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Fighting for the Future

Activists and scholars debate the role of social movements in climate change

By Jonathan Mingle



The world is on track to experience an average increase in air temperature of four to six degrees Celsius over pre-industrial levels, according to recent analysis by the International Energy Agency. Such warming would pose severe threats to human society: displacement by rising seas of millions of people who live along vulnerable coastlines; increasing frequency and intensity of storms; diminished agricultural harvests; declines in biodiversity; desertification; and more severe droughts and floods, among its effects.

Carbon-capping legislation, which most climate experts and economists say will be necessary (if not sufficient) if we are to

avert the most dire scenarios, and which stalled in Congress in 2010—is unlikely to be revived soon. But the political fight is just beginning.

Harvard faculty, students, and alumni are actively considering how the climate change issue will move forward. Many do this through their scholarship and teaching, but some are getting more involved, from shaping climate policy inside the White House to engaging in civil disobedience outside its front gate. Their work confronts a wide range of questions. What is the role of social movements in addressing a challenge as complex and daunting as climate change? What kinds

of specific actions will be effective in swaying decision-makers, polluters and the public? What mix of tactics, targets and articulated goals are most likely to break political gridlock on the issue, and make a real difference in everyone's stated goal: dramatically reducing emissions of carbon dioxide and other greenhouse pollutants? And most importantly, what should be the goal of activism? That question is at the center of an impending battle for the heart and soul of the environmental movement.

Morality as Motivation

On the climate issue, the problem is that “urgency is not felt by many people,” says

Marshall Ganz, a senior lecturer at Harvard Kennedy School. “But one thing that movements do is come up with ways to make the important urgent.”

Ganz speaks from experience. He left Harvard during his junior year to work with the civil rights movement in Mississippi in 1964. He went on to work with Cesar Chavez and the United Farm Workers for 16 years, before eventually returning to Harvard to complete a Ph.D. in sociology. One of the lessons he draws from his decades working in and studying social movements is that moral urgency—a sense of injustice, or even anger—is often needed to move individuals to act.

This is often accompanied by hope, or the sense of the plausible, the possible. Action of this kind may produce change in the participants themselves, as well as in the world around them.

“If you look at the core of any social movement there are highly committed people who are ready to take risks,” he says. “It’s not just about passing a law—at heart they are movements of *moral* reform. Take the Harvard living wage campaign back in 2001, when the students sat in the president’s office and said, ‘We’re not going to leave until it gets dealt with.’” This had the effect of turning what the students saw as a morally urgent problem into a

practically urgent problem for decision-makers to resolve.

“How to make that cosmic sense of urgency immediately felt is one of the challenges of this (climate) movement,” Ganz continues. “That’s where civil disobedience and that kind of activity comes in—it’s a way of saying we’re not going to cooperate until you address this need.”

Ganz met recently with a group of law school students seeking advice on the campaign to press Harvard’s administration to divest from fossil fuel companies. He says he supports the students’ efforts on the merits of their moral argument, but also as a means to stir up and “mobilize the kind

Letter from the Director

Dear Friends:

As another academic year draws to a close, I am delighted to share with you this new edition of our Newsletter. The Harvard environmental community continues to grow, with colleagues from around the University coming together to address some of society’s greatest challenges. Last fall, on the 50th anniversary of the publication of Rachel Carson’s *Silent Spring*, we brought together a group of scholars and environmental leaders to consider Carson’s impact, and how her work might inform our own as we ponder the path forward on current environmental challenges. The overwhelming support for landmark legislation such as the Clean Air Act of 1970, for which many people credit the effectiveness of Carson’s prose

in mobilizing public opinion, seems almost unimaginable today in this time of partisanship and political gridlock. And yet there are signs of progress. For the first time in many years, there has been student-led environmental activism on campus. In our cover article, Jonathan Mingle explores this

burst of activism focused on divestment from fossil fuel companies, and the question of how social movements fit into the broad array of efforts to accelerate action on climate change. From my perspective, it is wonderful to see such student engagement on environmental issues, even if I disagree with their divestment goal. It is a moment to educate and to learn, and we must seize this opportunity wholeheartedly.

As a geologist, I have spent some time thinking about the timescale of climate change. I am struck by how ill-prepared our institutions are for the multiple timescales of climate change, from the tens of thousands of years that carbon dioxide will reside in the atmosphere, to the century (or more) it will take to decarbonize our society. Long-term planning is always difficult, but after our nation spent nearly \$100 billion on weather-related disasters during the past year, it seems that now is the time to try. Extreme weather, from the drought of last summer to Superstorm Sandy, reminds us that human society will have to prepare for the Earth’s changing climate, regardless of what we do to prevent such change. A focus on “climate preparedness,” on local actions to protect people, our communities (and perhaps even our ecosystems) by building robustness and resilience, raises an important set of new challenges. How can economic signals, including insurance and disaster relief, be used to encourage the types of investments necessary over the coming decades? What about low-income communities that cannot afford the necessary investments to prepare for more extreme weather? How does preparing for climate change affect public support for policies to reduce greenhouse gas emissions and keep the problem from getting worse? These questions and many more require expertise from many disciplines, from the natural sciences and economics, to business, law, political science, history, public policy, public health, urban planning and design, and even the humanities. They are perfect examples of why it is so important for Harvard to bring together the formidable talents of our faculty and students from around the University to address these questions and challenges, as humanity plans for an uncertain future. We have much to do, so it is time to get busy. 🌍

With best wishes for a productive summer,



Dan Schrag
Director, HUCE

"How to make that cosmic sense of urgency immediately felt is one of the challenges of this climate movement."

of movement it will take to make broader and deeper change."

"There is a very strong generational dynamic to this whole thing," Ganz says. "Generation change is one of the great drivers of cultural and political change. Bill McKibben [’82] gets that, which is why he has this focus on divestment: give the rising generation a strategic focus." But some scholars question whether McKibben is chasing the wrong targets.

How to Build a Movement

McKibben, a journalist by training and temperament, is arguably the most prominent climate activist on the planet. In 1989, he wrote the first book on climate change for a popular audience, *The End of Nature*. After decades of covering climate science—and observing the collective failure to create commensurate solutions—in 2008 he co-founded 350.org with students at Middlebury College, where he is a scholar in residence. Their explicit goal was to build a grassroots movement to fight climate change.

McKibben has become the leader of a fast-growing movement that he dubs the "Fossil Fuel Resistance." Like Ganz, he sees a need for proven tactics such as civil disobedience and demonstrations. In October 2009, prior to the international climate negotiations in Copenhagen, 350.org orchestrated simultaneous rallies in 181 countries—possibly the largest coordinated protest in history. In August 2011, in one of the largest civil disobedience actions in decades, McKibben was

arrested along with more than 1200 others in front of the White House during a protest of the proposed Keystone XL pipeline, which would ferry oil extracted from the tar sands of Alberta to the Gulf of Mexico for export. He spent three days in jail.

The tempo of McKibben’s campaigning picked up last summer, after he wrote an article in *Rolling Stone* magazine titled "Global Warming’s Terrifying New Math". In it he described recent research outlining how, if the world’s governments are serious about their commitments to staying under the two degree Celsius warming threshold, then 80 percent of the estimated carbon reserves held by fossil fuel companies around the world will need to stay in the ground, and out of the atmosphere. The story went viral, prompting McKibben and fellow activists to go on a barnstorming tour to spread this message in packed lecture halls and theaters across the country.

Their message resonates with students, at least. Since last fall, fossil fuel divestment campaigns have sprung up on more than 300 college campuses. On April 11, almost 200 people gathered in Harvard Yard



Marshall Ganz, senior lecturer at Harvard Kennedy School and social movement scholar.

to deliver a petition calling on Harvard’s administration to divest the University’s \$31 billion endowment—the nation’s largest—from fossil fuel companies. Their goal wasn’t only to get the Harvard Corporation to rethink its investment priorities, but to make a statement, and loudly.

"It was incredible," recalled Chloe Maxmin ’15, co-coordinator of Divest Harvard, the day after the rally. "We have so many voices calling for divestment. Alumni were emailing President Faust yesterday as we were rallying outside, and faculty and the chaplain at Memorial Church were with us."

Maxmin and her fellow demonstrators persuaded Secretary of the University and Vice President Marc Goodheart to come outside and publicly accept the 1300 signatures on a petition that didn’t mince words: "Although Harvard has been a national leader in institutional sustainability, we find it contradictory and self-defeating that Harvard invests its endowment in companies that threaten the future of its students and life on Earth as we know it." Many of Maxmin’s peers seem to agree: in a November referendum held by the Harvard Undergraduate Council, 72 percent of participating students voted to support divestment. "On some level it’s

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Top: Bill McKibben, journalist and prominent climate activist. Bottom: Chloe Maxmin, an undergraduate student activist and co-coordinator of Divest Harvard.

very intuitive,” Maxmin says. “It’s wrong to be investing in these corporations because their business model is incompatible with the future of our generation.”

But while faculty members laud students for civic engagement, they do not necessarily embrace the aims of the current protest. “It is wonderful to see student activism arise surrounding climate change,” says Hooper professor of geology Daniel Schrag, who directs the Harvard Center for the Environment (HUCE).

“But what does it mean when students push Harvard to divest from fossil fuel companies, but then fly home on airplanes and drive around in cars fueled by petroleum, communicating on their iPhones using electricity generated from coal and natural gas? We need a profound change in the energy systems and infrastructure that underlie our society, and Harvard’s role is to develop new technologies and ways of implementing them, and most of all to educate our students who will lead the world through this transition.”

These future leaders, some of whom are involved in groups now at the forefront of climate activism, are leveraging their voices



COURTESY OF BILL MCKIBBEN

through the use of social media such as Twitter and other low-cost and lightning-quick tools for reaching vast numbers of people. “It’s a good thing that we have the Internet—a globally linked way to communicate—just as we hit our first truly global problem,” says McKibben. “It can’t be the only way we proceed (emailing each other petitions has its limits of effectiveness) but it is a huge help. It helps spread the news of older, time-honored tactics like civil disobedience.”

Still, if climate campaigners are to build a truly broad coalition that can compete with the political clout of the fossil fuel industry, he acknowledges that no amount of Tweeting can take the place of the patient, painstaking work of outreach to grassroots organizations: “Working with partners across the progressive spectrum always takes lots of talk, and lots of respect in all directions.”

Meanwhile, the Keystone protests gathered diverse support, from college students to Nebraska ranchers to Appalachians opposed to mountaintop-removal coal mining. McKibben compares this burgeoning movement to Occupy Wall Street: they are more interested in creating a national groundswell than in counting votes in the Senate or getting engaged in

specific policy fights. “Before we have any real chance,” McKibben says, “we have to change the mood around this issue, building a real movement.”

Forging a Broader Coalition

Theda Skocpol, Thomas professor of government and sociology, has been studying political and social movements for much of her career. She recently conducted a thorough post-mortem on the failed push for cap-and-trade legislation in Congress in 2009 and 2010. Her analysis concludes that mainstream environmental organizations were overly focused on making an “insider deal” with business interests, with little grassroots support.

“To build leverage on Congress,” she writes, “and to push back effectively against elite and populist anti-environmental forces, global warming reformers must mobilize broad, popularly rooted support for carbon-capping measures that have something concrete to offer not just to big corporate players, but also to ordinary American citizens and to local and state groups.”

Skocpol is focused on what can shift lawmakers’ thinking on the costs and benefits of climate action. Her answer: strong constituencies for change. “I’m asking people to think not about the science or the urgency of the moral crisis, but the politics,” she said in an interview. “And that’s not easy to separate.”

“I don’t think people are clear-eyed about any of this,” she continued, referring to “bipartisan fantasies” that the big environmental groups brought to negotia-



COURTESY OF CHLOE MAXMIN



HARVARD PHOTO SERVICES / BROOKS CANADAY

tions. “There is romanticism on the far left, too, that all you have to have is some demonstrations, the Occupy Wall Street fantasy”—one which McKibben seems to embrace.

In preparation for the next round of battles over carbon-pricing or -capping legislation, Skocpol sees potential in persuading both Republican and Democratic moderates that this can be a winning issue for them. “You do need to go well beyond the network of organizations that already think of themselves as environmentalists,” she says. “Environmentalism remains a very upper middle class, coastal movement.”

Skocpol advocates better-organized outreach to church groups, labor unions, community organizations and groups like the League of Women’s Voters. “I think one has to cast a wide net and prepare to be surprised.” She further argues that any successful alliance pushing climate legislation will have to be built around specific policy proposals that do not impose undue economic burdens on the public. “People have to realize that policy directions and coalitions go together,” she says. “My research shows that the bottom four-fifths of Americans have not seen real income growth, and that creates a real dilemma any time you’re doing something that raises costs. And frankly, it will raise costs.”

“We need a profound change in the energy systems and infrastructure that underlie our society, and Harvard’s role is to educate our students who will lead the world through this transition.”

Choosing the Right Targets

What *are* the requisite ingredients of successful social movements? Several scholars identify key components: passionate participants driven by a sense of moral urgency; careful organization; diverse coalitions; and the identification of effective—and sensible—points of leverage.

On that latter point, Joseph Aldy, an assistant professor of public policy at HKS and former special assistant to President Obama for energy and environment, would encourage activists to focus on those actors blocking action in Congress.

In 2008, the presidential nominees of both major parties agreed that climate change was a serious problem, and both expressed support for cap-and-trade-based solutions. But after the failure of climate legislation in the Senate in 2010, “cap-and-trade” became a dirty word in Washington, largely thanks to aggressive lobbying by fossil fuel interests and outspoken opposition from the Tea Party faction of the Republican Party. “We have too many people who think the earth is just

flat again,” Aldy says, referring to Republican lawmakers and their supporters who deny climate change is an urgent, or even real, problem. Social movements need “to mobilize people to impose a political cost on people who say there is no such thing as climate change.”

“It’s a little peculiar to be targeting those who are already trying to do what they can to tackle this issue,” he says in reference to McKibben’s Washington, D.C. Keystone protests. Citing President Obama’s achievements on fuel efficiency standards and other fronts, he says his former boss has done more than any previous president to reduce emissions. Protesters’ energy would be better spent, he suggests, targeting those politicians who “still don’t think this is an important issue at all.”

Likewise, Aldy thinks activists should target the energy industry more carefully. “Keystone is a very transparent measure of success from a social movement standpoint,” he says, in that the pipeline will either be approved or denied. “But does it affect global climate in the next twenty years? I don’t think so.”

William Hogan, Plank professor of

Top: Joseph Aldy, assistant professor of public policy at Harvard Kennedy School.

Bottom: Theda Skocpol, Thomas professor of government and sociology.



MARTHA STEWART



Instead of a ‘stop things’ movement, Clark would like to see more emphasis on making proactive, positive investments: “We can preferentially direct our investments into areas with an energy and climate agenda.”

global energy policy at HKS, agrees that approval of Keystone wouldn’t make big a difference in terms of global carbon dioxide emissions. He is concerned that the “theater” of fights over Keystone and divestment makes it more difficult to have an honest conversation about the costs and benefits of specific policies that *would* make a difference in global emissions. “The worldview of the people arguing for divestment and so forth often seems to be disconnected from the facts,” he says. “I’m always fundamentally concerned about people who say things that are not true: ‘Keystone is the end of the world. Game over.’ That’s just silly.”

“I’m in favor of taxing all energy-related emissions and putting a price on them,” he says. “A lot of people would be prepared to pay five percent of GDP” to stay within safe limits on atmospheric carbon levels, “but not everybody would.” He laments that environmental groups’ current tack leaves little room for a “nuanced conversation” about the critical question of “how much we’re willing to pay” to slow climate change.

William Clark, Brooks professor of international science, public policy and human development at HKS, concedes that activists like McKibben “have a great moral advantage in this, in that they are doing something instead of simply wringing their hands.” He also acknowledges the potential symbolic power of campaigns to make a moral statement about the urgency of reigning in our consumption of fossil

fuels. But he shares his colleagues’ skepticism that divestment is the best way to go about it. “It’s not enough to say, ‘This is something we can get people to rally around.’”

“There’s somewhere between a lack of clarity and a muddle in terms of what the divestment movement is trying to accom-

plish,” he says. “Divestiture isn’t a goal, it’s a means to some end.”

If fossil fuel production stopped tomorrow, he points out, society as we know it would collapse. As individuals, we demand fossil fuels, he says. And the world economy is built on them.

Clark appreciates the need to build momentum on the issue. But he points to Occupy Wall Street as a cautionary example of a movement that had some impact on the national conversation, and then faded for lack of clear objectives. “If you look back at the civil rights movement, one of the pieces of genius was managing to keep the outrage and moral focus of the movement tied to relatively small, achievable steps.” Clark would like to see, instead of a “negative, ‘stop things’ movement,” more emphasis on making proactive, positive investments: “We can preferentially direct our investments into areas with an energy and climate agenda.”

If opposition is “needed to rally people,” Clark continues, “then let’s target the very worst, obstructionist actors, the ones undermining science and spreading disinforma-

tion. I would say, look, we’re a university, we may well have different perspectives as individuals over the right mix of fuels, the right degree of government intervention. But some individuals and firms out there are undermining the center of our existence as a university: respect for the importance and power of efforts to get closer to the truth. Target them.”

McKibben has heard such criticisms before, and given his goal of “changing the mood” around the issue, he thinks targeting the Keystone pipeline and investments in fossil fuel companies might offer symbolic, rabble-rousing value that goes beyond the precise amount of carbon kept out of the atmosphere. The cognitive dissonance of the investment positions of institutions such as Harvard, he says, are fair game.

“I don’t think we’re radical at all,” he says. “All we want is a world that works the way it did when we were born. We’re conservatives. It’s oil companies—and the

Top: William Clark, Brooks professor of international science, public policy and human development at HKS. Bottom: William Hogan, Plank professor of global energy policy at HKS.



institutions like Harvard willing to profit from them—that are radicals, willing to change the chemical composition of the atmosphere. I don't think there's ever been a more radical act in human history.”

A Rational Path?

So where does the climate movement go from here?

As Marshall Ganz likes to point out, all social movements are “unpredictable, messy, contentious.” Debate over how to push for climate solutions will no doubt continue, and will likely take new, unanticipated directions—but only if these

nascent stirrings of energy are sustained through what is sure to be a decades-long struggle to transform the very underpinnings of the modern global economy.

In 1964, Ganz picketed Harvard administrators to demand they divest from Mississippi Light and Power Company. That effort failed, but “a lot of us who cut our teeth challenging them to divest... went on to play a role in the movement.” Whether or not Maxmin and her colleagues are successful in their push for divestment, there will be a need for continued engagement in the coming years, much as Ganz went on to work for decades to advance civil

and labor rights. Says Schrag, “Student activism is exactly what we need, and the exact demands seem less important than the fact that they are actually mobilizing and demanding change. So I applaud their protests to gain attention. I just don't think the University should follow their specific demands.”

What is clear is that the University will continue to be a “place of contention,” said Ganz at a recent event in Sanders Theatre. Reasonable people can disagree on the path forward, on the choice of tactics, targets, even goals. But simply doing nothing is looking increasingly unreasonable. ■

Climate Change & Social Action Symposium

In late February, HUCE organized “Climate Change and Social Action,” a panel discussion considering the role of social action in confronting climate change and the impact grassroots environmental movements can play in sustaining long-term action.

Panelists included: Marshall Ganz, senior lecturer in public policy at the Harvard Kennedy School; Theda Skocpol, Thomas professor of government and sociology; Stephen Ansolabehere, professor of government; Rebecca Henderson, McArthur university professor; and Andrew Hoffman, Holcim (US) professor of sustainable enterprise at the University of Michigan. Daniel

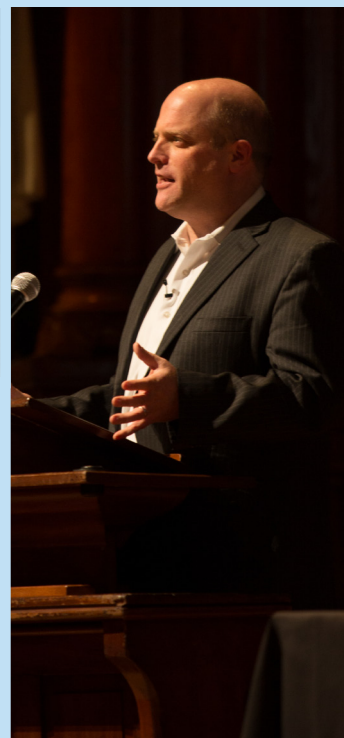
Schrag, Hooper professor of geology and HUCE director, moderated the discussion.

The talk touched on a variety of topics, such as: the intersection of change and conflict; the failure of climate activism in gaining traction like other past social movements; the outlook in Washington; and public opinion of climate change. And even though climate change has yet to spark enough public support to prompt federal action, several panelists suggested that this is already a period of change. Hoffman reflected on recent moves to embrace green technologies, and suggested that we might be in something of a renaissance.

“The funny thing about a renaissance is you don't see it until it's done. All you can see is the pain” leading toward it, he said.

Harvard University President Drew Faust offered closing comments: “I look forward to more conversations, more arguments, more vibrant democracy, and to mobilizing universities in ways that enable us to support the very best of human life and the best for the planet on which we live.” ■

Photos (clockwise, from left): President Drew Faust; Discussants Marshall Ganz, Theda Skocpol, Andrew Hoffman, Daniel Schrag, Rebecca Henderson, and Stephen Ansolabehere; Moderator Daniel Schrag; Ansolabehere; Skocpol and Ganz.



PHOTOS BY SUSAN YOUNG

Caring About Climate—Close to Home

Polling shows support for cleaner power supply, backyard environment

By Alvin Powell

U.S. climate change legislation remains stalled, even as global greenhouse gas emissions reach new highs, the extent of summer arctic sea ice plumbs new lows, and nations around the world are reportedly drawing up plans for some 1,200 new coal-fired power plants.

These developments may drive environmentalists to despair, but recent public opinion surveys show there's hope for those seeking a way forward on climate change, summed up in an old adage attributed to former U.S. House Speaker Tip O'Neill: all politics is local.

While popular attention remains focused on making a living and making ends meet, once citizens tear their eyes from pocketbook issues, their responses to questions about energy and the environment demonstrate concern for global environmental issues such as climate change.

Americans favor cleaner energy sources—particularly if a power plant is close to home—and would pay higher energy bills to make progress toward a cleaner future. They also support unilateral national action on climate change over the tit-for-tat rhetoric that has marked U.S. participation in international climate discussions.

“The big issues for the American public are always the economy, jobs, sometimes prices—when inflation is high—and war,” says Stephen Ansolabehere, professor of government at Harvard and an associate of the Harvard University Center for the Environment (HUCE). “What we’re

trying to figure out is, given [the] energy choices the U.S. faces—we have to build power plants to replace old plants coming offline and to meet growing demand—then *what sort of* power plants? What characteristics of those plants are most desirable? What we’ve found is that people weigh environmental concerns and local

lar and wind power in the U.S. energy portfolio, and a majority want to reduce coal and oil. Those trends hold, with a slight decline in numbers, Ansolabehere says, when the higher prices of alternative energy sources are cited in the question phrasing.

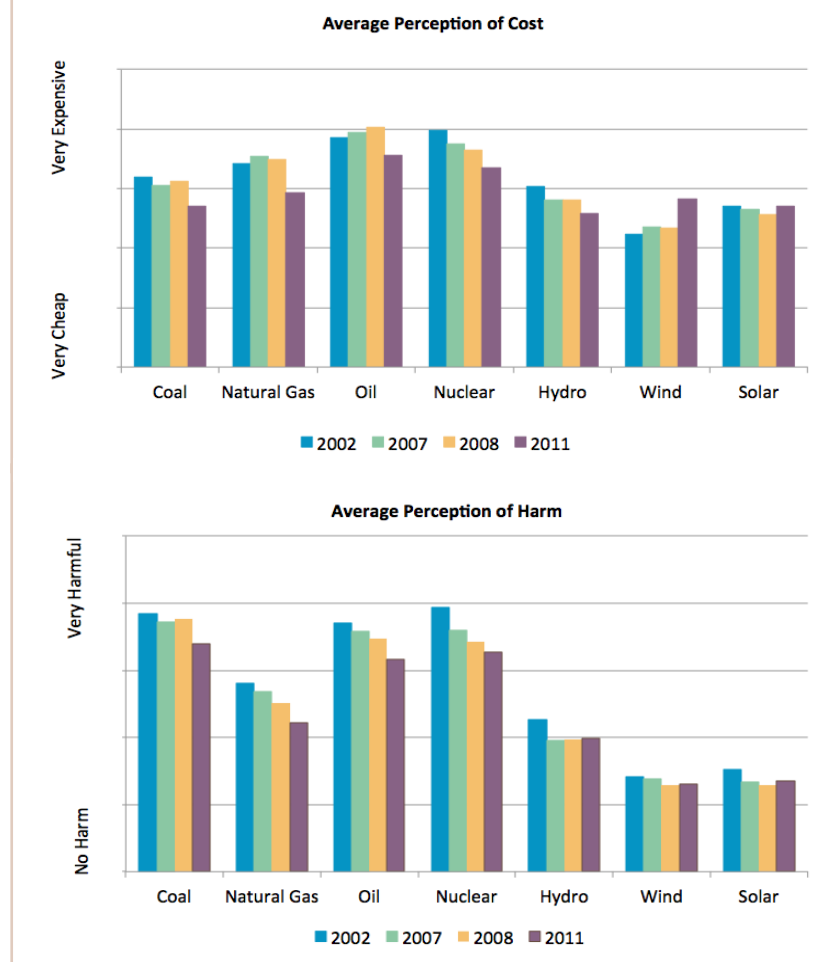
Though environmental concerns weigh heavily on Americans’ electricity generating

preferences, Ansolabehere says that isn’t due to climate change. In fact, the 2002 survey showed that concern about global warming was “statistically indistinguishable from zero” for most power choices. Climate change concern has risen in the intervening years, but still lags other factors in determining energy supply preferences, according to a 2012 paper in the journal *Daedalus* by Ansolabehere and David Konisky, an assistant professor in the public policy institute at Georgetown University. “People’s concern about global warming is uncorrelated to their preference for any particular power source. That has been constant throughout [the polling],” Ansolabehere says. “There’s a real disconnect between what the public is willing to do and what these elite discussions about global warming and the energy sector have focused on in the last decade.”

The major factors driving the public’s power plant choices are not global issues like climate change, but rather local concerns about pollution and health effects.

“People are much more willing to accept a wind facility than a coal or nuclear facility, with natural gas [falling somewhere] in between. Even with all the objections, big blades turning in the background and... [increased mortality of] birds, it’s much

What are the determinants of energy preferences?



COURTESY/STEPHEN ANSO LABEHERE, "CLIMATE, ENERGY, AND THE AMERICAN PUBLIC" PRESENTATION

more acceptable than a traditional power plant of any sort,” Ansolabehere said. “People want an expansion of solar and wind, and want a contraction of coal, oil and nuclear power. Natural gas, they want to keep the same or expand somewhat.”

The local focus illustrated in Ansolabehere’s results was also reflected in a recent survey by assistant professor of government Dustin Tingley, an HUCE associate. Tingley recently looked at people’s beliefs about how far-reaching the effects of their energy choices are. People believe their impacts are local.

“When you drive the car and consume fossil fuels, those fuels contribute to global climate change,” Tingley points out. “[But] we find across all groups a big drop off in the impact people think they’re having on a person in a land far away versus an individual in their own town or the state next to you. They get the local pollution. They get the local impacts. What they don’t understand as well is the global impacts.”

The lesson, Tingley says, is that when framing the issue of climate change, it will resonate with the public more if one talks about local impacts, like the devastation caused in New York and New Jersey by Hurricane Sandy, though he cautions that it remains to be seen how long the public’s memory will be for that event.

“You need to talk about the local circumstances. It seems the grizzly bears on the Arctic sheet or starving children in India, that’s not the sort of native or natural way people think about it.... [Talking about local effects] is a more natural fit. It’s in their face, something a marketing campaign would direct your attention to. If we’re in the camp of trying to effect change, maybe pictures of the New Jersey coastline are what are really going to resonate with people.”

Though their motivation is purely local, Ansolabehere says that the premium people are willing to pay for cleaner power close to home goes a long way toward meeting the cost of changes necessary to meet global environmental needs.

“If people are willing to pay higher prices for electricity locally to offset costs of asthma and lung disease, missed days from work because of particulates and other air pollution, you [account for] two-

thirds of the [price] you’d need to [pay to] pursue alternate fuels, wind and solar power, more aggressively,” Ansolabehere says. “And I think that’s the real opening going forward. How much would [the public] support more regulations or increased prices to avoid all the effects that come from burning coal ... in terms of pollution? People really don’t want a coal plant near them and really don’t want a nuclear plant near them.”

In a separate survey, Joseph Aldy, assistant professor of public policy at the Harvard Kennedy School and a HUCE associate faculty member, worked with colleagues from Yale University seeking to quantify just how much people would pay for cleaner energy. The survey, published in the journal *Nature Climate Change* in May 2012, indicated that in a national referendum on the issue, a new clean energy standard would pass.

“If you had a national referendum for a clean energy standard, you could get a pretty aggressive standard, based on the results of our survey,” says Aldy, who worked on clean energy issues for nearly two years in the Obama administration. “People are willing to act, to give up some real money.”

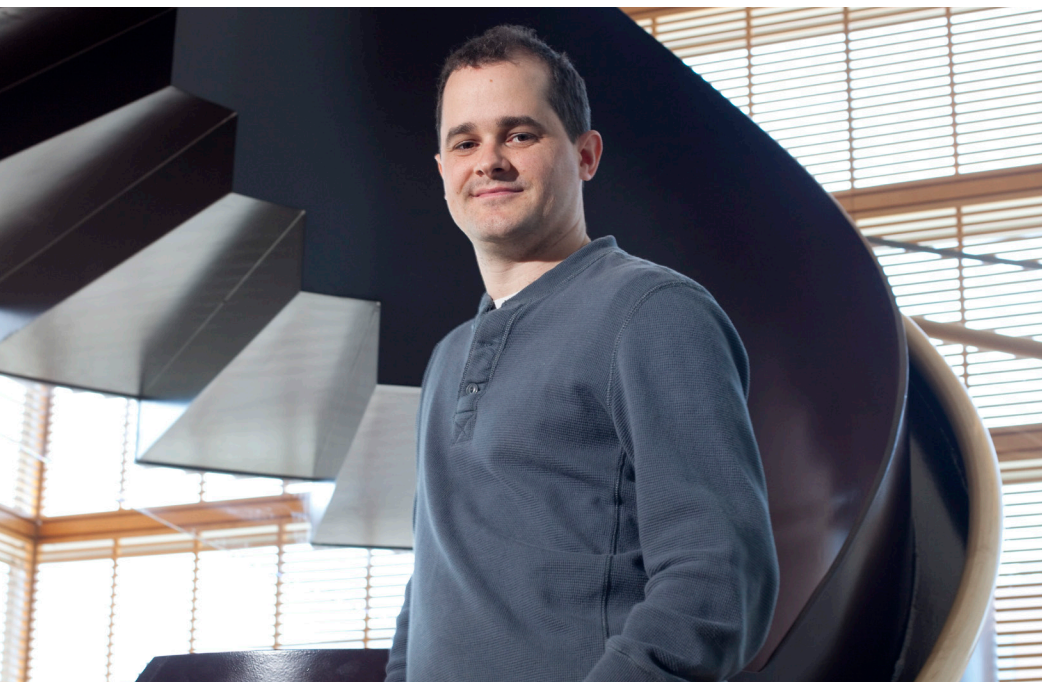
The survey, which was conducted in 2011 and included 1,010 respondents, showed that the average American is willing to pay \$162 a year more for electricity from clean sources, an amount that would raise their annual bill an average 13 percent.

The survey showed that each \$10 increase in the cost of clean power decreased the probability a respondent would support it by 1 percent. It also showed that between 24 percent and 30 percent of respondents would oppose a national clean energy standard even if it didn’t cost anything. Willingness to pay for clean energy

“What we’ve found through our public attitude surveys is that people weigh environmental concerns and local health concerns in new power plant choices more than they weigh economic concerns like prices and jobs.”



Stephen Ansolabehere, professor of government at Harvard University, has conducted public surveys on energy and the environment since 2002.



Dustin Tingley, assistant professor of government at Harvard University, looked at people's beliefs about how far-reaching the effects of their energy choices are.

rose if the definition included only renewable sources, to \$199, versus \$142 for a mix of renewables and natural gas, and \$147 for renewables coupled with nuclear power.

Aldy and his coauthors, Yale associate professor of environmental economics and policy Matthew Kotchen and Anthony Leiserowitz, director of the Yale Project on Climate Change Communication, took their analysis a step further, extrapolating those results to Congress in order to determine whether a clean energy standard could pass there. They used a measure of the “median voter” in each Congressional and Senatorial district and found that the environmental standard that could pass Congress is a lot weaker than that which the average American voter would hope for.

In the Republican-dominated House of Representatives, a clean-energy standard could raise electricity bills by no more than 5 percent, or about \$48 annually, or risk failing to pass. In the Democratically-controlled Senate, a majority would support standards similar to those acceptable to the survey's average American. Given that a 60-vote majority is needed to block a filibuster, however, only a weaker measure, one that would raise the average energy bill by no more than \$59, could reach the floor for a vote and go on to pass.

Think globally, act locally

With public attention focused closer to home and Congress focused on the public, the best way to get climate change legislation passed may be with an indirect

approach, Ansolabehere and Aldy agree.

“Whether a carbon tax [could pass] and what people will pay to alleviate climate issues are critical questions,” Ansolabehere says. “Our answer is you're not going to get there directly. You can't just stand up [in Congress] and say, ‘We're going to have an energy tax to get rid of climate change.’ You can stand up and say, ‘We're going to have an energy tax or cap on environmental pollutants to try and make everyone's health better.’ If the president wants to take on this issue, he will need to do it in a very politically palatable way.”

When he has conducted surveys that ask about the issue of a carbon tax directly, Ansolabehere says, he's found the public is willing to support either a revenue-neutral proposal or one that improves local health.

“I don't think Congress is going to go any place where public opinion is not behind it, especially on an issue that's not front and center,” Ansolabehere says.

The extreme partisanship that characterizes Congressional attitudes toward environmental issues is particularly troubling, says Aldy, because it means that politics—more than economics or environmental effectiveness—dictates which plans have a chance of passing. For example, though a cap-and-trade scheme might be the most effective way to reduce carbon dioxide emissions, that approach became associated with President Obama during his unsuccessful foray into climate change legislation in his first term, and Republicans will therefore have no part of it.

“Cap-and-trade has been demonized by the right,” Aldy says, even though it is “a market-friendly approach to tackling environmental problems that is cost effective and more efficient than traditional regulatory command-and-control approaches. It's frustrating to see how partisan this has become. It's not clear how one breaks that down.”

Negotiations on broader national issues may provide opportunities for climate change legislation, Aldy says. Though a debate on stand-alone climate legislation is unlikely to be successful, it is possible that a discussion of climate change issues could be part of a larger debate on tax and spending issues where the revenue raised [through measures such as a carbon tax] could forestall cuts to prized programs.

“The important question is how they [a carbon tax or other climate-related scheme] poll relative to getting rid of the mortgage interest deduction or the business tax benefit for providing health insurance for employees, or how it compares relative to not cutting marginal rates on income,” Aldy says. “Some feel that if cap-and-trade couldn't pass... a carbon tax certainly can't pass... [but] if the reference point is cutting Medicare, cutting the Pentagon's budget, or cutting the mortgage interest deduction, then I think the politics are a little different.”

A little different may still not be enough while the economy is struggling, Aldy acknowledges. He says he wouldn't be surprised if meaningful reform for both the budget and the climate were put off until the economy improves.

“It may be that the politics are such that you don't get a big fiscal package, you just kick the can down the road,” Aldy says. “That's possible, if you realize all the ways of raising revenue are lousy now and would be easier with a better economy.”

The glaring absence of the environment as an issue in the recent presidential campaign, Aldy says, was a reflection of the difficult politics surrounding environmental policy. With the environment seen as a second- or third-tier issue and the election turning on narrow percentages in key states, it's not surprising that when climate change was brought up at all, it was phrased in terms of economics, as a

step toward “energy independence,” or as the driver in the creation of new technology that could be sold overseas and that would create jobs at home.

“All of those have a positive impact on carbon dioxide emissions, but there’s been very little discussion of climate change,” Aldy continues. “In the context of this economy, and in the context of high fuel prices, climate change is not what people want to hear”—certainly not the “five to ten percent who [were] in play in any given state.”

Just as sticky as developing domestic standards for regulating greenhouse gas emissions has been the nation’s participation in international climate agreements. A common theme sounded by some national leaders is that U.S. participation in international climate agreements is contingent on the participation of other nations, particularly large emitters of carbon dioxide in the developing world such as China and India. Tingley’s work in a

forthcoming paper in the journal *Comparative Political Studies*, co-written with Stanford University professor of political science Mike Tomz, looked at the American public’s attitude toward international climate agreements in order to probe how big a factor the actions of other nations should be in our own climate moves.

“If others cooperate,” Tingley asks, “should we cooperate? And, if others defect—fail to make progressive policy changes—should we also defect?” Such questions “build on the idea that people are willing to cooperate, but only conditionally. I’m willing to do the right thing, but only if you do the right thing. We asked a basic question about whether we should be conditional or whether we should be unilateral.”

The paper analyzed data from two previous surveys, one conducted in 2009 by the German Marshall Fund and another carried out that same year by the World Bank. It also examined U.S. public attitudes in more depth through an online

survey of 708 adults.

Their analysis showed that people want their country to make concrete strides toward a sustainable future, regardless of what other nations are doing. But they also indicate that while people don’t think their own nation’s actions should be tied to those of other countries, they believe that nations that cheat on climate change emissions should be punished, either by means of trade sanctions or through public humiliation in international arenas like the United Nations.

“We find, interestingly, in contrast to a lot of elite rhetoric, many people across the world—on the order of 70 to 90 percent—are unilateral cooperators” Tingley says. “That to me is interesting because it suggests [that the government positions]...in international climate conferences [to the effect that] ‘the Chinese aren’t willing to go far enough so we won’t—that just doesn’t seem to be a theme that resonates around the world.’”

FACULTY PROFILE

Joseph Aldy

Assistant Professor of Public Policy Joseph Aldy accepted a job teaching at the Kennedy School two years before he actually stepped into a classroom there. He had a good reason for the delay: a week after accepting the job in December 2008, he was asked by Lawrence H. Summers, then director of the National Economic Council, to join the incoming Obama administration.

Unable to pursue both positions simultaneously, Aldy was granted a public policy service leave before he even spent any time in residence. “In the end,” he recalls, “our dean, David Ellwood, knew the opportunity I was facing.”

Aldy’s path to Washington began with an appreciation for the natural environment cultivated among the Black Angus cows and fruit orchards of his family’s 20-acre farm outside Lexington, Kentucky. “It was a hobby farm,” says Aldy. “As my dad would put it, ‘Not enough to live on, but enough to kill you.’”

After finishing his master’s degree in environmental management at Duke, he got his first taste of the White House during the summer of 1997 while working with the Council of Economic Advisers (CEA) in the Clinton administration. It was good timing:

the federal budget was balanced, the unemployment rate was close to historic lows, and the GDP was doing fine—giving him and his colleagues plenty of time to develop the administration’s international climate change policy for that year’s Kyoto conference. What was supposed to have been a six-month stint at the CEA turned into three years; Aldy had “caught the climate bug,” as he puts it.

When Aldy returned to the White House to work for Summers and director of the Office of Energy and Climate Change Carol Browner—after an eight-year absence, which included his doctoral studies—he found a changed Capitol Hill. Whereas Clinton had faced Republican majorities in both chambers and had little hope of moving legislation, the Democratic majorities that welcomed the Obama administration allowed Aldy and his colleagues to develop a policy framework through legislation. He spent much of his time working with members of the House and Senate on bills to mitigate climate change and on the energy portion of the American Recovery and Reinvestment Act—an almost \$90-billion package of clean energy, efficiency, electric grid, and transportation-related initiatives.



While Aldy is now busy with research and teaching—his energy policy analysis course is part of a University-wide graduate consortium sponsored by the Harvard University Center for the Environment—he maintains ties to the White House, talking shop with former colleagues, offering support on an ad-hoc basis, and even working as a campaign surrogate (he debated energy policy with Romney’s domestic policy advisor this October at MIT). He says he is cautiously optimistic about the prospects for energy policy in a second Obama term. “We lived through two years of a House of Representatives that just said ‘No.’ And the question now is, are they going to continue to do that for the next four years? Or is there a way for us to actually move forward?”

— Dan Morrell

"Liking" Trees Takes on a New Meaning

As Harvard's Arnold Arboretum pushes into social media, trees and technology form an unexpected partnership

By Steve Bradt



HARVARD PHOTO SERVICES / ROSE LINCOLN

While the planet's trees outnumber humans roughly 60 to 1, they're bit players in the burgeoning world of social media; few magnolias or maples have gone viral on YouTube. Lindens, lilacs, and larches aren't attracting thousands of Twitter followers. Willows and walnuts haven't garnered many "likes" on Facebook.

But Harvard University's Arnold Arboretum aims to change that, giving the world's trees a place alongside more charismatic species—the kittens and panda cubs that have rocketed to prominence via social media. Already recognized as one of the world's best-documented botanical collections, the Arboretum's 15,000 trees, shrubs, and woody vines are now making the leap into our hyper-networked world.

In the process, the Arboretum aims to create arboreal celebrities, as it were, whose roots and canopies extend far beyond its 281 acres in the Boston neighborhoods of Jamaica Plain and Roslindale.

"We're charged, as a University, with sharing, and with making the world at large a more informed place," says William (Ned) Friedman, the Arboretum's director and the Arnold professor of organismic and evolutionary biology. Noting that many of the Arboretum's 250,000 annual visitors speak Russian and Chinese—among many other languages—Friedman says, "We want to interact with 6 billion people, not just 250,000. Social media has the capacity to internationalize us."

Seeing the forest for the trees

When he became the Arboretum's director two years ago—joining Harvard after a decade and a half on the faculty of the University of Colorado, Boulder—Friedman faced a steep climb to refashion the institution into the rising social-media star it is today. Working with a small committee of staffers—including George Morris, the Arboretum's director of information technology, applications programmer

The Arnold Arboretum uses a number of social media tools to spread the word about their programs and collections. Above, visitors snap photographs of the Arboretum's collections. Many of these images will make their way to the Arboretum's Flickr stream, Twitter, or Facebook pages. Visitors can also use their smartphones to access an interactive map of the grounds.

Donna Tremonte, and director of science facilitation Faye Rosin—Friedman set out to freshen the Arboretum's online persona. "It doesn't exist at the Arboretum if it's not on our web site," Friedman recalls telling his colleagues.

Morris and Tremonte worked to modernize the site and move it to a content management system, allowing a much larger group of Arboretum staffers to post material. A Flickr stream opened the site even more broadly by soliciting photos of "My Arboretum" from visitors. This democratization of content creation quickly lent the Arboretum's site a needed dose of

dynamism—laying the groundwork for an expansion into more freewheeling media, such as Twitter and Facebook.

The Arboretum's long and distinguished history gives it a rich trove of information to share with the public: founded in 1872 as the first public arboretum in North America, the Arnold Arboretum is now a leading center for the study of plants and biodiversity. It holds one of the world's most comprehensive living collections of temperate woody plants, and its herbaria, library, and archives contain more than 1.4 million dried specimens, innumerable rare books, and more than a century of imagery and documentation of plants and plant collections from around the world.

But bringing that vast data to the forefront in a compelling, user-friendly, and social-media-savvy way has taken some doing—and remains an ongoing process.

Freeing the data

After the Arboretum's web presence was updated, the next significant step

toward putting its collections at the fingertips of visitors near and far was the launch, in fall 2011, of a desktop web application called Collections Researcher. This tool, linking decades of accumulated data on the Arboretum's flora with a powerful GIS, or geographic information system, was a leap forward in sharing information with global audiences.

"We wanted to free all this data from lockdown," says Friedman, an evolutionary biologist who has researched the origins and early evolution of flowering plants—giving the information reach far beyond the Boston-based libraries and archives where it had remained sequestered for decades.

Last spring, the Arboretum took another step toward establishing its living collections as a public resource for science, learning, and recreation: building on Collections Researcher with an interactive map and web application dubbed Arnold Arboretum Mobile Interactive Map (MIM). With the launch of this tool, Arboretum visitors can use their mobile devices—whether

Android, iPhone, or iPad—to access a suite of tools, maps, and in-depth information on species. MIM allows users to search the collection, locate individual plants, and view seasonal highlights.

While eagle-eyed observers may notice QR codes and other discreet signs of technology's creep into the Arboretum, these guideposts are intentionally unobtrusive, Friedman says, so as not to overwhelm visitors or mar their experience of the natural world.

"Those who want to can use their mobile devices to listen to people talk about a given plant on iTunes," Friedman says. "Or, using GenBank, they can, if they want, dig deep into genetic analysis of the plants in front of them."

Using these tools in conjunction with their social media accounts, "people can create their own archive of experiences here," Friedman says. "We're reinvigorating people's relationships with plants, and...showing that their experience at the Arboretum doesn't have to end when they go home."

Mobbing the trees

Taking a cue from flash mobs (spontaneous group dance), the Arboretum's so-called "Tree Mobs" have used social

"We're charged, as a University, with sharing, and with making the world a more informed place. We want to interact with 6 billion people, not just 250,000, and social media has the capacity to internationalize us."

Arnold Arboretum director William (Ned) Friedman, the Arnold professor of organismic and evolutionary biology at Harvard University.





Kai Wang



Ryan Catalani



Karen Marlene Larsen



Ted Bradford

media to put individual plants in the limelight. Since May, Tree Mobs, a concept hatched by Friedman, has allowed Arboretum devotees—alerted via Twitter, Facebook, or e-mail, often on short notice as warranted by fleeting arboreal occurrences—to engage in brief encounters with experts focusing on some facet of the landscape. These 20-minute talks, which draw on the expertise of Arboretum staff as well as scientists from other Boston-area institutions, heighten visitors’ awareness of the environment’s depth and variety, one species at a time.

As many as 50 people have showed up for each Tree Mob: diehard Arboretum fans, scrubs-clad medical staff from the adjacent Faulkner Hospital or Hebrew Senior Life Center, even unsuspecting visitors who happen upon Tree Mobs in progress. Topics have included the gnarled Sargent’s crabapple tree; the evolutionary modification of shoots to create the sharp thorns of the honey locust; the pollination droplets produced by the female ginkgo to capture airborne pollen from male trees; and how early New England settlers would have produced ships from native trees.

“It’s all about spontaneity: moving away from the formulaic and liberating us from old patterns,” Friedman says, noting that the Arboretum’s embrace of social media has quadrupled attendance at traditional evening events, such as talks by scientists.

New scholarly relationships

With the unlocking of data that have long resided six miles from Harvard Square, the Arboretum now finds itself connecting with the rest of the University as never before. One new partnership is with metaLAB (at) Harvard, a research and teaching unit interested in examining and expanding networked culture in the arts and humanities. The Arboretum’s partnership with metaLAB brings it into direct contact with three Harvard schools: the Graduate School of Design, which is metaLAB’s physical home; the Law School; and the School of Engineering and Applied Sciences (the latter two through metaLAB’s academic home in the Berkman Center for Internet and Society).

The metaLAB’s “Digital Ecologies” project, led by Kyle Parry, a doctoral student in film and visual studies, aims to further enrich the Arboretum’s social-media experience, and to align its digital growth with Harvard’s humanities and scientific collections in Cambridge.

Together, metaLAB and the Arboretum are examining three ideas for extending the Arboretum’s marriage of trees and technology: first, they hope to help social-media users construct records of their experiences and discoveries at the Arboretum through “digital field notebooks” by documenting and reflecting on their experiences and sharing images with the Arboretum’s Flickr stream; second, they hope—

using the sensors already placed inconspicuously on Arboretum trees, shrubs, and vines—to build deep timelines for specific organisms. These would stretch from these organisms’ origins through to the present, and extend forward into a future shaped by climate change; third, they seek ways of melding diverse perceptions of the environment, and of its individual components, into a single, unified whole.

“At the moment, in networked cultures, trees are not as obviously present,” Parry observes, “but nature and networks can meaningfully coexist, and their relationship needn’t be seen as inauthentic.”

Evolving social impact

While Friedman says the Arboretum’s social-media efforts are intended to reach anybody and everybody, he has seen particular engagement among a few specific demographics.

“Older people have responded well,” he says. “They may not care to see Facebook pictures of the party you attended last night, but the Arboretum’s involvement can show them the value of social media.”

“We want to allow people to engage with technology,” Friedman continues. “We want them to get excited about how these technologies can enhance their experiences.”

At the other end of the spectrum, Parry points out, children can be brought to an appreciation and rever-



Dana Ward



Bimal Nepal



Ryan Catalani



Amy Joyce

ence for the natural world through the judicious use of technology and social media. “Technology,” he says, “can make you pay attention.”

As part of its partnership with the City of Boston, the Arboretum is charged with helping to educate students in the city’s schools about plants, ecology, and the natural world.

“We can use electronics to draw students here,” Friedman says, “to change kids’ connection to nature.”

Leadership for the future

Friedman and Parry say that the increasingly rich, long-term, and fine-grained data now available on the Arboretum’s living collection could also point the way toward a better understanding of one of the most pressing issues of our age: climate change.

“The Arboretum is a rich repository of environmental data from the past 140 years,” Friedman says—and social-media users could add to this data by noting such annual milestones as leaf-out times and flowering times, or phenology. “It can help explain the likely effects of climate change in the coming years.”

A major initiative on this front has been launched quite recently: last year, Richard Primack, a professor of biology at Boston University, began an intensive examination of phenology and climate change using the living collections and environmental data from the Arnold Arboretum.

Over the last two years, Friedman and Tremonte say, the Arboretum has moved from the middle of the social-media pack among its peer arboretums and botanical gardens to the vanguard. The National Arboretum in Washington and the Royal Botanic Garden in London—better known as Kew Gardens—have both expressed interest in the Arnold Arboretum’s use of information technology to enhance access to data for applications in research and public outreach.

“Several years ago, the integration of social media and information technology within the botanical community was emerging and immature,” Tremonte says. “Now, they’re looking to us.” Indeed, to keep its efforts accessible to all, the Arboretum has taken care to keep its social-media efforts open-source, and to avoid creating proprietary solutions.

What else is on the Arboretum’s social media to-do list? Tremonte and Friedman are mulling the possibility of having trees “text” alerts to interested followers when blooming begins. Head-mounted cameras, worn by arborists who scale trees, could add treetop views to the wealth of data in the Arnold Arboretum Mobile Interactive Map (<http://arboretum.harvard.edu/mobile>).

Another possibility, Friedman adds, is the formation of communities around individual plants: creating Facebook pages for trees, and allowing visitors to “like” species.

“Maybe you want to find other

Above: A collage of visitor-generated Flickr photos captures the beauty of the Arboretum. Images courtesy of Kai Wang; Ryan Catalani; Karen Marlene Larsen; Ted Bradford; Dana Ward; Bimal Nepal; and Amy Joyce.

Below: Once scanned with a smartphone (download the QR Reader app), this QR code provides visitors with a direct link to the Arnold Arboretum’s Interactive Map.

people who really like sugar maples, or people who live to see a ginkgo when it’s bright gold,” Friedman says. “This gives people a new opportunity to be active, contributing members of the Arboretum.”

It’s an approach that could give the Arboretum’s noble trees their rightful place among the other endearing species that have dominated social media to date. 🌳





SCIENCE & ADVOCACY: The Legacy of *Silent Spring*

The 50th anniversary of Rachel Carson’s *Silent Spring*, a book often heralded with sparking the modern environmental movement, was celebrated with a September 28 HUCE special event, “Science & Advocacy: The Legacy of *Silent Spring*.” The panel discussion, moderated by HUCE director and Hooper professor of geology Daniel Schrag, featured *New York Times* columnist Andrew Revkin; Natural Resources Defense Council President Frances Beinecke; and writer and activist Bill McKibben. It also featured a number of Harvard faculty, including William Clark (Harvard Kennedy School); Rebecca Henderson, (Harvard Business School); Sheila Jasanoff (Harvard Kennedy School); James McCarthy (Faculty of Arts and Sciences); and John Spengler (Harvard School of Public Health).

The book chronicles the environmental harm wrought by pesticides, and is widely credited for the federal ban on the toxic pesticide DDT. Schrag called Carson’s work a “plea for a change in the course of human history,” noting that “[*Silent Spring*] is about morality as well as pesticides.”

Panelists began by reflecting on what makes the book’s lessons so enduring. Revkin explained that Carson’s treatment of uncertainty—particularly with what experts did and did not know—lent credence to her work. She presented the information in such a way that encouraged her readers to action, and let them make up their own minds—something Revkin says is lacking in today’s science discussions. “She was able to allow the reader to have authority to worry. She wasn’t telling them to worry,” Revkin said.

The panel also focused on the relevance of Carson’s work to today’s environmental challenges. “Fifty years on we very much live in Rachel Carson’s world,” McKibben said, noting that she was the “first person to knock the shine off modernity.” He urged advocacy as a means to continue her mission, and explained that simply erecting green buildings doesn’t go far enough in fighting climate change.

Speaking of Carson’s legacy, Beinecke said, “she was a fearless woman...a moral crusader of her time.” And though Carson came under scrutiny and attack from chemical and agricultural industries, she never wavered in her commitment to the cause. If she were alive today, she’d likely continue the challenge against the thousands of chemicals that surround us, and the dangers of climate change. “Would she be distressed?” Beinecke asked. “I’m sure she’d share the distress we all have, but I think she’d be motivated” to act. 🌱







EXTREME WEATHER & CLIMATE CHANGE:

In late October, HUCE director Daniel Schrag met with three other Harvard climate scientists to discuss the relationship between weather anomalies and climate change, and considered how the general public's concerns about extreme weather events might affect the scientific research agenda. The group included Zhiming Kuang, McKay professor of atmospheric and environmental science; Peter Huybers, professor of earth and planetary sciences; and Brian Farrell, Burden professor of meteorology.



Peter Huybers, professor of earth and planetary sciences.

Schrag: The United States population suddenly is thinking about climate change again, ironically because of a hurricane that may or may not have had anything to do with climate change.

Kuang: That's right, there was a similar event like this in the past, when a hurricane was tracking with a low and caused a lot of damage.

Schrag: Late October hurricanes themselves are not unheard of, but there are two aspects of this hurricane that have me intrigued. One is

that if you look at the data, sea surface temperatures off the coast of New Jersey down to the Carolinas averaged about four degrees warmer than usual. This hurricane strengthened as it traveled from North Carolina up to New Jersey, with 75 mile-an-hour winds increasing to about ninety mile-an-hour winds. That's pretty unusual when a hurricane moves north along the Atlantic coast. Even more interesting is a point that Peter has made about steering.

Huybers: If you look at conditions 1,000 kilometers north of New Jersey during the summer and the fall, we've been losing sea ice on the Labrador Sea. We've been losing snow cover in Northeastern Canada. And there's warming associated with that. And associated with the warming is the establishment of a high pressure system that's been much more prevalent there during the last five years than during the prior thirty years, the period for which we have decent records.

This system, centered right over Labrador, is associated with a clockwise circulation, which decreases the average wind speed over New Jersey, resulting in an increased prevalence of winds going from east to west than had been observed previously. I think it's clear that this is associated with Arctic warming.

Schrag: When you say prevalence, you don't mean a small change in prevalence. Since 2007 you've calculated something on the order of a fivefold change.

Huybers: It really depends how you count storm systems, but essentially, there is a fivefold increase in storm systems going east to west, as opposed to west to east. Those numbers are still early.

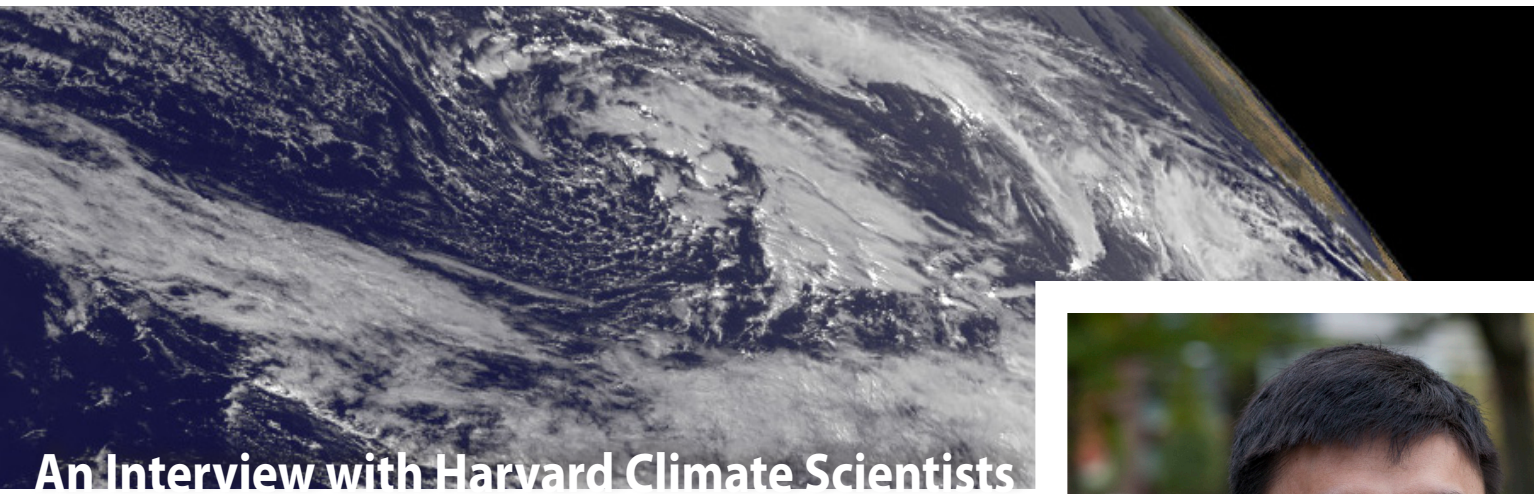
Schrag: Now you say storm systems. Do you mean tropical storm systems?

Huybers: No—all storm systems. The number of tropical storms that are coming through is small.

Farrell: If you look just at low-pressure systems, comparing storm systems that are moving west to east to those moving east to west, Peter saw that, before 2007, something like six percent were moving east to west.

Huybers: Yes. And then by our count it went up to thirty percent during October and November because, apparently, there's a routine block pattern [a blocking high, or large-scale pattern in the atmospheric pressure-field that can remain in place for days or weeks, effectively redirecting migratory hurricanes].

Schrag: In our community, beginning around 2005 when MIT professor of meteorology Kerry Emanuel linked rising ocean temperatures to increased tropical cyclone strength, the debate was defined around total energy dissipation. But energy dissipation measured during the season is actually not that interesting since most storms actually never hit land. If you had a de-



An Interview with Harvard Climate Scientists

crease in storm intensity, but an increase in landfall, that would be much more troubling than the reverse, right?

Kuang: Right. The more recent work Kerry is doing addresses that point.

Huybers: There was another paper in 2010 that found that the loss of sea ice—and the associated pattern of warming—tended to generate a high-pressure system over the Labrador and Greenland region. That’s potentially another piece of evidence for this steering effect.

Kuang: Yes, but a similar type of storm did happen before.

Farrell: “The Perfect Storm” of 1991 was actually one of those.

Schrag: The question is, could we see meteorological conditions set up by the loss of sea ice that make this a much more common occurrence? It’s all about probabilities.

Kuang: Agreed. Do you think you can ascertain that from the data we already have, or are you talking about a modeling exercise?

Huybers: I think it’s quite solid. There are mean circulation pattern changes, so we can think about the likely consequences for tropical storms.

There are other factors that one has to take into account because the circulation anomalies are complicated. It’s not simply this one high-pressure system, but I think it’s worth looking into in more detail.

Schrag: Fifteen years ago, independent of storms and tracking, Kevin Trenberth [head of the Climate Analysis Section at the USA National Center for Atmospheric Research] was writing about changes in rain rate. And what’s interesting is we have now started to see a lot of unusual precipitation events. Did you hear what happened in the summer of 2012 at the Duluth Zoo? The polar bear and seals escaped because of incredible

downpours. Seven to ten inches of rain fell in twenty-four hours, enabling the polar bear to swim out of its cage. Seals were crawling across the roads.

We have seen more and more extreme precipitation events, including thunderstorms in Maryland last July that shut down a huge swath of suburban neighborhoods, and people were out of power for weeks. Is something unusual happening?

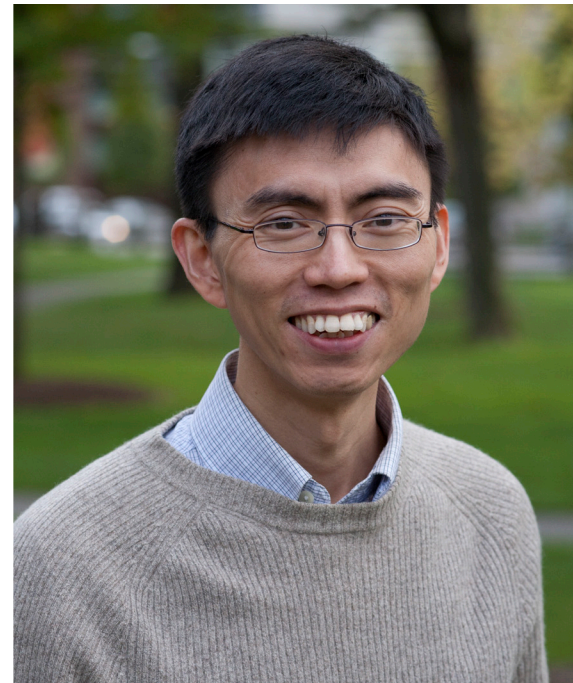
Kuang: It’s hard to say—we don’t have a theory to predict that this was going to happen. This is an attempt to link events that occur to a cause.

Farrell: Here’s the problem: we all know that as climate scientists we don’t want to say anything about specific weather events. And yet the public is freaking out because of specific weather events.

As scientists, we are afraid of the topic because we can’t nail it down. And it’s a hard problem, but a year and half ago, we talked about tornadoes...

Schrag: Yes, we did, when all those tornadoes were happening. There’s almost no work on how climate change affects tornadoes—we talked about how crude that work was. Do you think the climate community is missing something? We know it’s a hard problem, but part of the problem is that there’s a communication disconnect, right?

Huybers: I think of George Lakoff [professor of cognitive science and linguistics at the University of California, Berkeley] making a distinction between systemic causation and specific causation. He points out that we don’t have a problem saying smoking causes cancer, but for any given person who gets cancer, you can’t really say, “Well, it’s the smoking that did it.” It just changes the odds. Yet we still use causative language



Zhiming Kuang, McKay professor of atmospheric and environmental science.

when we talk about health.

For climate science you won’t find people talking in the equivalent language even if there is a statistical or probabilistic connection between events. I don’t know if that’s a cultural issue or if that’s because our problem is different because we have a much smaller number of samples to analyze.

Farrell: I wonder if the public is actually going to force us to work on this problem in a more serious way. What’s remarkable is how little work has been done.

Kuang: Fifteen to twenty years ago there was little work on climate change and hurricanes. That’s changed. So maybe going forward, things are going to change with respect to tornadoes and extreme weather events.

Farrell: I think that in the case of cancer and smoking there were plausible connections that had to do with mutations and DNA damage. So you could point to plausible connections that scientists could agree on.

In the case of increasing hurricane intensity, the theory has gone nowhere. Some



Brian Farrell, Burden professor of meteorology.

times, when hurricanes pass over warm water, they intensify. Sometimes they don't. So the theory is not good. In the case of tornadoes, there is no really good theory.

Schrag: We don't know yet how to count them—is any extreme convection event a tornado? At least with cyclones we have data. We don't even have data on tornadoes.

Farrell: Right. With tornadoes we do know that you need a lot of CAPE [convection available potential energy]. And it helps a lot if you have shear. Maybe we will end up saying something like this: if, when you raise the mean atmospheric temperature, this generates more shear, that might be conducive to more tornadoes. But the problem is, the science isn't strong.

Schrag: The science isn't strong, but we're also a conservative community, so that when the science isn't strong we like to assume that there is no connection, which is in some ways a miscommunication of the state of understanding, right?

Huybers: Maybe this conservative bent is a bad way of capturing the risk that might exist.

Schrag: Most researchers have stayed away even from thunderstorms: if you look at the literature on how thunderstorms will be affected by climate change, it's miniscule. And yet it's actually one of the ways that people are most affected.

Farrell: If you look at drought—the dust bowl—I think it is fairly well associated with climate change. Observed temperature

anomalies of as little as 0.2 degrees can give you a dust bowl. It's not well understood why, but the models tend to show it. So clearly you can get droughts of great magnitude with very small forcing. And those connections are straightforward. You don't need large climate change.

Schrag: We tend to view extreme weather events like the heat wave in March or the heat wave in Russia in 2010 in a statistical context. We're trained to think about things statistically, but in a system that's changing there's a question of how

valid statistical approaches are.

Huybers: You just need to use non-stationary statistics. It's just a matter of whether or not your statistical model is up to the task.

Farrell: You have statistics showing a correlation. And then you have the science trying to show why that is.

Schrag: I think the summer drought in the United States and the heat wave in Russia are reasons why we see a lot of scientists now starting to focus on soil moisture as a mechanism. That's a step forward, but we need to talk more about specific mechanisms.

Kuang: Yes. I think that should be an area

observe them and then search for explanations. There are a few instances where we actually predicted the phenomenon, and then went out and measured it. Usually it works the other way.

To the extent that we identify things that don't fit into our current understanding of the climate system, that's going to provide motivation for seeking the mechanisms.

Schrag: Do you think that is right?

Farrell: Well, Ed Lorenz [the MIT meteorologist famous for describing “the butterfly effect”] wrote in the first part of his book on the general circulation of the atmosphere that a person who attempts to explain the general circulation of the atmosphere without first observing it places himself at a considerable disadvantage. Essentially, if you were a desert island physicist you would not have conjured up most of what we see in the atmosphere—that is, ab initio [relying on basic and established laws of nature].

Schrag: The earth is such a complex system, that a simple theory is never going to predict the existence of most natural phenomena.

Huybers: I'm saying we should pay really close attention to things that seem out of the ordinary as a way of determining what our mechanistic explorations ought to focus on.

Schrag: Yes. Why did it get so hot in Russia? Why did it get so hot in the States for so long? And the answer is there must be something that was broken. And what was broken, probably, was that soils were so dry that they didn't provide the evaporation

“I think that the research agenda does respond to extreme weather events quite strongly. But if this winter there's a lot of snow in the west and next year we have a cool summer, do you think everybody will forget about this?”

of a lot more official research. Mechanistic explanations provide a motivation for the theorists to focus on particular areas: for example, how the weakening of the jet stream can change the climate. That hypothesis may not be correct, but the theory provides some motivation for further study.

Huybers: It's not surprising that mechanistic understanding is lagging behind the changes themselves because it's an observation-driven science. On the whole, I would say we don't predict phenomena so much as

that cooled everything off.

Farrell: That's just been advanced as an explanation for the Midwestern floods too.

Schrag: Right. You see this also in the heat wave in Texas in 2011. If you look at a soil moisture map from that period, that area is dry as a bone. What about other types of mechanisms?

Huybers: Are you trying to connect this to climate change? Are you going to argue that it was dry because of climate change and it

could cause a little change like that?

Schrag: I think we don't know yet. But at least it suggests where we should begin to look. You can at least ask, How would climate change affect soil moisture? Because if you don't ask that question you're not going to guess how climate change might cause heat waves. You might suggest that with more greenhouse gases in the atmosphere you're going to get more heat waves because it gets warmer on average. And you'd be wrong. There's actually an amplification of heat because of the soil moisture feedback, but if you didn't ask the right question you might not recognize the link.

Kuang: So how would one go about this? This probably provides motivation for particular studies on dynamics focusing on how changes in the new state are affecting the extreme. But I think from the data alone it's hard to draw a causal conclusion.

Schrag: But you might look at things that you wouldn't have looked at otherwise. For example, in Russia, you might look at the

snowpack and notice that the snowpack is reduced. Intuitively, that wouldn't be the first thing you'd look at. You'd say, Why is there a heat wave in Russia? Because there's too little snow in the winter? That doesn't make a lot of sense until you think about a mechanism, right? The snow cover in the Western U.S. was miniscule in early 2012. And the following summer there was an incredible drought and heat wave.

Huybers: Another way to phrase this is that this offers an opportunity to test our models. In some of the models we're not able to get the heat wave that was observed in Russia. That tells you that probably something is missing. Even when simulating a blocking pattern there, they seemed not to be able to model the actual excessive heat. That may be because the model didn't correctly account for soil moisture. So that's a nice falsification of the model that suggests, okay, we need to include more factors that adequately represent what's likely to happen in the future.

Schrag: I am intrigued by the idea that public concerns are going to start steering our scientific community a little bit.

Farrell: That's already happened! Our entire focus is on climate because of public concern. And the 1982 El Niño and the conditions in South America and the Southern U.S. set an entire research agenda.

Huybers: Your point is that fluctuations in the environment that have consequences for society have garnered a lot of attention. And in the case of El Niño it's a natural event. Now we're seeing some extreme events that may have a connection with climate change.

Farrell: Hurricanes are the tip of the iceberg. The heat wave in France in 2003 instigated a number of efforts. I think that the research agenda does respond to extreme weather events quite strongly. But if this winter there's a lot of snow in the west and next year we have a cool summer, do you think everybody will forget about this?

Kuang: Well, until the next big event happens, I guess.

Huybers: We won't forget about it. 🌍

FACULTY PROFILE

Forest Reinhardt

Growing up in Missoula, Montana during a late-1960s community controversy over clear-cutting in nearby federal lands, Forest Reinhardt had an early, firsthand look at the effects of environmental policy. "The discussions between people who thought that public lands ought to be used primarily for commodity production and people who thought they should be used primarily for recreation and other kinds of benefits were pretty heated," says Reinhardt, professor of business administration at Harvard Business School. "It seemed like an important and interesting set of problems to study."

Reinhardt began working at the EPA in 1979 after his undergraduate studies at Harvard, and soon recognized a disconnect that afflicted the capital. "Many of the people in the regulatory agencies never had any firsthand understanding of the people and businesses whose behavior they were trying to affect," says Reinhardt. "And that didn't seem like a good state of affairs." Eager for a chance to better understand how the natural, political, and economic systems interact, Reinhardt headed off to HBS. "I came to realize that you cannot understand those interactions with-

out understanding the behavior of firms—and understanding how the world looks at the people who lead those firms."

Today, Reinhardt is helping lead conversations about these interactions as part of Harvard Business School's Global Energy Seminar. Inspired by a 55-year-old HBS agribusiness executive seminar, Reinhardt and colleague Rawi Abdelal, HBS professor of business administration, launched the program for energy executives in 2009. "There are energy conferences every week somewhere in the world where you can look at PowerPoint presentations in a dark room. That's not what we are trying to do; we are trying to create an interactive, case-based, classroom experience in which there is a genuine opportunity for people to learn from one another." Starting conversations has been a focus for Reinhardt of late: he and fellow Harvard professor Rebecca Henderson began a business and environment initiative two years ago that includes a series of informal interdisciplinary meetings for faculty and various projects in casewriting and research.

Reinhardt points out that, contrary to much of the conventional wisdom, the world is not



running out of oil and gas. "It turns out that 'reserves' are an economic idea, not a physical idea," says Reinhardt. Forty years ago, he says, we supposedly had forty years of hydrocarbon reserves at then-current consumption rates. Since then, consumption has increased, and yet we still have 40 years of reserves. How did that happen? Basic economics, he says. As the price increased, there was a greater incentive to produce oil and develop new methods and locations for extraction. "So the idea of peak oil is a very misleading one," says Reinhardt. "We're not running out of hydrocarbons. What we will run out of—if we're not careful—is space to put the CO₂." 🌍

— Dan Morrell

Humanitarian Response to Climate Disasters

An interview with professors Jennifer Leaning and Michael VanRooyen

HUCE Director Daniel Schrag spoke in November with Jennifer Leaning and Michael VanRooyen, both physicians expert in humanitarian responses to disasters. Leaning, an associate professor of medicine at Harvard Medical School (HMS) and director of the Inter-University Initiative on Humanitarian Studies and Field Practice, served from 2005-2009 as founding director of the Harvard Humanitarian Initiative (HHI). Michael VanRooyen, HHI's current director, is an associate professor of medicine at HMS and associate professor of global health and population at Harvard School of Public Health who has worked extensively in humanitarian assistance in more than 30 countries affected by war and natural disasters. What follows is an edited excerpt of their conversation, focusing on the way that extreme events are changing the way they think about disaster relief.

Daniel Schrag: When you both got into this field, with training as emergency room doctors, you weren't thinking about the environment or climate change were you?

Jennifer Leaning: I was thinking about environmental protection and conservation, but I was thinking about disasters much more from an industrial standpoint—major explosions, fires and even earthquakes—things that would require an emergency response, and definitely from the standpoint of someone in an emergency department.

Michael VanRooyen: My work has been on both the medical response side, and also in looking at large-scale population movements. While the issue of climate itself was not on my radar at all, certainly environmental issues played a huge role: for example, drought and the Horn of Africa famines in Ethiopia and Somalia in the 1980s and 1990s. Those events were very much on everybody's mind in terms of how environmental issues can affect populations, but we didn't see it as an evolving, dynamic issue—something that would affect other communities as well.

Schrag: You still thought it was really affecting the poorest countries in the world and the most vulnerable?

Leaning: Right. Most of it was drought and famine. We both had public health degrees. I got involved in thinking about planning humanitarian responses in the mid-1980s with the major Ethiopian famine of '84. I was part of a group in the U.S. that was figuring out how to disperse aid. It was a very hectic and ad hoc time; to the extent that we were thinking of large populations it was over there, not here.

Schrag: What has changed? The climate's been changing steadily. Certainly now as a community, disaster relief experts are beginning to think about the environment in a different way.

VanRooyen: I'm perhaps representative of that relief community. We're reactive in the way that we think about large-scale emergencies, disasters, and events such as recurrent flooding in Bangladesh, for example. It's been a cyclical fixture of nature, not something that we thought of as getting

progressively worse. It took a series of 100-year disasters—huge, epic disasters happening during a short period of time—for us to say, "Something seems different about this."

Now it seems there is not only the interaction between population growth in vulnerable areas and the environment, but progressively worsening environmental emergencies, for a variety of reasons. For us, there has been a realization that climate issues are playing an increasingly important role, and that a lot of relief organizations' response-planning strategies have not accounted for that.

Leaning: I agree. A pivotal time in my thinking as I got more involved in disaster planning with the Red Cross and in teaching about disasters was in 2005—fairly late. There was the Asian tsunami in late 2004. And then in 2005 we had Hurricane Katrina and the Pakistan earthquake. Hurricane Katrina in particular really began to make a lot of us think about the vulnerabilities of coastal cities to severe storms.

Schrag: Jennifer, you were working in Rwanda and other very poor countries. And all of a sudden, you were being asked to work in New Orleans. What was that like?

Leaning: Mike and I organized a public health response to that disaster by working with the Red Cross and sending members of our group to assess the capacity to deal with medical needs and overall public health structures of the shelters that were being flung up in a rapid way, well beyond what the Red Cross had ever done before on these shores. And we were struck by the extent to which the vast population movement that ensued was not well handled.

Jennifer Leaning, associate professor of medicine at Harvard Medical School and director of the Inter-University Initiative on Humanitarian Studies and Field Practice.



Michael VanRooyen, associate professor of medicine at Harvard Medical School; associate professor of global health and population at Harvard School of Public Health; and director of the Harvard Humanitarian Initiative.

This was not a Red Cross problem. It was the overall response from FEMA on down, and also the way in which this disaster affected the vulnerable disproportionately, something we'd been talking about for years in our teaching and our observation of disasters. This event brought into harsh relief the ways in which that cohort of 100,000 people in the most flood-prone areas of New Orleans were basically abandoned by city planners and by the state, and had to fend for themselves.

It was a terrible wakeup call for all of us, not only those from the disaster and public health community, but I think also for the general public and the world at large, because it illustrated the ways in which we were not thinking ahead about population and geographic vulnerability to major floods. That event was not a once in a hundred years storm. It was just a category three hurricane when it hit a little bit off target from New Orleans.

Schrag: It hit Mississippi, not New Orleans. If it had, we could have had 100,000 dead.

Leaning: Exactly. That was when I began teaching about what were then considered outmoded approaches to disaster response that involved accommodation. In the intervening years, beginning in the 1960s and 1970s and peaking in the 1980s, planners had begun to think that we could engineer our way out of these disasters with earthquake hardening, and advanced warning systems, and so on; and that we, like the Army Corps of Engineers, were able to proactively anticipate disasters and make the environment and vulnerable cities fit for whatever nature had to send our way. But in the aftermath of Katrina, a number of us began to say, "You know what, disaster planning and our whole stance towards natural disasters has to move towards accommodation and recognition that we are not going to be able to conquer nature. We have to get out of its way or adapt." That was a very unpopular point of view. Remember, there was a movement to "build back New Orleans," and in fact that's what's been undertaken.

Schrag: Yes, except for one parish, we spent



“For the relief community, there has been a realization that climate issues are playing an increasingly important role, and that a lot of relief organizations’ response-planning strategies have not accounted for that.”

a lot of money essentially rebuilding New Orleans in its entirety. I just finished a report for the President on climate adaptation, distinguishing robustness from resilience. Resilience is sometimes misunderstood in the media, but it means increasing your ability to recover from a stress, as opposed to robustness, which is trying to withstand that stress. The relief community is really focused on resilience, right?

Leaning: Right.

Schrag: Have we learned how to make communities more resilient in the face of these major disasters?

Leaning: I think we're learning. If you look at Bangladesh, which is the poster child for resilience in terms of adaptation, the government has done a great deal during the last 25 years. With advice and help from the international community, Bangladesh has instituted improved warning systems, better evacuation directions, and shelters that are usable and within reach of people who are running or moving quickly because they have a little bit of time, given a better warning about these major cyclones.

That has led to reduced mortality from powerful storms during high tides at the time of the full moon. But there are an increasing number of people who lose their land, can't go back, and are drifting into the

low-lying cities of Dhaka and Chittagong.

With high population density my concern is that we're going to have to adopt strategies that involve out-migration in these coastal areas.

Schrag: Displaced people are not just in Dhaka and Chittagong, right? It's also in Houston, Texas from New Orleans.

VanRooyen: Katrina gave us a classic example of well-known vulnerability that was ignored.

I think that we've not come very far in the recognition of building robustness versus building resilience in many of the places Jennifer talked about. For example, even after a major catastrophe, people build on the same area again for lack of options, for lack of economic options, for lack of zoning, for a variety of reasons.

I think there are several factors at play that have continued to create more, rather than less, vulnerability. One is more urbanization and the interplay between climate, migration and urbanization. Another is that we don't as an international community have the will to invest in either resilience or robustness.

Leaning: Yes, because it would first of all involve some very serious thinking and political persuasion based on analysis of that thinking. For instance, take New York City and New Jersey post-Hurricane Sandy. We

FACULTY PROFILE

Loretta Mickley



Atmospheric chemist Loretta Mickley thinks of the atmosphere's layers, currents, and chemistry as a complex mechanism whose many components interact in strange and surprising ways.

As global climate change has raised the ante on understanding these interactions, Mickley, a senior research fellow at Harvard's School of Engineering and Applied Sciences, has illuminated the behavior of ozone, particles, and other key atmospheric constituents, technically called species. Mickley and her team of graduate students and postdoctoral fellows, for example, helped explain a "warming hole" over the eastern U.S., where particulate pollution that cooled the region in the 1980s by reflecting the sun's rays has now abated. They have also predicted more stagnant summer air over the northeast because of a decline in cold fronts pushing through from the north, and examined 100-year old measurements of ozone to better understand the atmosphere before humans altered it.


Mickley uses detailed computer models in her work, focusing on short-lived atmospheric components like ozone and smog and particulate pollution. She seeks to illuminate their ever-changing behavior and how it impacts the atmosphere on a regional basis.

"Wherever you are on the globe, while long-lived gases are warming the earth like a blanket, you're going to get lots of variation due to these short-lived species and due to local feedbacks involving snow, glaciers, soil moisture, and deforestation," Mickley says. "All of these feedbacks make interesting challenges."

Among her many projects is working to understand how wildfires might change in a warming world and, in turn, what the impacts

of their smoke might be. The smoke from agricultural fires in Indonesia, for example, could affect the health of millions of people regionally, she says. In another project, she's examining the impacts of ozone, soot, dust, and sulfate on Arctic climate. And in work conducted with former graduate student Eric Leibensperger, now an assistant professor at the State University of New York, Plattsburgh, Mickley found that recent climate change in the Northeast may have negated some of the effects of regulatory efforts to clear the air of smog ozone.

Mickley's passion for science came early in life. She recalls keeping notebooks on pollination and astronomy as a teenager, although she majored in English at Marlboro College. After a stint as an editor at World Book Encyclopedia, she followed her passion and enrolled in the chemistry program at the University of Illinois at Chicago. She earned a master's degree in chemistry there in 1990 and joined the University of Chicago for her doctoral studies, spending much of her time analyzing stratospheric ozone measurements from NASA's Upper Atmosphere Research Satellite.

After receiving her Ph.D. in 1996, Mickley came to Harvard for a postdoctoral fellowship in the lab of Daniel Jacob, McCoy Family professor of atmospheric chemistry and environmental engineering. She is now a senior research fellow. "She's done a lot of work about how climate change affects the atmospheric composition," Jacob says. "The work she does is in a very difficult area of earth science. You need familiarity with global climate models and with the intricate chemistry of the atmosphere. It's a unique capability." 

—Alvin Powell

can talk about population resilience, but Mike and I knew very well that within three or four days the population would start complaining bitterly about a range of things: electricity, transportation, food; haven't seen FEMA for weeks; where's the Red Cross?

Schrag: Yes. After three days of no running water and no electricity, life becomes really unpleasant.

Leaning: Right. It gets a little old. So this is a population that does not do well. They're cut off from the life supports of 21st century East Coast America.

These supports are critical for populations that are seriously disabled and elderly and ill who, in harsher situations, would not have survived to that stage of life. Coastal Bangladesh, where they have to move fast periodically and fairly frequently, does not have many people who are unable to ambulate.

The problem with our very wealthy technological societies, and here I would include the coastal areas of the United States in general, is first, that we have pockets of poverty where almost by definition there are fewer options. That was heralded with Hurricane Katrina. But we also have large sections of the population who cannot manage if the utilities and other engineering feats of modern cities are torn away for a week or more.

VanRooyen: An additional issue relates to that. It is not widely recognized that in the U.S., initial disaster relief is neighbor helping neighbor. It is all very local because of logistics, infrastructure, and the difficulty of reaching people.

So when people are out of power for three days or a week, the responses are local. Yet we expect to be rescued. In the aftermath of Katrina there was a huge population that essentially needed to be rescued. Whereas, if you look at places that are used to having catastrophes, they know that they are on their own for the first three days or a week anyway.

Leaning: Part of this policy work is telling people in the developed world who live in regions vulnerable to climate change that there are steps that they can take to help themselves. Of course there are things that they can ask the government to do at various stages and levels, but there are a number of things that will always remain local.

If you're going to be resilient, that includes not only preparedness plans but also recognizing that if you're on the 11th floor, and if that requires an elevator and you can't walk down 11 flights, that this is a situation where you need to be thinking about other ways or places to live.

Schrag: You've both been teaching a course on migration, again focused on places like the Sahel region of Africa, drought-stricken areas with extreme vulnerability because they're just on the edge of existence to begin with. Disaster response has traditionally focused on what happens afterwards. But in this class you are calling for preemptive interventions and migration.

Leaning: We're thinking about anticipatory things first. Part of our work involves preparedness and planning, working on steps that you can institute ahead of time if you can't prevent the flood to mitigate its impact on the population; how you can get people out of the way or strengthen systems so that the impact is not so terrible and the required response so vast, so expensive, and costly in terms of lives lost.

VanRooyen: We both work largely in the reactive community, and the heavy lifters in the humanitarian response structures, particularly around emergencies, have not sunk a lot of money, effort, or innovation into preparedness or resilience.

The best defense against vulnerability due to disaster is large-scale, well-thought out development. The relief providers have never been very good at thinking about preemptive planning insofar as building structures for resilience. They're good at preemptive planning for staging responses to emergencies. That is their business.

I'm on the board of the International Rescue Committee, and we talk about this fairly frequently. I don't see huge moves with many of the United Nations agencies such as the Office for the Coordination of Humanitarian Affairs, for example, taking major steps in thinking about building resilience. They're thinking about building better coordination and communication structures around response.

Schrag: Harvard hosted a *Humanitarian Action Summit: Climate and Crisis* workshop in May that brought together relief organizations, academics from the relief community, and climate scientists to discuss the intersection of climate change and humanitarian aid. What does the relief community need

to think about moving forward?

Leaning: I think the message is going to have to be something along the lines of improved capacity to handle larger scale displacement in longer duration distress—in other words, to build up and enhance the response capacity. And then at the headquarters or policy level, I think we should be talking about having an increasing number of agencies working with others who are beginning to assess possibilities for this mix of robustness and resilience.

Schrag: Twenty years ago, food security was at the top of the international relief community's agenda. Do events such as the 2010 Russian heat wave or the drought this summer in the U.S. that caused corn prices to spike raise the issue of food security again for the international community?

VanRooyen: Food is always a dominant issue. There are still many billions of dollars of food aid that go out every year.

Leaning: I agree. The intersection with food and security and climate change is one that needs considerable unpacking because the areas of the world that are becoming increasingly food insecure are the areas where drought and population growth are colliding. And the reliance on food aid from the United States and other parts of the world is wearing thin because there are periods when the United States is not producing all that much food for surplus exports, although the stockpiles are great.

“Part of what Mike and I have been involved in is preparing the next generation of humanitarian responders. We have the opportunity to craft a curriculum that will have a policy impact down the road.”

Schrag: Do we have an opportunity to put adaptation and preparedness firmly on the agenda for the relief community?

VanRooyen: What will drive resilience planning will be the funders; if USAID, for example, makes it a priority to put money behind it and says we need organizations that have learned this and are going to step forward and build this kind of capacity.

Leaning: The humanitarian community has become moderately stereotyped in its response. It is financed by government aid primarily. It has packages of delivery that the government says to get out there. It is overseen by its own sets of communities and a series of standards around how to bring


down indices of morbidity and mortality and how to provide good food and potable water in sufficient amounts—but it is not local. And that's the point that Mike was getting at. The development agencies that are there all the time have more enduring, stable relationships with the communities across the nonemergency periods. This is where the resilience has to be built in.

Even when ready and predeployed as a disaster is impending, the humanitarian community is positioned to arrive mid crisis, and to tide people over until the crisis abates. The structure, the mindset, the skill set and the entire body of functions of the humanitarian community are a bit wrong-footed for building in resilience. It's not that we don't know what needs are there, but the humanitarian organizations are not structured to be in the right position all the time.

VanRooyen: That's exactly right. NGOs and a large swath of nongovernmental agencies don't have independent lines of funding for doing preemptive work unless it's identified. They propose programs. They get them funded. They do them. They do the next one. The real work that needs to be done is convincing the donor or the community of funders that this kind of work is important.

Leaning: Part of what Mike and I have been involved in is preparing the next generation of humanitarian responders. We're in a position to affect some of the best and brightest who come to Harvard. We also have convening power, to bring to Harvard

people who are excellent and in leadership positions, which the summit exemplified. Our curriculum is being adjusted to proactively recognize the need to build resilience. And HHI already has a big project on urban disasters and distressed migration to cities.

These are issues that we talk about and teach in the disaster and forced migration classes that I run, and that are being institutionalized in the Humanitarian Academy at Harvard, where we're bringing all of the different scholars and practitioners who are interested in these issues together with students. We have the opportunity to craft a curriculum that will have a policy impact down the road. 

Field Notes: Undergraduate Summer Research

In summer 2012, 22 Harvard undergraduates set out to destinations near and far as recipients of grants from the Center's Undergraduate Summer Research Fund. The students completed independent and faculty-sponsored research on a variety of topics, including climate dynamics, ecology, and energy. The following is a sample of two student projects, retold in their own words.

Laila Kasuri '13

Project Title: Hydrological Modeling for Flood Management

"The main goal of my research project was to study what kind of hydrological and hydraulic models were used for flood risk reduction in the Mississippi River Basin, and whether these flood models would prove useful in better management in countries such as Pakistan. I also wanted to integrate some of these models with geospatial information systems (GIS), to produce a response plan in times of massive flood events, which would "make way for the river" and minimize risk and damage.

The goal of my summer project was to design a flood routing model in the Lower Indus Basin without compromising on irrigation and power. As part of this research, I had to acquire some formal training in GIS, and other hydraulic and hydrologic modeling software; conduct literature reading; and interview hydrologists and modelers.

The first part of the project was spent on campus where I took a Geographical Information Systems (GIS) course at

Harvard offered by the Center for Geographic Analysis. Following this two-week course, I traveled to the Institute of Water Resources, U.S. Army Corps of Engineers (USACE) in Alexandria, VA, where I met a number of water consultants, hydrologists and engineers, who introduced me to two models used for calculating water surface profiles for steady flow that are also capable of handling a full network of channels or a single river reach. This kind

Center, which is operated by the USACE. While there, I furthered my knowledge of hydraulic modeling, and worked with a number of hydrological software models. By the conclusion of my experience there, not only did I learn how to model rivers to obtain discharges and flows as outputs, I fully understood the limitations of the models as well as the limitations of the input data as well.

After these weeks of intensive learning, I

"The main goal of my research project was to study what kind of hydrological and hydraulic models were used for flood risk reduction in the Mississippi River Basin, and whether these models would prove useful in Pakistan."

of software would be helpful for countries in predicting 100-year, 200-year or even 1000-year flood events given past historical data as inputs.

After my time in Alexandria, I flew to Vicksburg, Mississippi, where I spent six weeks at the Coastal and Hydraulic Lab at the Engineers Research and Development

spent two weeks in Lahore, Pakistan where I used the skills I acquired to calibrate my own hydraulic model. The inputs for the model required obtaining cross-sectional profiles of the Indus River, discharge curves of the reservoirs, information on the existing canals and infrastructure—all in a format that could be used with GIS software.



The most rewarding part of my experience was actually interviewing the people in the basins, and conducting first-hand research rather than depending on literature. This first-hand engagement helped me immensely in understanding how federal rivers like the Indus and Mississippi are managed, where different political constituencies vie for water resources, and where states compete with one another and with the federal government for control of water. Even within the federal government, there are so many competitors and stakeholders that water has become a highly politicized issue. However, I learned from this experience that managing any rivershed, large or small, is complex, and resolving any issue pertaining to its use, management and sharing requires contextualization, for which nothing is more important than being aware of the politics, history and background, because these frame the priorities and concerns of various stakeholders.

In my field of environmental engineering, the buzz words have always been ‘energy’ and ‘entrepreneurship.’ Water was never seen as a concern, particularly on the East Coast—however, I feel certain through my past experiences that water management will become a growing global concern, especially as commodity prices rise. Many countries with a growing demand for energy will also want to utilize their hydro-power potential. The need to manage, use, and share water

resources judiciously and prudently will be of utmost significance in the future, which is why these issues have excited me. Ultimately, after graduate school in a civil and environmental engineering program, I hope to undertake both direct fieldwork and applied research so as to propose more effective policies toward water resource management, development, and conflict resolution.”

Charles Gertler ‘13

Project Title: Potential for Solar-Generated Electricity in China

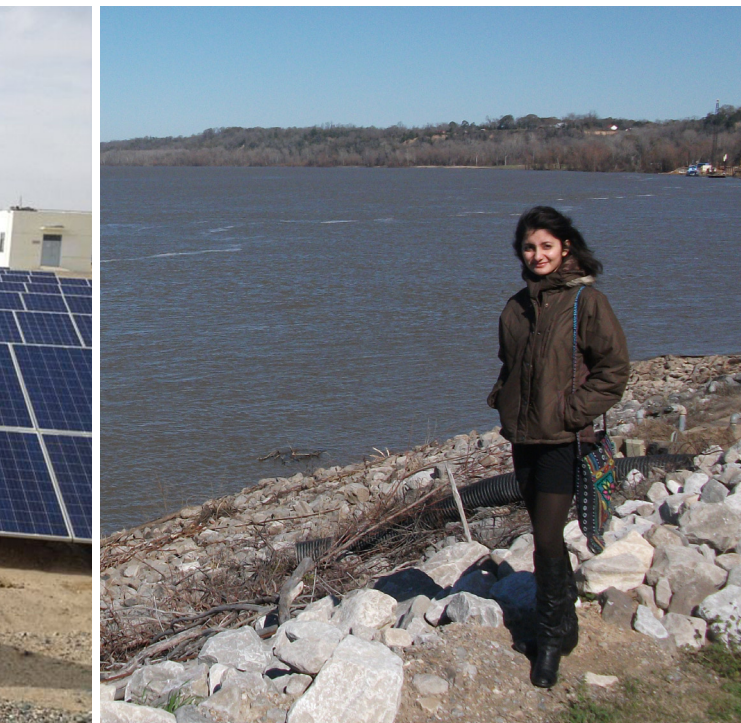
“In the summer of 2012 I began my first long-term, independent research project: a senior thesis in Earth & Planetary Sciences and Environmental Science & Public Policy. Through analysis of relevant policies, industry factors, and solar resources, my senior thesis will evaluate the total potential for solar-generated electricity in China, as well as possible wind-solar coupling (to smooth out temporal variability in the resources) and atmospheric effects (including CO₂ abatement). It is an exciting project with numerous intricacies and difficulties that my work this summer has helped illuminate.

Briefly, my research took me to three major cities: Shanghai, Beijing, and Cambridge. Immediately after my last final of the spring term, I boarded a plane to Shanghai, where I spent 6 days attending the SNEC international solar PV

(photovoltaic) conference. There, I gained a sense of the vast PV industry, especially in China, and gained appreciation for the oft-noted “commodification” of mono-crystalline and poly-crystalline silicon PV cells. I also made valuable contact with industry analysts, who have helped provide perspective for my project.

From Shanghai, I boarded the high-speed maglev train to Beijing, where I spent the majority of my time in China. For about 5 weeks, I was stationed in the Research Institute at the China Three Gorges Corporation, a company with a research partnership with the Harvard China Project (HCP). At Three Gorges, I deepened my knowledge of Chinese policies relevant to solar-generated electricity; a trip to a solar plant run by the corporation shed light on the practical challenges and considerations utility-scale solar power is facing in China. I also made important connections with developers on the ground in China. Being the only foreigner in a state-owned Chinese corporation was really exciting—eating in the dining hall, playing ping pong after lunch, going on company outings, and getting to tour a solar power facility in the western province of Qinghai,

Photos (L to R): Charles Gertler at the China Three Gorges Corporation; Gertler on a tour of a solar power facility in Qinghai province; Laila Kasuri poses by the Mississippi; Kasuri (third from right) stands before the Indus river in Pakistan.




were all fantastic experiences.

After Beijing, I made my way back to Cambridge, where I spent the rest of the summer stationed at the HCP, further researching solar power generation in general, and contextualizing industry and market development in China and internationally. There, I was in close contact with my faculty advisor, Michael B. McElroy, as well as postdoc Xi Lu, who helped keep my work in perspective with regular meetings and continued guidance.

If there is one thing I've learned in the

course of this preliminary research, it is that solar-generated electricity truly is, as is often said, a moving target. Reports from three years ago seem hopelessly out of date as the regulatory landscape, cell efficiency, manufacturing costs, and even forward projections tell stories vastly different from more recent analysis. That being said, it seems Chinese regulation and attitudes surrounding solar power and, more specifically, utility-scale Solar PV power, have reached a critical point of maturity, and can now be studied with

more stability and certainty. I am in a good position, with fortuitous timing, to write a meaningful analysis of this resource's potential in China. I think the opportunity to really dig into my research in a very immersive way has given me insight and experience that would have been hard to acquire by any other means, and hopefully this will eventually make my thesis a product I'm proud of.

The HUCE funds allowed me to experience an incredible, academically and intellectually rich summer." 

2013 Undergraduate Summer Research Award Recipients

The Harvard University Center for the Environment provides scholarships for students to complete environmental research each summer through the Undergraduate Summer Research Fund. This year, the Center awarded nine research assistantships with Harvard faculty and 12 independent research projects to undergraduate concentrators in Organismic and Evolutionary Biology, Environmental Science and Public Policy, Social Studies, Earth and Planetary Sciences, Anthropology, Slavic Languages, Environmental Health, Physics, Neurobiology, Chemistry and Chemical Biology, and Applied Mathematics. For more about the Undergraduate Summer Research Fund, visit <http://environment.harvard.edu/student-resources/undergraduate-summer-research-fund>. Summer research opportunities are made possible through the generous support of Bertram Cohn '47, Barbara "B." Wu (Ph.D. '81), and Eric Larson ('77).

- **Iananna Carter '14**, "Insect Herbivore Community of Hawaiian Lobeliads"
- **Jung (Daniel) Dong '16**, "Economic and Environmental Incentives and Capacity of Solar Infrastructures and Investments in China"
- **Claire Flintoff '15**, "Salting the Earth: A Documentary Film on the Impact of the Aral Sea disaster on Kazakh Farmers"
- **Marissa Grenon '14**, "Designing the Urban Public Realm to Promote Social and Psychological Wealth: An Examination of Three Thriving Regions"
- **Jose Rodrigo Leal '16**, will work with Professor James Anderson (Department of Chemistry and Chemical Biology) on "Multi-Regional Scale Aircraft Observations of CH₄/CO₂ Isotopic Fluxes in the Arctic."
- **Won (Ryan) Ik Lee '14**, will work with Professor Eli Tziperman (Department of Earth and Planetary Sciences) on "Deep Ocean Stratification: Observational Fit and Theoretical Exploration of Possible Models."
- **Emma Lucken '14**, "Lessons from Copenhagen and Muenster, Germany for Boston's Bike System"
- **Hannah Morrill '14**, "Needs Assessment of Community-Based Adaptation to Climate Change in Bangladesh"
- **Megan Murdock '14**, "Biofuel Collection Analysis at Makerere University Biological Field Station at Kibale National Park (Uganda)"
- **Li Eleanor Murphy '15**, will work with Professor Chensheng (Alex) Lu (Harvard School of Public Health) on "Honeybee Health and the Eco-politics of CCD."
- **Ekta Jayantilal Patel '15**, will work with Professor Chad Vecitis (School of Engineering and Applied Sciences) on "Water Treatment Technologies: Electrochemical Filtration."
- **Jun Shepard '14**, will work with Professor Michael McElroy (School of Engineering and Applied Sciences / Department of Earth and Planetary Sciences) on "The Use of Dye-Sensitized Solar Cells as a Primary Energy Source in the United States."
- **Joseph Wall '14**, "Public Markets, Supermarkets, and Local Agriculture in Rural Mexico"
- **Kate Wetstone '15**, will work with Professor Chad Vecitis (School of Engineering and Applied Sciences) on "Water and Wastewater Treatment Technologies."
- **Kristen Wraith '14**, "The Peruvian GMO Ban: The Importance of the Ayllu as an Ecological System for Change"
- **Didi Xie '14**, will work with Professor Michael McElroy (School of Engineering and Applied Sciences / Department of Earth and Planetary Sciences) on "Reducing Chinese CO₂ Emissions Through Effective Use of Wind."
- **Howard Zhang '15**, will work with Professor Joseph Aldy (Harvard Kennedy School) on "The Economic Returns to Investment in Clean Energy." 

Workshop Examines Climate Change and Human Response in the History of Western Eurasia from AD 1 to 1600

By Francis Ludlow, Ziff Environmental Fellow

On November 28, the Harvard Initiative for the Science of the Human Past and the Harvard University Center for the Environment (HUCE) co-sponsored a day-long workshop on “Climate Change and Human Response in the History of Western Eurasia, AD 1-1600.” Convened and chaired by Michael McCormick, Goelet professor of medieval history, the workshop brought together scholars from all sides of the traditional divisions between the humanities, social and natural sciences. The goal was to review recent progress and explore the potential to further combine historical and archaeological records with high-resolution palaeo climate proxy data to better understand the development of climate across this broad period and region—and ultimately, climate’s influence on human society.

The workshop was preceded a day earlier by a lecture entitled “Climate and Cultural Change in Western Eurasia: Progress and Challenges from Millennia-Length Tree-Ring Records,” delivered by Edward R. Cook, Ewing research professor at the Tree-Ring Laboratory, Lamont-Doherty Earth Observatory of Columbia University. Cook, who co-founded the lab in 1975, has contributed his expertise in dendroclimatology to provide an environmental backdrop to major cultural changes in the Americas and Eurasia. For example, he identified the role of climate variability in the eventual decline of Angkor, the capital of the Khmer Empire in Cambodia, via the twin stressors of alternating multi-decadal drought and markedly intense monsoon years in the fourteenth and fifteenth centuries. He documented these stresses through a hydroclimatic reconstruction based on seven and half centuries of data from nearby Vietnamese tree-rings.

Cook’s lecture provided a striking preface to the workshop by introducing ongoing developments in the field of dendroclimatology, particularly the creation of millennia-length tree-ring chronologies and associated climate reconstructions for regions previously lacking proxy-based historic climate data. He reviewed recent

successes in synchronizing marked climate fluctuations with episodes of major cultural change that have been documented in the historical and archaeological record. At the same time he stressed that such efforts must be contextualized by recognizing uncertainties in climate reconstructions, and by acknowledging the complex relationship between humans and their environment. For example, proxy data also document instances of severe multi-decade-long droughts without any clear corresponding societal stress.

These considerations were carried into the workshop the following day. Among the participants in the workshop, there

Natural scientists must work directly with their colleagues in the human and social sciences in order to understand the relationships between climate and historic social change. The input of climate scientists is crucial to negotiating uncertainties in available climate reconstructions.


was a general understanding that attempts at uncovering simple, direct associations between climate change and social outcomes can be confounded by complex and potentially idiosyncratic societal responses.

The workshop considered at length the methodological challenges inherent in linking social and cultural responses to changes in climate, since climate can operate on a wide range of spatial and temporal scales. HUCE director Daniel P. Schrag remarked upon the unsuitability of globally or hemispherically-averaged climate reconstructions as input into such studies. He stressed the need for regional reconstructions of climate, in which

changes are often more dramatic and apparent, and which are likely to be more relevant to individual historic societies and their networks of trade and communication.

Natural scientists must work directly with their colleagues in the human and social sciences in order to understand the relationships between climate and historic social change, workshop participants agreed. The input of climate scientists was regarded as crucial to negotiating uncertainties in available climate reconstructions such as the onset, magnitude, seasonality and spatial extent of proposed large-scale climate phases including the Medieval Climate Anomaly (circa AD 900 to 1300) and Little Ice Age (circa AD 1350 to 1850).

In energetic exchanges, historians, archaeologists and other scholars of the human past were called upon to delineate the complex mechanisms by which climate change might promote significant social and cultural responses. Discussion ranged from the impact of extreme weather and abrupt climate change on food security, to the evolving disease environment experienced by societies under particular climate conditions. Climate scientists, for their part, were challenged to tailor their reconstructions to those variables most relevant to historic societies, such as the timing and length of the growing season. The workshop highlighted the fact that historians and other social science scholars must lead the way in identifying the means by which climate change might influence society in one period or region but not in another.

In conclusion, professor McCormick remarked on the striking extent to which historians and related scholars have begun to incorporate disciplinary terminology and results from the natural sciences in their work. He remarked, moreover, upon the extraordinarily rapid convergence of shared research concerns between the natural and human sciences at a time when a fuller understanding of our climate’s past and its influence on humanity has never been more relevant for the future. 

Introducing the 2013-15 Environmental Fellows

HUCE extends a warm welcome to its newest cohort of postdoctoral researchers, a diverse group of scholars who work with Harvard faculty to tackle complex energy and environmental challenges.

Pedram Hassanzadeh, Ph.D. Mechanical Engineering, UC Berkeley

Pedram is a fluid dynamicist interested in climate dynamics, particularly the effect of climate change on extreme weather events.

Pedram's Ph.D. research used numerical simulations and mathematical models to explore geophysical and astrophysical vortices to improve our understanding of their dynamics and their roles in oceans and atmospheres.



Pedram will work with Brian Farrell (Dept. of Earth and Planetary Sciences) to study jet streams and atmospheric blocking events in a warming climate. Improved understanding of the blocks will then be used to investigate changes in some types of weather extremes in a warming climate, such as heat waves, cold spells, and heavy precipitation events.

Nathaniel Mueller, Ph.D. Natural Resource Science & Management, University of Minnesota

Nathan is an applied ecologist who studies

how agricultural systems influence—and are influenced by—environmental change.

Nathan's dissertation research analyzed environmental tradeoffs to intensifying crop production at the global scale and how climate change may influence capacity for agricultural intensification.



Nathan will work with Peter Huybers (Dept. of Earth and Planetary Sciences) and Noel Michele Holbrook (Dept. of Organismic and Evolutionary Biology) to improve statistical models relating climate to crop yields. His work will also investigate the interaction between changing agricultural management practices and climate using recently compiled time-series data.

Charles Willis, Ph.D. Biology, Duke University

Charlie is an evolutionary ecologist interested in the impacts of climate change on plant biodiversity in North America.



Charlie's dissertation research focused on understanding how dispersal and adaptive divergence to climate influenced the diversification and speciation of *Brassicaceae cakile* (sea-rocket).

Charlie will work with Charles Davis

(Dept. of Organismic and Evolutionary Biology) to explore how climate change will affect continental-scale patterns of biodiversity and phylogenetic diversity in North America. His work will incorporate a large-scale climatic niche modeling effort to assess which plant species will be winners and losers under future climate change scenarios, and whether these species are concentrated in specific branches of the tree of life.

Danielle Medek, Ph.D. Plant Physiology, Australian National University

Danielle Medek is an ecophysiologicalist, with interests in medicine, plant ecophysiology, and global change.



Danielle's Ph.D. research explored cold tolerance in subantarctic grasses, and suggested trade-offs between nitrogen use efficiency and hydraulic safety in cold environments. Danielle is also finishing a medical degree (MBBS) at the Australian National University.

Danielle will work with Samuel Myers (Harvard School of Public Health) to investigate the effects of climate change on human nutrition. In particular, Danielle will focus on how rising CO₂ levels may influence crop nutrient content and thereby the global burden of disease from nutrient deficiency. 🌱

Reflections on Rio

HUCE provided funding for Sachi Oshima '13, Organismic and Evolutionary Biology, to attend the Rio+20 Earth Summit in Brazil this past summer. She recounts her journey here:



In the wake of the United Nation's Rio+20 Earth Summit, popular opinion of the outcome is clear: "colossal failure," one observer called it. The summit, held in June 2012 in Rio de Janeiro, marked the 20th anniversary of the original Earth Summit, in which the world's top leaders gathered to sign two groundbreaking treaties promoting sustainable development. This time, few key leaders even showed up, and the resulting official declaration lacked consequential substance.

I received funding to attend the Rio+20 Summit from HUCE, and I traveled there as part of the faction from the New Economics Institute, a think tank based in the Massachusetts Berkshires that is dedicated to advancing economic policies that promote environmental health and human well being. This was my first experience in the interna-

tional policy sphere, and I walked into the conference with the inexperienced eyes of a student, and few expectations. After 10 days in Rio, almost 40 events attended, and one full notebook, I left the conference with two main conclusions, reasons to hope that Rio+20 was not a complete failure.

First, Rio+20 created a wealth of conversations, brought an astounding number of people together, and allowed numerous meaningful dialogues to occur, even if not all among our official delegates. I had the privilege of carrying a photo ID that allowed me to pass through the metal detectors, and into the official UN tents of the Rio+20 conference. But even for those who did not have this badge, there were more than 3,000 related events occurring throughout the city during the conference. Every day I sifted

Environment @ Harvard

A sampling of the spring semester's events

Ongoing Series

The Future of Energy

The Future of Energy lecture series, which focuses on finding secure, safe, and reliable sources of energy to power world economic growth, kicked off the spring semester with a talk by **Allison Macfarlane**, Chairman of the Nuclear Regulatory Commission. She touched on the Fukushima Daiichi nuclear disaster, and explored how to best regulate nuclear power plants in the current political and economic climate.

The Center also hosted **Sir David King**, former Chief Scientific Adviser to the British government under prime ministers Tony Blair and Gordon Brown; currently Director, Cambridge Kaspakas; Senior Science Advisor, UBS; Chancellor, University of Liverpool. Sir David explained that the Earth's pressing environmental challenge is not a booming population, but rather, how many members of the middle-class it can support. There are already signs the growing middle class is prompting increased competition for resources in global markets for oil, food, and minerals, King said. However, there have been positive developments and change in some countries, like China, where middle class population growth is rapid.

The series concluded with a talk by

Jonathan Rose, President, Jonathan Rose Companies, a multi-disciplinary real estate investment, development, planning, and consulting firm. Rose spoke about developing affordable green housing, a growing sector particularly important in the face of population growth.

This lecture series is sponsored through generous support from Bank of America. Past lectures can be viewed online anytime at <http://www.environment.harvard.edu/events/video>. Stay tuned to our website for the upcoming Fall 2013 list of speakers.

Geoengineering: Science & Governance

This new seminar series, held jointly by the Harvard University Center for the Environment and MIT's Joint Program on the Science and Policy of Global Change, explores the science, technology, governance and ethics of solar geoengineering. In bringing together international experts, participants explore the challenges and opportunities of geoengineering, and analyze how this technology could and should be managed.

The inaugural installment, "The Risks and Efficacy of Solar Geoengineering," took place in October with **David Keith**, McKay professor of applied physics in the School of Engineering and Applied Sciences and professor of public policy in

the Harvard Kennedy School.

The series continued in December with a lecture on "International Governance of Climate Engineering" by **Edward Parson**, professor of law, UCLA.

The series concluded in early May with a talk by **Ken Caldeira**, senior scientist at Carnegie Institution's Department of Global Ecology, Stanford University and professor in the Department of Environmental Earth Systems, Stanford University, on "The Physical Science of Solar Geoengineering."

Visit www.environment.harvard.edu/geoengineering for more information.

Energy Materials at Harvard

This lecture series, which was revived by the Harvard University Center for the Environment in the spring semester, focuses on how new energy materials, which are central to every energy technology, can help raise energy efficiencies and resolve emissions problems.

The series began with a lecture by **Jin Suntivich**, HUCE Ziff Environmental Fellow, on "Material Challenges for Clean Electric Vehicle Applications." His talk explored the pursuit of clean and cost-effective electric transportation.

The series also brought **Thomas Jaramillo**, assistant professor of chemical engineering at Stanford University, to campus in early May for a discussion on "Catalyzing Key Chemical Transformations for Renewable, Sustainable Energy."

through the multitude of events to choose only a select few. The topics ranged from agroforestry to clean energy technology to innovative poverty alleviation policies. The events brought together activists, government officials, business leaders, and students: dedicated citizens engaged in meaningful discussions. These conversations proliferated outside official venues. For instance, I will always remember discussing indigenous rights with a tribal leader from British Columbia on the long plane ride back from Rio, as well as my conversation with a former environmental judge from Pennsylvania during the bus ride from the conference to the hotel. These conversations must continue and grow beyond conference walls in order to make progress.

Second, there was an impressive youth

presence at the Rio+20 conference. Although their impact could have been more strongly felt, Children and Youth was one of nine major groups represented at the conference, and that constituency released statements and responses to official decisions alongside NGOs and business leaders. Sadly, in remarks during the closing ceremony, the Children and Youth representatives were given only two minutes to make a statement.

While my peers and I may not have the experience of others in the field, we are hopeful, determined and ready to engage directly with the challenges of climate change, poverty, and sustainable development. These are the inescapable issues of our generation, and they are going to require some creative solutions. It is time for young people to collaborate on creative solutions, and to

be given the time, and the forum, to speak about what we are willing to do to achieve our goals for the future. 🌱

Photos: Sachi Oshima poses in Rio de Janeiro (left); A display of naturally-colored organic cotton outside the Summit tents (below).



Ongoing Series Continued Science & Democracy

This series, co-sponsored with the Harvard Kennedy School Program on Science, Technology, & Society, explores the benefits of scientific/technological breakthroughs and the harmful consequences of inadequately understood developments. This past Febru-

Publication Note

SPRING/SUMMER 2013

The Harvard University Center for the Environment (HUCE) encourages research and education about the environment and its many interactions with human society. By connecting scholars and practitioners from different disciplines, the Center seeks to raise the quality of environmental research at Harvard and beyond.

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Daniel P. Schrag,
Director

James I. Clem,
Managing Director

Kellie Corcoran Nault,
Communications Coordinator,
Designer

All portraits by **Claudio Cambon**
unless otherwise noted.

ary, **Sir Paul Nurse**, Nobel Laureate and President of the Royal Society of London, and Director, UK Centre for Medical Research and Innovation, traveled to Harvard for a lecture on “Making Science Work.” His talk was followed by a panel discussion with Eric Lander (Broad Institute and Biology, MIT), Lisa Randall (Physics, Harvard University), and Charles Rosenberg (History of Science, Harvard University). The discussion was moderated by Sheila Jasanoff, Pforzheimer professor of science & technology studies, Harvard Kennedy School.

New Directions in EcoPlanning

This seminar, co-sponsored with the Harvard Museum of Natural History, honors an individual who is making outstanding contributions to the integration of biology, conservation biology and ecology and the fields of land-use and environmental planning, architecture, and related sectors. This year, **Antje Stokman**, professor and director of the Institute of Landscape Planning and Ecology at Stuttgart University delivered a lunch seminar and public talk on “River. Space. Design: Towards a New Urban Water Culture.” She focused on how human relationships with water result in very different landscape and city forms. She also outlined a vision for reintegrating the dynamics of water into our cities in order to meet broader human, ecological, and aesthetic objectives.

HUCE Workshop

Workshop on Clumped Isotopes

This past January, HUCE hosted the 3rd International Workshop on Clumped Iso-

Comments

Do you have a comment you'd like to share? Send your thoughts to the Center for the Environment at huce@environment.harvard.edu, and let us know if you'd like to continue receiving this newsletter.

topes. The workshop drew scientists from across the globe active in studying multiply-substituted isotopologues (or clumped isotopes), a growing field within Earth sciences. Attendees shared insights into clumped isotope systematics; explored applications to the study of paleoclimates; and discussed new avenues of clumped isotope research.

Special Lecture

The Dust Bowl: A Discussion with Ken Burns

Academy Award-winning documentary filmmaker **Ken Burns** visited Harvard in November to share clips from “The Dust Bowl,” his new PBS film that chronicles the environmental disaster that struck the Great Plains in the 1930s. The catastrophe, which was caused by severe drought and poor agricultural practices, is often called one of the worst human-created environmental disasters in history. Burns shared stories of his craft, and devoted much of his talk to a question-and-answer segment moderated by HUCE faculty associate **Robin Kelsey**, Burden professor of photography and chair of the Department of the History of Art and Architecture. The talk was co-sponsored with WGBH Boston. ■■

