchez, Daniel L; Johnson, Nils; McCoy, Sean T; Turner, Peter A; Mach, Katharine J. (2018). Near-term deployment of carbon capture and sequestration from biorefineries in the United States. *Proceedings of the National Academy of Sciences*, 115(19), 4875-4880.

Although considered critical to meeting the world's climate goals, removing carbon dioxide from the atmosphere and storing it underground – known as negative emissions – has been in question.

> Most technologies for carbon removal are immature, largely unavailable or expensive.
>
> — *Katharine Mach, senior research scientist at Stanford's School of Earth, Energy & Environmental Sciences*

But researchers at Stanford and other institutions have found new hope for cost-effective carbon capture and sequestration (CCS). In a paper published in the Proceedings of the National Academy of Sciences, they run the numbers on different options for removing carbon dioxide from the atmosphere in the U.S. and find opportunities where it is not only commercially feasible with existing technology, but profitable. The researchers presented their findings at a 2018 Stanford Energy and Environment series briefing in Washington, D.C., where they also convened a private roundtable with DOE researchers and briefing with Senate staff.

The research shows one type of bioenergy with carbon capture and sequestration (BECCS), could work immediately for U.S. ethanol producers.

"We found that between tax credits for CCS and upcoming financial incentives from low-carbon fuel standards, CCS is an untapped financial opportunity for ethanol producers across the U.S.," said Daniel Sanchez, a postdoctoral scholar with the Carnegie Institution for Science and lead author on the paper.

"Negative emissions at biorefineries is commercially ready and affordable. It offers a compelling way to build the real-world experience we need to develop future BECCS technologies," said Mach.

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Research Brief

SPRING 2018

Profitable Opportunities for Carbon Removal During Biofuel Production

Background

Removing carbon dioxide (CO_2) from the atmosphere, called CO_2 or carbon removal, has a critical role in fighting climate change, enabling stringent emissions reductions in energy and land systems worldwide. One way to achieve such negative emissions is by harvesting plants, which grow by removing CO_2 from the atmosphere. The plant mass, called biomass, is used to generate energy, and the resulting CO_2 emissions are captured and permanently stored in geologic formations deep underground. Technologies with this capability, known as bioenergy with carbon capture and sequestration (BECCS), feature prominently in scenarios that limit warming to the Paris Agreement goal of well below 2°C above preindustrial levels, as assessed by the Intergovernmental Panel on Climate Change and others.

About the Researchers

This research was led by **Daniel Sanchez**, a postdoctoral research scientist at the Carnegie Institution for Science, in partnership with **Nils Johnson**, International Institute for Applied Systems Analysis; **Sean McCoy**, Lawrence Livermore National Laboratory; **Peter Turner**, Carnegie Institution for Science; and **Katharine Mach**, Stanford University Earth System Science and the Stanford Woods Institute for the Environment.

Although potentially essential to achieving climate goals, most BECCS technologies are technically immature or commercially unavailable. Research and development is necessary to reduce costs, improve performance, and clarify their sustainable scale. Concerns include the viability of large-scale deployments, ranging from

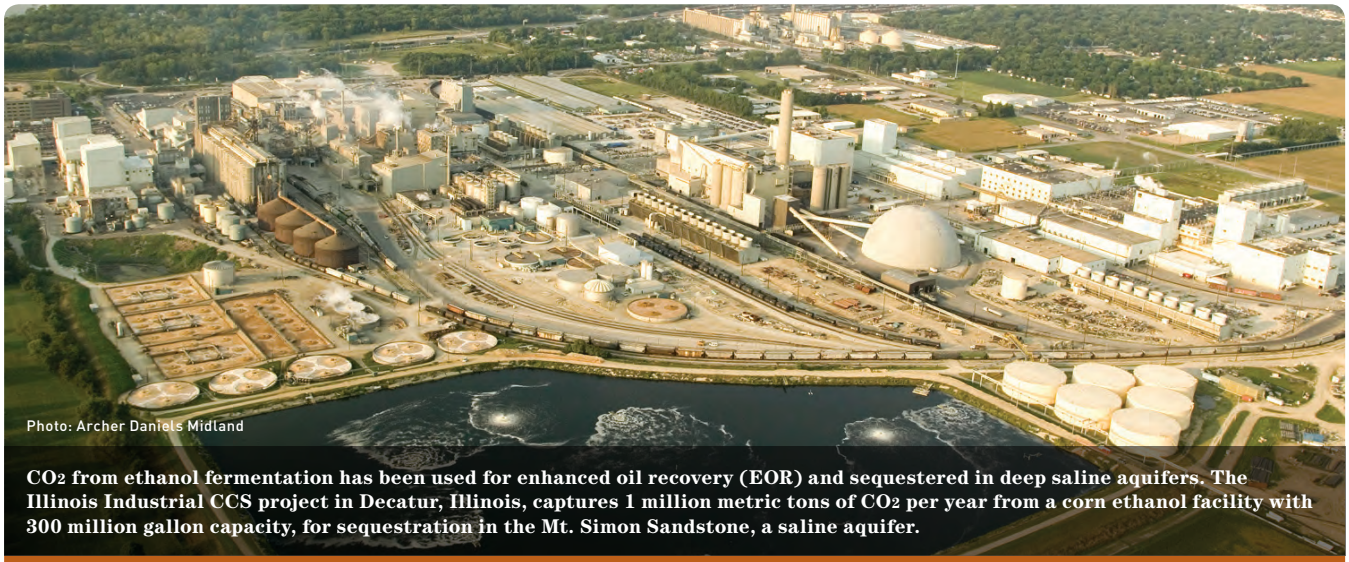

Photo: Archer Daniels Midland

CO_2 from ethanol fermentation has been used for enhanced oil recovery (EOR) and sequestered in deep saline aquifers. The Illinois Industrial CCS project in Decatur, Illinois, captures 1 million metric tons of CO_2 per year from a corn ethanol facility with 300 million gallon capacity, for sequestration in the Mt. Simon Sandstone, a saline aquifer.

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land and water requirements, to the feasibility of CO_2 pipeline networks, to the commercialization of advanced bioenergy technologies.

In contrast, examples of carbon removal from biofuels production already exist at scale. Practiced commercially for several decades, fermentation of sugars and starch currently produces over 26 billion gallons of ethanol each year worldwide. Because ethanol production through fermentation produces a high-purity stream of CO_2, capturing the CO_2 and compressing it for injection underground are cheaper than from other sources—and possible with existing technologies.

In this brief, we examine low-cost, commercially ready carbon removal opportunities for existing biorefineries in the United States. Our analysis combines process engineering, spatial optimization, and lifecycle assessment to consider the technical, economic, and institutional feasibility of capturing and storing CO_2 through existing infrastructure, technologies, and policies. The analysis informs decisionmaking that seeks to enhance both near-term and long-term efforts to fight climate change by deploying existing technologies and developing new approaches for carbon removal.

Key Findings

Deployment of carbon removal from biorefineries is cost-effective:

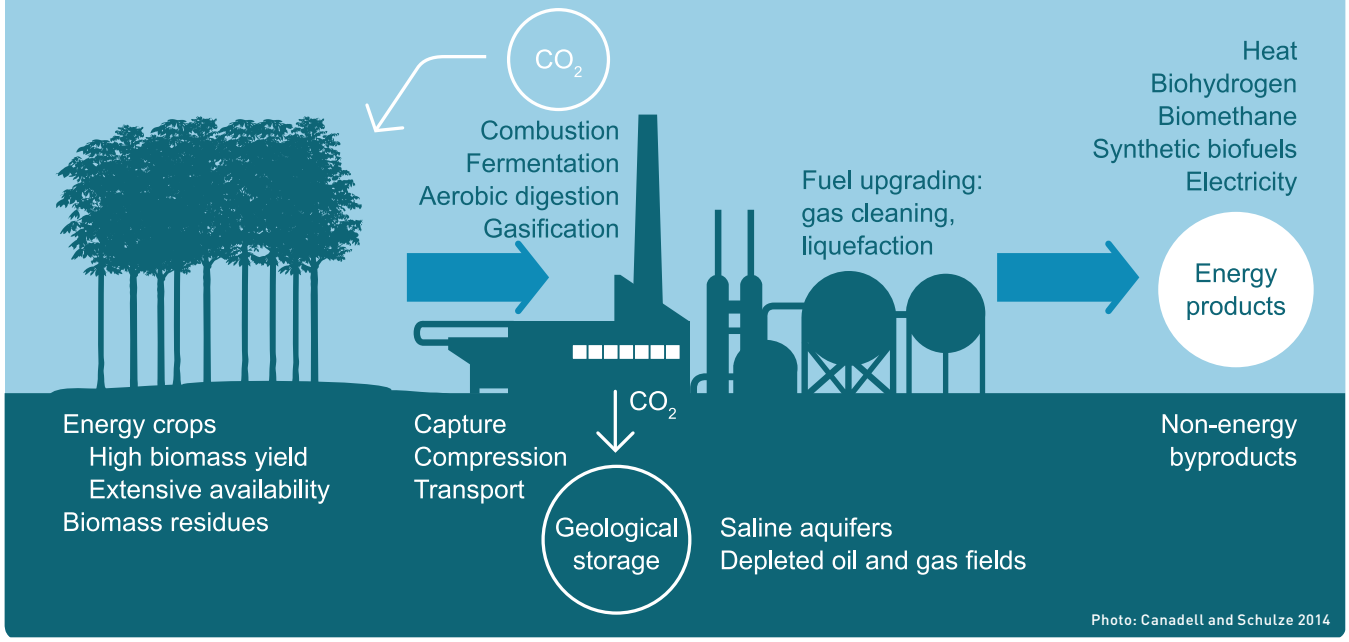
We identify a near-term financial opportunity for existing biorefineries:

- There are over 200 U.S. biorefineries in the United States, producing the equivalent of 6% of energy demand for road transport. These facilities emit 45 million metric tons of CO_2 annually from bioethanol production through fermentation, about 1% of U.S. emissions.
- 60% of this amount (27 million metric tons of CO2 per year) could be captured and compressed for pipeline transport for under $25 per ton.
- A sequestration credit, similar to existing tax credits, of $60 per metric ton of CO_2 could lead to 30 million tons of sequestration (equivalent to emissions from about 6 million cars taken off the road) and spur construction of approximately 4,300 miles of pipeline infrastructure.
- A carbon abatement credit, similar to existing tradeable CO_2 credits, of $90 per metric ton of CO_2 could lead to 38 million tons of abatement.

Iowa farmland.

Photo: Steven Vaughn

An ethanol plant in West Burlington, Iowa.



Bioenergy with carbon capture and sequestration (BECCS) technologies capture and permanently store CO_2 emissions released during the production of heat, fuels, or electricity from biomass.

- Aggregation of CO_2 sources enables cost-effective long-distance pipeline transport to distant storage sites.

Existing and proposed policies suggest a substantial near-term opportunity for deploying BECCS:

The U.S. and other countries have developed energy and climate policies that could incentivize carbon removal from existing biorefineries. These policies exist at the sub-national, national, and international level.

- Newly revised tax policy in the U.S. can produce revenues for existing ethanol biorefineries. The Bipartisan Budget Act of 2018 (H.R. 1892) includes a section 45Q tax credit of up to $50 per metric ton of CO_2 sequestered in secure geologic storage for a 12-year duration. Smaller tax credits are also available for enhanced oil recovery operations.
- Several states and provincial jurisdictions (e.g. California, Oregon, British Columbia) have implemented low-carbon fuel standards, which are market-based policies to reduce the lifecycle carbon intensity of transportation fuels over time. These systems provide an economic incentive for emissions abatement in biofuel production.
- California is in the process of adopting a quantification methodology and permanence protocol for capture and storage of CO_2. Should this occur, biorefiners will be able to provide an additional source of low-carbon fuels for California.
- Canada is currently the largest importer of U.S. ethanol. Should it implement a national clean fuels standard, it could serve as an additional market driver for carbon removal.
- In contrast to other policy instruments, the U.S. Renewable Fuels Standard (RFS) provides limited support for deployment. Nevertheless, the U.S. Environmental Protection Agency has proposed registration, recordkeeping, and reporting requirements to allow carbon removal in the RFS.

Benefits for carbon capture technology, biofuels, and carbon removal:

Carbon removal at biorefineries can have broader benefits for deploying carbon capture and sequestration technologies. Specifically, it can:

- Develop experience in carbon sequestration, project finance, and business models for carbon storage and carbon removal.
- Begin immediately. Implementation does not rely on widespread deployment of costly or unproven solvents, sorbents, or membranes, unlike some other technologies for carbon removal.
- Provide valuable experience for future cellulosic biorefineries equipped with carbon removal. Cellulosic biorefineries with carbon removal can achieve net-negative lifecycle emissions. Furthermore, there is a geographic overlap between existing ethanol biorefineries and potential cellulosic feedstocks like agricultural residues and dedicated energy crops.

Points for Policymakers

- Ethanol production at biorefineries is a low-cost entry point for carbon capture and storage in the United States.
- Carbon capture paired with permanent sequestration can reduce the carbon intensity of existing ethanol production.
- The majority of Midwestern biorefineries are not co-located with suitable sites for geologic sequestration of CO_2, meaning that planning, permitting, and financial incentives for the construction of CO_2 transport networks would be needed to achieve carbon removal.
- Allowing carbon removal in low-carbon fuel standards would encourage carbon capture and sequestration at biorefineries.
- The U.S. Renewable Fuel Standard (RFS) could be altered to better incentivize BECCS deployment.

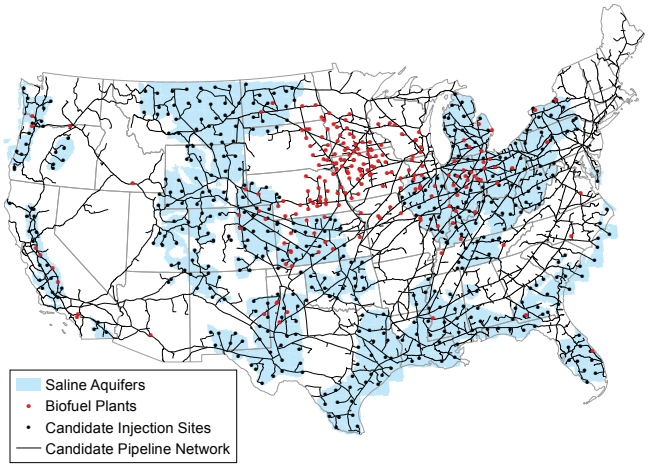


Illustration: Sanchez et al. 2018

Existing and planned ethanol biorefineries, saline aquifers for permanent storage of CO_2, candidate CO_2 pipelines, and candidate injection sites in the U.S.

Conclusion

Carbon capture and storage at existing bioethanol refineries is a largely untapped financial opportunity. The benefits are multiple. It could catalyze the growth of carbon capture, transport, and sequestration technologies and industries. The lifecycle impacts of conventional biofuels would be improved, while supporting development of carbon-negative fuels. And it can help fulfill the mandates of low-carbon fuel policies across the U.S. Furthermore, existing and proposed policies appear poised to make carbon removal cost-effective. Deploying carbon removal at existing biorefineries is an important step forward towards understanding the potential for large-scale CO_2 removal from the atmosphere.

This brief is based on the paper "Near-term deployment of carbon capture and storage from biorefineries in the United States" published in *Proceedings of the National Academies of Sciences* by Daniel Sanchez, Nils Johnson, Sean McCoy, Peter Turner, and Katharine Mach.

Pricey Fungus Faces Threats from Climate Change and Overharvesting

Hopping, Kelly A; Chignell, Stephen M; Lambin, Eric F. (2018). The demise of caterpillar fungus in the Himalayan region due to climate change and overharvesting. *Proceedings of the National Academy of Sciences*, 115(45), 11489-11494.

Photo: Kelly Hopping

Photo: L. Shyamal

A parasitic fungus, Ophiocordyceps sinensis, that preys on ghost moth caterpillars and grows high in the Himalayas could disappear if trends in climate change and current harvesting practices continue. Demand for the fungus, which is thought to be an aphrodisiac and remedy for the SARS virus (though this is unsupported by scientific evidence), has gone through the roof making it one of the world's most expensive commodities and creating an $11 billion market.

A study by Kelly Hopping, an ecologist who conducted the research as a postdoctoral scholar working with Eric Lambin, Professor of Earth System Science, looked at whether demand for the fungus is starting to decline and the consequences for the ecosystems it is produced in and the communities that depend on it to survive.

Because official harvest records are unreliable, the researchers used interviews, case studies, and other data to create a model that predicts how much fungus would grow in an area given factors like climate and elevation. Results showed the fungus is more prolific in higher, colder areas near the margins of areas underlain by permafrost.

With warmer winters, permafrost disappears from lower elevations and the fungus can only adapt and shift to colder upslope habitats if its caterpillar hosts shift as well. If the fungus trade is sustained, it could raise the standard of living for those whose livelihoods herding livestock are being imperiled by climate change. On the other hand, if demand continues to rise but supply decreases, it could aggravate tensions over access to harvesting area.

> Communities in areas where it's still growing will need to remain vigilant about potential conflicts and poaching as people seek to harvest this increasingly rare and valuable species.
>
> *— Kelly Hopping, Ecologist*

Meeting Paris Agreement Targets Could Save Trillions

Burke, Marshall; Davis, W Matthew; Diffenbaugh, Noah S. (2018). Large potential reduction in economic damages under UN mitigation targets. *Nature*, 557(7706), 549.

Failing to meet climate mitigation goals laid out in the U.N. Paris Agreement could cost the global economy tens of trillions of dollars, according to a study led by Marshall Burke, Professor of Earth System Science.

Researchers studied how economic performance over the past half-century correlated with chang-es in temperature and found that most countries benefit economically from limiting global warm-ing to 1.5 degrees instead of 2 degrees.

The projected costs from higher temperatures come from factors such as increases in spending to deal with extreme events, lower agricultural productivity and worse health, the scientists said.

"It is clear from our analysis that achieving the more ambitious Paris goals is highly likely to benefit most countries – and the global economy overall – by avoiding more severe economic damages," said Noah Diffenbaugh, Professor of Earth System Science and coauthor on the study.

> "The countries likely to benefit the most are already relatively hot today. The historical record tells us that additional warming will be very harmful to these countries' economies, and so even small reductions in future warming could have large benefits for most countries."
>
> *— Marshall Burke, Professor of Earth System Science*

Stanford WOODS INSTITUTE for the ENVIRONMENT

Research Brief

SPRING 2018

UN Paris Accord Targets: Extreme Events and Economic Effects

Background

The United Nations (UN) Paris Accord, the first worldwide agreement to limit GHG emissions, seeks to hold the global average temperature to well below 2°C and limit the temperature increase to 1.5°C above pre-industrial levels. However, despite the international agreement to pursue pathways that hold global temperature rise below 2°C, the individual voluntary commitments made by countries to scale back their emissions (called nationally determined contributions, or "NDCs") suggest likely global warming that is closer to 3°C.

Two recent studies by Stanford researchers attempt to quantify the consequences of the different global warming goals and commitments articulated in the UN Paris Agreement.

The first study, led by Noah Diffenbaugh, quantifies the probability of unprecedented climate extremes for a future in which the 2°C goal is met and for a future in which only the NDC commitments are met. Extreme events pose critical risks to humans and ecosystems. Diffenbaugh and his colleagues find that the 1°C of global warming that has already occurred has increased the odds of record-breaking extreme events. They also find that constraining global warming to less than 2°C is very likely to limit the risk relative to the 3°C world implied by the NDCs, but that the odds of unprecedented extremes will still increase in a 2°C world relative to present.

About the Researchers

Noah Diffenbaugh is the Kimmelman Family Senior Fellow of the Stanford Woods Institute for the Environment and the Kara J Foundation Professor of Earth System Science at Stanford University. **Marshall Burke** is an Assistant Professor of Earth System Science and a fellow of the Freeman Spogli Institute for International Studies, the Stanford Woods Institute for the Environment and the Center on Food Security and the Environment at Stanford University.

Photo: DasWortgewand

Limiting warming to the 1.5°C target is likely to generate tens of trillions of dollars in avoided damages.

Jerry Yang & Akiko Yamazaki Environment & Energy Building | MC 4205 | 473 Via Ortega, Stanford, CA 94305 | woods.stanford.edu

The second study, led by Marshall Burke, quantifies the economic damages that are likely to occur at the different levels of global warming outlined in the Paris Agreement. A major deterrent to achieving the Paris goals is the perceived cost associated with the transition away from fossil fuels and other GHG emitting activities. However, in order to accurately reflect the value of reducing emissions, such assessments must also consider the economic benefits that arise from avoiding climate damages. Burke and his colleagues (including Diffenbaugh) find that achieving the 1.5°C global warming target is likely to save trillions of dollars in avoided damages relative to the 2°C target, with most countries and people in the world likely to benefit. They also find that achieving the 2°C target is likely to provide substantial economic benefits relative to the NDCs. Critically, the magnitude of the economic benefits that they calculate are substantially greater than the most recent published estimates of the cost of achieving the lower global warming targets.

Research Findings – Risk of Extreme Events

The researchers found that human activities have already increased the probability of both the hottest day and the warmest night over most of the world, including over the majority of the geographic area of East Asia, North America, Europe and Australia. They also found that limiting global warming to 2°C is likely to substantially limit exposure to large increases in record-setting hot events. For example, more than half of Europe exhibits three-fold increases in record-setting hot days for 2-3°C of global warming, but those increases are held to less than 10% of Europe if global warming is held to less than 2°C.

As with temperature extremes, large fractions of the observed area already exhibit increased probability of record-level wet events, including more than two thirds of the geographic area in North America, Europe, East Asia, and Australia. Likewise, exceeding 2°C of global warming is likely to lead to three-fold increases in record-setting wet events for up to one half of the geographic area in those regions. At the same time, large fractions of Earth's temperate zones are likely to experience increased probability of record-setting dry conditions should global warming surpass 2°C, especially in many heavily populated and highly vulnerable areas like the Mediterranean, southern Africa, Southeast Asia, and southern South America.

Photo: Staff Sgt. Daniel J. Martinez, USANG

Higher global temperatures increase the odds of record-breaking extreme events.

Research Findings – Economic Benefits

The research team used measurements of gross domestic product (GDP) to estimate the global and country-specific economic impacts of the 1.5°C, 2°C and NDC warming targets. The results indicate significant economic savings associated with limiting warming to 1.5°C instead of 2C. By mid-century, holding global temperatures to 1.5°C instead of 2°C would lead to an increase in global GDP (gGDP) of 1.5%-2.0% and $7.7-11.1 trillion in avoided damages. By end-of-century, meeting those would lead to median gains in gGDP per capita of 3.4% and $36.4 trillion in avoided damages. For example, the researchers found that by end of this century, there is more than a 75% chance that limiting warming to 1.5°C will reduce economic damages relative to 2°C, and more than a 60% chance that the accumulated global benefits will exceed $20 trillion (under a 3% discount rate). Further, they found that the 2.5-3°C of global warming implied by the NDC national commitments can be expected to reduce per capita economic output by 15-25% by end of this century, relative to a world that didn't warm.

At the country level, most countries – containing more than 90% of the global population – are likely to experience benefits at 1.5°C compared to 2°C, including the world's three largest economies (United States, China, and Japan) and a large fraction of the world's poorest countries. Countries in the tropics and sub-tropics—where temperatures are already warmer than the economic optimum—are particularly vulnerable to economic damages from global warming. Many of these countries have the highest chance of gaining economic benefits at 1.5°C compared to 2°C, and even a small reduction in future warming would have a significant positive effect on GDP.

Points for Policymakers

- Emissions consistent with the commitments countries have made are likely to fall short of averting substantial increases in record-setting extreme events, as well as reductions in global GDP of 15-25% at the end of this century.
- The UN aspirational emissions targets (1-2°C scenario) are likely to yield substantial reductions in climate risk – and associated reductions in economic damages – relative to the warming implied by the nationally determined contributions (2-3°C scenario) under the UN Paris Accord.
- The overall global benefit of reaching the UN Paris Accord's aspirational goal (1.5°C) is likely in the tens of trillions of dollars—more than 30 times greater than recent estimates of the cost of abatement necessary to achieve that goal.
- Achieving more stringent mitigation targets than those set forth by the NDCs will likely benefit most countries, with particularly large benefits for the poorest populations.
- The researchers have been intentionally conservative in their analyses, meaning that future climate risk could be higher than predicted - an important consideration as policymakers consider planning and investment for climate mitigation, infrastructure investment, and land use development.

Conclusion

The new Stanford research shows that the UN Paris Agreement's goals of limiting global warming to 2°C and pursuing 1.5°C is likely to generate substantial benefits, both in terms of avoided economic and environmental damages due to reductions in the risk of unprecedented extreme events. In particular, the research finds that achieving the 1.5°C target is likely to generate tens of trillions of dollars in avoided damages, making the benefits of achieving the 1.5°C target at least 10 times larger than recent published estimates of the cost of reducing emissions. Further, the researchers find that, at the national level, most countries are likely to benefit, including the United States and China, as well as most of the world's poorest countries. Taken together, the new studies show that aspirational goals articulated in the UN Paris Agreement are likely to both reduce economic damages and curb the increasing risk of record-setting extreme climate events.

Discovery of Meltwater Stored Inside Greenland's Ice

Kendrick, AK; Schroeder, DM; Chu, W; Young, TJ; Christoffersen, Poul; Todd, J; Doyle, SH; Box, JE; Hubbard, A; Hubbard, B. (2018). Surface meltwater impounded by seasonal englacial storage in West Greenland. *Geophysical Research Letters*, 45(19) 10,474-10,481.

Researchers have discovered water stored within a glacier in West Greenland where the quickly changing ice sheet will be a major contributor to sea level rise in the next 100 years.

Alexander Kendrick, a graduate student in Geophysics and lead author of the study, found evidence of glacier meltwater from the surface being stored within damaged, solid ice. What happens to meltwater below and inside of glaciers once it leaves the surface is one of the big mysteries plaguing glaciologists and a problem for understanding how glaciers will behave and flow for sea level contribution predictions.

Photos: Sean Peters

"All of our predictions of sea-level rise are missing this meltwater component," said Dustin Schroeder, Professor of Geophysics and senior author on the study. "I think we're only just realizing how important it is to understand at a fundamental physical scale what glacier meltwater does on its way from the surface to the bed."

Kendrick used radar data collected hourly from May to November 2014 to show information coming from deep within the glacier correlated with when the glacier surface had been melting. This reinforced the idea that a significant amount of water had melted on the surface, trickled down into the glacier, and then got trapped between 15 to 148 feet below the surface.

> This component Alex has discovered shows that there is a piece of this glacier in particular – and maybe the entire Greenland hydrologic system in general – that we just were not modeling or thinking about in this way.
>
> *— Dustin Schroeder, Professor of Geophysics*

Evidence for EPA's Endangerment Finding is Stronger Than Ever

Duffy, Philip B; Field, Christopher B; Diffenbaugh, Noah S; Doney, Scott C; Dutton, Zoe; Goodman, Sherri; Heinzerling, Lisa; Hsiang, Solomon; Lobell, David B; Mickley, Loretta J. ; Myers, Samuel; Natali, Susan M.; Parmesan, Camille; Tierney, Susan; Williams, A. Park (2018). Strengthened scientific support for the Endangerment Finding for atmospheric greenhouse gases. *Science*, eaat5982.

Scientific evidence supporting the Environmental Protection Agency's 2009 Endangerment Finding for greenhouse gases, which allows for the regulation of greenhouse gases under the Clean Air Act, is even stronger and more conclusive now, according to a study published in the journal Science. This finding could strengthen challenges to proposed efforts to rollback emissions standards and carbon emissions regulations in the United States.

> There is no question that public health and welfare are endangered by climate change and we know that with much more confidence now than we did in 2009.
>
> — *Chris Field, Director of the Stanford Woods Institute for the Environment*

Chris Field, jointly led the study with Noah Diffenbaugh, Professor of Earth System Science and Philip Duffy, President of the Woods Hole Research Center.

The paper includes 15 authors from 16 different research institutions and assesses how the scientific evidence has changed in the nine years since the finding was issued.

"Much of what we've learned since the original Endangerment Finding in 2009 arises from extreme events," said Diffenbaugh. "Our understanding of how global warming influences the odds of heat waves, droughts, heavy precipitation, storm surge flooding, and wildfires has increased dramatically in the last decade, as has our understanding of the related impacts, such as how hot conditions af-fect mental health, violence, and economic productivity."

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Research Brief

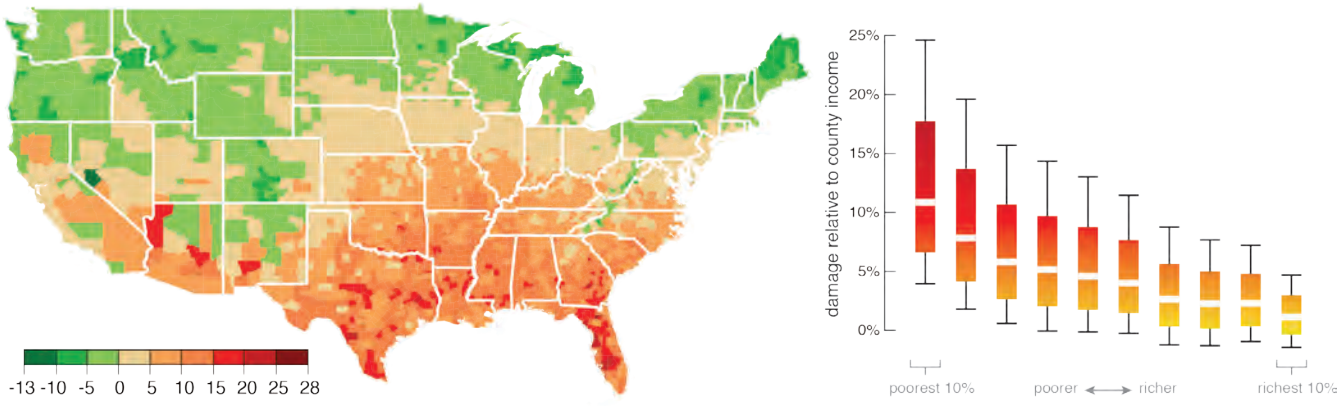
The Endangerment Finding: An Even Stronger Case Now

Introduction

In 2007, the United States Supreme Court ruled in Massachusetts v EPA that the U.S. Environmental Protection Agency (EPA) has the authority to regulate greenhouse gases under the Clean Air Act and may not refuse to regulate these pollutants once it has made a finding of endangerment. EPA released official findings in 2009 on six greenhouse gases, which were determined to endanger human health and welfare by causing climate change. This "Endangerment Finding" is an essential component of the legal basis for regulating greenhouse gas emissions as air pollution under the Clean Air Act, providing foundational support for important aspects of U.S. climate policy. Primarily focused on impacts to people living in the United States, the Endangerment Finding was based on best available knowledge related to public health and public welfare, examining such factors as air quality; food production and agriculture; forestry; water resources; sea level rise and coastal areas; energy, infrastructure and settlements; and ecosystems and wildlife.

A team of scientists led by researchers at Woods Hole Research Center and Stanford University recently assessed new scientific evidence that has emerged since the release

Figure 1. Economic Damage from Climate Change in United States Counties
Damage projected for 2080-2099 of RCP8.5



Hsiang et al. 2017: http://science.sciencemag.org/content/356/6345/1362

Left: damages in the median scenario for each county, negative damages indicate benefits. Right: Range of economic damages per year for groupings of U.S. counties, based on their income (29,000 simulations for each of 3,143 counties) in fraction of county income (white lines=median, boxes=inner 66% of possible outcomes, outer whiskers=inner 90% of possible outcomes).

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of the Endangerment Finding. This new analysis lends increased support to the case for endangerment in three important ways. First, the new evidence strengthens the finding and provides evidence that the case is even stronger now when advancements in climate science are considered. Second, it highlights that impacts could be worse than we understood in 2009. Finally, it goes beyond the public health and welfare topics considered in 2009 to include new areas such as national security.

Figure 2. Summary of New Evidence Since the Endangerment Finding
New evidence for impacts in areas included in and emergent beyond the EF

Key: An upward pointing arrow indicates increasing evidence of endangerment. A solid arrow indicates that the new evidence is abundant and robust. An outlined arrow indicates that the new evidence, in addition, comes from multiple approaches, is based on independent lines of information, or builds on a new level of mechanistic understanding.

New Evidence of Endangerment

Since the Endangerment Finding, numerous scientific reports, reviews, and assessments have strengthened our understanding of the public health and public welfare threats posed by climate change. Much of the new information comes from recent extreme events, such as heat and drought causing acute crop declines in the central U.S., the storm surge flooding during hurricanes, and the recent wildfires that have devastated California and the West. This new evidence strengthens and expands our knowledge in several key areas:

Air quality: ***The impact of climate change on air quality will vary across the U.S.*** Greater effects from particulate matter are projected to negatively impact the East, while dust and wildfire smoke will affect air quality in the West, where the frequency of smoke episodes is projected to double in California.

Forests: ***U.S. forests in western states are facing increasing risks of tree mortality or forest loss.*** Threats include wildfires, insect outbreaks, and drought. Increases in the size, frequency, and severity of these events can have long-term impacts on forest ecosystems. Annual western U.S. forest-fire area increased by approximately 1000% during 1984-2017.

Energy, infrastructure, and settlements: ***Much of America's energy and transportation infrastructure is vulnerable to flooding from extreme weather events, as is its military infrastructure.*** Coastal communities in Alaska are faced with particularly high risks from climate impacts due to storms and permafrost thaw exacerbating coastal erosion rates.

Water resources: ***Accelerated changes in snow hydrology and risks from snowpack droughts (periods of extremely low snowpack) will affect the western U.S. with the Southwest noted as a region of particular concern.*** Periods of snowpack drought endanger water supply and reduce river flows, as well as threatening rare and endangered species (e.g.,

salmon, trout, and wolverine). Future global warming is also likely to erode water quality in the U.S. by increasing nutrient loading and eutrophication, particularly in the Midwest and Northeast.

Sea level rise and coastal areas: ***Higher levels of sea level rise (SLR) will cause increased risks, exposing coastal populations, economies, and infrastructure to hazards such as flooding, erosion, and extreme events.*** In the U.S., intermediate scenario SLR leads to daily flooding in all coastal regions by 2100. Coastal erosion and flooding risk are already affecting real estate values and causing displacement through "climate gentrification," in which properties at higher elevations attain higher values. SLR and extreme events also threaten the movement of goods among major port cities, which can cause economic disruption with cascading impacts far from coastal zones, and disrupt missions of the U.S. military—including disaster and humanitarian relief.

National security: ***Climate change increasingly disrupts existing international security dynamics in geostrategic environments.*** In the Arctic, for example, reduced sea ice will open the way for more Chinese trade routes and Russian oil and gas extraction, potentially causing tensions between the two countries and the U.S.

Violence and instability: ***High temperatures and rainfall extremes amplify underlying risks of violence and instability.*** In the U.S., exposure to high temperatures is associated with higher rates of domestic violence, rape, assault, and murder. Emerging evidence indicates that hot periods elevate the risk of self-harm, including suicide.

Economic well-being: ***Analyses of overall macro-economic performance estimate that warming by an additional 1C over 75 years can be expected to permanently reduce U.S. Gross Domestic Product (GDP) approximately 3% through direct thermal effects.*** U.S. GDP is expected to be approximately 4% greater if warming is limited to 2.7F compared to 3.6F. Analyses that combine sector-by-sector evidence suggest that poorer counties suffer an economic burden roughly five times larger than wealthier counties.

Ocean acidification: ***The ocean exhibits a wide range of biological responses to elevated CO2 and ocean acidification.*** Warming is reducing open-ocean oxygen levels and exacerbating coastal hypoxia (oxygen deficiency) driven by excess nutrients. Coral reefs and marine life such as shellfish and potentially some crustaceans are vulnerable to acidification.

About the Authors

The peer-reviewed paper this brief is based on, "Science supporting an endangerment finding for atmospheric greenhouse gases: an update," was published Dec. 13, 2018, in *Science*. Authors include: **Philip B. Duffy** (Woods Hole Research Center), **Christopher B. Field** (Stanford University), **Noah S. Diffenbaugh** (Stanford University), **Scott C. Doney** (University of Virginia), **Zoe Dutton** (Wilson Center), **Sherri Goodman** (Wilson Center), **Lisa Heinzerling** (Georgetown University), **Solomon Hsiang** (U.C. Berkeley), **David B. Lobell** (Stanford University), **Loretta J. Mickley** (Harvard University), **Samuel Myers** (Harvard University), **Susan M. Natali** (Woods Hole Research Center), **Camille Parmesan** (Plymouth University), **Susan Tierney** (Analysis Group Inc.), **A. Park Williams** (Lamont-Doherty Earth Observatory of Columbia University)

This brief is based on the study "Strengthened scientific support for the Endangerment Finding for atmospheric greenhouse gases," published in *Science*.

Tiny Swimmers Can Impact Ocean Mixing

Houghton, Isabel A; Koseff, Jeffrey R; Monismith, Stephen G; Dabiri, John O. (2018). Vertically migrating swimmers generate aggregation-scale eddies in a stratified column. *Nature*, 556(7702), 497.

Clusters of individual centimeter-long oceanic organisms beating their tiny feathered legs can create strong currents that may mix water over hundreds of meters in depth. Krill, a common zooplankton, migrate in giant swarms in the ocean up and down hundreds of meters daily.

Isabel Houghton, a Ph.D. candidate working with John Dabiri, Professor of Civil and Environmental Engineering and of Mechanical Engineering, teamed up with Civil and Environmental Engineering Professors Jeffrey Koseff and Stephen Monismith to demonstrate for the first time that migrating zooplankton can create turbulence at a large enough scale to mix ocean waters.

The team created flow environments in tanks in a lab that mimic the ocean where saltier water is on the bottom and less salty water is on the top. They created a migration by attracting brine shrimp with lights, moving them up and down in tank. The individual water eddies around each shrimp and the larger currents in the tank showed the turbulence aggregates into a jet in the wake of the migration powerful enough to mix the salt gradient.

The researchers plan to verify their findings in the ocean by following swarms of krill. The findings could impact understanding of ocean carbon dioxide sequestration, global nutrient cycles and ocean climate models.

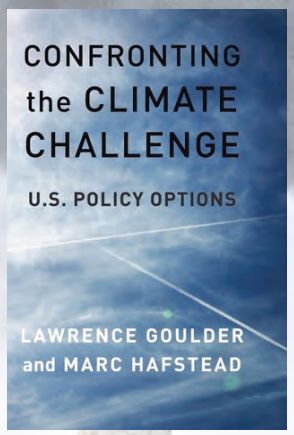
"Right now, a lot of our ocean climate models don't include the effect of animals or if they do it's as passive participants in the process," said Dabiri.

> Ocean dynamics are directly connected to global climate through interactions with the atmos-phere. The fact that swimming animals could play a significant role in ocean mixing – an idea that has been almost heretical in oceanography – could therefore have consequences far beyond the immediate waters where the animals reside.
>
> *John Dabiri, Professor of Civil & Environmental Engineering & Mechanical Engineering*

Isabel Houghton

Investigating Effective and Fair U.S. Climate Change Policy

Goulder, Lawrence, Hafstead, Marc. (2018). *Confronting the Climate Challenge: U.S. Policy Options*. Columbia University Press.



In their book, "Confronting the Climate Challenge," Larry Goulder, Professor of Economics, and co-author Marc Hafstead examine a range of U.S. climate policy options with the goal of identifying policies that are low cost to the economy as a whole as well as fair in the way that any economic sacrifices are distributed across industries and households.

"Suppose the policy is a carbon tax," explains Goulder, "Under some designs this policy would lower the profits of fossil fuel suppliers and other 'carbon-intensive' industries. But we find that if the policy design involves using just a small fraction of the revenues to provide corporate income tax credits to firms in the most vulnerable industries, the potential adverse profit impacts are avoided."

The authors also discuss impacts on low-income households and find that if a small fraction of carbon tax revenues is used to provide rebates, a negative impact on these households' standard of living will be avoided and some may even see a positive impact in terms of income. They present-ed their findings at a joint book launch with Resources for the Future, an independent research institution focused on environmental economics. Goulder and Hafstead also met with key Congressional staff to discuss their findings in the context of draft climate legislation.

State regulations to address climate change are encouraging but Goulder explained the benefits of a nationwide carbon tax.

"Our work and numerous other economic analyses suggest that a carbon tax would enable the economy to achieve emissions reductions at lower cost than conventional forms of regulation such as low-carbon fuel standards," said Goulder. "States often rely on conventional forms of regulation that in several cases are more costly. To the extent that a nationwide carbon tax replaces such state-level regulations, there can be considerable cost savings."

One thing that surprised the authors was that some policy designs not only have low overall costs but also avoid unfair distributions.

> "Under these policy designs, the United States can produce significant reductions of greenhouse gas emissions at low cost and at the same time avoid adverse impacts on profits in key industries as well as adverse impacts on real incomes of low-income households."
>
> *— Larry Goulder, Professor of Economics*

New Tool Enables More Efficient and Sustainable Fishing

Hazen, Elliott L; Scales, Kylie L; Maxwell, Sara M; Briscoe, Dana K; Welch, Heather; Bograd, Steven J; Bailey, Helen; Benson, Scott R; Eguchi, Tomo; Dewar, Heidi; Kohin, Suzy; Costa, Daniel P; Crowder, Larry B; Lewison, Rebecca L; (2018). A dynamic ocean management tool to reduce bycatch and support sustainable fisheries. *Science advances*, 4(5), eaar3001.

Worldwide, fishing fleets discard as many as two of every five sea creatures they catch. However, a new experimental tool called EcoCast can help fishers locate the most productive fishing spots while avoiding unwanted or protected species such as sea turtles and dolphins.

Developed by researchers at Stanford and other universities, EcoCast combines satellite data of ocean conditions, records from fisheries observers and species tracking data to pinpoint ideal fishing areas on a daily basis. Resource managers can adjust the weighting of each species as risks change and the fishing season progresses. This helps fishers optimize their harvest of target fish, while reducing the risk of inadvertently catching and killing sensitive species.

Research shows that this approach can be up to 10 times more efficient for protecting species than previous management styles.

> EcoCast is leading the way toward more dynamic management of marine resources. We're putting the information directly in the hands of the fishers and managers.
>
> *— Larry Crowder, Professor at Hopkins Marine Station*

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Research Brief

Tools for Sustainable Fisheries: EcoCast and Dynamic Ocean Management

Overview

Traditional approaches to sustainable fisheries management can put ecological goals in conflict with economic needs. How can fishers continue to catch the same amount of fish while decreasing the amount of protected or threatened species they catch? This conflict eases when fisheries managers use a new tool that integrates multiple sources of data—collected by satellites, remote sensors and people—to improve fishing operations. Called "EcoCast," this **eco**system fore**cast** tool was developed by researchers with NOAA, Stanford and other research institutions. It allows fisheries managers to predict daily relative catch and bycatch probabilities in near real-time.

Key Points for Policymakers

- **Dynamic ocean management tools like EcoCast allow fisheries managers to meet the dual objectives of ecological and economic sustainability.** This tool helps fishers choose ideal fishing locations by tracking ocean conditions, collecting on-site fisheries data and incorporating species tracking data.
- **Tools like EcoCast can help increase productivity by improving efficiency (reducing bycatch).** The use of approaches like EcoCast can help safeguard protected and endangered species, such as loggerhead and leatherback turtles, small dolphins, beaked whales and California sea lions, each of which frequently becomes bycatch along the California coast.
- **These types of ocean management tools can be used to reduce the frequency of fisheries closures (fishing bans).** By implementing dynamic management approaches, the area of existing closures could be reduced by 2 to 10 times while maintaining conservation goals.

Background

Preventing overfishing is integral to achieving the UN Sustainable Development Goals of zero hunger (*SDG2*) and protecting life below water (*SDG14*). Maintaining global fish populations is also critical in order to feed the 3 billion people worldwide for whom seafood is

Fishing vessel off the coast of southern California.

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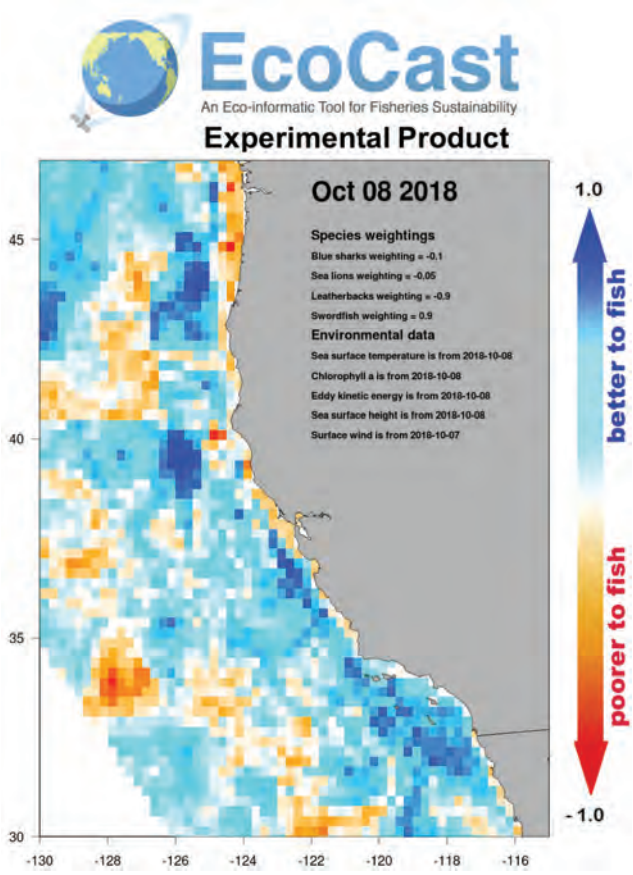
an essential source of protein. Fishing efficiently and sustainably will only become increasingly difficult as the ocean reacts to the changing climate and other human impacts. For example, fish populations will shift as temperature and chemical changes in the ocean alter habitat conditions.



The above map uses environmental data to predict where species are likely to be each day, minimizing bycatch and maximizing target catch for fishers.

While U.S. fisheries have made significant progress in balancing conservation with fishing industry needs—primarily due to the historic *Magnuson-Stevens Fishery Conservation and Management Act of 1976*—transitioning from static, single species management approaches to dynamic, multispecies approaches can help sustainably manage fisheries and reduce bycatch in the future.

With the advent of tools like EcoCast and sufficient available data, bycatch can be dramatically reduced. This will help protect endangered species, keep our fisheries sustainable and support fishing communities. While EcoCast was designed for a specific fishery that had ample accessible data, evidence suggests that in the future, dynamic methods—with real-time monitoring tools that allow fisheries managers to rapidly adapt to changing conditions—will improve our ability to fish sustainably.

About the Authors

Elliott L. Hazen is a research ecologist with the National Oceanic and Atmospheric Administration Southwest Fisheries Science Center and a visiting scholar at the Stanford Woods Institute for the Environment.

Larry Crowder is the Edward Ricketts Provostial Professor of Marine Ecology and Conservation at Stanford's Hopkins Marine Station, a senior fellow at the Stanford Woods Institute for the Environment and codirector of Stanford's Osa & Golfito Initiative.

Sarah Mesnick is an ecologist and the lead for Communications at the Southwest Fisheries Science Center, NOAA Fisheries, and adjunct professor at Scripps Institution of Oceanography, UC San Diego.

This brief is based on the paper *"A dynamic ocean management tool to reduce bycatch and support sustainable fisheries."*

A Cap-And-Trade System of Water Conservation

Gonzales, Patricia; Ajami, Newsha; Sun, Yujie. (2017). Coordinating water conservation efforts through tradable credits: A proof of concept for drought response in the San Francisco Bay area. *Water Resources Research*, 53(9) 7662-7677.

California experienced the driest four-year period on record from 2011 to 2015, leading to a state mandate to reduce water use by 25 percent. At the drought's height, water conservation levels varied widely as utilities worked independently towards this goal.

Looking at 26 communities in the Bay Area, Stanford researchers explored how a system of tradable credits might allow utilities to meet their conservation goals more effectively. Patricia Gonzales, a doctoral student in Civil and Environmental Engineering working with Newsha Ajami, Director of Urban Water Policy at Stanford's Water in the West and NSF-ReNUWIt initiatives, proposed a cap and trade approach to water conservation based on local supply and demand realities.

> What if instead you gave the region a target, and then you allow utilities to figure out the best way to achieve that target collectively?
>
> *— Patricia Gonzales, doctoral student in Civil and Environmental Engineering*

When the government mandates conservation due to drought, communities that haven't been as forward on water efficiency may be able to conserve water in low-cost ways, while others must invest in bigger projects to meet the same goals.

If a community has already done 'low-hanging fruit', such as replacing toilets and showers with low-water versions, they have to move to more expensive options, like paying residents to replace lawns, which may or may not be enough to achieve their target.

Instead of this expensive option, the community would contribute to the overall conservation funding pool, essentially buying conservation credits from other areas.

"The basic idea of cap and trade is to incentivize people to do things that are cost effective for them, but also potentially invest in the community and system as a whole," said Ajami.

The team is expanding the current platform, HydroTrade, to allow communities to not only share conservation credits but also develop and share other water supply sources in order to enhance regional resiliency.

Florence Low/CA DWR

Efficient, Cost-Effective Systems to Replenish Aquifers

Bradshaw, Jonathan L; Luthy. Richard G. (2017). Modeling and optimization of recycled water systems to augment urban groundwater recharge through underutilized stormwater spreading basins. *Environmental Science & Technology* 51.20 (2017): 11809-11819.

Groundwater depletion is a critical issue and communities and cities are investigating how to re-charge and replenish aquifers. However, collecting stormwater runoff and recycling treated wastewater, the two main strategies to replenish aquifers, are often separate processes that can produce expensive and underused infrastructure.

To address this, Stanford engineers Jonathan Bradshaw, a doctoral candidate in the Department of Civil and Environmental Engineering, and Richard Luthy, Professor of Civil and Environmental Engineering, developed a computational planning tool called AquaCharge that allows urban water utilities to examine their local circumstances and understand opportunities for combining these processes to better balance water supplies and replenish aquifers.

"The ideas of recycling waste water and capturing stormwater are not new," said Luthy. "What's new here is to think about how to combine what had been separate systems into a single approach to recharge groundwater."

AquaCharge could greatly improve the use and reuse of water, especially in California, which cur-rently recycles around 15 percent of its available treated wastewater.

> Our method not only allows you to think about a new kind of hybrid water replenishment system. It also helps determine what sort of system will meet a city's goals at the lowest cost.
>
> *— Jonathan Bradshaw, doctoral student in Civil and Environmental Engineering*

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Research Brief

AquaCharge: A Design Tool for Balancing Groundwater Management Trade-Offs

Overview

Many arid regions face groundwater security and reliability challenges, such as overdraft and climate change-driven precipitation shifts. Increasingly, water managers are considering recharging aquifers using stormwater and recycled water–Managed Aquifer Recharge (MAR). These projects are hindered by a lack of tools to evaluate system design costs and trade-offs. Stanford researchers have developed AquaCharge, a planning tool that can optimize system costs and performance to help water managers make more informed decisions about how MAR can fit into water management strategies.

Waterfowl gather at groundwater recharge ponds located on the grounds of the Stockton East Water District.

Key Points for Policymakers

- The AquaCharge model allows for more comprehensive and precise analyses of cost, water volume and energy trade-offs among different design scenarios. It can improve water planners' understanding of these trade-offs and the best strategies for fitting them into water management plans;
- AquaCharge can efficiently and accurately inform decisions about groundwater recharge pond policies and development of new water supplies;
- AquaCharge can improve design of multi-supply recharge ponds, including how to best manage issues of locating and scaling infrastructure. In case studies, AquaCharge was able to identify designs that were up to 20% more cost-effective;
- AquaCharge is able to identify system designs that optimize infrastructure lifecycle cost and total groundwater recharge while satisfying regulatory or other policy constraints. This allows water planners to adapt the model to accommodate site-specific geographic, policy and technological contexts.

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Background

Increasing groundwater recharge capability is a critical component to ensuring water security for regions across the U.S. where scarcity is an ongoing issue. In California, for example, it is imperative for urban water utilities to determine cost-effective opportunities to safely diversify water supplies and efficiently recharge aquifers. To successfully plan for sustainable freshwater systems, innovative water sources, such as recycled water and stormwater, must be viewed as potential recharge assets when compiling a water manager's portfolio.

In urban districts, the two main strategies for increasing water supplies–collecting stormwater runoff and recycling treated wastewater–are usually separate processes that necessitate the construction of costly and under-utilized infrastructure. Applying the AquaCharge model can inform water planning and quantify trade-offs among different groundwater recharge pond designs. The model considers factors such as the availability of recharge ponds and stormwater supplies, the potential to produce recycled water and options for installing recycled water pipelines. More specifically, AquaCharge helps to clarify how augmented groundwater recharge ponds can accommodate both stormwater and recycled water with improved cost-effectiveness.

Groundwater recharge pond.

Adding advanced treated recycled water into a recharge pond can also create more consistent, higher-quality groundwater recharge. Case studies in Los Angeles have shown that dynamic management of recycled water deliveries could result in 68% more recharge capacity when compared to more conservative strategies. Increased water recycling facility utilization may also serve as a politically important performance metric that water utility boards and rate payers perceive favorably. Leveraging the capabilities of AquaCharge to demonstrate lower overall operating costs makes it more likely for water planners to pursue these types of multi-supply projects without having to seek funds from external partners.

In addition to being a useful tool for water managers, AquaCharge may help lower the barrier for planning future multi-supply groundwater recharge pond projects to enhance urban water supplies and improve water supply resiliency.

About the Authors

Jonathan Bradshaw is a Ph.D. candidate in the Department of Civil and Environmental Engineering.

Richard Luthy is the Silas H. Palmer Professor of Civil and Environmental Engineering; Director, National Science Foundation Engineering Research Center for Re-inventing the Nation's Urban Water Infrastructure (ReNUWIt); and a Stanford Woods Institute for the Environment faculty affiliate.

This brief is based on the study *"Modeling and Optimization of Recycled Water Systems to Augment Urban Groundwater Recharge through Underutilized Stormwater Spreading Basins"* and ongoing case studies funded by ReNUWIt.

Effects of the Border Wall on Wildlife

Peters, Robert; Ripple, William J; Wolf, Christopher; Moskwik, Matthew; Carreón-Arroyo, Gerardo; Ceballos, Gerardo; Córdova, Ana; Dirzo, Rodolfo; Ehrlich, Paul R; Flesch, Aaron D.; et. al. (2018). Nature Divided, Scientists United: US–Mexico Border Wall Threatens Biodiversity and Binational Conservation. *BioScience*, 68(10), 740-743.

The nearly 2,000-mile-long Mexico-US border traverses some of the continent's most biologically diverse regions, including forests, grasslands and salt marshes – home to more than 1,500 native animal and plant species, according to a study co-authored by Stanford biologists Paul Ehrlich and Rodolfo Dirzo. It warns that some of these species face extinction within the U.S. if their movements are cut off by a continuous border wall U.S. President Donald Trump pledged to build.

Physical barriers prevent or discourage animals from accessing food, water, mates and other critical resources by disrupting annual or seasonal migration and dispersal routes. Work on border walls, fences and related infrastructure, such as roads, fragments habitat, erodes soil, changes fire regimes and alters hydrological processes by causing floods.

> "Barriers will impede the bighorn sheep's migrations and movements to track habitats that shift due to a changing climate. Cut off like this, the bighorn and other animals and plants will become zombie species – populations that are demographically and genetically doomed."
>
> *— Rodolfo Dirzo, Professor of Biology*

The paper calls on scientists around the world to support solutions, such as requirements that Department of Homeland Security identify species, habitats and ecological resources at risk from barrier construction and security operations; design barriers for maximum wildlife permeability where possible; and purchase or restore replacement habitat when environmental harm is inevitable. Nearly 3,000 scientists have signed on to endorse the paper's message.

"Many hundreds of miles of border wall and the accompanying construction and maintenance infrastructure would be a crime against biodiversity," said Erhlich.

Limits of Corporate Sustainability in Supply Chains

Thorlakson, Tannis; Hainmueller, Jens; Lambin, Eric F. (2018). Improving environmental practices in agricultural supply chains: the role of company-led standards. *Global Environmental Change*, 48, 32-42.

Buying ethically sourced products is not as easy as trusting a Fair-Trade certification, according to Stanford researchers who undertook the first large-scale analysis of sustainable sourcing practices.

> Our results show a glass half full and half empty.
>
> *— Eric Lambin, Professor of Earth System Science*

The researchers analyzed 449 publicly listed companies in the food, textile and wood-products sec-tors, and found about half use some form of sustainable sourcing practice. However, more than 70 percent of sustainable sourcing practices cover only a subset of input materials for a given product. Only 15 percent of sustainable sourcing practices focus on health, energy, infrastructure, climate change, education, gender or poverty.

The researchers find that companies on the receiving end of consumer and civil society pressure are "significantly more likely" to adopt at least one sustainable sourcing practice.

"The pressure consumers put on firms when they demand more sustainable products might be pay-ing off," said study lead author Tannis Thorlakson, a doctoral student in the Emmett Interdisciplinary Program in Environment and Resources. "I hope this paper acts as a call to action for those 48 percent of companies that aren't doing anything to address sustainability challenges in their supply chain."

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Research Brief

SPRING 2018

Importance of Global Supply Chains for Meeting the UN Sustainable Development Goals

Background

The Sustainable Development Goals (SDGs) are a set of 17 goals adopted by the United Nations General Assembly in 2015 that set the international development agenda through 2030. The SDGs focus on a range of issues aimed at improving the quality of life for people around the world, including ending poverty, eradicating hunger, improving health, and providing clean water, sanitation, energy and education for all. Leading international development banks and aid agencies such as the World Bank and USAID play important implementing roles to the success of the SDGs, but there is recognition that civil society and the private sector must also be involved to meet the global targets. Eighty percent of global trade flows through multinational corporations, emphasizing the particularly critical position of the private sector to achieving the envisioned sustainable future.

About the Authors

Tannis Thorlakson is a PhD Candidate with the Emmett Interdisciplinary Program in Environment and Resources at Stanford University. **Eric Lambin** is a Professor of Earth System Science at Stanford University and a Senior Fellow with the Stanford Woods Institute for the Environment. **Joann de Zegher** is a post-doctoral fellow at the SEED Institute at Stanford Graduate School of Business.

Responding to this call, companies are taking a variety of actions to address their corporate social responsibility. Some of these trends include hiring a sustainability officer; increasing transparency and reporting on social and environmental risks and impacts; and adopting policies and standards for greater efficiency and conservation of resources. Increasingly, companies are focusing not only on internal policies and procedures, but

Photo: Joann de Zegher

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also on external factors such as supply chains. A full 95% of environmental impacts in the food and retail industries stems from their supply chains, so ensuring those chains are sustainable is becoming an integral part of companies' strategies to contribute to sustainable development.

Despite this recent growth in companies' commitments to sustainable supply chains, we do not have a comprehensive understanding of how successful companies are in advancing this cause. We lack data on the sustainable development topics that companies address, practices companies commonly use, or even the types of companies that are taking action to advance sustainability in their supply chains. New research examines the specific questions: What sustainable-sourcing practices (SSPs) currently exist and which are most commonly used by companies? How do these SSPs contribute to the fulfillment of the United Nations SDGs? And what factors influence the adoption of SSPs by companies?

Research Findings

Existing sustainable-sourcing practices and those most commonly used

- **Overall 52% of companies have adopted at least 1 of 16 distinct SSPs, with a supplier code of conduct being the most common (over 40% of companies studied had adopted this SSP).** The other 15 SSPs are not nearly as widely used, with under 20% of companies using any one. These include multi-stakeholder standards, using recycled sourcing, and training suppliers on environmental and social issues.
- **Seventy-one percent of SSPs are tied to a single or subset of input materials,** the most common being wood and palm oil. For example, a company might use recycled materials for the packaging of a product but leave the remainder of that product's upstream impact unaddressed.
- **The vast majority of SSPs apply only to a single tier in the supply chain, with 60.5% of SSPs applying only to direct, or first-tier, suppliers.** Suppliers further down the supply-chain are less commonly covered by SSPs including raw material producers that are not direct suppliers of the company.

Sustainable-sourcing practices contribution to the UN Sustainable Development Goals

- **SSPs rarely address the broad social and environmental challenges outlined in the SDGs, focusing primarily on SDGs related to responsible production, working conditions and compliance with national laws.** All SSPs address SDG 12: Responsible Production and Consumption. In addition,

Photo: M. Edliadi/ CIFOR

Graphic: UNDP

SSPs primarily address SDG 8: Decent Work and Economic Growth by seeking to improve labor rights; and SDG 16: Peace, Justice, and Strong Institutions by compliance with national law requirements.

- **Only 15% of companies address health, energy, infrastructure, climate change, education, gender or poverty in the supply chain directly**.

Factors influencing the adoption of sustainable-sourcing practices

- **Large, branded companies exposed to consumer and civil society pressure are significantly more likely to adopt SSPs.** Companies headquartered in a country with a high density of international NGOs were more likely to have adopted at least one SSP. In contrast, stringency of environmental regulation in the company's headquarter cwith country is not associated with SSP adoption.
- **Companies that have a strong brand, such as Coca Cola and L'Oreal, demonstrate a seven percentage point increase in likelihood to adopt an SSP compared with companies that do not have recognizable brand names.**

Points for Policy Makers

Only 52% of the companies in the study address some component of social or environmental issues within their supply chain. This figure is lower than other estimates have suggested. Limitations to current SSPs affect their ability to drive change. These include:

- **SSPs are most commonly adopted by downstream firms to address issues with their first tier suppliers only.** This raises concern about the potential impact of SSPs when the most pressing social and environmental practices are often taking place among subsuppliers.
- **Companies are often using SSPs for only a small subset of their input materials of product lines.** A lack of comprehensive coverage across suppliers and input materials highlights an important limitation of the reach and impact of SSPs that is rarely acknowledged in the discourse on sustainable sourcing.
- **The research shows that consumer and civil society pressure significantly drives SSP adoption.** This may lead companies to target their sustainable-sourcing efforts only at input materials that have been the topic of visible campaigns.
- **Other studies have suggested that the inability to effectively monitor and punish actors based on adherence to requirements makes compliance unlikely.** A better understanding of how different types of verification, or lack thereof, influence the effectiveness of SSPs is critically needed.
- **Further research is needed to explore the headquarter countries' role in influencing SSP adoption as regulations are increasingly applying to a company's entire supply chain.**

Conclusion

Although there are positive indications of SSP uptake, the reach of these practices is limited by the types of companies that adopt them, the products and supply chain tiers they cover, the strength by which they are enforced, and the SDGs they address. Consumer and civil society pressure among branded firms appears to be an effective tool to encourage SSP uptake. For non-consumer facing firms, encouraging uptake of SSPs is more difficult. Identifying key social and environment risks may be an effective tool to encourage change among these companies. Although not directly explored in this paper, government regulations that apply to a company's entire supply chain may also be an effective way to increase private sector contributions to the SDGs. For supply chain interventions to effectively drive social and environmental change at a global scale, private sector actors need to more widely adopt SSPs that are stringent and verifiable, address a broad set of sustainability issues, and reach all tiers of global supply chains.

Future Research

Companies are increasingly facing regulation of their supply chain activities. Laws like the California Transparency in Supply Chain Act or the UK Modern Slavery Act both require some companies to disclose actions they are taking to combat slavery and human trafficking. The French Duty of Vigilance Law requires major companies to identify and prevent adverse human rights and environmental impacts among their suppliers. Although not examined directly in this research, these types of supply-chain regulations may help to increase the coverage of SSPs among companies.

This brief is based on recent research on companies' sustainable-sourcing practices in the food, textile and wood-products sectors. For more information, read "Companies' contribution to sustainability through global supply chains" by Tannis Thorlakson, Joann de Zegher and Eric Lambin published in the Proceedings of the National Academy of Sciences (*https://doi.org/10.1073/pnas.1716695115*)

Nipah Virus: A Potential Global Pandemic

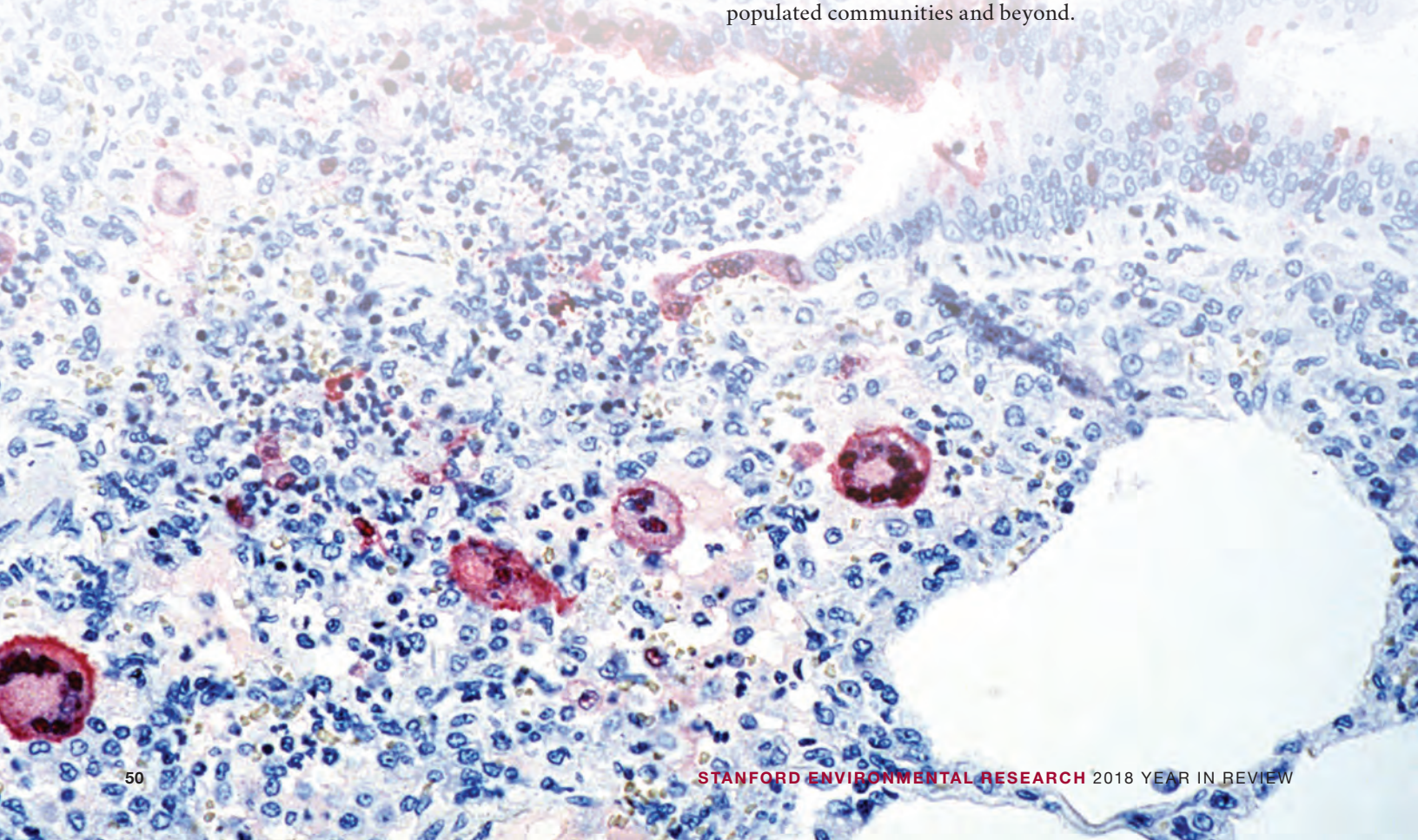
Cortes, Maria C; Cauchemez, Simon; Lefrancq, Noemie; Luby, Stephen P; Jahangir Hossain, M; Sazzad, Hossain MS; Rahman, Mahmudur; Daszak, Peter; Salje, Henrik; Gurley, Emily S. (2018). Characterization of the Spatial and Temporal Distribution of Nipah Virus Spillover Events in Bangladesh, 2007–2013. *The Journal of Infectious Diseases*, 217(9), 1390-1394.

A little-known virus discovered 20 years ago could become the next global pandemic. The Nipah virus, a disease that generally spreads from bats or pigs to humans, kills nearly three-quarters of those infected. It has no vaccine and no cure. Recent outbreaks in South Asia are worrying scientists like Stephen Luby, Professor of Medicine, who has co-authored many studies illustrating potential pathways of the disease, such as contaminated hospital surfaces, and investigating the impact of behavioral changes that reduce the likelihood of people consuming potentially virus-contaminated tree sap. In a paper in The Journal of Infectious Diseases, he and his colleagues showed links between changes in temperature to the virus's spread from bats to humans.

> Emerging infections have resulted in the most devastating infectious diseases that humanity has ever faced. These include HIV, tuberculosis, measles and smallpox. History has taught us that emerging infections can be major threats.
>
> *— Stephen Luby, Professor of Medicine*

In Bangladesh, bat-to-human spillovers are happening every winter. Using data from 57 spillovers from 2007 to 2013, researchers found that temperature differences explained 36 percent of the year-to-year variation in the number of spillovers each winter. The distance to hospitals explained another 45 percent. Low precipitation and low temperatures were both strongly associated with an increased risk of a spillover. Thus, the colder the winter, the more important it is to intervene to prevent human infections.

The virus has many strains capable of spreading from person to person, which increases the chances of a strain emerging that rapidly spreads among South Asia's densely populated communities and beyond.



New Standard for Biodegradable Microplastics

McDevitt, Jason P; Criddle, Craig S; Morse, Molly; Hale, Robert C; Bott, Charles B; Rochman, Chelsea M. (2017). Addressing the Issue of Microplastics in the Wake of the Microbead-Free Waters Act—A New Standard Can Facilitate Improved Policy. *Environmental Science & Technology*, 51 (12), 6611–6617.

In the world's oceans, plastic waste, mostly broken down into tiny particles, floats in huge blobs that together cover as much as 40 percent of Earth's ocean surface. Laws and bills are being discussed and passed to address parts of the microplastic pollution problem but biodegradable alternatives to plastic will ultimately be needed to solve the bigger issue. However, there has not been an acknowledged standard for environmentally safe microplastics.

Researchers including Craig Criddle, Professor of Civil and Environmental Engineering, have developed a framework for a standard called "Ecocyclable" that includes requirements on toxicity, degradation, and bioaccumulation. They hope this will help enable legislation and regulation to reduce pollution.

> In addition to recycling more and reusing materials more, we need new materials that can do the same jobs as current plastics, but are biodegradable, nontoxic and do not concentrate in food chains. Such materials already exist in nature. As it turns out, many microorganisms make moldable bioplastic polymers that are fully degradable. In effect, nature has designed this plastic for disassembly. We should do likewise.
>
> *— Craig Criddle, Professor of Civil and Environmental Engineering*

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Research Brief

Microplastics: Developing Standards that Inform Policy

Overview

Plastics have become an indispensable and pervasive material in modern society, but their true cost to humanity and the environment is not reflected in their price. Costs include harm to environmental aesthetics, habitat, tourism, marine wildlife and food chains. State and federal legislation has fallen short of fully addressing the problem. Defining a scientifically recognized standard for degradable plastic materials that are safe for human health and the environment will be a critical first step to a solution. Stanford researchers have joined a team of scientists to develop such a standard, *Ecocyclable* (see Box). The aim of this standard is to enable policymakers to distinguish plastic materials' safety based on biodegradability, toxicity and potential for accumulation within food chains.

Harmful plastic accumulates in natural and man-made environments.

Key Points for Policymakers

- **A scientifically-vetted microplastics standard, such as *Ecocyclable*, could alleviate the growing plastic pollution problem by helping policymakers determine whether a material is bio-safe and environmentally benign (see Box);**
- **Microplastics should be required to biodegrade within environments of concern, such as the ocean;** they should also be non-toxic to humans and wildlife; and contain no additives that accumulate in food chains;
- **Standards should be applicable to all environments where microplastics may be present, including natural soils, landfills, wastewater treatment facilities and marine ecosystems;**
- **Standards should include designations that distinguish between environments.** For example, a material could be certified as 'generally *Ecocyclable*' if it is biodegradable, non-toxic and non-bioaccumulative in all environments; and "conditionally *Ecocyclable*" within a specified environment in which it meets these three criteria.
- **Official certification by a designated agency or organization could be compulsory.** State-funded land grant university laboratories or non-profits could serve as the certifying entity, or a legislatively defined standard could be mandated.

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Background

An estimated eight million metric tons of plastic waste enters our oceans annually, with a tenfold increase projected by 2025. These microplastics come from many sources, including manufactured microbeads and the breakdown of larger plastic products. The Microbead-Free Waters Act of 2015 bans the use of small manufactured plastic particles in personal care products such as facewash, toothpaste and bodywash, but overlooks other microplastics.

Microbeads

To understand broader health and environment implications, and to find solutions, California legislators passed the California Safe Drinking Water Act: microplastics (SB-1422) and the Ocean Protection Council: Statewide Microplastics Strategy (SB-1263). Both require the development of scientific testing methodologies and standards. When developing such standards and strategies, it is important to consider multiple scenarios because microplastics contamination occurs in both natural and man-made environments.

Banning a particular compound is usually unsuccessful because plastic compositions can be readily changed. A more effective policy strategy would involve establishing a set of universally accepted and scientifically verifiable standards. These standards would ensure that all plastic materials be uniformly tested and given objective environmental safety ratings.

Ecocyclable Definition*

A material, including its additives, is Ecocyclable in a given environment if it satisfies the following criteria for degradability, bioaccumulation and toxicity:

1. In a 180-day period in a specific environment, representative samples of the material degrade to an extent at least 25% of that observed in an equivalent mass of the reference sample – either cotton fiber or poly-3-hydroxybutyrate (PHB) - and the reference sample has equivalent or greater surface area relative to the material sample; AND within 180 days to 18 months in that environment, samples of the material degrade to at least 90% of that observed in an equivalent mass of the reference sample;

2. The material and associated additives do not bioaccumulate in representative organisms; and

3. The material and/or its additives have toxicity that is not significantly greater than that of a comparable composition of either cotton fiber or PHB under acute and chronic exposures to environmentally relevant concentrations.

*Note: the Ecocyclable standard is a trial model and will require refinement through additional laboratory testing.

McDevitt, J., C. S. Criddle, M. Morse, R. Hale, C. Bott, and C. Rochman. 2017. Addressing the issue of microplastics in the wake of the Microbead-Free Waters Act—a new standard can facilitate improved policy. Environmental Science and Technology 51 (12): 6611–6617.

The *Ecocyclable* framework outlines a standardized set of criteria that can be employed to measure a plastic's degradability, toxicity and bioaccumulation against known bio-safe polymers. Those that fail the test would not receive the *Ecocyclable* or bio-safe designation.

Implementing microplastics standards approved by scientists, using *Ecocyclable* or a similar framework like Greenscreen (*www.greenscreenchemicals.org*), could also lead to wider adoption of safer, already-available plastic alternatives. A standard can provide material designers with clear targets. Legislation can incentivize development and use of *Ecocyclable* materials, creating new markets. This, in turn, can stimulate private-sector innovation and scale up, decrease costs, and ensure market prices of conventional plastics reflect their true costs to the environment and society.

About the Author

Craig Criddle is a Professor of Civil and Environmental Engineering; Director of the William and Cloy Codiga Resource Recovery Center; and a Senior Fellow at the Woods Institute for the Environment. Special thanks to co-author Jason McDevitt for his helpful comments and suggestions.

This brief is based on the paper *"Addressing the Issue of Microplastics in the Wake of the Microbead-Free Waters Act: A New Standard Can Facilitate Improved Policy."*

Eight million metric tons of plastic waste enters the oceans annually. 3

Mapping Stressors and Coral Reef Recovery

Wedding, Lisa M; Lecky, Joey; Gove, Jamison M; Walecka, Hilary R; Donovan, Mary K; Williams, Gareth J; Jouffray, Jean-Baptiste; Crowder, Larry B; Erickson, Ashley; Falinski, Kim. (2018). Advancing the integration of spatial data to map human and natural drivers on coral reefs. *Plos ONE*, 13(3), e0189792.

Many of Hawaii's once-thriving coral reefs are now struggling to recover from recent extreme coral bleaching caused by rising water temperatures. These periodic increased temperatures combined with coastal runoff, fishing pressure and other impacts are all suspected of contributing to slow reef recovery.

As a way of understanding which factors had the biggest impacts on Hawaii's corals, a group of researchers from the collaborative Ocean Tipping Points project, co-led by Larry Crowder, Professor at Hopkins Marine Station, completed the first-ever comprehensive map of how both humans and natural events influence overall reef health.

> When we jumped into the water in west Hawaii, over half of the coral reef was dead. These are some of Hawaii's most vibrant coral reefs, so we were heartbroken – and determined to better understand how reef ecosystems could be more resilient in the future.
>
> *— Lisa Wedding, research associate at Stanford's Center for Ocean Solutions*

To find out what factors play the largest role in reef resilience, the group synthesized 10 years of datasets from university and government sources examining factors they knew had an impact on coral reefs, such as sedimentation, development and fishing.

This analysis revealed that for the densely populated island of Oahu, dominant stressors were human activities, such as fishing and loss of natural habitat to coastal development. Sedimentation and nutrient runoff were dominant forces on less populated islands.

The research team's findings highlight the importance of tailoring strategies based on location to effectively address local impacts. Data created by this mapping study are available for free at the Pacific Islands Ocean Observing System, where scientists, managers and members of the public can explore and further analyze what drives variation on coral reefs.

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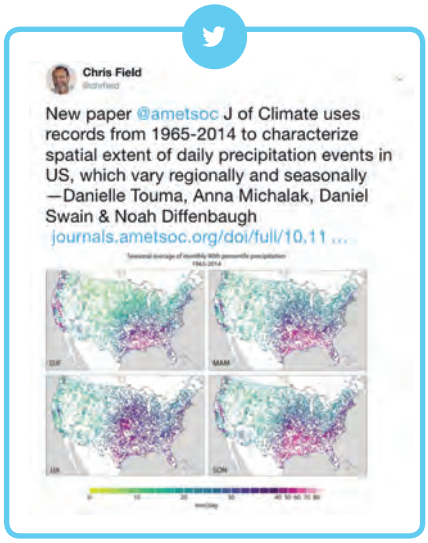


Aburto-Oropeza, O., Johnson, A. F., Agha, M., Allen, E. B., Allen, M. F., González, J. A., … Taylor, J. E. (2018). Harnessing cross-border resources to confront climate change. Environmental Science & Policy, 87, 128–132.

Alemohammad, S. H., Konings, A. G., Jagdhuber, T., Moghaddam, M., & Entekhabi, D. (2018). Characterization of vegetation and soil scattering mechanisms across different biomes using P-band SAR polarimetry. Remote Sensing of Environment, 209, 107–117.

Alvarez, R. A., Zavala-Araiza, D., Lyon, D. R., Allen, D. T., Barkley, Z. R., Brandt, A. R., … Hamburg, S. P. (2018). Assessment of methane emissions from the U.S. oil and gas supply chain. Science (New York, N.Y.), 361(6398), 186–188.

Anderegg, W. R. L., Konings, A. G., Trugman, A. T., Yu, K., Bowling, D. R., Gabbitas, R., … Zenes, N. (2018). Hydraulic diversity of forests regulates ecosystem resilience during drought. Nature, 561(7724), 538–541.

Anderson, C. M., Kissel, K. A., Field, C. B., & Mach, K. J. (2018). Climate Change Mitigation, Air Pollution, and Environmental Justice in California. Environmental Science & Technology, 52(18), 10829–10838.

Bauer, N., Rose, S. K., Fujimori, S., van Vuuren, D. P., Weyant, J., Wise, M., … Muratori, M. (2018). Global energy sector emission reductions and bioenergy use: overview of the bioenergy demand phase of the EMF-33 model comparison. Climatic Change, 1–16.

Baysan, C., Burke, M., González, F., Hsiang, S., & Miguel, E. (2018). Economic and Non-Economic Factors in Violence: Evidence from Organized Crime, Suicides and Climate in Mexico. Cambridge, MA.

Benson, S. M., & Deutch, J. (2018). Advancing Enhanced Oil Recovery as a Sequestration Asset. Joule, 2(8), 1386–1389.

Beyer, H. L., Kennedy, E. V., Beger, M., Chen, C. A., Cinner, J. E., Darling, E. S., … Hoegh-Guldberg, O. (2018). Risk-sensitive planning for conserving coral reefs under rapid climate change. Conservation Letters, 11(6), e12587.

Boag, T. H., Stockey, R. G., Elder, L. E., Hull, P. M., & Sperling, E. A. (2018). Oxygen, temperature and the deep-marine stenothermal cradle of Ediacaran evolution. Proceedings of the Royal Society B: Biological Sciences, 285(1893), 20181724.

Brandt, A. R., Masnadi, M. S., Englander, J. G., Koomey, J., & Gordon, D. (2018). Climate-wise choices in a world of oil abundance. Environmental Research Letters, 13(4), 044027.

Bremer, L. L., Mandle, L., Trauernicht, C., Pascua, P., McMillen, H. L., Burnett, K., … Ticktin, T. (2018). Bringing multiple values to the table: assessing future land-use and climate change in North Kona, Hawai'i. Ecology and Society, 23(1), art33.

Burke, M., Davis, W. M., & Diffenbaugh, N. S. (2018). Large potential reduction in economic damages under UN mitigation targets. Nature, 557(7706), 549–553.

Burke, M., González, F., Baylis, P., Heft-Neal, S., Baysan, C., Basu, S., & Hsiang, S. (2018). Higher temperatures increase suicide rates in the United States and Mexico. Nature Climate Change, 8(8), 723–729.

Castelletti, D., Schroeder, D. M., Mantelli, E., & Hilger, A. (2018). Unfocused SAR Processing for Englacial Layer Slope Estimation Using Radar Sounder Data. In IGARSS 2018 - 2018 IEEE International Geoscience and Remote Sensing Symposium (pp. 4150–4153). IEEE.

Chen, S., Chen, Z., Siahrostami, S., Higgins, D., Nordlund, D., Sokaras, D., … Bao, Z. (2018). Designing Boron Nitride Islands in Carbon Materials for Efficient Electrochemical Synthesis of Hydrogen Peroxide. Journal of the American Chemical Society, 140(25), 7851–7859.

Chen, Y., Goulder, L. H., & Hafstead, M. A. C. (2018). The sensitivity of CO2 emissions under a carbon tax to alternative baseline forecasts. Climate Change Economics, 09(01), 1840012.

Chu, W., Schroeder, D. M., Seroussi, H., Creyts, T. T., & Bell, R. E. (2018). Complex Basal Thermal Transition Near the Onset of Petermann Glacier, Greenland. Journal of Geophysical Research: Earth Surface, 123(5), 985–995.

Diffenbaugh, N. S., Singh, D., & Mankin, J. S. (2018). Unprecedented climate events: Historical changes, aspirational targets, and national commitments. Science Advances, 4(2), eaao3354.

Duffy, P. B., Field, C. B., Diffenbaugh, N. S., Doney, S. C., Dutton, Z., Goodman, S., … Williams, A. P. (2019). Strengthened scientific support for the Endangerment Finding for atmospheric greenhouse gases. Science (New York, N.Y.), 363(6427), eaat5982.

Duyar, M. S., Tsai, C., Snider, J. L., Singh, J. A., Gallo, A., Yoo, J. S., … Jaramillo, T. F. (2018). A Highly Active Molybdenum Phosphide Catalyst for Methanol Synthesis from CO and CO 2. Angewandte Chemie, 130(46), 15265–15270.

Englander, J. G., Brandt, A. R., Conley, S., Lyon, D. R., & Jackson, R. B. (2018). Aerial Interyear Comparison and Quantification of Methane Emissions Persistence in the Bakken Formation of North Dakota, USA. Environmental Science & Technology, 52(15), 8947–8953.

Fang, Z., Freeman, P. T., Field, C. B., & Mach, K. J. (2018). Reduced sea ice protection period increases storm exposure in Kivalina, Alaska. Arctic Science, 4(4), 525–537.

Feldman, A. F., Short Gianotti, D. J., Konings, A. G., McColl, K. A., Akbar, R., Salvucci, G. D., & Entekhabi, D. (2018). Moisture pulse-reserve in the soil-plant continuum observed across biomes. Nature Plants, 4(12), 1026–1033.

Giardina, F., Konings, A. G., Kennedy, D., Alemohammad, S. H., Oliveira, R. S., Uriarte, M., & Gentine, P. (2018). Tall Amazonian forests are less sensitive to precipitation variability. Nature Geoscience, 11(6), 405–409.

Goss, M., Lee, S., Feldstein, S. B., Diffenbaugh, N. S., Goss, M., Lee, S., … Diffenbaugh, N. S. (2018). Can ENSO-Like Convection Force an ENSO-Like Extratropical Response on Subseasonal Time Scales? Journal of Climate, 31(20), 8339–8349.

Goulder, L. H., & Hafstead, M. (2017). Confronting the Climate Challenge: US Policy Options. Columbia University Press.

Goulder, L. H., & Morgenstern, R. D. (2018). China's Rate-Based Approach to Reducing CO 2 Emissions: Attractions, Limitations, and Alternatives. AEA Papers and Proceedings, 108, 458–462.

Goulder, L. H., Hafstead, M. A. C., Kim, G., & Long, X. (2018). Impacts of a Carbon Tax across US Household Income Groups: What Are the Equity-Efficiency Trade-Offs?

Gross, P.-A., Jaramillo, T., & Pruitt, B. (2018). Cyclic-Voltammetry-Based Solid-State Gas Sensor for Methane and Other VOC Detection. Analytical Chemistry, 90(10), 6102–6108.

Harden, J. W., Hugelius, G., Ahlström, A., Blankinship, J. C., Bond-Lamberty, B., Lawrence, C. R., … Nave, L. E. (2018). Networking our science to characterize the state, vulnerabilities, and management opportunities of soil organic matter. Global Change Biology, 24(2), e705–e718.

Helfenstein, J., Tamburini, F., von Sperber, C., Massey, M. S., Pistocchi, C., Chadwick, O. A., … Frossard, E. (2018). Combining spectroscopic and isotopic techniques gives a dynamic view of phosphorus cycling in soil. Nature Communications, 9(1), 3226.

Hopping, K. A., Chignell, S. M., & Lambin, E. F. (2018). The demise of caterpillar fungus in the Himalayan region due to climate change and overharvesting. Proceedings of the National Academy of Sciences of the United States of America, 115(45), 11489–11494.

Jackson, R. B., Le Quéré, C., Andrew, R. M., Canadell, J. G., Korsbakken, J. I., Liu, Z., … Zheng, B. (2018). Global energy growth is outpacing decarbonization. Environmental Research Letters, 13(12), 120401.

Jagdhuber, T., Konings, A. G., McColl, K. A., Alemohammad, S. H., Das, N. N., Montzka, C., … Entekhabi, D. (2018). Physics-Based Modeling of Active and Passive Microwave Covariations Over Vegetated Surfaces. IEEE Transactions on Geoscience and Remote Sensing, 1–15.

Jin, Z. L., & Durlofsky, L. J. (2018). Reduced-order modeling of CO2 storage operations. International Journal of Greenhouse Gas Control, 68, 49–67.

Johnson, D. M., Domec, J.-C., Carter Berry, Z., Schwantes, A. M., McCulloh, K. A., Woodruff, D. R., … Jackson, R. B. (2018). Co-occurring woody species have diverse hydraulic strategies and mortality rates during an extreme drought. Plant, Cell & Environment, 41(3), 576–588.

Jordan, T. M., Williams, C. N., Schroeder, D. M., Martos, Y. M., Cooper, M. A., Siegert, M. J., … Bamber, J. L. (2018). A constraint upon the basal water distribution and thermal state of the Greenland Ice Sheet from radar bed echoes. The Cryosphere, 12, 2831–2854.

Keiluweit, M., Gee, K., Denney, A., & Fendorf, S. (2018). Anoxic microsites in upland soils dominantly controlled by clay content. Soil Biology and Biochemistry, 118, 42–50.

Kendrick, A. K., Schroeder, D. M., Chu, W., Young, T. J., Christoffersen, P., Todd, J., … Lok, L. B. (2018). Surface Meltwater Impounded by Seasonal Englacial Storage in West Greenland. Geophysical Research Letters, 45(19), 10,474-10,481.

Kim, H., Parinussa, R., Konings, A. G., Wagner, W., Cosh, M. H., Lakshmi, V., … Choi, M. (2018). Global-scale assessment and combination of SMAP with ASCAT (active) and AMSR2 (passive) soil moisture products. Remote Sensing of Environment, 204, 260–275.

Konings, A. G., & Momen, M. (2018). Frequency-Dependence of Vegetation Optical Depth-Derived Isohydriciy Estimates. In IGARSS 2018 - 2018 IEEE International Geoscience and Remote Sensing Symposium (pp. 9045–9047). IEEE.

Koomey, J., Schmidt, Z., Hummel, H., & Weyant, J. (2019). Inside the Black Box: Understanding key drivers of global emission scenarios. Environmental Modelling & Software, 111, 268–281.

Ladefoged, T. N., Preston, A., Vitousek, P. M., Chadwick O. A., Stein, J., Graves, M. W., & Lincoln, N. (2018). Soil nutrients and pre-European contact agriculture in the leeward Kohala field system, Island of Hawai'i. Archaeology in Oceania, 53(1), 28–40.

Lalonde, S. J., Mach, K. J., Anderson, C. M., Francis, E. J., Sanchez, D. L., Stanton, C. Y., … Field, C. B. (2018). Forest management in the Sierra Nevada provides limited carbon storage potential: an expert elicitation. Ecosphere, 9(7), e02321.

Le Quéré, C., Andrew, R. M., Friedlingstein, P., Sitch, S., Pongratz, J., Manning, A. C., … Zhu, D. (2017). Global Carbon Budget 2017. Earth System Science Data Discussions, 1–79.

Li, C., Fang, Y., Caldeira, K., Zhang, X., Diffenbaugh, N. S., & Michalak, A. M. (2018). Widespread persistent changes to temperature extremes occurred earlier than predicted. Scientific Reports, 8(1), 1007.

Lu, X., Vitousek, P. M., Mao, Q., Gilliam, F. S., Luo, Y., Zhou, G., … Mo, J. (2018). Plant acclimation to long-term high nitrogen deposition in an N-rich tropical forest. Proceedings of the National Academy of Sciences of the United States of America, 115(20), 5187–5192.

Mach, K. J., & Hino, M. (2018). The role of managed retreat in adapting to sea level rise. Aspen Global Change Institute Quarterly Research Review, December.

Majumdar, A., & Deutch, J. (2018). Research Opportunities for CO2 Utilization and Negative Emissions at the Gigatonne Scale. Joule, 2(5), 805–809.

Markowitz, D. M., Laha, R., Perone, B. P., Pea, R. D., & Bailenson, J. N. (2018). Immersive Virtual Reality Field Trips Facilitate Learning About Climate Change. Frontiers in Psychology, 9, 2364.

Masnadi, M. S., El-Houjeiri, H. M., Schunack, D., Li, Y., Englander, J. G., Badahdah, A., … Brandt, A. R. (2018). Global carbon intensity of crude oil production. Science, 361(6405), 851–853.

Masnadi, M. S., El-Houjeiri, H. M., Schunack, D., Li, Y., Roberts, S. O., Przesmitzki, S., … Wang, M. (2018). Well-to-refinery emissions and net-energy analysis of China's crude-oil supply. Nature Energy, 3(3), 220–226.

Meinhardt, K. A., Stopnisek, N., Pannu, M. W., Strand, S. E., Fransen, S. C., Casciotti, K. L., & Stahl, D. A. (2018). Ammonia-oxidizing bacteria are the primary N 2 O producers in an ammonia-oxidizing archaea dominated alkaline agricultural soil. Environmental Microbiology, 20(6), 2195–2206.

Michaelides, R., Schaefer, K., Zebker, H., Parsekian, A., Liu, L., Chen, J., … Schaefer, S. (2018). Inference of the impact of wildfire on permafrost and active layer thickness in a discontinuous permafrost region using the remotely sensed active layer thickness (ReSALT) algorithm. Environmental Research Letters.

Ostrom, N. E., Gandhi, H., Coplen, T. B., Toyoda, S., Böhlke, J. K., Brand, W. A., … Yoshida, N. (2018). Preliminary assessment of stable nitrogen and oxygen isotopic composition of USGS51 and USGS52 nitrous oxide reference gases and perspectives on calibration needs. Rapid Communications in Mass Spectrometry, 32(15), 1207–1214.

Pellegrini, A. F. A., Ahlström, A., Hobbie, S. E., Reich, P. B., Nieradzik, L. P., Staver, A. C., … Jackson, R. B. (2017). Fire frequency drives decadal changes in soil carbon and nitrogen and ecosystem productivity. Nature, 553(7687), 194–198.

Penn, J. L., Deutsch, C., Payne, J. L., & Sperling, E. A. (2018). Temperature-dependent hypoxia explains biogeography and severity of end-Permian marine mass extinction. Science (New York, N.Y.), 362(6419), eaat1327.

Peters, B., Horak, R., Devol, A., Fuchsman, C., Forbes, M., Mordy, C. W., & Casciotti, K. L. (2018). Estimating fixed nitrogen loss and associated isotope effects using concentration and isotope measurements of NO3−, NO2−, and N2 from the Eastern Tropical South Pacific oxygen deficient zone. Deep Sea Research Part II: Topical Studies in Oceanography, 156, 121–136.

Peters, S. T., Schroeder, D. M., Castelletti, D., Haynes, M., & Romero-Wolf, A. (2018). First in-Situ Demonstration of Passive Radio Sounding Using the Sun as a Source for Echo Detection. In IGARSS 2018 - 2018 IEEE International Geoscience and Remote Sensing Symposium (pp. 4154–4157). IEEE.

Polley, H. W., Aspinwall, M. J., Collins, H. P., Gibson, A. E., Gill, R. A., Jackson, R. B., … Fay, P. A. (2018). CO 2 enrichment and soil type additively regulate grassland productivity. New Phytologist.

Polley, H. W., Johnson, D. M., & Jackson, R. B. (2018). Projected drought effects on the demography of Ashe juniper populations inferred from remote measurements of tree canopies. Plant Ecology, 219(10), 1259–1267.

Raji, W. O., Harris, J. M., & Lu, S. (2018). Seismic velocity tomography for CO2 monitor in subsurface geological structures. Journal of King Saud University - Science, 30(1), 57–64.

Rasmusson, K., Rasmusson, M., Tsang, Y., Benson, S., Hingerl, F., Fagerlund, F., & Niemi, A. (2018). Residual trapping of carbon dioxide during geological storage—Insight gained through a pore-network modeling approach. International Journal of Greenhouse Gas Control, 74, 62–78.

Ravikumar, A. P., Wang, J., McGuire, M., Bell, C. S., Zimmerle, D., & Brandt, A. R. (2018). "Good versus Good Enough?" Empirical Tests of Methane Leak Detection Sensitivity of a Commercial Infrared Camera. Environmental Science & Technology, 52(4), 2368–2374.

Rutishauser, A., Blankenship, D. D., Sharp, M., Skidmore, M. L., Greenbaum, J. S., Grima, C., … Young, D. A. (2018). Discovery of a hypersaline subglacial lake complex beneath Devon Ice Cap, Canadian Arctic. Science Advances, 4(4), eaar4353.

Ryan, C. A., Billington, S. L., & Criddle, C. S. (2018). Biocomposite Fiber-Matrix Treatments that Enhance In-Service Performance Can Also Accelerate End-of-Life Fragmentation and Anaerobic Biodegradation to Methane. Journal of Polymers and the Environment, 26(4), 1715–1726.

Sanchez, D. L., Johnson, N., McCoy, S. T., Turner, P. A., & Mach, K. J. (2018). Near-term deployment of carbon capture and sequestration from biorefineries in the United States. Proceedings of the National Academy of Sciences of the United States of America, 115(19), 4875–4880.

Sarhadi, A., Ausín, M. C., Wiper, M. P., Touma, D., & Diffenbaugh, N. S. (2018). Multidimensional risk in a nonstationary climate: Joint probability of increasingly severe warm and dry conditions. Science Advances, 4(11), eaau3487.

Sato, K., & Horne, R. N. (2018). Time-lapse analysis of pressure transients due to ocean tides for estimating CO2 saturation changes. International Journal of Greenhouse Gas Control, 78, 160–167.

Schroeder, D. M., Hilger, A. M., Paden, J. D., Young, D. A., & Corr, H. F. J. (2018). Ocean access beneath the southwest tributary of Pine Island Glacier, West Antarctica. Annals of Glaciology, 59(76pt1), 10–15.

Schwantes, A. M., Parolari, A. J., Swenson, J. J., Johnson, D. M., Domec, J.-C., Jackson, R. B., … Porporato, A. (2018). Accounting for landscape heterogeneity improves spatial predictions of tree vulnerability to drought. New Phytologist, 220(1), 132–146.

Sheshadri, A., Plumb, R. A., Lindgren, E. A., Domeisen, D. I. V., Sheshadri, A., Plumb, R. A., … Domeisen, D. I. V. (2018). The Vertical Structure of Annular Modes. Journal of the Atmospheric Sciences, 75(10), 3507–3519.

Shi, X., Hagen, H. L., Chow, F. K., Bryan, G. H., Street, R. L., Shi, X., … Street, R. L. (2018). Large-Eddy Simulation of the Stratocumulus-Capped Boundary Layer with Explicit Filtering and Reconstruction Turbulence Modeling. Journal of the Atmospheric Sciences, 75(2), 611–637.

Siders, A. R. (2019). Social justice implications of US managed retreat buyout programs. Climatic Change, 152(2), 239–257.

Singh, D., Bollasina, M., Ting, M., & Diffenbaugh, N. S. (2018). Disentangling the influence of local and remote anthropogenic aerosols on South Asian monsoon daily rainfall characteristics. Climate Dynamics, 1–20.

Singh, J. A., Cao, A., Schumann, J., Wang, T., Nørskov, J. K., Abild-Pedersen, F., & Bent, S. F. (2018). Theoretical and Experimental Studies of CoGa Catalysts for the Hydrogenation of CO2 to Methanol. Catalysis Letters, 148(12), 3583–3591.

Sivaram, V., Dabiri, J. O., & Hart, D. M. (2018). The Need for Continued Innovation in Solar, Wind, and Energy Storage. Joule, 2(9), 1639–1642.

Slotznick, S. P., Swanson-Hysell, N. L., & Sperling, E. A. (2018). Oxygenated Mesoproterozoic lake revealed through magnetic mineralogy. Proceedings of the National Academy of Sciences of the United States of America, 115(51), 12938–12943.

Solari, K. A., & Hadly, E. A. (2018). Evolution for extreme living: variation in mitochondrial cytochrome c oxidase genes correlated with elevation in pikas (genus Ochotona). Integrative Zoology, 13(5), 517–535.

Solari, K. A., Ramakrishnan, U., & Hadly, E. A. (2018). Gene expression is implicated in the ability of pikas to occupy Himalayan elevational gradient. PLOS ONE, 13(12), e0207936.

Sperling, E. A., & Stockey, R. G. (2018). The Temporal and Environmental Context of Early Animal Evolution: Considering All the Ingredients of an "Explosion." Integrative and Comparative Biology, 58(4), 605–622.

Sperling, E. A., Balthasar, U., & Skovsted, C. B. (2018). On the edge of exceptional preservation: insights into the role of redox state in Burgess Shale-type taphonomic windows from the Mural Formation, Alberta, Canada. Emerging Topics in Life Sciences, 2(2), 311–323.

Stanton, C. Y., Mach, K. J., Turner, P. A., Lalonde, S. J., Sanchez, D. L., & Field, C. B. (2018). Managing cropland and rangeland for climate mitigation: an expert elicitation on soil carbon in California. Climatic Change, 147(3–4), 633–646.

Sun, W., & Durlofsky, L. J. (2019). Data-space approaches for uncertainty quantification of CO2 plume location in geological carbon storage. Advances in Water Resources, 123, 234–255.

Teixidó, N., Gambi, M. C., Parravacini, V., Kroeker, K., Micheli, F., Villéger, S., & Ballesteros, E. (2018). Functional biodiversity loss along natural CO2 gradients. Nature Communications, 9(1), 5149.

Tian, H., Yang, J., Xu, R., Lu, C., Canadell, J. G., Davidson, E. A., … Zhang, B. (2019). Global soil nitrous oxide emissions since the preindustrial era estimated by an ensemble of terrestrial biosphere models: Magnitude, attribution, and uncertainty. Global Change Biology, 25(2), 640–659.

Touma, D., Michalak, A. M., Swain, D. L., Diffenbaugh, N. S., Touma, D., Michalak, A. M., … Diffenbaugh, N. S. (2018). Characterizing the Spatial Scales of Extreme Daily Precipitation in the United States. Journal of Climate, 31(19), 8023–8037.

Turner, P. A., Field, C. B., Lobell, D. B., Sanchez, D. L., & Mach, K. J. (2018). Unprecedented rates of land-use transformation in modelled climate change mitigation pathways. Nature Sustainability, 1(5), 240–245.

Vitousek, P. M., Paulus, E. L., & Chadwick, O. A. (2019). Nitrogen dynamics along a climate gradient on geologically old substrate, Kaua'i, Hawai'i. Oecologia, 189(1), 211–219.

Wanzek, T., Keiluweit, M., Baham, J., Dragila, M. I., Fendorf, S., Fiedler, S., … Kleber, M. (2018). Quantifying biogeochemical heterogeneity in soil systems. Geoderma, 324, 89–97.

Wanzek, T., Keiluweit, M., Varga, T., Lindsley, A., Nico, P. S., Fendorf, S., … Kleber, M. (2018). The Ability of Soil Pore Network Metrics to Predict Redox Dynamics is Scale Dependent. Soil Systems, 2(4), 66.

Ward, E. M., & Gorelick, S. M. (2018). Drying drives decline in muskrat population in the Peace-Athabasca Delta, Canada. Environmental Research Letters, 13(12), 124026.

Winnick, M. J., & Maher, K. (2018). Relationships between CO2, thermodynamic limits on silicate weathering, and the strength of the silicate weathering feedback. Earth and Planetary Science Letters, 485, 111–120.

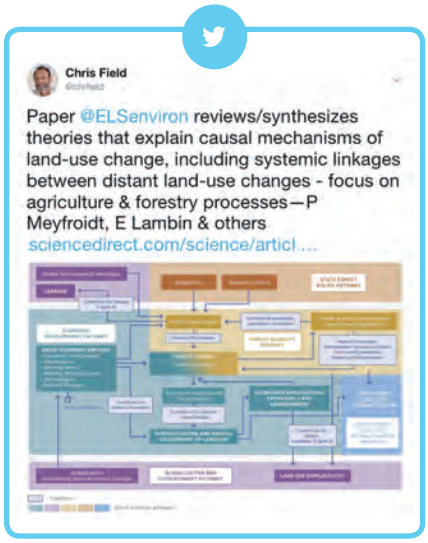
Woodson, C. B., Micheli, F., Boch, C., Al-Najjar, M., Espinoza, A., Hernandez, A., … Torre, J. (2018). Harnessing marine microclimates for climate change adaptation and marine conservation. Conservation Letters, e12609.

Yang, S., Zheng, Q., Yuan, M., Shi, Z., Chiariello, N. R., Docherty, K. M., … Yang, Y. (2019). Long-term elevated CO2 shifts composition of soil microbial communities in a Californian annual grassland, reducing growth and N utilization potentials. Science of The Total Environment, 652, 1474–1481.

Young, T. J., Schroeder, D. M., Christoffersen, P., Lok, L. B., Nicholls, K. W., Brennan, P. V., … Hubbard, A. (2018). Resolving the internal and basal geometry of ice masses using imaging phase-sensitive radar. Journal of Glaciology, 64(246), 649–660.

Zebker, H. A. (2018). Insar Mission-Level Products on Demand - do we Need Range-Doppler? In IGARSS 2018 - 2018 IEEE International Geoscience and Remote Sensing Symposium (pp. 68–71). IEEE.

CONSERVATION



Anderson, C. M., Asner, G. P., Llactayo, W., & Lambin, E. F. (2018). Overlapping land allocations reduce deforestation in Peru. Land Use Policy, 79, 174–178.

Bateman, J. B., & Vitousek, P. M. (2018). Soil fertility response to Ulex europaeus invasion and restoration efforts. Biological Invasions, 20(10), 2777–2791.

Bruggeman, D., Meyfroidt, P., & Lambin, E. F. (2018). Impact of land-use zoning for forest protection and production on forest cover changes in Bhutan. Applied Geography, 96, 153–165.

Ceballos, G., & Ehrlich, P. (2018). The misunderstood sixth mass extinction. Science (New York, N.Y.), 360(6393), 1080–1081.

Chandrasekhar, A., Gordon, D. M., & Navlakha, S. (2018). A distributed algorithm to maintain and repair the trail networks of arboreal ants. Scientific Reports, 8(1), 9297.

Chauvin, K. M., Asner, G. P., Martin, R. E., Kress, W. J., Wright, S. J., & Field, C. B. (2018). Decoupled dimensions of leaf economic and anti-herbivore defense strategies in a tropical canopy tree community. Oecologia, 186(3), 765–782.

Cornejo, O. E., Yee, M.-C., Dominguez, V., Andrews, M., Sockell, A., Strandberg, E., … Motamayor, J. C. (2018). Population genomic analyses of the chocolate tree, Theobroma cacao L., provide insights into its domestication process. Communications Biology, 1(1), 167.

de Freitas, P. D., Mendez, F. L., Chávez-Congrains, K., Galetti, P. M., Coutinho, L. L., Pissinatti, A., & Bustamante, C. D. (2018). Next-Generation Sequencing of the Complete Mitochondrial Genome of the Endangered Species Black Lion Tamarin Leontopithecus chrysopygus (Primates) and Mitogenomic Phylogeny Focusing on the Callitrichidae Family. G3 (Bethesda, Md.), 8(6), 1985–1991.

Di Franco, A., Plass-Johnson, J. G., Di Lorenzo, M., Meola, B., Claudet, J., Gaines, S. D., … Guidetti, P. (2018). Linking home ranges to protected area size: The case study of the Mediterranean Sea. Biological Conservation, 221, 175–181.

Feger, C., Mermet, L., Vira, B., Addison, P. F. E., Barker, R., Birkin, F., … Sutherland, W. J. (2018). Four priorities for new links between conservation science and accounting research. Conservation Biology, cobi.13254.

Ferretti, F., Curnick, D., Liu, K., Romanov, E. V., & Block, B. A. (2018). Shark baselines and the conservation role of remote coral reef ecosystems. Science Advances, 4(3), eaaq0333.

Gordon, D. M. (2018). 7 An Ecological Perspective on Collective Behavior. Landscapes of Collectivity in the Life Sciences, 95.

Gordon, D. M. (2019). The Ecology of Collective Behavior in Ants. Annual Review of Entomology, 64(1), 35–50.

Gravel, D., Baiser, B., Dunne, J. A., Kopelke, J.-P., Martinez, N. D., Nyman, T., … Roslin, T. (2018). Bringing Elton and Grinnell together: a quantitative framework to represent the biogeography of ecological interaction networks. Ecography.

Hallett, L. M., Farrer, E. C., Suding, K. N., Mooney, H. A., & Hobbs, R. J. (2018). Tradeoffs in demographic mechanisms underlie differences in species abundance and stability. Nature Communications, 9(1), 5047.

Hill, A. P., & Hadly, E. A. (2018). Rethinking "Native" in the Anthropocene. Frontiers in Earth Science, 6, 96.

Keesing, F., Ostfeld, R. S., Okanga, S., Huckett, S., Bayles, B. R., Chaplin-Kramer, R., … Allan, B. F. (2018). Consequences of integrating livestock and wildlife in an African savanna. Nature Sustainability, 1(10), 566–573.

Ling, H., Mclvor, G. E., Nagy, G., MohaimenianPour, S., Vaughan, R. T., Thornton, A., & Ouellette, N. T. (2018). Simultaneous measurements of three-dimensional trajectories and wingbeat frequencies of birds in the field. Journal of The Royal Society Interface, 15(147), 20180653.

Martinez-Harms, M. J., Bryan, B. A., Wood, S. A., Fisher, D. M., Law, E., Rhodes, J. R., … Wilson, K. A. (2018). Inequality in access to cultural ecosystem services from protected areas in the Chilean biodiversity hotspot. Science of The Total Environment, 636, 1128–1138.

McClain, C. R., Heim, N. A., Knope, M. L., & Payne, J. L. (2018). Is biodiversity energy-limited or unbounded? A test in fossil and modern bivalves. Paleobiology, 44(03), 385–401.

McFadden, T. N., & Dirzo, R. (2018). Opening the silvicultural toolbox: A new framework for conserving biodiversity in Chilean timber plantations. Forest Ecology and Management, 425, 75–84.

Meskell, L. (2018). One world, two missions. In Decolonising Heritage in South Asia (pp. 33–60). Routledge India.

Meskell, L. (n.d.). A future in ruins : UNESCO, world heritage, and the dream of peace. Oxford University Press.

Morales-Díaz, S. P., Alvarez-Añorve, M. Y., Zamora-Espinoza, M. E., Dirzo, R., Oyama, K., & Avila-Cabadilla, L. D. (2019). Rodent community responses to vegetation and landscape changes in early successional stages of tropical dry forest. Forest Ecology and Management, 433, 633–644.

Neylan, I. P., Dirzo, R., & Sobral, M. (2018). Cumulative effects of transgenerational induction on plant palatability to generalist and specialist herbivores. Web Ecol, 18, 41–46.

Nolte, C., Gobbi, B., le Polain de Waroux, Y., Piquer-Rodríguez, M., Butsic, V., & Lambin, E. F. (2018). Challenges in Attributing Avoided Deforestation to Policies and Actors: Lessons From Provincial Forest Zoning in the Argentine Dry Chaco. Ecological Economics, 150, 346–352.

Perea, R., Fernandes, G. W., & Dirzo, R. (2018). Embryo size as a tolerance trait against seed predation: Contribution of embryo-damaged seeds to plant regeneration. Perspectives in Plant Ecology, Evolution and Systematics, 31, 7–16.

Peters, R., Ripple, W. J., Wolf, C., Moskwik, M., Carreón-Arroyo, G., Ceballos, G., … Miller, J. R. B. (2018). Nature Divided, Scientists United: US–Mexico Border Wall Threatens Biodiversity and Binational Conservation. BioScience, 68(10), 740–743.

Pluskowski, A., Makowiecki, D., Maltby, M., Rannamäe, E., Lõugas, L., Maldre, L., … Seetah, K. (2018). The Baltic Crusades and ecological transformation: The zooarchaeology of conquest and cultural change in the Eastern Baltic in the second millennium AD. Quaternary International.

Prakash, V. N., Bhargava, A., & Prakash, M. (2018). Local Epithelial Fracture and Healing Mechanics Dictate Morphogenesis and Asexual Reproduction in Trichoplax adhaerens. Biophysical Journal, 114(3), 651a–652a.

Reshamwala, H. S., Shrotriya, S., Bora, B., Lyngdoh, S., Dirzo, R., & Habib, B. (2018). Anthropogenic food subsidies change the pattern of red fox diet and occurrence across Trans-Himalayas, India. Journal of Arid Environments, 150, 15–20.

Schachat, S. R., Labandeira, C. C., Saltzman, M. R., Cramer, B. D., Payne, J. L., & Boyce, C. K. (2018). Phanerozoic p O 2 and the early evolution of terrestrial animals. Proceedings of the Royal Society B: Biological Sciences, 285(1871), 20172631.

Schroeder, J. W., Martin, J. T., Angulo, D. F., Barbosa, J. M., Perea, R., Arias-Del Razo, I., … Dirzo, R. (2018). Community composition and diversity of Neotropical root-associated fungi in common and rare trees. Biotropica, 50(4), 694–703.

Searchinger, T. D., Beringer, T., Holtsmark, B., Kammen, D. M., Lambin, E. F., Lucht, W., … van Ypersele, J.-P. (2018). Europe's renewable energy directive poised to harm global forests. Nature Communications, 9(1), 3741.

Smith, F. A., Elliott Smith, R. E., Lyons, S. K., & Payne, J. L. (2018). Body size downgrading of mammals over the late Quaternary. Science (New York, N.Y.), 360(6386), 310–313.

Somero, G. N. (2018). RNA thermosensors: how might animals exploit their regulatory potential? The Journal of Experimental Biology, 221(Pt 4), jeb162842.

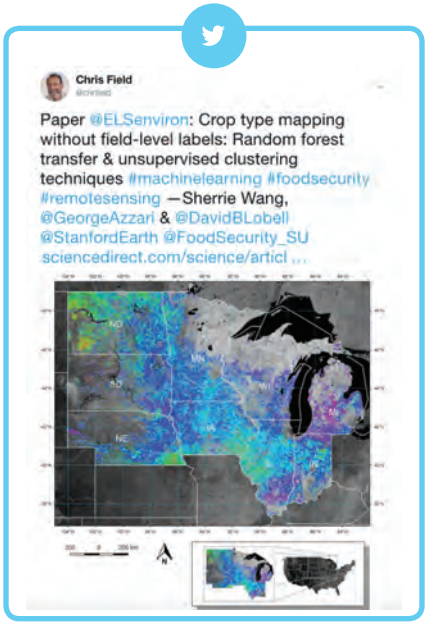
Werth, A. J., Potvin, J., Shadwick, R. E., Jensen, M. M., Cade, D. E., & Goldbogen, J. A. (2018). Filtration area scaling and evolution in mysticetes: trophic niche partitioning and the curious cases of sei and pygmy right whales. Biological Journal of the Linnean Society, 125(2), 264–279.

Wolf, C. A., Young, H. S., Zilliacus, K. M., Wegmann, A. S., McKown, M., Holmes, N. D., … Croll, D. A. (2018). Invasive rat eradication strongly impacts plant recruitment on a tropical atoll. PLOS ONE, 13(7), e0200743.

Yin, T., Te, S. H., Reinhard, M., Yang, Y., Chen, H., He, Y., & Gin, K. Y.-H. (2018). Biotransformation of Sulfluramid (N-ethyl perfluorooctane sulfonamide) and dynamics of associated rhizospheric microbial community in microcosms of wetland plants. Chemosphere, 211, 379–389.

Zumberge, J. A., Love, G. D., Cárdenas, P., Sperling, E. A., Gunasekera, S., Rohrssen, M., … Summons, R. E. (2018). Demosponge steroid biomarker 26-methylstigmastane provides evidence for Neoproterozoic animals. Nature Ecology & Evolution, 2(11), 1709–1714.

FOOD SECURITY



Azzari, G., Grassini, P., Edreira, J. I. R., Conley, S., Mourtzinis, S., & Lobell, D. B. (2019). Satellite mapping of tillage practices in the North Central US region from 2005 to 2016. Remote Sensing of Environment, 221, 417–429.

Berkowitz, S. A., Basu, S., Meigs, J. B., & Seligman, H. K. (2018b). Food Insecurity and Health Care Expenditures in the United States, 2011-2013. Health Services Research, 53(3), 1600–1620.

Berkowitz, S. A., Seligman, H. K., Meigs, J. B., & Basu, S. (2018). Food Insecurity, Healthcare Utilization, and High Cost. American Journal of Managed Care, 24(9):399-404

Chaparro, D., Piles, M., Vall-llossera, M., Camps, A., Konings, A. G., & Entekhabi, D. (2018). L-band vegetation optical depth seasonal metrics for crop yield assessment. Remote Sensing of Environment, 212, 249–259.

Chaudhary, A., Kablan, A., Edwards, A., Stratton, A. E., Otto, C., Stöckle, C., … Conrad, Z. (2018). Sustainable and Equitable Increases in Fruit and Vegetable Productivity and Consumption are Needed to Achieve Global Nutrition Security. Conference Paper, Aspen Global Change Institute, July 30 - August 3, 2018.

Ciscar, J.-C., Fisher-Vanden, K., & Lobell, D. B. (2018). Synthesis and Review: an inter-method comparison of climate change impacts on agriculture. Environmental Research Letters, 13(7), 070401.

Deutsch, C. A., Tewksbury, J. J., Tigchelaar, M., Battisti, D. S., Merrill, S. C., Huey, R. B., & Naylor, R. L. (2018). Increase in crop losses to insect pests in a warming climate. Science (New York, N.Y.), 361(6405), 916–919.

Frei, B., Renard, D., Mitchell, M. G. E., Seufert, V., Chaplin-Kramer, R., Rhemtulla, J. M., & Bennett, E. M. (2018). Bright spots in agricultural landscapes: Identifying areas exceeding expectations for multifunctionality and biodiversity. Journal of Applied Ecology, 55(6), 2731–2743.

Hess, L. J. T., Hinckley, E.-L. S., Robertson, G. P., Hamilton, S. K., & Matson, P. A. (2018). Rainfall Intensification Enhances Deep Percolation and Soil Water Content in Tilled and No-Till Cropping Systems of the US Midwest. Vadose Zone Journal, 17(1), 0.

Hinojosa, L., Lambin, E. F., Mzoughi, N., & Napoléone, C. (2018). Constraints to farming in the Mediterranean Alps: Reconciling environmental and agricultural policies. Land Use Policy, 75, 726–733.

Jin, Z., Ainsworth, E. A., Leakey, A. D. B., & Lobell, D. B. (2018). Increasing drought and diminishing benefits of elevated carbon dioxide for soybean yields across the US Midwest. Global Change Biology, 24(2), e522–e533.

Kalkanci, B., & Plambeck, E. L. (2015). Measuring and Improving Supplier Responsibility Under Voluntary vs. Mandatory Disclosure. SSRN Electronic Journal.

Karp, D. S., Chaplin-Kramer, R., Meehan, T. D., Martin, E. A., DeClerck, F., Grab, H., … Zou, Y. (2018). Crop pests and predators exhibit inconsistent responses to surrounding landscape composition. Proceedings of the National Academy of Sciences of the United States of America, 115(33), E7863–E7870.

Klein, H. S., & Luna, F. V. (2018). Feeding the World. Cambridge University Press.

Lobell, D. B., Azzari, G., Burke, M., Gourlay, S., Jin, Z., Kilic, T., & Murray, S. (2018). Eyes in the Sky, Boots on the Ground: Assessing Satellite- and Ground-Based Approaches to Crop Yield Measurement and Analysis in Uganda. The World Bank.

López-Sánchez, A., Dirzo, R., & Roig, S. (2018). Changes in livestock footprint and tree layer coverage in Mediterranean dehesas: a six-decade study based on remote sensing. International Journal of Remote Sensing, 39(14), 4727–4743.

Martre, P., Kimball, B. A., Ottman, M. J., Wall, G. W., White, J. W., Asseng, S., … Aggarwal, P. K. (2018). The Hot Serial Cereal Experiment for modeling wheat response to temperature: field experiments and AgMIP-Wheat multi-model simulations | Open Data Journal for Agricultural Research.

Meyfroidt, P., Roy Chowdhury, R., de Bremond, A., Ellis, E. C., Erb, K.-H., Filatova, T., … Verburg, P. H. (2018). Middle-range theories of land system change. Global Environmental Change, 53, 52–67.

Middendorp, R. S., Vanacker, V., & Lambin, E. F. (2018). Impacts of shaded agroforestry management on carbon sequestration, biodiversity and farmers income in cocoa production landscapes. Landscape Ecology, 33(11), 1953–1974.

Naylor, R. L. (2018). The Elusive Goal of Global Food Security. Current History, 117(795), 3–9.

Naylor, R. L., & Higgins, M. M. (2012). Global food security. Global Food Security (Vol. 16). Elsevier B.V.

Naylor, R. L., & Higgins, M. M. (2018). The rise in global biodiesel production: Implications for food security. Global Food Security, 16, 75–84.

Proctor, J., Hsiang, S., Burney, J., Burke, M., & Schlenker, W. (2018). Estimating global agricultural effects of geoengineering using volcanic eruptions. Nature, 560(7719), 480–483.

Rueda, X., Paz, A., Gibbs-Plessl, T., Leon, R., Moyano, B., & Lambin, E. F. (2018). Smallholders at a Crossroad: Intensify or Fall behind? Exploring Alternative Livelihood Strategies in a Globalized World. Business Strategy and the Environment, 27(2), 215–229.

Seifert, C. A., Azzari, G., & Lobell, D. B. (2018). Satellite detection of cover crops and their effects on crop yield in the Midwestern United States. Environmental Research Letters, 13(6), 064033.

Sun, J., Mooney, H., Wu, W., Tang, H., Tong, Y., Xu, Z., … Liu, J. (2018). Importing food damages domestic environment: Evidence from global soybean trade. Proceedings of the National Academy of Sciences, 115(21), 5415–5419.

Tebaldi, C., & Lobell, D. (2018a). Differences, or lack thereof, in wheat and maize yields under three low-warming scenarios. Environmental Research Letters, 13(6), 065001.

Tebaldi, C., & Lobell, D. (2018b). Estimated impacts of emission reductions on wheat and maize crops. Climatic Change, 146(3–4), 533–545.

Thorlakson, T., Hainmueller, J., & Lambin, E. F. (2018). Improving environmental practices in agricultural supply chains: The role of company-led standards. Global Environmental Change, 48, 32–42.

Tigchelaar, M., Battisti, D. S., Naylor, R. L., & Ray, D. K. (2018). Future warming increases probability of globally synchronized maize production shocks. Proceedings of the National Academy of Sciences, 115(26), 6644–6649.

van der Linde, K., Egger, R. L., Timofejeva, L., & Walbot, V. (2018). Application of the pathogen Trojan horse approach in maize (Zea mays). Plant Signaling & Behavior, 13(12), e1547575.

van der Linde, K., Timofejeva, L., Egger, R. L., Ilau, B., Hammond, R., Teng, C., … Walbot, V. (2018). Pathogen Trojan Horse Delivers Bioactive Host Protein to Alter Maize Anther Cell Behavior in Situ. The Plant Cell, 30(3), 528–542.

Wang, A. X., Tran, C., Desai, N., Lobell, D., & Ermon, S. (2018). Deep Transfer Learning for Crop Yield Prediction with Remote Sensing Data. In Proceedings of the 1st ACM SIGCAS Conference on Computing and Sustainable Societies (COMPASS) - COMPASS '18 (pp. 1–5). New York, New York, USA: ACM Press.

Wu, Y., Xi, X., Tang, X., Luo, D., Gu, B., Lam, S. K., … Chen, D. (2018). Policy distortions, farm size, and the overuse of agricultural chemicals in China. Proceedings of the National Academy of Sciences of the United States of America, 115(27), 7010–7015.

Yang, J., Luo, D., Yang, B., Frommer, W. B., & Eom, J.-S. (2018). SWEET11 and 15 as key players in seed filling in rice. New Phytologist, 218(2), 604–615.

Zhong, H., Li, X., Lobell, D., Ermon, S., & Brandeau, M. L. (2018). Hierarchical modeling of seed variety yields and decision making for future planting plans. Environment Systems and Decisions, 38(4), 458–470.

Zhu, P., Jin, Z., Zhuang, Q., Ciais, P., Bernacchi, C., Wang, X., … Lobell, D. (2018). The important but weakening maize yield benefit of grain filling prolongation in the US Midwest. Global Change Biology, 24(10), 4718–4730.

Zimmerer, K. S., Lambin, E. F., & Vanek, S. J. (2018). Smallholder telecoupling and potential sustainability. Ecology and Society, 23(1), art30.

FRESHWATER

Benjamin-Chung, J., Amin, N., Ercumen, A., Arnold, B. F., Hubbard, A. E., Unicomb, L., … Colford, J. M. (2018). A Randomized Controlled Trial to Measure Spillover Effects of a Combined Water, Sanitation, and Handwashing Intervention in Rural Bangladesh. American Journal of Epidemiology, 187(8), 1733–1744.

Boehm, A. B., Graham, K. E., & Jennings, W. C. (2018). Can We Swim Yet? Systematic Review, Meta-Analysis, and Risk Assessment of Aging Sewage in Surface Waters. Environmental Science & Technology, 52(17), 9634–9645.

Bolorinos, J., Yu, Y., Ajami, N. K., & Rajagopal, R. (2018). Balancing marine ecosystem impact and freshwater consumption with water-use fees in California's power markets: An evaluation of possibilities and trade-offs. Applied Energy, 226, 644–654.

Cao, Y., Sivaganesan, M., Kelty, C. A., Wang, D., Boehm, A. B., Griffith, J. F., … Shanks, O. C. (2018). A human fecal contamination score for ranking recreational sites using the HF183/ BacR287 quantitative real-time PCR method. Water Research, 128, 148–156.

Conrad, E., Moran, T., DuPraw, M. E., Ceppos, D., Martinez, J., & Blomquist, W. (2018). Diverse stakeholders create collaborative, multilevel basin governance for groundwater sustainability. California Agriculture, 72(1), 44–53.

Crider, Y., Sultana, S., Unicomb, L., Davis, J., Luby, S. P., & Pickering, A. J. (2018). Can you taste it? Taste detection and acceptability thresholds for chlorine residual in drinking water in Dhaka, Bangladesh. Science of The Total Environment, 613–614, 840–846.

Duan, Y., Schaefer, M. V., Wang, Y., Gan, Y., Yu, K., Deng, Y., & Fendorf, S. (2019). Experimental constraints on redox-induced arsenic release and retention from aquifer sediments in the central Yangtze River Basin. Science of The Total Environment, 649, 629–639.

Furst, K. E., Pecson, B. M., Webber, B. D., & Mitch, W. A. (2018a). Distributed Chlorine Injection To Minimize NDMA Formation during Chloramination of Wastewater. Environmental Science & Technology Letters, 5(7), 462–466.

Furst, K. E., Pecson, B. M., Webber, B. D., & Mitch, W. A. (2018b). Tradeoffs between pathogen inactivation and disinfection byproduct formation during sequential chlorine and chloramine disinfection for wastewater reuse. Water Research, 143, 579–588.

Gordon, B. L., Quesnel, K. J., Abs, R., & Ajami, N. K. (2018). A case-study based framework for assessing the multi-sector performance of green infrastructure. Journal of Environmental Management, 223, 371–384.

Hausladen, D. M., Alexander-Ozinskas, A., McClain, C., & Fendorf, S. (2018). Hexavalent Chromium Sources and Distribution in California Groundwater. Environmental Science & Technology, 52(15), 8242–8251.

Herrera-Estrada, J. E., Diffenbaugh, N. S., Wagner, F., Craft, A., & Sheffield, J. (2018). Response of electricity sector air pollution emissions to drought conditions in the western United States. Environmental Research Letters, 13(12), 124032.

Hui, I., & Cain, B. E. (2018). Overcoming psychological resistance toward using recycled water in California. Water and Environment Journal, 32(1), 17–25.

Hui, I., Ulibarri, N., & Cain, B. (2018). Patterns of Participation and Representation in a Regional Water Collaboration. Policy Studies Journal.

Jung, J.-E., Liguori, S., Jew, A. D., Brown, G. E., & Wilcox, J. (2018). Theoretical and experimental investigations of mercury adsorption on hematite surfaces. Journal of the Air & Waste Management Association, 68(1), 39–53.

Kendy, E., Aylward, B., Ziemer, L. S., Richter, B. D., Colby, B. G., Grantham, T. E., … Kappel, C. V. (2018). Water Transactions for Streamflow Restoration, Water Supply Reliability, and Rural Economic Vitality in the Western United States. JAWRA Journal of the American Water Resources Association, 54(2), 487–504.

Knight, R., Smith, R., Asch, T., Abraham, J., Cannia, J., Viezzoli, A., & Fogg, G. (2018). Mapping Aquifer Systems with Airborne Electromagnetics in the Central Valley of California. Groundwater, 56(6), 893–908.

Komaki, Y., Simpson, A. M.-A., Choe, J. K., Plewa, M. J., & Mitch, W. A. (2018). Chlorotyrosines versus Volatile Byproducts from Chlorine Disinfection during Washing of Spinach and Lettuce. Environmental Science & Technology, 52(16), 9361–9369.

Krasner, S. W., Lee, C. F. T., Mitch, W. A., & von Gunten, U. (2018). Impact of Combined Chlorination and Chloramination Conditions on N -Nitrosodimethylamine Formation. Journal - American Water Works Association, 110(12), 11–24.

Kreuzer, R. L., Darrah, T. H., Grove, B. S., Moore, M. T., Warner, N. R., Eymold, W. K., … Poreda, R. J. (2018). Structural and Hydrogeological Controls on Hydrocarbon and Brine Migration into Drinking Water Aquifers in Southern New York. Groundwater, 56(2), 225–244.

Laramee, J., Tilmans, S., & Davis, J. (2018). Costs and benefits of biogas recovery from communal anaerobic digesters treating domestic wastewater: Evidence from peri-urban Zambia. Journal of Environmental Management, 210, 23–35.

Lee, E. J., Criddle, C. S., Geza, M., Cath, T. Y., & Freyberg, D. L. (2018). Decision support toolkit for integrated analysis and design of reclaimed water infrastructure. Water Research, 134, 234–252.

Lee, J., Ghorbanidehno, H., Farthing, M. W., Hesser, T. J., Darve, E. F., & Kitanidis, P. K. (2018). Riverine Bathymetry Imaging With Indirect Observations. Water Resources Research, 54(5), 3704–3727.

Lee, J., Rolle, M., & Kitanidis, P. K. (2018). Longitudinal dispersion coefficients for numerical modeling of groundwater solute transport in heterogeneous formations. Journal of Contaminant Hydrology, 212, 41–54.

Li, X.-F., & Mitch, W. A. (2018). Drinking Water Disinfection Byproducts (DBPs) and Human Health Effects: Multidisciplinary Challenges and Opportunities. Environmental Science & Technology, 52(4), 1681–1689.

Li, Y., & Mitch, W. A. (2018). Capture and Reductive Transformation of Halogenated Pesticides by an Activated Carbon-Based Electrolysis System for Treatment of Runoff. Environmental Science & Technology, 52(3), 1435–1443.

Lin, A., Ercumen, A., Benjamin-Chung, J., Arnold, B. F., Das, S., Haque, R., … Luby, S. P. (2018). Effects of Water, Sanitation, Handwashing, and Nutritional Interventions on Child Enteric Protozoan Infections in Rural Bangladesh: A Cluster-Randomized Controlled Trial. Clinical Infectious Diseases, 67(10), 1515–1522.

Lin, D., Cho, Y.-M., Tommerdahl, J. P., Werner, D., & Luthy, R. G. (2018). Bioturbation facilitates DDT sequestration by activated carbon against recontamination by sediment deposition. Environmental Toxicology and Chemistry, 37(7), 2013–2021.

Ling, R., Chen, J. P., Shao, J., & Reinhard, M. (2018). Degradation of organic compounds during the corrosion of ZVI by hydrogen peroxide at neutral pH: Kinetics, mechanisms and effect of corrosion promoting and inhibiting ions. Water Research, 134, 44–53.

Mao, F., You, L., Reinhard, M., He, Y., & Gin, K. Y.-H. (2018). Occurrence and Fate of Benzophenone-Type UV Filters in a Tropical Urban Watershed. Environmental Science & Technology, 52(7), 3960–3967.

Marks, S. J., Kumpel, E., Guo, J., Bartram, J., & Davis, J. (2018). Pathways to sustainability: A fuzzy-set qualitative comparative analysis of rural water supply programs. Journal of Cleaner Production, 205, 789–798.

Marras, S., Kopera, M. A., Constantinescu, E. M., Suckale, J., & Giraldo, F. X. (2018). A residual-based shock capturing scheme for the continuous/discontinuous spectral element solution of the 2D shallow water equations. Advances in Water Resources, 114, 45–63.

McCarty, P. L. (2018). What is the Best Biological Process for Nitrogen Removal: When and Why? Environmental Science & Technology, 52(7), 3835–3841.

McLellan, S. L., Sauer, E. P., Corsi, S. R., Bootsma, M. J., Boehm, A. B., Spencer, S. K., & Borchardt, M. A. (2018). Sewage loading and microbial risk in urban waters of the Great Lakes. Elem Sci Anth, 6(1), 46.

Nelson, K. L., Boehm, A. B., Davies-Colley, R. J., Dodd, M. C., Kohn, T., Linden, K. G., … Zepp, R. G. (2018). Sunlight-mediated inactivation of health-relevant microorganisms in water: a review of mechanisms and modeling approaches. Environmental Science: Processes & Impacts, 20(8), 1089–1122.

Pritchard, J., Cho, Y.-M., Ashoori, N., Wolfand, J., Sutton, J., Carolan, M., … Luthy, R. G. (2018). Benzotriazole Uptake and Removal in Vegetated Biofilter Mesocosms Planted with Carex praegracilis. Water, 10(11), 1605.

Quesnel, K. J., & Ajami, N. K. (2018). Advancing Water Innovation Through Public Benefit Funds: Examining California's Approach for Electricity. Journal - American Water Works Association, 110(2), E18–E32.

Quesnel, K. J., & Ajami, N. K. (2019). Large Landscape Urban Irrigation: A Data-Driven Approach to Evaluate Conservation Behavior. Water Resources Research.

Roby, N. A., Gonzales, P., Quesnel, K. J., & Ajami, N. K. (2018). A novel search algorithm for quantifying news media coverage as a measure of environmental issue salience. Environmental Modelling & Software, 101, 249–255.

Sánchez-Triana, E., Ortolano, L., & Paul, T. (2018). Managing water-related risks in the West Bengal Sundarbans: policy alternatives and institutions. International Journal of Water Resources Development, 34(1), 78–96.

Sari, M. A., Badruzzaman, M., Cherchi, C., Swindle, M., Ajami, N., & Jacangelo, J. G. (2018). Recent innovations and trends in in-conduit hydropower technologies and their applications in water distribution systems. Journal of Environmental Management, 228, 416–428.

Schaefer, M. V., Shantz, A., Fendorf, S., & Ying, S. C. (2018). Arsenic leaching from ceramic water filters. Environmental Science: Water Research & Technology, 4(2), 234–240.

Scheu, K. R., Fong, D., Monismith, S. G., & Fringer, O. B. (2018). Modeling Sedimentation Dynamics of Sediment-Laden River Intrusions in a Rotationally-Influenced, Stratified Lake. Water Resources Research, 54(6), 4084–4107.

Smith, R., Knight, R., & Fendorf, S. (2018). Overpumping leads to California groundwater arsenic threat. Nature Communications, 9(1), 2089.

Sridharan, V. K., Monimsith, S. G., Fringer, O. B., & Fong, D. A. (n.d.). Evaluation of the Delta Simulation Model-2 in Computing Tidally Driven Flows in the Sacramento-San Joaquin Delta.

Szeptycki, L. F., & Ajami, N. K. (2018). Learning from Challenges in the Arid West: Stanford's Water in the West. EuropeNow.

Tran, N. H., Reinhard, M., & Gin, K. Y.-H. (2018). Occurrence and fate of emerging contaminants in municipal wastewater treatment plants from different geographical regions-a review. Water Research, 133, 182–207.

Vasco, D. W., Pride, S. R., Zahasky, C., & Benson, S. M. (2018). Calculating Trajectories Associated With Solute Transport in a Heterogeneous Medium. Water Resources Research, 54(9), 6890–6908.

Wolfand, J. M., Bell, C. D., Boehm, A. B., Hogue, T. S., & Luthy, R. G. (2018). Multiple Pathways to Bacterial Load Reduction by Stormwater Best Management Practices: Trade-Offs in Performance, Volume, and Treated Area. Environmental Science & Technology, 52(11), 6370–6379.

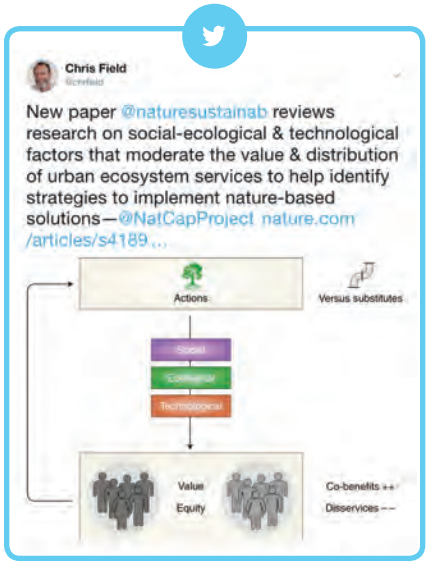
Womble, P., Perrone, D., Jasechko, S., Nelson, R. L., Szeptycki, L. F., Anderson, R. T., & Gorelick, S. M. (2018). Indigenous communities, groundwater opportunities. Science, 361(6401), 453–455.

Xu, L., Li, H., Mitch, W. A., Tao, S., & Zhu, D. (2019). Enhanced Phototransformation of Tetracycline at Smectite Clay Surfaces under Simulated Sunlight via a Lewis-Base Catalyzed Alkalization Mechanism. Environmental Science & Technology, 53(2), 710–718.

Zahasky, C., & Benson, S. M. (2018). Micro-positron emission tomography for measuring sub-core scale single and multiphase transport parameters in porous media. Advances in Water Resources, 115, 1–16.

Zahasky, C., Thomas, D., Matter, J., Maher, K., & Benson, S. M. (2018). Multimodal imaging and stochastic percolation simulation for improved quantification of effective porosity and surface area in vesicular basalt. Advances in Water Resources, 121, 235–244.

NATURAL CAPITAL



Burnett, K. M., Ticktin, T., Bremer, L. L., Quazi, S. A., Geslani, C., Wada, C. A., … Winter, K. B. (2018). Restoring to the future: Environmental, cultural, and management trade-offs in historical versus hybrid restoration of a highly modified ecosystem. Conservation Letters, e12606.

Daily, G. C., & Katz, C. J. (2018). One Tree. Trinity University Press.

Donahue, M. L., Keeler, B. L., Wood, S. A., Fisher, D. M., Hamstead, Z. A., & McPhearson, T. (2018). Using social media to understand drivers of urban park visitation in the Twin Cities, MN. Landscape and Urban Planning, 175, 1–10.

Fisher, D. M., Wood, S. A., White, E. M., Blahna, D. J., Lange, S., Weinberg, A., … Lia, E. (2018). Recreational use in dispersed public lands measured using social media data and on-site counts. Journal of Environmental Management, 222, 465–474.

Hamstead, Z. A., Fisher, D., Ilieva, R. T., Wood, S. A., McPhearson, T., & Kremer, P. (2018). Geolocated social media as a rapid indicator of park visitation and equitable park access. Computers, Environment and Urban Systems, 72, 38–50.

Li, C., Li, S., Feldman, M. W., Li, J., Zheng, H., & Daily, G. C. (2018). The impact on rural livelihoods and ecosystem services of a major relocation and settlement program: A case in Shaanxi, China. Ambio, 47(2), 245–259.

Neugarten, R. A., Langhammer, P. F., Osipova, E., Bagstad, K. J., Bhagabati, N., Butchart, S. H. M., … Willcock, S. (2018). Tools for measuring, modelling, and valuing ecosystem services: guidance for Key Biodiversity Areas, natural World Heritage sites, and protected areas. (C. Groves, Ed.). IUCN, International Union for Conservation of Nature.

Pejchar, L., Gallo, T., Hooten, M. B., & Daily, G. C. (2018). Predicting effects of large-scale reforestation on native and exotic birds. Diversity and Distributions, 24(6), 811–819.

Redhead, J. W., May, L., Oliver, T. H., Hamel, P., Sharp, R., & Bullock, J. M. (2018). National scale evaluation of the InVEST nutrient retention model in the United Kingdom. Science of The Total Environment, 610–611, 666–677.

Ren, L., Li, J., Li, C., Li, S., Daily, G., Ren, L., … Daily, G. C. (2018). Does Poverty Matter in Payment for Ecosystem Services Program? Participation in the New Stage Sloping Land Conversion Program. Sustainability, 10(6), 1888.

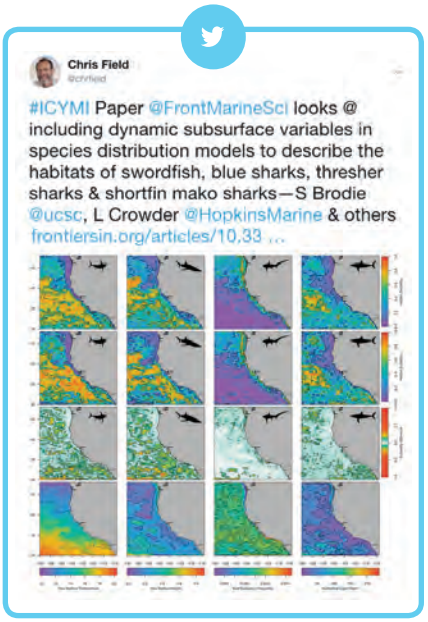
Selig, E. R., Hole, D. G., Allison, E. H., Arkema, K. K., McKinnon, M. C., Chu, J., … Zvoleff, A. (2018). Mapping global human dependence on marine ecosystems. Conservation Letters, e12617.

Smith, J. R., Letten, A. D., Ke, P.-J., Anderson, C. B., Hendershot, J. N., Dhami, M. K., … Daily, G. C. (2018). A global test of ecoregions. Nature Ecology & Evolution, 2(12), 1889–1896.

Tellman, B., McDonald, R. I., Goldstein, J. H., Vogl, A. L., Flörke, M., Shemie, D., … Veiga, F. (2018). Opportunities for natural infrastructure to improve urban water security in Latin America. PLOS ONE, 13(12), e0209470.

Wood, S. L. R., Jones, S. K., Johnson, J. A., Brauman, K. A., Chaplin-Kramer, R., Fremier, A., … DeClerck, F. A. (2018). Distilling the role of ecosystem services in the Sustainable Development Goals. Ecosystem Services, 29, 70–82.

OCEANS



Bastari, A., Pica, D., Ferretti, F., Micheli, F., & Cerrano, C. (2018). Sea pens in the Mediterranean Sea: habitat suitability and opportunities for ecosystem recovery. ICES Journal of Marine Science, 75(5), 1722–1732.

Brault, E., Koch, P., McMahon, K., Broach, K., Rosenfield, A., Sauthoff, W., … Smith, W. (2018). Carbon and nitrogen zooplankton isoscapes in West Antarctica reflect oceanographic transitions. Marine Ecology Progress Series, 593, 29–45.

Briscoe, D. K., Fossette, S., Scales, K. L., Hazen, E. L., Bograd, S. J., Maxwell, S. M., … Lewison, R. L. (2018). Characterizing habitat suitability for a central-place forager in a dynamic marine environment. Ecology and Evolution, 8(5), 2788–2801.

Brodie, S., Jacox, M. G., Bograd, S. J., Welch, H., Dewar, H., Scales, K. L., … Hazen, E. L. (2018). Integrating Dynamic Subsurface Habitat Metrics Into Species Distribution Models. Frontiers in Marine Science, 5, 219.

Brooks, C. M., Caccavo, J. A., Ashford, J., Dunbar, R., Goetz, K., La Mesa, M., & Zane, L. (2018). Early life history connectivity of Antarctic silverfish (Pleuragramma antarctica) in the Ross Sea. Fisheries Oceanography, 27(3), 274–287.

Bruno, J. F., Saumweber, W., Crowder, L. B., Pendleton, L., Roady, S. E., Rouleau, T., & Sakashita, M. (2018). Safe Harbors: The Many Benefits of Marine Monuments and Sanctuaries. Frontiers in Marine Science, 5, 189.

Cade, D. E., Barr, K. R., Calambokidis, J., Friedlaender, A. S., & Goldbogen, J. A. (2018). Determining forward speed from accelerometer jiggle in aquatic environments. The Journal of Experimental Biology, 221(Pt 2), jeb170449.

Chou, Y.-J., Nelson, K. S., Holleman, R. C., Fringer, O. B., Stacey, M. T., Lacy, J. R., … Koseff, J. R. (2018). Three-Dimensional Modeling of Fine Sediment Transport by Waves and Currents in a Shallow Estuary. Journal of Geophysical Research: Oceans, 123(6), 4177–4199.

Ciezarek, A. G., Osborne, O. G., Shipley, O. N., Brooks, E. J., Tracey, S. R., McAllister, J. D., … Savolainen, V. (2019). Phylotranscriptomic Insights into the Diversification of Endothermic Thunnus Tunas. Molecular Biology and Evolution, 36(1), 84–96.

Connell, P., Michel, C., Meisterhans, G., Arrigo, K., & Caron, D. (2018). Phytoplankton and bacterial dynamics on the Chukchi Sea Shelf during the spring-summer transition. Marine Ecology Progress Series, 602, 49–62.

Correia, M. J., Costa, J. L., Antunes, C., De Leo, G., & Domingos, I. (2018). The decline in recruitment of the European eel: new insights from a 40-year-long time-series in the Minho estuary (Portugal). ICES Journal of Marine Science, 75(6), 1975–1983.

Damashek, J., & Francis, C. A. (2018). Microbial Nitrogen Cycling in Estuaries: From Genes to Ecosystem Processes. Estuaries and Coasts, 41(3), 626–660.

DeJong, H. B., Dunbar, R. B., & Lyons, E. A. (2018). Late Summer Frazil Ice-Associated Algal Blooms around Antarctica. Geophysical Research Letters, 45(2), 826–833.

DiBenedetto, M. H., Ouellette, N. T., & Koseff, J. R. (2018). Transport of anisotropic particles under waves. Journal of Fluid Mechanics, 837, 320–340.

Dong, Y.-W., Liao, M.-L., Meng, X.-L., & Somero, G. N. (2018). Structural flexibility and protein adaptation to temperature: Molecular dynamics analysis of malate dehydrogenases of marine molluscs. Proceedings of the National Academy of Sciences of the United States of America, 115(6), 1274–1279.

Donovan, M. K., Friedlander, A. M., Lecky, J., Jouffray, J.-B., Williams, G. J., Wedding, L. M., … Selkoe, K. A. (2018). Combining fish and benthic communities into multiple regimes reveals complex reef dynamics. Scientific Reports, 8(1), 16943.

Elahi, R., Ferretti, F., Bastari, A., Cerrano, C., Colloca, F., Kowalik, J., … Micheli, F. (2018). Leveraging vessel traffic data and a temporary fishing closure to inform marine management. Frontiers in Ecology and the Environment, 16(8), 440–446.

Finkbeiner, E. M., Micheli, F., Bennett, N. J., Ayers, A. L., Le Cornu, E., & Doerr, A. N. (2018). Exploring trade-offs in climate change response in the context of Pacific Island fisheries. Marine Policy, 88, 359–364.

Fuchsman, C. A., Devol, A. H., Casciotti, K. L., Buchwald, C., Chang, B. X., & Horak, R. E. A. (2018). An N isotopic mass balance of the Eastern Tropical North Pacific oxygen deficient zone. Deep Sea Research Part II: Topical Studies in Oceanography, 156, 137–147.

Fulton, S., Hernández-Velasco, A., Suarez-Castillo, A., Fernández-Rivera Melo, F., Rojo, M., Sáenz-Arroyo, A., … Torre, J. (2019). From Fishing Fish to Fishing Data: The Role of Artisanal Fishers in Conservation and Resource Management in Mexico (pp. 151–175). Springer, Cham.

Gattuso, J.-P., Magnan, A. K., Bopp, L., Cheung, W. W. L., Duarte, C. M., Hinkel, J., … Rau, G. H. (2018). Ocean Solutions to Address Climate Change and Its Effects on Marine Ecosystems. Frontiers in Marine Science, 5, 337.

Gearty, W., McClain, C. R., & Payne, J. L. (2018). Energetic tradeoffs control the size distribution of aquatic mammals. Proceedings of the National Academy of Sciences of the United States of America, 115(16), 4194–4199.

Giakoumi, S., McGowan, J., Mills, M., Beger, M., Bustamante, R. H., Charles, A., … Possingham, H. P. (2018). Revisiting "Success" and "Failure" of Marine Protected Areas: A Conservation Scientist Perspective. Frontiers in Marine Science, 5, 223.

Gissi, E., Fraschetti, S., & Micheli, F. (2019). Incorporating change in marine spatial planning: A review. Environmental Science & Policy, 92, 191–200.

Gold, Z., & Palumbi, S. R. (2018). Long-term growth rates and effects of bleaching in Acropora hyacinthus. Coral Reefs, 37(1), 267–277.

Graham, K. E., Prussin, A. J., Marr, L. C., Sassoubre, L. M., & Boehm, A. B. (2018). Microbial community structure of sea spray aerosols at three California beaches. FEMS Microbiology Ecology, 94(3).

Hazen, E. L., Scales, K. L., Maxwell, S. M., Briscoe, D. K., Welch, H., Bograd, S. J., … Lewison, R. L. (2018). A dynamic ocean management tool to reduce bycatch and support sustainable fisheries. Science Advances, 4(5), eaar3001.

Hogg, C. A. R., Egan, G. C., Ouellette, N. T., & Koseff, J. R. (2018). Shoaling internal waves may reduce gravity current transport. Environmental Fluid Mechanics, 18(2), 383–394.

Houghton, I. A., Koseff, J. R., Monismith, S. G., & Dabiri, J. O. (2018). Vertically migrating swimmers generate aggregation-scale eddies in a stratified column. Nature, 556(7702), 497–500.

Jennings, W. C., Chern, E. C., O'Donohue, D., Kellogg, M. G., & Boehm, A. B. (2018). Frequent detection of a human fecal indicator in the urban ocean: environmental drivers and covariation with enterococci. Environmental Science: Processes & Impacts, 20(3), 480–492.

Kahane-Rapport, S. R., & Goldbogen, J. A. (2018). Allometric scaling of morphology and engulfment capacity in rorqual whales. Journal of Morphology, 279(9), 1256–1268.

Kroodsma, D. A., Mayorga, J., Hochberg, T., Miller, N. A., Boerder, K., Ferretti, F., … Worm, B. (2018). Tracking the global footprint of fisheries. Science (New York, N.Y.), 359(6378), 904–908.

Le Cornu, E., Doerr, A. N., Finkbeiner, E. M., Gourlie, D., & Crowder, L. B. (2018). Spatial management in small-scale fisheries: A potential approach for climate change adaptation in Pacific Islands. Marine Policy, 88, 350–358.

Low, N., & Micheli, F. (2018). Lethal and functional thresholds of hypoxia in two key benthic grazers. Marine Ecology Progress Series, 594, 165–173.

Lowry, K. E., Pickart, R. S., Selz, V., Mills, M. M., Pacini, A., Lewis, K. M., … Arrigo, K. R. (2018). Under-Ice Phytoplankton Blooms Inhibited by Spring Convective Mixing in Refreezing Leads. Journal of Geophysical Research: Oceans, 123(1), 90–109.

McCauley, D. J., Gellner, G., Martinez, N. D., Williams, R. J., Sandin, S. A., Micheli, F., … McCann, K. S. (2018). On the prevalence and dynamics of inverted trophic pyramids and otherwise top-heavy communities. Ecology Letters, 21(3), 439–454.

McHuron, E. A., Block, B. A., & Costa, D. P. (2018). Movements and dive behavior of juvenile California sea lions from Año Nuevo Island. Marine Mammal Science, 34(1), 238–249.

Mills, M. M., Brown, Z. W., Laney, S. R., Ortega-Retuerta, E., Lowry, K. E., van Dijken, G. L., & Arrigo, K. R. (2018). Nitrogen Limitation of the Summer Phytoplankton and Heterotrophic Prokaryote Communities in the Chukchi Sea. Frontiers in Marine Science, 5.

Monismith, S. G., Barkdull, M. K., Nunome, Y., & Mitarai, S. (2018). Transport Between Palau and the Eastern Coral Triangle: Larval Connectivity or Near Misses. Geophysical Research Letters, 45(10), 4974–4981.

Monismith, S. G., Koseff, J. R., & White, B. L. (2018). Mixing Efficiency in the Presence of Stratification: When Is It Constant? Geophysical Research Letters, 45(11), 5627–5634.

Muller-Karger, F. E., Hestir, E., Ade, C., Turpie, K., Roberts, D. A., Siegel, D., … Jetz, W. (2018). Satellite sensor requirements for monitoring essential biodiversity variables of coastal ecosystems. Ecological Applications, 28(3), 749–760.

Oliver, H., Luo, H., Castelao, R. M., van Dijken, G. L., Mattingly, K. S., Rosen, J. J., … Yager, P. L. (2018). Exploring the Potential Impact of Greenland Meltwater on Stratification, Photosynthetically Active Radiation, and Primary Production in the Labrador Sea. Journal of Geophysical Research: Oceans, 123(4), 2570–2591.

Peters, B. D., Jenkins, W. J., Swift, J. H., German, C. R., Moffett, J. W., Cutter, G. A., … Casciotti, K. L. (2018). Water mass analysis of the 2013 US GEOTRACES eastern Pacific zonal transect (GP16). Marine Chemistry, 201, 6–19.

Peters, B. D., Lam, P. J., & Casciotti, K. L. (2018). Nitrogen and oxygen isotope measurements of nitrate along the US GEOTRACES Eastern Pacific Zonal Transect (GP16) yield insights into nitrate supply, remineralization, and water mass transport. Marine Chemistry, 201, 137–150.

Pirotta, E., Mangel, M., Costa, D. P., Mate, B., Goldbogen, J. A., Palacios, D. M., … New, L. (2018). A Dynamic State Model of Migratory Behavior and Physiology to Assess the Consequences of Environmental Variation and Anthropogenic Disturbance on Marine Vertebrates. The American Naturalist, 191(2), E40–E56.

Rayson, M. D., Ivey, G. N., Jones, N. L., & Fringer, O. B. (2018). Resolving high-frequency internal waves generated at an isolated coral atoll using an unstructured grid ocean model. Ocean Modelling, 122, 67–84.

Rogers, J. S., Maticka, S. A., Chirayath, V., Woodson, C. B., Alonso, J. J., Monismith, S. G., … Monismith, S. G. (2018). Connecting Flow over Complex Terrain to Hydrodynamic Roughness on a Coral Reef. Journal of Physical Oceanography, 48(7), 1567–1587.

Rose, N. H., Bay, R. A., Morikawa, M. K., & Palumbi, S. R. (2018). Polygenic evolution drives species divergence and climate adaptation in corals. Evolution, 72(1), 82–94.

Santos, C. F., Agardy, T., Andrade, F., Crowder, L. B., Ehler, C. N., & Orbach, M. K. (2018). Major challenges in developing marine spatial planning. Marine Policy.

Santos, C. F., Ehler, C. N., Agardy, T., Andrade, F., Orbach, M. K., & Crowder, L. B. (2018). Marine Spatial Planning. In World seas : An Environmental Evaluation. Volume III, Ecological Issues and Environmental Impacts (p. 666).

Sasmal, K., Masunaga, E., Webb, A., Fringer, O. B., Gross, E. S., Rayson, M. D., & Yamazaki, H. (2018). A three-dimensional numerical study of river plume mixing processes in Otsuchi Bay, Japan. Journal of Oceanography, 74(2), 169–186.

Searcy, R. T., Taggart, M., Gold, M., & Boehm, A. B. (2018). Implementation of an automated beach water quality nowcast system at ten California oceanic beaches. Journal of Environmental Management, 223, 633–643.

Selz, V., Laney, S., Arnsten, A. E., Lewis, K. M., Lowry, K. E., Joy-Warren, H. L., … Arrigo, K. R. (2018). Ice algal communities in the Chukchi and Beaufort Seas in spring and early summer: Composition, distribution, and coupling with phytoplankton assemblages. Limnology and Oceanography, 63(3), 1109–1133.

Selz, V., Lowry, K., Lewis, K., Joy-Warren, H., Van de Poll, W., Nirmel, S., … Arrigo, K. (2018). Marine ecology progress series. Marine Ecology Progress Series (Vol. 586). Inter-Research.

Selz, V., Saenz, B. T., van Dijken, G. L., & Arrigo, K. R. (2018). Drivers of Ice Algal Bloom Variability Between 1980 and 2015 in the Chukchi Sea. Journal of Geophysical Research: Oceans, 123(10), 7037–7052.

Sheets, E. A., Warner, P. A., & Palumbi, S. R. (2018). Accurate population genetic measurements require cryptic species identification in corals. Coral Reefs, 37(2), 549–563.

Silva-Tamayo, J. C., Lau, K. V., Jost, A. B., Payne, J. L., Wignall, P. B., Newton, R. J., … Paytan, A. (2018). Global perturbation of the marine calcium cycle during the Permian-Triassic transition. GSA Bulletin, 130(7–8), 1323–1338.

Stelzenmüller, V., Coll, M., Mazaris, A. D., Giakoumi, S., Katsanevakis, S., Portman, M. E., … Ojaveer, H. (2018). A risk-based approach to cumulative effect assessments for marine management. Science of The Total Environment, 612, 1132–1140.

Stock, A., Crowder, L. B., Halpern, B. S., & Micheli, F. (2018). Uncertainty analysis and robust areas of high and low modeled human impact on the global oceans. Conservation Biology, 32(6), 1368–1379.

Thomas, L., Rose, N. H., Bay, R. A., López, E. H., Morikawa, M. K., Ruiz-Jones, L., & Palumbi, S. R. (2018). Mechanisms of Thermal Tolerance in Reef-Building Corals across a Fine-Grained Environmental Mosaic: Lessons from Ofu, American Samoa. Frontiers in Marine Science, 4, 434.

Ulloa, H. N., Davis, K. A., Monismith, S. G., Pawlak, G., Ulloa, H. N., Davis, K. A., … Pawlak, G. (2018). Temporal Variability in Thermally Driven Cross-Shore Exchange: The Role of Semidiurnal Tides. Journal of Physical Oceanography, 48(7), 1513–1531.

van Leeuwe, M. A., Tedesco, L., Arrigo, K. R., Assmy, P., Campbell, K., Meiners, K. M., … Stefels, J. (2018). Microalgal community structure and primary production in Arctic and Antarctic sea ice: A synthesis. Elem Sci Anth, 6(1).

Vieira, L. H., Achterberg, E. P., Scholten, J., Beck, A. J., Liebetrau, V., Mills, M. M., & Arrigo, K. R. (2019). Benthic fluxes of trace metals in the Chukchi Sea and their transport into the Arctic Ocean. Marine Chemistry, 208, 43–55.

Vilalta-Navas, A., Beas-Luna, R., Calderon-Aguilera, L. E., Ladah, L., Micheli, F., Christensen, V., & Torre, J. (2018). A mass-balanced food web model for a kelp forest ecosystem near its southern distributional limit in the northern hemisphere. Food Webs, 17, e00091.

Villaseñor-Derbez, J. C., Faro, C., Wright, M., Martínez, J., Fitzgerald, S., Fulton, S., … Costello, C. (2018). A user-friendly tool to evaluate the effectiveness of no-take marine reserves. PLOS ONE, 13(1), e0191821.

Wang, B., Cao, L., Micheli, F., Naylor, R. L., & Fringer, O. B. (2018). The effects of intensive aquaculture on nutrient residence time and transport in a coastal embayment. Environmental Fluid Mechanics, 18(6), 1321–1349.

Wedding, L. M., Lecky, J., Gove, J. M., Walecka, H. R., Donovan, M. K., Williams, G. J., … Selkoe, K. A. (2018). Advancing the integration of spatial data to map human and natural drivers on coral reefs. PLOS ONE, 13(3), e0189792.

Yao, Y., Huang, Z., He, W., & Monismith, S. G. (2018). Wave-induced setup and wave-driven current over Quasi-2DH reef-lagoon-channel systems. Coastal Engineering, 138, 113–125.

Zeng, C., Rosengard, S. Z., Burt, W., Peña, M. A., Nemcek, N., Zeng, T., … Tortell, P. D. (2018). Optically-derived estimates of phytoplankton size class and taxonomic group biomass in the Eastern Subarctic Pacific Ocean. Deep Sea Research Part I: Oceanographic Research Papers, 136, 107–118.

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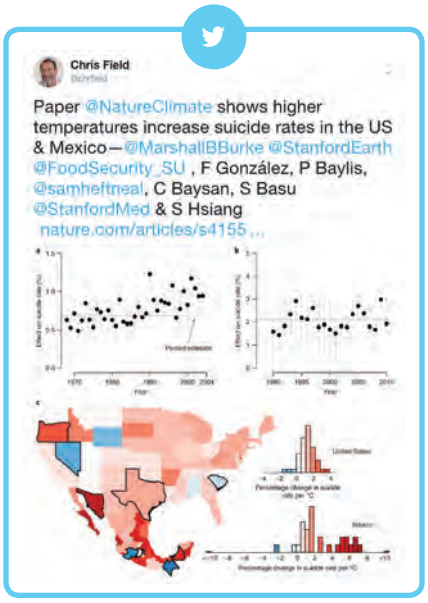

Afrooz, A. R. M. N., Pitol, A. K., Kitt, D., & Boehm, A. B. (2018). Role of microbial cell properties on bacterial pathogen and coliphage removal in biochar-modified stormwater biofilters. Environmental Science: Water Research & Technology, 4(12), 2160–2169.

Ahmed, M., Abedin, J., Alam, K. F., Al Mamun, A., Paul, R. C., Rahman, M., … Gurley, E. S. (2018). Incidence of Acute Diarrhea-Associated Death among Children < 5 Years of Age in Bangladesh, 2010–12. Am. J. Trop. Med. Hyg, 98(1), 281–286.

Anand, S., Abdalla, S., Gathecha, G., Oladapo, O. O., Joseph, K., Montez-Rath, M. E., … Friedman, D. J. (2018). Association of Apolipoprotein L-1 polymorphisms with blood pressure in three multi-ethnic African studies. Journal of Global Health Reports, 2.

Andrews, J. R., Baker, S., Marks, F., Alsan, M., Garrett, D., Gellin, B. G., … Lo, N. C. (2019). Typhoid conjugate vaccines: a new tool in the fight against antimicrobial resistance. The Lancet Infectious Diseases, 19(1), e26–e30.

Andrews, J. R., Barkume, C., Yu, A. T., Saha, S. K., Qamar, F. N., Garrett, D., & Luby, S. P. (2018). Integrating Facility-Based Surveillance With Healthcare Utilization Surveys to Estimate Enteric Fever Incidence: Methods and Challenges. The Journal of Infectious Diseases, 218(suppl_4), S268–S276.

Arakala, A., Hoover, C. M., Marshall, J. M., Sokolow, S. H., De Leo, G. A., Rohr, J. R., … Gambhir, M. (2018). Estimating the elimination feasibility in the "end game" of control efforts for parasites subjected to regular mass drug administration: Methods and their application to schistosomiasis. PLOS Neglected Tropical Diseases, 12(11), e0006794.

Armon, S., Bull, M. S., Aranda-Diaz, A., & Prakash, M. (2018). Ultrafast epithelial contractions provide insights into contraction speed limits and tissue integrity. Proceedings of the National Academy of Sciences, 115(44), E10333–E10341.

Arostegui, M. C., Wood, C. L., Jones, I. J., Chamberlin, A. J., Jouanard, N., Faye, D. S., … Sokolow, S. H. (2019). Potential Biological Control of Schistosomiasis by Fishes in the Lower Senegal River Basin. The American Journal of Tropical Medicine and Hygiene, 100(1), 117–126.

Bailenson, J. (2018). Protecting Nonverbal Data Tracked in Virtual Reality. JAMA Pediatrics, 172(10), 905.

Barkume, C., Date, K., Saha, S. K., Qamar, F. N., Sur, D., Andrews, J. R., … Garrett, D. (2018). Phase I of the Surveillance for Enteric Fever in Asia Project (SEAP): An Overview and Lessons Learned. The Journal of Infectious Diseases, 218(suppl_4), S188–S194.

Basu, S., Phillips, R. S., Bitton, A., Song, Z., & Landon, B. E. (2018). Finance and Time Use Implications of Team Documentation for Primary Care: A Microsimulation. Annals of Family Medicine, 16(4), 308–313.

Basu, S., Williams, J. W., & Phillips, R. S. (2018). Behavioral health integration model. Journal of General Internal Medicine, 33(10), 1597–1597.

Basu, S., Yudkin, J. S., Berkowitz, S. A., Jawad, M., & Millett, C. (2018). Reducing chronic disease through changes in food aid: A microsimulation of nutrition and cardiometabolic disease among Palestinian refugees in the Middle East. PLOS Medicine, 15(11), e1002700.

Bendavid, E. (2018). The fog of development: evaluating the Millennium Villages Project. The Lancet Global Health, 6(5), e470–e471.

Bhutta, Z. A., Gaffey, M. F., Crump, J. A., Steele, D., Breiman, R. F., Mintz, E. D., … Levine, M. M. (2018). Typhoid Fever: Way Forward. The American Journal of Tropical Medicine and Hygiene, 99(3_Suppl), 89–96.

Biswas, D., Gurley, E. S., Rutherford, S., & Luby, S. P. (2018). The Drivers and Impacts of Selling Soil for Brick Making in Bangladesh. Environmental Management, 62(4), 792–802.

Blitvich, B. J., Beaty, B. J., Blair, C. D., Brault, A. C., Dobler, G., Drebot, M. A., … Weaver, S. C. (2018). Bunyavirus Taxonomy: Limitations and Misconceptions Associated with the Current ICTV Criteria Used for Species Demarcation. The American Journal of Tropical Medicine and Hygiene, 99(1), 11–16.

Brenciaglia, M., Noël, T. P., Fields, P. J., Bidaisee, S., Myers, T. E., Nelson, W. M., … Macpherson, C. N. L. (2018). Clinical, Serological, and Molecular Observations from a Case Series Study during the Asian Lineage Zika Virus Outbreak in Grenada during 2016. Canadian Journal of Infectious Diseases and Medical Microbiology, 2018, 1–9.

Byrd, K. A., Williams, T. N., Lin, A., Pickering, A. J., Arnold, B. F., Arnold, C. D., … Stewart, C. P. (2018). Sickle Cell and β+-Thalassemia Traits Influence the Association between Ferritin and Hepcidin in Rural Kenyan Children Aged 14–26 Months. The Journal of Nutrition, 148(12), 1903–1910.

Contopoulos-Ioannidis, D., Newman-Lindsay, S., Chow, C., & LaBeaud, A. D. (2018). Mother-to-child transmission of Chikungunya virus: A systematic review and meta-analysis. PLOS Neglected Tropical Diseases, 12(6), e0006510.

Cortes, M. C., Cauchemez, S., Lefrancq, N., Luby, S. P., Jahangir Hossain, M., Sazzad, H. M. S., … Gurley, E. S. (2018). Characterization of the Spatial and Temporal Distribution of Nipah Virus Spillover Events in Bangladesh, 2007–2013. The Journal of Infectious Diseases, 217(9), 1390–1394.

da Maia, J. T. S., Vidal, S. J. A., Mendes, T. V., Lins, M. G., Zacarkim, M. R., Rolim, D. D., … Mendes Neto, N. N. (2018). Perinatal Case Fatality Rate in Cases of Congenital Zika Syndrome: a Cross-Sectional Study (P5.160). Neurology, 90(15 Supplement), P5.160.

De Alcantara, T., da Silva Maia, J. T., Aronoff, D., Rolim, D. D., Zacarkim, M. R., LaBeaud, A. D., … Neto, N. N. M. (2018). Radiological Findings and Neurological Disorders in Microcephaly Cases Related to Zika Virus: A Cohort Study (P2.314). Neurology, 90(15 Supplement), P2.314.

De Alcantara, T., LaBeaud, A. D., Aronoff, D., Zacarkim, M. R., da Silva Maia, J. T., Fernandes, K. E., & Mendes Neto, N. N. (2018). CT Scan Findings in Microcephaly Cases During 2015–2016 Zika Outbreak: A Cohort Study (P2.310). Neurology, 90(15 Supplement), P2.310.

DeBoever, C., Tanigawa, Y., Lindholm, M. E., McInnes, G., Lavertu, A., Ingelsson, E., … Rivas, M. A. (2018). Medical relevance of protein-truncating variants across 337,205 individuals in the UK Biobank study. Nature Communications, 9(1), 1612.

Dicker, D., Nguyen, G., Abate, D., Abate, K. H., Abay, S. M., Abbafati, C., … Murray, C. J. L. (2018). Global, regional, and national age-sex-specific mortality and life expectancy, 1950–2017: a systematic analysis for the Global Burden of Disease Study 2017. The Lancet, 392(10159), 1684–1735.

Doza, S., Jabeen Rahman, M., Islam, M. A., Kwong, L. H., Unicomb, L., Ercumen, A., … Luby, S. P. (2018). Prevalence and Association of Escherichia coli and Diarrheagenic Escherichia coli in Stored Foods for Young Children and Flies Caught in the Same Households in Rural Bangladesh. The American Journal of Tropical Medicine and Hygiene, 98(4), 1031–1038.

Dulay, M., Zaman, N., Jaramillo, D., Mody, A., Zare, R., Dulay, M. T., … Zare, R. N. (2018). Pathogen-Imprinted Organosiloxane Polymers as Selective Biosensors for the Detection of Targeted E. coli. C, 4(2), 29.

Ehrenkaufer, G. M., Suresh, S., Solow-Cordero, D., & Singh, U. (2018). High-Throughput Screening of Entamoeba Identifies Compounds Which Target Both Life Cycle Stages and Which Are Effective Against Metronidazole Resistant Parasites. Frontiers in Cellular and Infection Microbiology, 8, 276.

Ercumen, A., Mertens, A., Arnold, B. F., Benjamin-Chung, J., Hubbard, A. E., Ahmed, M. A., … Colford, J. M. (2018). Effects of Single and Combined Water, Sanitation and Handwashing Interventions on Fecal Contamination in the Domestic Environment: A Cluster-Randomized Controlled Trial in Rural Bangladesh. Environmental Science & Technology, 52(21), 12078–12088.

Ercumen, A., Pickering, A. J., Kwong, L. H., Mertens, A., Arnold, B. F., Benjamin-Chung, J., … Colford, J. M. (2018). Do Sanitation Improvements Reduce Fecal Contamination of Water, Hands, Food, Soil, and Flies? Evidence from a Cluster-Randomized Controlled Trial in Rural Bangladesh. Environmental Science & Technology, 52(21), 12089–12097.

Fleming, N. H., Grade, M. M., & Bendavid, E. (2018). Impact of primary care provider density on detection and diagnosis of cutaneous melanoma. PLOS ONE, 13(7), e0200097.

Forsyth, J. E., Saiful Islam, M., Parvez, S. M., Raqib, R., Sajjadur Rahman, M., Marie Muehe, E., … Luby, S. P. (2018). Prevalence of elevated blood lead levels among pregnant women and sources of lead exposure in rural Bangladesh: A case control study. Environmental Research, 166, 1–9.

Frank, H. K., Boyd, S. D., & Hadly, E. A. (2018). Global fingerprint of humans on the distribution of Bartonella bacteria in mammals. PLOS Neglected Tropical Diseases, 12(11), e0006865.

Fullman, N., Yearwood, J., Abay, S. M., Abbafati, C., Abd-Allah, F., Abdela, J., … Lozano, R. (2018). Measuring performance on the Healthcare Access and Quality Index for 195 countries and territories and selected subnational locations: a systematic analysis from the Global Burden of Disease Study 2016. Lancet (London, England), 391(10136), 2236–2271.

Gadgil, M. A., Sharker, Y., Unicomb, L., Ram, P. K., & Luby, S. P. (2018). Serial Measurements of Soap Weights and Soap Availability to Describe Handwashing Behavior. The American Journal of Tropical Medicine and Hygiene, 99(4), 899–904.

Hakim, J. G., Chidzonga, M. M., Borok, M. Z., Nathoo, K. J., Matenga, J., Havranek, E., … Campbell, T. B. (2018). Medical Education Partnership Initiative (MEPI) in Zimbabwe: Outcomes and Challenges. Global Health, Science and Practice, 6(1), 82–92.

Harris, A. R., Islam, M. A., Unicomb, L., Boehm, A. B., Luby, S., Davis, J., & Pickering, A. J. (2018). Fecal Contamination on Produce from Wholesale and Retail Food Markets in Dhaka, Bangladesh. The American Journal of Tropical Medicine and Hygiene, 98(1), 287–294.

Hassan, M. Z., Sazzad, H. M. S., Luby, S. P., Sturm-Ramirez, K., Bhuiyan, M. U., Rahman, M. Z., … Gurley, E. S. (2018). Nipah Virus Contamination of Hospital Surfaces during Outbreaks, Bangladesh, 2013-2014. Emerging Infectious Diseases, 24(1), 15–21.

Hazel, A., & Holland Jones, J. (2018). Remoteness influences access to sexual partners and drives patterns of viral sexually transmitted infection prevalence among nomadic pastoralists. PLOS ONE, 13(1), e0191168.

Heath, C. J., LaBeaud, A. D., King, C. H., Malhotra, I., Mukoko, D., Nayakwadi-Singer, M., & Mutuku, F. (2018). Nasopharyngeal Carriage of Streptococcus pneumoniae in Children in Coastal Kenya. The American Journal of Tropical Medicine and Hygiene, 98(4), 1046–1050.

Heath, C. J., Lowther, J., Noël, T. P., Mark-George, I., Boothroyd, D. B., Mitchell, G., … Desiree LaBeaud, A. (2018). The Identification of Risk Factors for Chronic Chikungunya Arthralgia in Grenada, West Indies: A Cross-Sectional Cohort Study. Open Forum Infectious Diseases, 5(1).

Heft-Neal, S., Burney, J., Bendavid, E., & Burke, M. (2018). Robust relationship between air quality and infant mortality in Africa. Nature, 559(7713), 254–258.

Ho, C.-S., Jean, N., Saleh, A., Ermon, S., Banaei, N., & Dionne, J. A. (2018). Rapid bacterial identification based on surface-enhanced Raman scattering and machine learning (Conference Presentation) (Withdrawal Notice). In T. Dai (Ed.), Light-Based Diagnosis and Treatment of Infectious Diseases (Vol. 10479, p. 3). SPIE.

Hodgkinson, L. M., Makori, J., Okwiri, J., Tsisiche, C., Arudo, J., & Barry, M. (2018). Community outreach programs and major adherence lapses with antiretroviral therapy in rural Kakamega, Kenya. AIDS Care, 30(6), 696–700.

Huda, T. M. N., Schmidt, W.-P., Pickering, A. J., Mahmud, Z. H., Islam, M. S., Rahman, M. S., … Biran, A. (2018). A Cross Sectional Study of the Association between Sanitation Type and Fecal Contamination of the Household Environment in Rural Bangladesh. The American Journal of Tropical Medicine and Hygiene, 98(4), 967–976.

Ioannidis, J. P. A. (2018b). Massive citations to misleading methods and research tools: Matthew effect, quotation error and citation copying. European Journal of Epidemiology, 33(11), 1021–1023.

Ioannidis, J. P. A. (2018d). The Challenge of Reforming Nutritional Epidemiologic Research. JAMA, 320(10), 969.

Islam, M., Ercumen, A., Ashraf, S., Rahman, M., Shoab, A. K., Luby, S. P., & Unicomb, L. (2018). Unsafe disposal of feces of children <3 years among households with latrine access in rural Bangladesh: Association with household characteristics, fly presence and child diarrhea. PLOS ONE, 13(4), e0195218.

Jannat, K., Luby, S. P., Unicomb, L., Rahman, M., Winch, P. J., Parvez, S. M., … Stewart, C. P. (2019). Complementary feeding practices among rural Bangladeshi mothers: Results from WASH Benefits study. Maternal & Child Nutrition, 15(1), e12654.

Johnson, L. R., Gramacy, R. B., Cohen, J., Mordecai, E., Murdock, C., Rohr, J., … Weikel, D. (2018). Phenomenological forecasting of disease incidence using heteroskedastic Gaussian processes: A dengue case study. The Annals of Applied Statistics, 12(1), 27–66.

Jones, I., Lund, A., Riveau, G., Jouanard, N., Ndione, R. A., Sokolow, S. H., & De Leo, G. A. (2018). Ecological control of schistosomiasis in Sub-Saharan Africa: restoration of predator-prey dynamics to reduce transmission (Vol. 1). Oxford University Press.

Kelly, J. D., Barrie, M. B., Mesman, A. W., Karku, S., Quiwa, K., Drasher, M., … Richardson, E. T. (2018). Anatomy of a Hotspot: Chain and Seroepidemiology of Ebola Virus Transmission, Sukudu, Sierra Leone, 2015–16. The Journal of Infectious Diseases, 217(8), 1214–1221.

Khalil, I. A., Troeger, C., Blacker, B. F., Rao, P. C., Brown, A., Atherly, D. E., … Reiner, R. C. (2018). Morbidity and mortality due to shigella and enterotoxigenic Escherichia coli diarrhoea: the Global Burden of Disease Study 1990–2016. The Lancet Infectious Diseases, 18(11), 1229–1240.

Khan, S. U., Gurley, E. S., Gerloff, N., Rahman, M. Z., Simpson, N., Rahman, M., … Luby, S. P. (2018). Avian influenza surveillance in domestic waterfowl and environment of live bird markets in Bangladesh, 2007–2012. Scientific Reports, 8(1), 9396.

Lo, N. C., Gupta, R., Stanaway, J. D., Garrett, D. O., Bogoch, I. I., Luby, S. P., & Andrews, J. R. (2018). Comparison of Strategies and Incidence Thresholds for Vi Conjugate Vaccines Against Typhoid Fever: A Cost-effectiveness Modeling Study. The Journal of Infectious Diseases, 218(suppl_4), S232–S242.

Lo, N. C., Gurarie, D., Yoon, N., Coulibaly, J. T., Bendavid, E., Andrews, J. R., & King, C. H. (2018). Impact and cost-effectiveness of snail control to achieve disease control targets for schistosomiasis. Proceedings of the National Academy of Sciences of the United States of America, 115(4), E584–E591.

Lo, N. C., Snyder, J., Addiss, D. G., Heft-Neal, S., Andrews, J. R., & Bendavid, E. (2018). Deworming in pre-school age children: A global empirical analysis of health outcomes. PLOS Neglected Tropical Diseases, 12(5), e0006500.

Lozano, R., Fullman, N., Abate, D., Abay, S. M., Abbafati, C., Abbasi, N., … Murray, C. J. L. (2018). Measuring progress from 1990 to 2017 and projecting attainment to 2030 of the health-related Sustainable Development Goals for 195 countries and territories: a systematic analysis for the Global Burden of Disease Study 2017. The Lancet, 392(10159), 2091–2138.

Luby, S. P. (2018). Urban Slums: A Supportive Ecosystem for Typhoidal Salmonellae. The Journal of Infectious Diseases, 218(suppl_4), S250–S254.

Luby, S. P., Rahman, M., Arnold, B. F., Unicomb, L., Ashraf, S., Winch, P. J., … Colford, J. M. (2018). Effects of water quality, sanitation, handwashing, and nutritional interventions on diarrhoea and child growth in rural Bangladesh: a cluster randomised controlled trial. The Lancet Global Health, 6(3), e302–e315.

McClary, J. S., & Boehm, A. B. (2018). Transcriptional Response of Staphylococcus aureus to Sunlight in Oxic and Anoxic Conditions. Frontiers in Microbiology, 9, 249.

McClary, J. S., Ramos, N. A., & Boehm, A. B. (2019). Photoinactivation of uncultured, indigenous enterococci. Environmental Science: Processes & Impacts, 21(1), 104–112.

McCuskee, S., Garchitorena, A., Miller, A. C., Hall, L., Ouenzar, M. A., Rabeza, V. R., … Bonds, M. H. (2018). Child malnutrition in Ifanadiana district, Madagascar: associated factors and timing of growth faltering ahead of a health system strengthening intervention. Global Health Action, 11(1), 1452357.

Mendes Neto, N. N., da Silva Maia, J. T., Zacarkim, M. R., Queiroz, I., Labeaud, A. D., & Aronoff, D. M. (2018). Perinatal Case Fatality Rate Related to Congenital Zika Syndrome in Brazil: A Cross-Sectional Study. Pediatric Neurology, 81, 47–48.

Naser, A. M., Higgins, E. M., Arman, S., Ercumen, A., Ashraf, S., Das, K. K., … Unicomb, L. (2018). Effect of Groundwater Iron on Residual Chlorine in Water Treated with Sodium Dichloroisocyanurate Tablets in Rural Bangladesh. The American Journal of Tropical Medicine and Hygiene, 98(4), 977–983.

Naziat, H., Saha, S., Islam, M., Saha, S., Uddin, M. J., Hussain, M., … Saha, S. K. (2018). Epidemiology of Otitis Media with Otorrhea Among Bangladeshi Children. The Pediatric Infectious Disease Journal, 1.

Neto, N. N. M., Maia, J., Zacarkim, M. R., Fernandes, K. E., Aronoff, D., Queiroz, I. T., … De Alcantara, T. (2018). 2357. Radiological Findings in Microcephaly Cases During 2015–2016 Zika Outbreak: A Descriptive Study. Open Forum Infectious Diseases, 5(suppl_1), S701–S702.

Neto, N. N. M., Medicine, F., Maia, J., Zacarkim, M. R., Queiroz, I. T., Labeaud, A. D., & Aronoff, D. (2018). 445. Cross-Reactivity Between Zika and Dengue Virus: A Cross-Sectional Analysis in Rio Grande do Norte, Brazil. Open Forum Infectious Diseases, 5(suppl_1), S167–S167.

Null, C., Stewart, C. P., Pickering, A. J., Dentz, H. N., Arnold, B. F., Arnold, C. D., … Colford, J. M. (2018). Effects of water quality, sanitation, handwashing, and nutritional interventions on diarrhoea and child growth in rural Kenya: a cluster-randomised controlled trial. The Lancet Global Health, 6(3), e316–e329.

Nwachukwu, C. R., Mudasiru, O., Million, L., Sheth, S., Qamoos, H., Onah, J. O., … Bhatt, A. S. (2018). Evaluating Barriers and Opportunities in Delivering High-Quality Oncology Care in a Resource-Limited Setting Using a Comprehensive Needs Assessment Tool. Journal of Global Oncology, (4), 1–9.

Openshaw, J. J., Medina, A., Felt, S. A., Li, T., Huan, Z., Rozelle, S., & Luby, S. P. (2018). Prevalence and risk factors for Taenia solium cysticercosis in school-aged children: A school based study in western Sichuan, People's Republic of China. PLOS Neglected Tropical Diseases, 12(5), e0006465.

Parveen, S. N. /A., Gurley, E. S., Sazzad, H. M. S., Sultana, R., Islam, M. S., Knust, B., … Chai, S. J. (2018). Identifying Acceptable and Feasible Infection Control Interventions for Nipah Encephalitis Outbreaks in Bangladesh. American Journal of Infection Control, 46(6), S24.

Parveen, S., Nasreen, S., Allen, J. V., Kamm, K. B., Khan, S., Akter, S., … Ram, P. K. (2018). Barriers to and motivators of handwashing behavior among mothers of neonates in rural Bangladesh. BMC Public Health, 18(1), 483.

Parvez, S. M., Azad, R., Rahman, M., Unicomb, L., Ram, P. K., Naser, A. M., … Luby, S. P. (2018). Achieving optimal technology and behavioral uptake of single and combined interventions of water, sanitation hygiene and nutrition, in an efficacy trial (WASH benefits) in rural Bangladesh. Trials, 19(1), 358.

Paul, R. C., Gidding, H. F., Nazneen, A., Banik, K. C., Sumon, S. A., Paul, K. K., … Hayen, A. (2018). A Low-Cost, Community Knowledge Approach to Estimate Maternal and Jaundice-Associated Mortality in Rural Bangladesh. The American Journal of Tropical Medicine and Hygiene, 99(6), 1633–1638.

Paul, R. C., Rahman, M., Wiesen, E., Patel, M., Banik, K. C., Sharif, A. R., … Mast, E. E. (2018). Hepatitis B Surface Antigen Seroprevalence among Prevaccine and Vaccine Era Children in Bangladesh. The American Journal of Tropical Medicine and Hygiene, 99(3), 764–771.

Pickering, A. J., Ercumen, A., Arnold, B. F., Kwong, L. H., Parvez, S. M., Alam, M., … Luby, S. P. (2018). Fecal Indicator Bacteria along Multiple Environmental Transmission Pathways (Water, Hands, Food, Soil, Flies) and Subsequent Child Diarrhea in Rural Bangladesh. Environmental Science & Technology, 52(14), 7928–7936.

Pitol, A. K., Bischel, H. N., Boehm, A. B., Kohn, T., & Julian, T. R. (2018). Transfer of Enteric Viruses Adenovirus and Coxsackievirus and Bacteriophage MS2 from Liquid to Human Skin. Applied and Environmental Microbiology, 84(22), e01809-18.

Rahman, M., Ashraf, S., Unicomb, L., Mainuddin, A. K. M., Parvez, S. M., Begum, F., … Winch, P. J. (2018). WASH Benefits Bangladesh trial: system for monitoring coverage and quality in an efficacy trial. Trials, 19(1), 360.

Rappoport, N., Toung, J., Hadley, D., Wong, R. J., Fujioka, K., Reuter, J., … Sirota, M. (2018). A genome-wide association study identifies only two ancestry specific variants associated with spontaneous preterm birth. Scientific Reports, 8(1), 226.

Rasella, D., Basu, S., Hone, T., Paes-Sousa, R., Ocké-Reis, C. O., & Millett, C. (2018). Child morbidity and mortality associated with alternative policy responses to the economic crisis in Brazil: A nationwide microsimulation study. PLOS Medicine, 15(5), e1002570.

Rehkopf, D. H., & Basu, S. (2018). A New Tool for Case Studies in Epidemiology—the Synthetic Control Method. Epidemiology, 29(4), 503–505.

Rimi, N. A., Sultana, R., Ishtiak-Ahmed, K., Haider, N., Azziz-Baumgartner, E., Nahar, N., & Luby, S. P. (2018). Where backyard poultry raisers seek care for sick poultry: implications for avian influenza prevention in Bangladesh. BMC Public Health, 18(1), 969.

Saha, S., Tanmoy, A. M., Andrews, J. R., Sajib, M. S. I., Yu, A. T., Baker, S., … Saha, S. K. (2019). Evaluating PCR-Based Detection of Salmonella Typhi and Paratyphi A in the Environment as an Enteric Fever Surveillance Tool. The American Journal of Tropical Medicine and Hygiene, 100(1), 43–46.

Satter, S. M., Gastañaduy, P. A., Haque, W., Mamun, A., Flora, M. S., Zaman, K., … Gurley, E. S. (2018). An update from hospital-based surveillance for rotavirus gastroenteritis among young children in Bangladesh, July 2012 to June 2017. Vaccine, 36(51), 7811–7815.

Satter, S. M., Yen, C., Gastañaduy, P. A., Ahmed, M., Mamun, A., Islam, K., … Gurley, E. S. (2018). Epidemiology of childhood intussusception in Bangladesh: Findings from an active national hospital based surveillance system, 2012–2016. Vaccine, 36(51), 7805–7810.

Schiebinger, L., & Klinge, I. (2018). Gendered Innovation in Health and Medicine (pp. 643–654). Springer, Cham.

Seligman, H. K., & Basu, S. (2018). In an unhealthy food system, what role should SNAP play? PLOS Medicine, 15(10), e1002662.

Singh, U. (2018). Supporting Research Career Development of Physician-Scientists. The Journal of Infectious Diseases, 218(suppl_1), S36–S39.

Singh, U., Levy, J., Armstrong, W., Bedimo, R., Creech, C. B., Lautenbach, E., … Vyas, J. M. (2018). Policy Recommendations for Optimizing the Infectious Diseases Physician-Scientist Workforce. The Journal of Infectious Diseases, 218(suppl_1), S49–S54.

Sokolow, S. H., Wood, C. L., Jones, I. J., Lafferty, K. D., Kuris, A. M., Hsieh, M. H., & De Leo, G. A. (2018). To Reduce the Global Burden of Human Schistosomiasis, Use 'Old Fashioned' Snail Control. Trends in Parasitology, 34(1), 23–40.

Stanaway, J. D., Afshin, A., Gakidou, E., Lim, S. S., Abate, D., Abate, K. H., … Murray, C. J. L. (2018). Global, regional, and national comparative risk assessment of 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks for 195 countries and territories, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. The Lancet, 392(10159), 1923–1994.

Stewart, C. P., Kariger, P., Fernald, L., Pickering, A. J., Arnold, C. D., Arnold, B. F., … Null, C. (2018). Effects of water quality, sanitation, handwashing, and nutritional interventions on child development in rural Kenya (WASH Benefits Kenya): a cluster-randomised controlled trial. The Lancet Child & Adolescent Health, 2(4), 269–280.

Suen, S., Goldhaber-Fiebert, J. D., & Basu, S. (2018). Matching Microsimulation Risk Factor Correlations to Cross-sectional Data: The Shortest Distance Method. Medical Decision Making, 38(4), 452–464.

Sultana, F., Unicomb, L. E., Nizame, F. A., Dutta, N. C., Ram, P. K., Luby, S. P., & Winch, P. J. (2018). Acceptability and Feasibility of Sharing a Soapy Water System for Handwashing in a Low-Income Urban Community in Dhaka, Bangladesh: A Qualitative Study. The American Journal of Tropical Medicine and Hygiene, 99(2), 502–512.

Tang, S. K. Y., & Marshall, W. F. (2018). Cell learning. Current Biology, 28(20), R1180–R1184.

Tofail, F., Fernald, L. C., Das, K. K., Rahman, M., Ahmed, T., Jannat, K. K., … Luby, S. P. (2018). Effect of water quality, sanitation, hand washing, and nutritional interventions on child development in rural Bangladesh (WASH Benefits Bangladesh): a cluster-randomised controlled trial. The Lancet Child & Adolescent Health, 2(4), 255–268.

Unicomb, L., Begum, F., Leontsini, E., Rahman, M., Ashraf, S., Naser, A. M., … Winch, P. J. (2018). WASH Benefits Bangladesh trial: management structure for achieving high coverage in an efficacy trial. Trials, 19(1), 359.

Unicomb, L., Horng, L., Alam, M.-U., Halder, A. K., Shoab, A. K., Ghosh, P. K., … Luby, S. P. (2018). Health-Care Facility Water, Sanitation, and Health-Care Waste Management Basic Service Levels in Bangladesh: Results from a Nation-Wide Survey. The American Journal of Tropical Medicine and Hygiene, 99(4), 916–923.

Vable, A. M., Kiang, M. V, Basu, S., Rudolph, K. E., Kawachi, I., Subramanian, S. V, & Glymour, M. M. (2018). Military Service, Childhood Socio-Economic Status, and Late-Life Lung Function: Korean War Era Military Service Associated with Smaller Disparities. Military Medicine, 183(9–10), e576–e582.

Wagner, Z., Heft-Neal, S., Bhutta, Z. A., Black, R. E., Burke, M., & Bendavid, E. (2018). Armed conflict and child mortality in Africa: a geospatial analysis. The Lancet, 392(10150), 857–865.

Weyant, C., Brandeau, M. L., Burke, M., Lobell, D. B., Bendavid, E., & Basu, S. (2018). Anticipated burden and mitigation of carbon-dioxide-induced nutritional deficiencies and related diseases: A simulation modeling study. PLOS Medicine, 15(7), e1002586.

Wood, C. L., Zgliczynski, B. J., Haupt, A. J., Guerra, A. S., Micheli, F., & Sandin, S. A. (2018). Human impacts decouple a fundamental ecological relationship-The positive association between host diversity and parasite diversity. Global Change Biology, 24(8), 3666–3679.

Yu, A. T., Amin, N., Rahman, M. W., Gurley, E. S., Rahman, K. M., & Luby, S. P. (2018). Case-Fatality Ratio of Blood Culture–Confirmed Typhoid Fever in Dhaka, Bangladesh. The Journal of Infectious Diseases, 218(suppl_4), S222–S226.

Yu, Y. J., Mccarty, C., & Jones, J. H. (2018). Flexible Labors: The Work Mobility of Female Sex Workers (FSWs) in Post-Socialist China. Human Organization (Vol. 77).

SUSTAINABILITY

Andre, J., Kiremidjian, A., & Georgakis, C. T. (2018). Statistical Modeling of Time Series for Ice Accretion Detection on Bridge Cables. Journal of Cold Regions Engineering, 32(2), 04018004.

Ansari, F., Ding, Y., Berglund, L. A., & Dauskardt, R. H. (2018). Toward Sustainable Multifunctional Coatings Containing Nanocellulose in a Hybrid Glass Matrix. ACS Nano, 12(6), 5495–5503.

Ardoin, N. M., Bowers, A. W., Roth, N. W., & Holthuis, N. (2018). Environmental education and K-12 student outcomes: A review and analysis of research. The Journal of Environmental Education, 49(1), 1–17.

Baik, E., Sanchez, D. L., Turner, P. A., Mach, K. J., Field, C. B., & Benson, S. M. (2018). Geospatial analysis of near-term potential for carbon-negative bioenergy in the United States. Proceedings of the National Academy of Sciences of the United States of America, 115(13), 3290–3295.

Bailenson, J. (2019). Experience on Demand: what virtual reality is, how it works, and what it can do. W W Norton.

Balafas, K., Kiremidjian, A. S., & Rajagopal, R. (2018). The wavelet transform as a Gaussian process for damage detection. Structural Control and Health Monitoring, 25(2), e2087.

Banerjee, S., Gnanamani, E., Lynch, S. R., Zuñiga, F. Z., Jiménez-Vargas, J. M., Possani, L. D., & Zare, R. N. (2018). An Alkaloid from Scorpion Venom: Chemical Structure and Synthesis. Journal of Natural Products, 81(8), 1899–1904.

Belisle, R. A., Bush, K. A., Bertoluzzi, L., Gold-Parker, A., Toney, M. F., & McGehee, M. D. (2018). Impact of Surfaces on Photoinduced Halide Segregation in Mixed-Halide Perovskites. ACS Energy Letters, 3(11), 2694–2700.

Benjamin, D. J., Berger, J. O., Johannesson, M., Nosek, B. A., Wagenmakers, E.-J., Berk, R., … Johnson, V. E. (2018). Redefine statistical significance. Nature Human Behaviour, 2(1), 6–10.

Bertoluzzi, L., Belisle, R. A., Bush, K. A., Cheacharoen, R., McGehee, M. D., & O'Regan, B. C. (2018). In Situ Measurement of Electric-Field Screening in Hysteresis-Free PTAA/FA 0.83 Cs 0.17 Pb(I 0.83 Br 0.17) 3 /C60 Perovskite Solar Cells Gives an Ion Mobility of □3 × 10 −7 cm 2 /(V s), 2 Orders of Magnitude Faster than Reported for Metal-Oxide-Contacted Perovskite Cells with Hysteresis. Journal of the American Chemical Society, 140(40), 12775–12784. https://doi.org/10.1021/jacs.8b04405

Bolorinos, J., Ajami, N. K., Muñoz Meléndez, G., & Jackson, R. B. (2018). Evaluating Environmental Governance along Cross-Border Electricity Supply Chains with Policy-Informed Life Cycle Assessment: The California–Mexico Energy Exchange. Environmental Science & Technology, 52(9), 5048–5061.

Boutry, C. M., Kaizawa, Y., Schroeder, B. C., Chortos, A., Legrand, A., Wang, Z., … Bao, Z. (2018). A stretchable and biodegradable strain and pressure sensor for orthopaedic application. Nature Electronics, 1(5), 314–321.

Bowring, A. R., Bertoluzzi, L., O'Regan, B. C., & McGehee, M. D. (2018). Reverse Bias Behavior of Halide Perovskite Solar Cells. Advanced Energy Materials, 8(8), 1702365.

Boyd, C. C., Cheacharoen, R., Bush, K. A., Prasanna, R., Leijtens, T., & McGehee, M. D. (2018). Barrier Design to Prevent Metal-Induced Degradation and Improve Thermal Stability in Perovskite Solar Cells. ACS Energy Letters, 3(7), 1772–1778.

Boyd, C. C., Cheacharoen, R., Leijtens, T., & McGehee, M. D. (2018). Understanding Degradation Mechanisms and Improving Stability of Perovskite Photovoltaics. Chemical Reviews, acs.chemrev.8b00336.

Boyd, C., Cheacharoen, R., Bush, K. A., Prasanna, R., Leijtens, T., & McGehee, M. D. (2018). Reducing permeability of indium tin oxide contacts to improve thermal stability in perovskite solar cells (Conference Presentation). In J. N. Munday, P. Bermel, & M. D. Kempe (Eds.), New Concepts in Solar and Thermal Radiation Conversion and Reliability (Vol. 10759, p. 10). SPIE.

Brandon, A. M., Gao, S.-H., Tian, R., Ning, D., Yang, S.-S., Zhou, J., … Criddle, C. S. (2018). Biodegradation of Polyethylene and Plastic Mixtures in Mealworms (Larvae of Tenebrio molitor) and Effects on the Gut Microbiome. Environmental Science & Technology, 52(11), 6526–6533.

Brodrick, P. G., Brandt, A. R., & Durlofsky, L. J. (2018). Optimal design and operation of integrated solar combined cycles under emissions intensity constraints. Applied Energy, 226, 979–990.

Browning, M. H. E. M., Stern, M. J., Ardoin, N. M., & Heimlich, J. E. (2018). Factors that contribute to community members' support of local nature centers. Environmental Education Research, 24(3), 326–342.

Burke, M., Bergquist, L. F., & Miguel, E. (2018). Sell Low and Buy High: Arbitrage and Local Price Effects in Kenyan Markets. Cambridge, MA.

Bush, K. A., Frohna, K., Prasanna, R., Beal, R. E., Leijtens, T., Swifter, S. A., & McGehee, M. D. (2018). Compositional Engineering for Efficient Wide Band Gap Perovskites with Improved Stability to Photoinduced Phase Segregation. ACS Energy Letters, 3(2), 428–435.

Bush, K. A., Manzoor, S., Frohna, K., Yu, Z. J., Raiford, J. A., Palmstrom, A. F., … McGehee, M. D. (2018). Minimizing Current and Voltage Losses to Reach 25% Efficient Monolithic Two-Terminal Perovskite–Silicon Tandem Solar Cells. ACS Energy Letters, 3(9), 2173–2180.

Bush, K. A., Palmstrom, A. F., Yu, Z. J., Frohna, K., Manzoor, S., Ali, A., … McGehee, M. D. (2018). Optical and Compositional Engineering of Wide Band Gap Perovskites with Improved Stability to Photoinduced Phase Segregation for Efficient Monolithic Perovskite/Silicon Tandem Solar Cells. In 2018 IEEE 7th World Conference on Photovoltaic Energy Conversion (WCPEC) (pp. 0157-3). IEEE.

Bush, K. A., Rolston, N., Gold-Parker, A., Manzoor, S., Hausele, J., Yu, Z. J., … McGehee, M. D. (2018). Controlling Thin-Film Stress and Wrinkling during Perovskite Film Formation. ACS Energy Letters, 3(6), 1225–1232.

Ceferino, L., Kiremidjian, A., & Deierlein, G. (2018a). Probabilistic Model for Regional Multiseverity Casualty Estimation due to Building Damage Following an Earthquake. ASCE-ASME Journal of Risk and Uncertainty in Engineering Systems, Part A: Civil Engineering, 4(3), 04018023.

Ceferino, L., Kiremidjian, A., & Deierlein, G. (2018b). Regional Multiseverity Casualty Estimation Due to Building Damage Following a Mw 8.8 Earthquake Scenario in Lima, Peru. Earthquake Spectra, 34(4), 1739–1761.

Cheacharoen, R., Boyd, C. C., Burkhard, G. F., Leijtens, T., Raiford, J. A., Bush, K. A., … McGehee, M. D. (2018). Encapsulating perovskite solar cells to withstand damp heat and thermal cycling. Sustainable Energy & Fuels, 2(11), 2398–2406.

Cheacharoen, R., Bush, K. A., Rolston, N., Harwood, D., Dauskardt, R. H., & McGehee, M. D. (2018). Damp Heat, Temperature Cycling and UV Stress Testing of Encapsulated Perovskite Photovoltaic Cells. In 2018 IEEE 7th World Conference on Photovoltaic Energy Conversion (WCPEC) (pp. 3498–3502). IEEE.

Cheacharoen, R., Rolston, N., Harwood, D., Bush, K. A., Dauskardt, R. H., & McGehee, M. D. (2018). Design and understanding of encapsulated perovskite solar cells to withstand temperature cycling. Energy & Environmental Science, 11(1), 144–150.

Closser, R. G., Bergsman, D. S., & Bent, S. F. (2018). Molecular Layer Deposition of a Highly Stable Silicon Oxycarbide Thin Film Using an Organic Chlorosilane and Water. ACS Applied Materials & Interfaces, 10(28), 24266–24274.

Cohen, M. A., Cui, S., Ernst, R., Huchzermeier, A., Kouvelis, P., Lee, H. L., … Tsay, A. A. (2018). OM Forum—Benchmarking Global Production Sourcing Decisions: Where and Why Firms Offshore and Reshore. Manufacturing & Service Operations Management, 20(3), 389–402.

Cruz, A. R., Selby, S. T., & Durham, W. H. (2018). Place-based education for environmental behavior: a 'funds of knowledge' and social capital approach. Environmental Education Research, 24(5), 627–647.

Davis, S. J., Lewis, N. S., Shaner, M., Aggarwal, S., Arent, D., Azevedo, I. L., … Caldeira, K. (2018). Net-zero emissions energy systems. Science, 360(6396), eaas9793.

de Zegher, J. F., Iancu, D. A., & Plambeck, E. (2018). Sustaining Rainforests and Smallholders by Eliminating Payment Delay in a Commodity Supply Chain--It Takes a Village. Working Paper No. 3684. Operations, Information & Technology

Dustin, M. K., Bargar, J. R., Jew, A. D., Harrison, A. L., Joe-Wong, C., Thomas, D. L., … Maher, K. (2018). Shale Kerogen: Hydraulic Fracturing Fluid Interactions and Contaminant Release. Energy & Fuels, 32(9), 8966–8977.

Ehrlich, P., Harte, J., Ehrlich, P. R., & Harte, J. (2018). Pessimism on the Food Front. Sustainability, 10(4), 1120.

Feng, D., Lei, T., Lukatskaya, M. R., Park, J., Huang, Z., Lee, M., … Bao, Z. (2018). Robust and conductive two-dimensional metal□organic frameworks with exceptionally high volumetric and areal capacitance. Nature Energy, 3(1), 30–36.

Ghaisas, N. S., Ghate, A. S., & Lele, S. K. (2018). Large-eddy simulation study of multi-rotor wind turbines. Journal of Physics: Conference Series, 1037(7), 072021.

Gould, R. K., Ardoin, N. M., Thomsen, J. M., & Wyman Roth, N. (2018). Exploring connections between environmental learning and behavior through four everyday-life case studies. Environmental Education Research, 1–27.

Gould, R. K., Krymkowski, D. H., & Ardoin, N. M. (2018). The importance of culture in predicting environmental behavior in middle school students on Hawai□i Island. PLOS ONE, 13(11), e0207087.

Gould, R. K., Phukan, I., Mendoza, M. E., Ardoin, N. M., & Panikkar, B. (2018). Seizing opportunities to diversify conservation. Conservation Letters, 11(4), e12431.

Guzelturk, B., Belisle, R. A., Smith, M. D., Bruening, K., Prasanna, R., Yuan, Y., … Lindenberg, A. M. (2018a). Terahertz Emission: Terahertz Emission from Hybrid Perovskites Driven by Ultrafast Charge Separation and Strong Electron-Phonon Coupling (Adv. Mater. 11/2018). Advanced Materials, 30(11), 1870079.

Guzelturk, B., Belisle, R. A., Smith, M. D., Bruening, K., Prasanna, R., Yuan, Y., … Lindenberg, A. M. (2018b). Terahertz Emission from Hybrid Perovskites Driven by Ultrafast Charge Separation and Strong Electron-Phonon Coupling. Advanced Materials, 30(11), 1704737.

Hadly, E. A. (2018). Making America great again requires acting on scientific knowledge. PLOS Biology, 16(2), e2004337.

Hall, D. M., Algiers, A., & Levitt, R. E. (2018). Identifying the Role of Supply Chain Integration Practices in the Adoption of Systemic Innovations. Journal of Management in Engineering, 34(6), 04018030.

Herrera, F., Bailenson, J., Weisz, E., Ogle, E., & Zaki, J. (2018). Building long-term empathy: A large-scale comparison of traditional and virtual reality perspective-taking. PLOS ONE, 13(10), e0204494.

Hezaveh, S. H., Bou-Zeid, E., Dabiri, J., Kinzel, M., Cortina, G., & Martinelli, L. (2018). Increasing the Power Production of Vertical-Axis Wind-Turbine Farms Using Synergistic Clustering. Boundary-Layer Meteorology, 169(2), 275–296.

Hino, M., Benami, E., & Brooks, N. (2018). Machine learning for environmental monitoring. Nature Sustainability, 1(10), 583–588.

Holmberg, P., & Wolak, F. A. (2018). Comparing auction designs where suppliers have uncertain costs and uncertain pivotal status. The RAND Journal of Economics, 49(4), 995–1027.

Howland, M. F., Ghate, A. S., & Lele, S. K. (2018). Influence of the horizontal component of Earth's rotation on wind turbine wakes. Journal of Physics: Conference Series, 1037(7), 072003.

Hoye, R. L. Z., Bush, K. A., Oviedo, F., Sofia, S. E., Thway, M., Li, X., … Buonassisi, T. (2018). Developing a Robust Recombination Contact to Realize Monolithic Perovskite Tandems With Industrially Common p-Type Silicon Solar Cells. IEEE Journal of Photovoltaics, 8(4), 1023–1028.

Hui, I., Cain, B. E., & Dabiri, J. O. (2018). Public receptiveness of vertical axis wind turbines. Energy Policy, 112, 258–271.

Ioannidis, J. P. A. (2018a). All science should inform policy and regulation. PLOS Medicine, 15(5), e1002576.

Ioannidis, J. P. A. (2018c). Meta-research: Why research on research matters. PLOS Biology, 16(3), e2005468.

Jacobson, M. Z., & Delucchi, M. A. (2018). 100% clean, renewable energy studies provide scientific solution that policymakers can rely on. The Electricity Journal, 31(2), 78–80.

Jacobson, M. Z., & Jadhav, V. (2018). World estimates of PV optimal tilt angles and ratios of sunlight incident upon tilted and tracked PV panels relative to horizontal panels. Solar Energy, 169, 55–66.

Jacobson, M. Z., Cameron, M. A., Hennessy, E. M., Petkov, I., Meyer, C. B., Gambhir, T. K., … Delucchi, M. A. (2018). 100% clean and renewable Wind, Water, and Sunlight (WWS) all-sector energy roadmaps for 53 towns and cities in North America. Sustainable Cities and Society, 42, 22–37.

Jacobson, M. Z., Delucchi, M. A., Cameron, M. A., & Mathiesen, B. V. (2018). Matching demand with supply at low cost in 139 countries among 20 world regions with 100% intermittent wind, water, and sunlight (WWS) for all purposes. Renewable Energy, 123, 236–248.

Jacobson, M. Z., Nghiem, S. V., & Sorichetta, A. (2018). Short-Term Impacts of the Mega-Urbanizations of New Delhi and Los Angeles between 2000 and 2009. Journal of Geophysical Research: Atmospheres, 124(1), 2018JD029310.

Jew, A. D., Li, Q., Cercone, D., Maher, K., Brown Jr., G. E., & Bargar, J. R. (2018). Barium Sources in Hydraulic Fracturing Systems and Chemical Controls on its Release into Solution. In Proceedings of the 6th Unconventional Resources Technology Conference. Tulsa, OK, USA: American Association of Petroleum Geologists.

Johansen, J. M., Jensen, P. A., Glarborg, P., De Martini, N., Ek, P., & Mitchell, R. E. (2018). High Heating Rate Devolatilization Kinetics of Pulverized Biomass Fuels. Energy & Fuels, 32(12), 12955–12961.

Johnson, D. U., Mitchell, R. E., & Gür, T. M. (2018). Insights into Sulfur Uptake by Solid Sorbents from Fossil Fuels and Biomass: Revisiting C–H–O Ternary Diagrams. Energy & Fuels, 32(12), 12066–12080.

Katila, R., Levitt, R. E., & Sheffer, D. (2018). Systemic Innovation of Complex One-off Products: The Case of Green Buildings (pp. 299–328).

Kim, Y., Chortos, A., Xu, W., Liu, Y., Oh, J. Y., Son, D., … Lee, T.-W. (2018). A bioinspired flexible organic artificial afferent nerve. Science (New York, N.Y.), 360(6392), 998–1003.

Kurosawa, T., Gu, X., Gu, K. L., Zhou, Y., Yan, H., Wang, C., … Bao, Z. (2018). Understanding the Impact of Oligomeric Polystyrene Side Chain Arrangement on the All-Polymer Solar Cell Performance. Advanced Energy Materials, 8(2), 1701552.

Lambin, E. F., & Thorlakson, T. (2018). Sustainability Standards: Interactions Between Private Actors, Civil Society, and Governments. Annual Review of Environment and Resources, 43(1), 369–393.

Lambin, E. F., Gibbs, H. K., Heilmayr, R., Carlson, K. M., Fleck, L. C., Garrett, R. D., … Walker, N. F. (2018). The role of supply-chain initiatives in reducing deforestation. Nature Climate Change, 8(2), 109–116.

Lee, H. L. (2018). Big Data and the Innovation Cycle. Production and Operations Management, 27(9), 1642–1646.

Leijtens, T., Bush, K. A., Prasanna, R., & McGehee, M. D. (2018). Opportunities and challenges for tandem solar cells using metal halide perovskite semiconductors. Nature Energy, 3(10), 828–838.

Leijtens, T., Prasanna, R., Bush, K. A., Eperon, G. E., Raiford, J. A., Gold-Parker, A., … McGehee, M. D. (2018). Tin–lead halide perovskites with improved thermal and air stability for efficient all-perovskite tandem solar cells. Sustainable Energy & Fuels, 2(11), 2450–2459.

Lemos, M. C., Arnott, J. C., Ardoin, N. M., Baja, K., Bednarek, A. T., Dewulf, A., … Wyborn, C. (2018). To co-produce or not to co-produce. Nature Sustainability, 1(12), 722–724.

Li, B., Wu, W.-M., Watson, D. B., Cardenas, E., Chao, Y., Phillips, D. H., … Zhang, T. (2018). Bacterial Community Shift and Coexisting/Coexcluding Patterns Revealed by Network Analysis in a Uranium-Contaminated Site after Bioreduction Followed by Reoxidation. Applied and Environmental Microbiology, 84(9), e02885-17.

Li, P.-N., Herrmann, J., Tolar, B. B., Poitevin, F., Ramdasi, R., Bargar, J. R., … van den Bedem, H. (2018). Nutrient transport suggests an evolutionary basis for charged archaeal surface layer proteins. The ISME Journal, 12(10), 2389–2402.

Li, R. J., Gutierrez, J., Chung, Y.-L., Frank, C. W., Billington, S. L., & Sattely, E. S. (2018). A lignin-epoxy resin derived from biomass as an alternative to formaldehyde-based wood adhesives. Green Chemistry, 20(7), 1459–1466.

Liao, Y., Kiremidjian, A. S., Rajagopal, R., & Loh, C.-H. (2019). Structural Damage Detection and Localization with Unknown Postdamage Feature Distribution Using Sequential Change-Point Detection Method. Journal of Aerospace Engineering, 32(2), 04018149.

Lincoln, N., Rossen, J., Vitousek, P., Kahoonei, J., Shapiro, D., Kalawe, K., … Meheula, K. (2018). Restoration of ʻAina Maloʻo on Hawaiʻi Island: Expanding Biocultural Relationships. Sustainability, 10(11), 3985.

Lukatskaya, M. R., Feldblyum, J. I., Mackanic, D. G., Lissel, F., Michels, D. L., Cui, Y., & Bao, Z. (2018). Concentrated mixed cation acetate "water-in-salt" solutions as green and low-cost high voltage electrolytes for aqueous batteries. Energy & Environmental Science, 11(10), 2876–2883.

Manzoor, S., Häusele, J., Bush, K. A., Palmstrom, A. F., Carpenter, J., Yu, Z. J., … Holman, Z. C. (2018). Optical modeling of wide-bandgap perovskite and perovskite/silicon tandem solar cells using complex refractive indices for arbitrary-bandgap perovskite absorbers. Optics Express, 26(21), 27441.

Manzoor, S., Hausele, J., Bush, K. A., Yu, Z. J., McGehee, M. D., & C.Holman, Z. (2018). Current-matching in two-terminal perovskite/silicon tandems employing wide-bandgap perovskites and varying light-management schemes. In 2018 IEEE 7th World Conference on Photovoltaic Energy Conversion (WCPEC) (pp. 0220–0223). IEEE.

Miller, M. A., Duvvuri, S., Brownstein, I., Lee, M., Dabiri, J. O., & Hultmark, M. (2018). Vertical-axis wind turbine experiments at full dynamic similarity. Journal of Fluid Mechanics, 844, 707–720.

Mundhaas, N., Yu, Z. J., Bush, K. A., Wang, H.-P., McGehee, M., & Holman, Z. C. (2018). Illumination-Dependent Series Resistance in Perovskite Solar Cells Revealed by Jsc]]>-V. In 2018 IEEE 7th World Conference on Photovoltaic Energy Conversion (WCPEC) (pp. 2266–2269). IEEE.

Nielsen, M. W., Bloch, C. W., & Schiebinger, L. (2018). Making gender diversity work for scientific discovery and innovation. Nature Human Behaviour, 2(10), 726–734.

Norbeck, J. H., & Horne, R. N. (2018). Maximum magnitude of injection-induced earthquakes: A criterion to assess the influence of pressure migration along faults. Tectonophysics, 733, 108–118.

Palmstrom, A. F., Raiford, J. A., Prasanna, R., Bush, K. A., Sponseller, M., Cheacharoen, R., … Bent, S. F. (2018). Interfacial Effects of Tin Oxide Atomic Layer Deposition in Metal Halide Perovskite Photovoltaics. Advanced Energy Materials, 8(23), 1800591.

Plambeck, E. L., & Taylor, T. A. (2018). Testing by Competitors in Enforcement of Product Standards. Management Science, mnsc.2017.3023.

Poletayev, A. D., McKay, I. S., Chueh, W. C., & Majumdar, A. (2018). Continuous electrochemical heat engines. Energy & Environmental Science, 11(10), 2964–2971.

Prasanna, R., Leijtens, T., Gold-Parker, A., Conings, B., Babayigit, A., Boyen, H.-G., … McGehee, M. D. (2018). Compositional engineering of tin-lead halide perovskites for efficient and stable low band gap solar cells. In 2018 IEEE 7th World Conference on Photovoltaic Energy Conversion (WCPEC) (pp. 1718–1720). IEEE.

Reineman, D. R., & Ardoin, N. M. (2018). Sustainable tourism and the management of nearshore coastal places: place attachment and disruption to surf-spots. Journal of Sustainable Tourism, 26(2), 325–340.

Rolston, N., Bush, K. A., Printz, A. D., Gold-Parker, A., Ding, Y., Toney, M. F., … Dauskardt, R. H. (2018). Engineering Stress in Perovskite Solar Cells to Improve Stability. Advanced Energy Materials, 8(29), 1802139.

Rolston, N., Printz, A. D., Tracy, J. M., Weerasinghe, H. C., Vak, D., Haur, L. J., … Dauskardt, R. H. (2018). Effect of Cation Composition on the Mechanical Stability of Perovskite Solar Cells. Advanced Energy Materials, 8(9), 1702116.

Rong, Y., Hu, Y., Mei, A., Tan, H., Saidaminov, M. I., Seok, S. Il, … Han, H. (2018). Challenges for commercializing perovskite solar cells. Science, 361(6408), eaat8235.

Salanie, B., & Wolak, F. (2018, October 1). Fast, "Robust", and Approximately Correct: Estimating Mixed Demand Systems. CEPR Discussion Papers 13236, C.E.P.R. Discussion Papers.

Sanchez, D. L., Amador, G., Funk, J., & Mach, K. J. (2018). Federal research, development, and demonstration priorities for carbon dioxide removal in the United States. Environmental Research Letters, 13(1), 015005.

Sevlian, R. A., Zhao, Y., Rajagopal, R., Goldsmith, A., & Poor, H. V. (2018). Outage Detection Using Load and Line Flow Measurements in Power Distribution Systems. IEEE Transactions on Power Systems, 33(2), 2053–2069.

South, A., Eriksson, K., & Levitt, R. (2018). How Infrastructure Public–Private Partnership Projects Change Over Project Development Phases. Project Management Journal, 49(4), 62–80.

Stern, M. J., Frensley, B. T., Powell, R. B., & Ardoin, N. M. (2018). What difference do role models make? Investigating outcomes at a residential environmental education center. Environmental Education Research, 24(6), 818–830.

Stojanovski, O., Leslie, G., Wolak, F. A., Huerta Wong, J. E., & Thurber, M. C. (2018). Promoting Energy Efficiency in Emerging Economies Through Consumer Education: Results From a Field Experiment in Mexico. SSRN Electronic Journal.

Stojanovski, O., Thurber, M. C., Wolak, F. A., Muwowo, G., & Harrison, K. (2018). Assessing Opportunities for Solar Lanterns to Improve Educational Outcomes in Rural Off-Grid Regions: Challenges and Lessons from a Randomized Controlled Trial. SSRN Electronic Journal.

Stone, K. H., Gold-Parker, A., Pool, V. L., Unger, E. L., Bowring, A. R., McGehee, M. D., … Tassone, C. J. (2018). Transformation from crystalline precursor to perovskite in PbCl2-derived MAPbI3. Nature Communications, 9(1), 3458.

Strand, M. T., Barile, C. J., Hernandez, T. S., Dayrit, T. E., Bertoluzzi, L., Slotcavage, D. J., & McGehee, M. D. (2018). Factors that Determine the Length Scale for Uniform Tinting in Dynamic Windows Based on Reversible Metal Electrodeposition. ACS Energy Letters, 3(11), 2823–2828.

Suckale, J., Saiyed, Z., Hilley, G., Alvisyahrin, T., Muhari, A., Zoback, M. Lou, & Truebe, S. (2018). Adding a community partner to service learning may elevate learning but not necessarily service. International Journal of Disaster Risk Reduction, 28, 80–87.

Sun, Y., Szücs, G., & Brandt, A. R. (2018). Solar PV output prediction from video streams using convolutional neural networks. Energy & Environmental Science, 11(7), 1811–1818.

Sutton-Grier, A. E., Gittman, R. K., Arkema, K. K., Bennett, R. O., Benoit, J., Blitch, S., … Grabowski, J. H. (2018). Investing in Natural and Nature-Based Infrastructure: Building Better Along Our Coasts. Sustainability, 10(2), 523.

Tan, W., Bowring, A. R., Meng, A. C., McGehee, M. D., & McIntyre, P. C. (2018). Thermal Stability of Mixed Cation Metal Halide Perovskites in Air. ACS Applied Materials & Interfaces, 10(6), 5485–5491.

Tan, W., Hendricks, O. L., Meng, A. C., Braun, M. R., McGehee, M. D., Chidsey, C. E. D., & McIntyre, P. C. (2018). Atomic Layer Deposited TiO 2 -IrO x Alloy as a Hole Transport Material for Perovskite Solar Cells. Advanced Materials Interfaces, 5(16), 1800191.

Teichgraeber, H., & Brandt, A. R. (2018). Systematic Comparison of Aggregation Methods for Input Data Time Series Aggregation of Energy Systems Optimization Problems. Computer Aided Chemical Engineering, 44, 955–960.

Thorlakson, T., de Zegher, J. F., & Lambin, E. F. (2018). Companies' contribution to sustainability through global supply chains. Proceedings of the National Academy of Sciences of the United States of America, 115(9), 2072–2077.

Troutman, V. A., & Dabiri, J. O. (2018). Single-camera three-dimensional tracking of natural particulate and zooplankton. Measurement Science and Technology, 29(7), 075401.

van Loon, A., Bailenson, J., Zaki, J., Bostick, J., & Willer, R. (2018). Virtual reality perspective-taking increases cognitive empathy for specific others. PLOS ONE, 13(8), e0202442.

Vilhelmsen, T. N., Maher, K., Da Silva, C., Hermans, T., Grujic, O., Park, J., & Yang, G. (2018a). Quantifying Uncertainty in Subsurface Systems (pp. 217–262). American Geophysical Union (AGU).

Vilhelmsen, T. N., Maher, K., Da Silva, C., Hermans, T., Grujic, O., Park, J., & Yang, G. (2018b). The Earth Resources Challenge (pp. 1–27). American Geophysical Union (AGU).

Wang, K., Ellsworth, W. L., Beroza, G. C., Williams, G., Zhang, M., Schroeder, D., & Rubinstein, J. (2018). Seismology with Dark Data: Image-Based Processing of Analog Records Using Machine Learning for the Rangely Earthquake Control Experiment. Seismological Research Letters.

Waymouth, R. M. (2018). Enabling Catalytic Strategies for Biomass Conversion. Argonne, IL (United States). Final Technical Report 2018: DOE DE-SC0005430

Williams, L. M., Pines, A., Goldstein-Piekarski, A. N., Rosas, L. G., Kullar, M., Sacchet, M. D., … Ma, J. (2018). The ENGAGE study: Integrating neuroimaging, virtual reality and smartphone sensing to understand self-regulation for managing depression and obesity in a precision medicine model. Behaviour Research and Therapy, 101, 58–70.

Wolak, F. (2018). The Evidence from California on the Economic Impact of Inefficient Distribution Network Pricing. NBER Working Paper No. 25087.

Xue, M., Islam, R., Chen, Y., Chen, J., Lu, C.-Y., Mitchell Pleus, A., … Harris, J. S. (2018). Carrier-selective interlayer materials for silicon solar cell contacts. Journal of Applied Physics, 123(14), 143101.

Xue, M., Islam, R., Chen, Y., Lu, C.-Y., Lyu, Z., Zang, K., … Harris, J. (2018). Investigation of Nickel Oxide as Carrier-selective Interlayer for Silicon Solar Cell Contacts. In 2018 IEEE 7th World Conference on Photovoltaic Energy Conversion (WCPEC) (pp. 2180–2182). IEEE.

Yang, S.-S., Brandon, A. M., Andrew Flanagan, J. C., Yang, J., Ning, D., Cai, S.-Y., … Wu, W.-M. (2018). Biodegradation of polystyrene wastes in yellow mealworms (larvae of Tenebrio molitor Linnaeus): Factors affecting biodegradation rates and the ability of polystyrene-fed larvae to complete their life cycle. Chemosphere, 191, 979–989.

Yang, S.-S., Wu, W.-M., Brandon, A. M., Fan, H.-Q., Receveur, J. P., Li, Y., … Criddle, C. S. (2018). Ubiquity of polystyrene digestion and biodegradation within yellow mealworms, larvae of Tenebrio molitor Linnaeus (Coleoptera: Tenebrionidae). Chemosphere, 212, 262–271.

Zhai, S., Rojas, J., Ahlborg, N., Lim, K., Toney, M. F., Jin, H., … Majumdar, A. (2018). The use of poly-cation oxides to lower the temperature of two-step thermochemical water splitting. Energy & Environmental Science, 11(8), 2172–2178.

Zhang, Z., Hamledari, H., Billington, S., & Fischer, M. (2018). 4D beyond construction: spatio-temporal and life-cyclic modeling and visualization of infrastructure data. Journal of Information Technology in Construction, 23(14), 285–304.

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