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SUMMER 2013 | ENVIRONMENTAL SOLUTIONS IN ACTION

IS CONSERVATION EXTINCT?

A new look at
PRESERVING BIODIVERSITY

PLUS:

GLOBAL GROUNDWATER

10 *lessons for* **TODAY'S CHILDREN**

placemaking, black carbon, organic meets genetically engineered & more

REMEMBERING THE DREAMS OF OUR ANCESTORS

THIS PAST SPRING, I was asked to give a commencement speech. In a moment of weakness, I agreed to do it.

I normally don't fret about the speeches I have to give, but this one had me sweating. What was I going to say? What lessons could I share? After worrying for weeks, I decided I would share the stories of ordinary people — ordinary people who did extraordinary things.

The first person I spoke about was named J. Edward. He was born in 1878, the son of a bricklayer who worked himself to death at the age of 32. Even though he was only 8 years old at the time, J. Edward started working to support his family, and he worked every day until he turned 90. His story is the quintessential American story: He started with *nothing* — but he worked hard, focused on helping his family and community, and eventually became a successful business leader.

Years later, as J. Edward lay dying, his family got a little bigger. His daughter-in-law was giving birth in the same hospital, one floor away.

The mother's name was Joan. She gave birth to a boy with a severe bacterial infection that covered his body, and he was not expected to live through the night. Joan refused to accept that and took him home to care for him. She went without sleep for days, boiling every scrap of fabric that touched his skin, and managed to keep the infection at bay. The boy lived. Doctors told her she saved her son's life; without her determination, he would not have survived.

They taught us that the key to a great life is to ***live for people you may never live to see.***

Like her father-in-law, Joan stood up when the chips were down, and gave everything she had for someone else.

Unfortunately, that boy's story was going to turn out differently. He couldn't help his mother when, 15 years later, she was diagnosed with ALS (Lou Gehrig's disease) — a degenerative neurological disease. He could do nothing while she was in agony, slowly dying in front of him. Here was the woman who gave him his life, and against all odds saved it, and he was powerless to help her.

The last thing his mother told him was that she was ready to die — it would release her from tremendous pain — but she wasn't done being his mother. Her last words to him were, "I can't be there for you anymore, so I need you to promise me something. *I need you to be the best person you can be."* She gave him one last gift: the gift of a lifelong direction. And that boy swore that he would do everything he could to follow it.

She died the next day. And he has been trying to figure out how to live up to that promise ever since.

As you probably guessed, I was that boy.

My mother and grandfather were ordinary people, but they did extraordinary things. When life became difficult, they didn't wallow in self-pity: They rolled up their sleeves and did something for those around them and those who would live after them. *In short, they lived good lives, and they gave something to the future.*

Of course, many families have similar stories of ordinary people who did extraordinary things. And these people all had something in common. They all lived according to a dream, something we used to call the "American Dream." This dream isn't uniquely American, of course. Many people around the world share it.

Unlike the current so-called American Dream — which seems to be about getting rich without working very hard, having a fancy house and car, and living like there's no tomorrow — the old American Dream is about building a better future. It's a dream that says *we should work hard, play by the rules, give something to our community and make sure our children have a better life than we did.* It says *creating a better future is more important than living comfortably in the present.* I think the lesson our ancestors taught us is that a meaningful life is not one lived for ourselves; it is one lived for others. They taught us that

PHOTO BY JOSH KOHANEK

the key to a great life is to live for people you may never live to see.

As I shared these stories with the audience members, I asked them to consider the lessons that could guide us along the way. I asked them to be guided by hope. And I asked them to develop a sense of history. We are at our best when we see we are connected to those who came before us, those we share the world with today and those who will come after we are gone.

I don't know what the audience made of my speech, but I know I learned something preparing it.

The challenges of the future might be met by remembering the lessons — and dreams — of our ancestors. They accepted the challenges of their time and rose to meet them. Will we?

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+FOR A COMPLETE TRANSCRIPT OF THE SPEECH: **ENSIA.US/GRAD**

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ENVIRONMENTAL SOLUTIONS IN ACTION

INSTITUTE ON THE ENVIRONMENT

UNIVERSITY OF MINNESOTA
Driven to Discover℠

Ensia is a magazine and event series showcasing environmental solutions in action. Powered by the Institute on the Environment at the University of Minnesota, we connect people who can change the world with the ideas and inspiration they need to do so. Ensia is funded in part by a major grant from the Gordon and Betty Moore Foundation. To subscribe, change your address or request an alternative format, email subscribe@ensia.com. To sign up for e-alerts, go to ensia.com/subscribe.

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ON THE COVER African elephant image ©iStockphoto.com/Taalvi and jar image ©iStockphoto.com/Jasmina81. Concept executed by Ensia.

DEPARTMENTS

FEATURES

FRAMED FARM BY DAVID WELLS | PHOTO BY ANN FOLEY

CARBON COUNTER

Think of a company that's a sustainability leader. A real visionary when it comes to protecting the environment. OK, stop. I bet Microsoft didn't come to mind. Perhaps surprisingly, the company is taking real steps toward becoming a "green tech" leader, thanks in large part to efforts by the company's senior director of environmental sustainability, **TJ DiCaprio**. In 2012 DiCaprio led the charge to launch an internal carbon fee that puts a price on carbon emissions from data centers, software development labs, offices and air travel. Funds raised through this fee are used to support renewable energy and carbon offset projects throughout the company. Ensia reached out to DiCaprio to learn more about Microsoft's efforts to address climate change through carbon reduction.

INTERVIEW BY TODD REUBOLD | PHOTO BY MERYL SCHENKER

HOW DID THE IDEA FOR AN INTERNAL CARBON FEE FIRST ARISE? Microsoft has been tracking emissions since 2009, and we had an earlier goal to reduce our carbon emissions 30 percent by 2012 based on 2007 levels. We met that target through driving efficiencies, investing in renewable energy and purchasing renewable energy. Once we met that goal, though, we realized that with the information and communication technologies industry contributing 2 percent of global emissions and growing, we needed to take a bolder approach. So we set a carbon neutral policy across the company. The carbon fee is really an incentive under our carbon neutral policy.

HOW DID YOU BUILD THE CASE INTERNALLY FOR A CARBON FEE? Well, the important thing was helping senior leadership understand pollution and how to really speak the language of pollution. By putting a price on carbon, suddenly the key leadership of the company understood the external impact of greenhouse gas emissions on our business, and we were able to then drive that accountability across the company. So it was [about] speaking the same language, then really presenting the business case and leading with the business case to the executives.

IT'S LEARNING THE LANGUAGE OF SUSTAINABILITY SO YOU HAVE A SHARED COMMON BOND? Yes. It enables engagement, brainstorming, creativity and understanding, and it opens doors to collaboration and cohesion in ways that we couldn't have imagined otherwise.

HOW ARE YOU DETERMINING THE FEE? The most important thing for us is to set the price signal so we have a common language, and then to evolve that over time. Currently we have price signals that are set based on the source of the greenhouse gas emissions, for example from electricity or business air travel. We're evolving that pricing model into a blended price so we can increase that over time with the goal being impacting behavior change.

By putting a price on carbon, ***suddenly the key leadership of the company understood the external impact of greenhouse gas emissions on our business.***

PROGRESS TO DATE? It's been over nine months since we kicked off the carbon model, and we've made significant progress in building the infrastructure — what we refer to as the plumbing of the model. For instance, I was just speaking to one of our general managers with our online business division, and he was talking about the ability to now incorporate the carbon price into long-term planning. Now there's an incremental cost associated with operational costs, and that's being included in long-term planning. That's a real step forward.

And the buy-in is what's really exciting. We established a carbon neutral council, and representatives from all across the company, or 14 different business divisions, get together on a monthly basis and discuss the progress, evolution and use of funds [from the internal carbon fee]. We're seeing quite a bit of passion and creativity coming forward to drive innovation — for instance, investing carbon fee funds into long-term internal improvements and efficiency projects across the company. The group from Bing said, "This is such a terrific start; we want to know how we can do more to support carbon reduction." Those are the types of conversation that the carbon fee model has enabled.

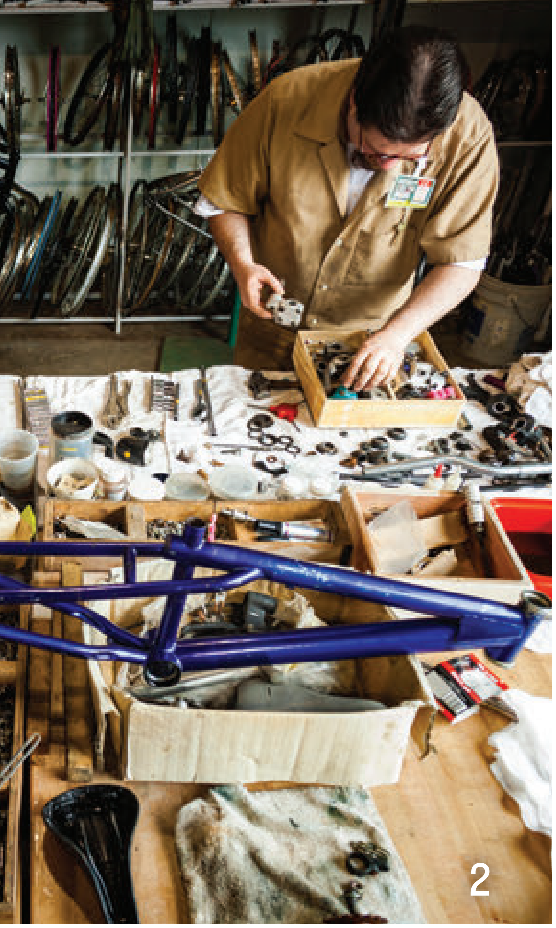
ANY CHALLENGES SO FAR? We have so many bright people asking, "How can we evolve this faster?" There's quite a bit of education and awareness that goes along with a program like this because it is a game changer. So the challenge is balancing between evolution and keeping the program simple.

ON TWITTER YOU MENTIONED THE IMPORTANCE OF THIS MODEL BEING "REPEATABLE." WHY IS THAT IMPORTANT? The exciting thing is that the solution is simple. It is repeatable. Certainly others need to customize it for their own financial structure. At Microsoft, we designed the carbon fee purposely to be repeatable so that other organizations can [implement] the model. Because while we're keeping our own house in order and making progress, Microsoft is just one organization. To have a bigger impact, we encourage and want to help other organizations implement models similar to this.

And the response has been very positive from different types of organizations, whether they're Fortune 100s or educational organizations, and even local, regional government up to the federal government. They're all looking at this as a way to help drive efficiencies and carbon reduction within their own internal operations.

DO YOU HAVE TO BELIEVE IN CLIMATE CHANGE TO SUPPORT THIS MODEL? What's important about the model is driving business objectives, and part of that is mitigating risk. It's mitigating risk from the organizational perspective or mitigating risk to revenue. And that translates into cost, and costs are relevant across any organization and any sector. So those two primary business goals are a key focus that can frankly be independent of the pros or cons of taking a position on climate change.

WHAT MORE CAN COMPANIES LIKE YOURS DO IN TERMS OF ENVIRONMENTAL STEWARDSHIP? Microsoft has invested quite a bit in driving additional energy efficiency measures, and we're asking ourselves questions such as, how do we use less? How do we provide more for less? How do we leverage innovative, clean energy as a source? And how do you use technology as part of the solution and to change behavior around energy use?



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DOING GOOD WHILE DOING TIME

BY MONIQUE DUBOS | PHOTOS BY BENJAMIN DRUMMOND

The Sustainability in Prisons Project is reducing the environmental footprint of Washington state's correctional system while preparing inmates to work in the green economy on the outside. A partnership between The Evergreen State College and the state Department of Corrections, SPP engages prisoners through science education and training, sustainable operations, and research and conservation projects. Launched in 2008, SPP has reduced the environmental impact of housing, feeding and clothing the more than 17,000 prisoners in the corrections system. These scenes depict some of the activities underway at Stafford Creek and Cedar Creek corrections centers.

+ WATCH THE VIDEO: **ENSIA.US/PRISONS**

5

(1) Inmates gain appreciation for nature's benefits as they tend vegetables they will eventually eat for dinner. **(2)** Residents restore bicycles and donate them to local communities. **(3)** Beekeeping helps researchers understand colony collapse disorder and gives inmates skills for future income. **(4)** Inmates plant seeds for a prairie restoration project at nearby Fort Lewis. **(5)** Offenders can attend monthly lectures on science, sustainability and green-collar jobs.

2030

What will the world be like in 2030? Your guess is as good as ours — but the National Intelligence Council's is probably even better. Global Trends 2030: Alternative Worlds, available at **ensia.us/2030,** offers a research-based peek into the future.

1 TRILLION gallons of water used to produce food that ends up wasted each day —*National Geographic*

PHOTO COURTESY OF LANDFILL HARMONIC

LANDFILL HARMONIC

What do you get when you cross an empty oil can with kitchen utensils? Music, if you live in the slums of Cateura, Paraguay. Go to **ensia.us/landfillharmonic** to watch a youth orchestra perform with instruments made of trash from the remnants of our throwaway civilization.

SILENT GREEN

Among the many benefits green roofs and walls provide to cities is a quieting effect as leaves absorb sounds bouncing off roads, buildings and other hard surfaces. But what arrangement of vegetation works best? A research team from Belgium developed a model that predicts green roofs hold the most opportunity for buffering noise, followed by green façade walls. Best of all? A combination of vegetated screens on roof edges and a green roof or green wall.

225,000 number of wind turbines in the world at the end of 2012

MICROLOANS, MACRO BENEFIT

The world is full of people in need of safe drinking water and sanitation, people engineering solutions, and people who would be glad to help save lives by boosting access to healthful water infrastructure. How to connect them? WaterCredit, a microfinance program, has provided more than 100,000 small loans totaling more than $17.4 million since 2003 to families and communities to bring clean water infrastructure to their homes and villages in India, Bangladesh, Kenya and Uganda. The program counts on its high loan repayment record — 99 percent since 2007 — to recycle funds into further projects. Learn more at **ensia.us/watercredit.**

4-FOR-2

Nations around the world have recognized a 2 degree C elevation in atmospheric temperature as a point of no return for climate change. The International Energy Agency recently outlined an ambitious but achievable four-step plan for staying within that limit: boost energy efficiency, limit construction and use of the most polluting coal power plants, halve methane released in fossil fuel production, and begin to phase out fossil fuel consumption subsidies. Learn more at **ensia.us/4for2.**

© ISTOCKPHOTO.COM/RZELICH

20,934

species on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species

BACTERIA BUDDIES

A solar-powered water filter developed by environmental engineers from the University of Cincinnati shows promise for using proteins derived from bacteria to remove antibiotics from lakes and rivers better than existing filtering technology based on activated carbon. Antibiotics are undesirable in surface waters because they can harm beneficial microorganisms and contribute to antibiotic resistance in germs. See for yourself at **ensia.us/nanofilter.**

CHANGING TIMES

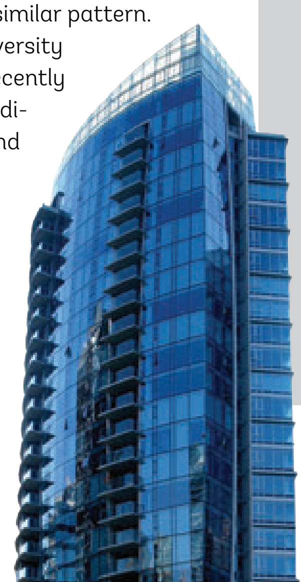
Think the seasons aren't what they used to be? You're probably right. Changes in phenology — the timing of natural events — in recent years include earlier arrival of spring migrating birds in upstate New York, a shift in the peak of rains in the Sonoran Desert from October to December, and earlier blooming of winter wheat on the Great Plains. Check out other signs of change across the U.S. at **ensia.us/phenology.**

INCOMING

Some 5 million tons of buildings, boats, personal belongings and more were washed into the Pacific Ocean by the tsunami that struck Japan in March 2011. Where is all that debris now? While some 70 percent sank, simulations indicate much of the rest is about four-fifths of the way to North America. Learn more at **ensia.us/tsunami.**

MAKING BIGGER BETTER

Larger animals are more energy efficient than smaller ones — a phenomenon known as Kleiber's Law — and it's long been assumed that cities follow a similar pattern. A research team led by Boise State University economics professor Michail Fragkias recently tested the notion using data on carbon dioxide emissions as a proxy for energy and surprisingly found no energy-efficiency economy of scale between big cities and small ones. The discovery suggests potent opportunities for increasing efficiency through strategic growth as cities' share of global population booms from just over 50 percent today to nearly 90 percent in 2100. Learn more at **ensia.us/scale.**



3.4 BILLION people living in cities in 2009

6.4 BILLION people expected to live in cities in 2050

—*World Health Organization*

CHANGING COURSE FOR CONSERVAT

PHOTO © GEORGE STEINMETZ/CORBIS

AS HUMAN POPULATION AND RESOURCE DEMANDS SOAR AND CLIMATE CONDITIONS SHIFT, TRADITIONAL APPROACHES TO NURTURING NATURE ARE NO LONGER MAKING THE GRADE.

BUT WHAT SHOULD TAKE THEIR PLACE?

by HILLARY ROSNER

Conservationists are used to justifying their work. Since the movement first took shape in the 1800s, they've provided a litany of contemporary arguments for conserving the natural world, from economic (protecting forests for wood) to spiritual (preserving places that stir the soul) to scientific (safeguarding biological systems). But lately they've been wrestling internally with another fundamental question about their task: not *why* we should save nature, but *what* exactly we should save and *how* we should save it. Against a backdrop of growing global resource demand and climate change — as well as emerging technologies, such as synthetic biology — that are wreaking philosophical havoc, finding the answers is urgent.

At issue is how to modernize a predominantly 20th-century enterprise. Since at least the 1960s, biodiversity conservation has largely taken its cue from the health of particular species. It's been reactive, focused on stopping things: habitat loss, habitat fragmentation, extinction. But despite valiant efforts, billions of dollars and years of long-fought battles, conservation seems perpetually on the losing side of a war.

For evidence, look no further than the International Union for the Conservation of Nature's Red List Index, which shows trends in the conservation status of mammals, birds, amphibians and corals. According to the IUCN's website, the index "clearly demonstrates that the status of these major groups is still declining." Around the world, we're transforming ecosystems at an ever-increasing rate. Even in areas set aside for wildlife — at great expense and effort — animals are struggling to survive amid frustratingly hard-to-squelch activities such as poaching and logging. It's not that there haven't been individual success stories — particularly in the U.S., where 40 percent of threatened or endangered species are stable or improving. Even those successes, however, come with caveats: 84 percent of species listed under the Endangered Species Act may require sustained human intervention in order to survive, according to a paper published by University of Idaho biologist J. Michael Scott and colleagues in 2010.

IN THE PAST, CONSERVATION INITIATIVES OFTEN FOCUSED ON INDIVIDUAL SPECIES — USUALLY CUTE, CUDDLY OR OTHERWISE CHARISMATIC ONES. TODAY'S CONSERVATION CALLS FOR A MORE COMPREHENSIVE APPROACH.

"We know absolutely that something has to be different," says Jon Hoekstra, chief scientist at the World Wildlife Fund. "In the 21st century, instead of starting with only 2 or 3 billion people, we start with 6 and go to 9, and do it under changing climate conditions and intense resource demands. The context of conservation is going to be profoundly different."

"Overall," says Kent Redford, a conservation biologist who spent many years at the Wildlife Conservation Society and now runs his own consulting firm, the current tools of conservation "are not up to the problems as they either are or will soon be."

BATTLE LINES & SHARED GROUND

Chat with a conservation leader today and you're likely to hear some surprising things. "We can't do it species by species." "Protected areas aren't going to be enough." "Saving the last place or the last of the species is not our focus."

The exact messages may differ — after all, there may be as many distinct conservation agendas as there are places, creatures and ways of life — but the theme is constant: Something needs to change. Conservation today is in need of a far more potent approach.

Answering those looming questions — what to save, how to save it — has sparked heated debate among practitioners. Last year the Breakthrough Institute, the pragmatic think tank that's been a thorn in the side of traditional environmentalism since its inception in 2003, published an essay by Peter Kareiva, chief scientist of The Nature Conservancy; Robert Lalasz, TNC's director of science communications; and Michelle Marvier, an ecologist at Santa Clara University. Titled "Conservation in the Anthropocene," the essay argued that conservation is failing in its efforts to save both biodiversity and ecosystems, despite setting aside an impressive number of protected areas. To succeed, the authors wrote,

> *conservation could promise instead … a new vision of a planet in which nature — forests, wetlands, diverse species, and other ancient ecosystem — exists amid a wide variety of modern, human landscapes. For this to happen, conservationists will have to jettison their idealized notions of nature, parks, and wilderness — ideas that have never been supported by good conservation science — and forge a more optimistic, human-friendly vision.*

The piece exposed a huge rift in the conservation world and ignited a feud that raged on the institute's website and spilled over onto Andrew Revkin's Dot Earth blog. John Lemons, an emeritus professor at the University of New England, took the authors to task for substituting value judgments for science and failing to recognize the "intrinsic values of organisms, species or ecosystems." Kierán Suckling, executive director of the Center for Biological Diversity, accused the authors of "exaggerations, strawman arguments and a forced optimism that too often crosses the line into denial."

Yet even Suckling acknowledged that in the current moment, "conservationists need honest, hard-headed reassessment of what works and what needs changing." On that point, it seems, few people disagree.

Even as some in the conservation community have drawn battle lines (in a now-infamous exchange at the Aspen Institute last summer, E.O. Wilson asked Emma Marris, author of the future-of-conservation book *Rambunctious Garden,* where she planned to plant the white flag she was carrying), much of the rhetoric has begun to hit on surprisingly common themes. Intense disagreement persists over how best to protect the planet's ecosystems and biodiversity. But there may be more shared ground than anyone realizes — and it's there we should look for the future of conservation, and of the natural world.

180-DEGREE TURN

WWF's Hoekstra likes to talk about "the pivot."

Reactive and defensive almost by definition, conservation has long made its living by

PHOTO BY DON WALLEN | UNIVERSITY OF WASHINGTON LIBRARIES, SPECIAL COLLECTIONS, MPH893

explicitly looking backward. It's an approach that made perfect sense, for a time. "We wanted to restore a species so that it spanned the breadth of its historic range," says Hoekstra. "We would look to the past and say, 'We should have this much of this habitat back again, or it should look this way.'" But while this strategy may still work in certain specific cases, as an overarching vision it no longer fits. You can't "dial back time" in a world of 9 billion people demanding water, food and energy.

Hoekstra's pivot is a 180-degree turn, shifting conservation to face the future. Population trends and global warming will leave the world looking very different than it does now, and no amount of money or effort seems destined to stop that. But we can, Hoekstra believes, try to ensure that a changed planet isn't a less healthy one. The way forward is to look forward: "Anticipating some of the trends that will be driving that change," Hoekstra says, "how can we influence it so as much nature comes with it as possible?" In other words, we can't stop progress, but we can shape it.

With the pivot, the goals of conservation remain roughly the same — protecting natural habitat, preventing species from vanishing — but they're set within an entirely different frame. Instead of asking, "How can we stop this thing we don't want?" — exurban sprawl in place of a prairie, say — we might ask, "How can we engineer this thing we do want?" — thriving urban centers or wildlife-friendly ranchland, for example. Instead of setting aside vast tracts of land, we stitch together mosaics — landscapes that combine sustainable food production with natural habitat. "If we apply conservation science in a smart way," Hoekstra says, "we can make those landscapes work for people and protect biodiversity. We're not going to always get both those things right, but I think it's our only chance."

So, the pivot is about managing change rather than trying to stop it. Which sounds similar to what Ted Nordhaus, chairman of the Breakthrough Institute, has been saying lately. "The question isn't whether Brazil is going to develop the Amazon," argues Nordhaus. "It's how. You have to think about how you're going to work with that process as opposed to resist it." If you think you're going to somehow block every dam that's proposed, Nordhaus says, "you can't have a conversation with the Brazilian government about how Brazil can utilize the resources it has in a way that preserves as much of the landscapes and species we want to preserve as possible."

That sentiment rankles many conservationists who believe it amounts to letting greedy, destructive forces have their way. Far from

ONE STRATEGY FOR CONSERVATION IN AN INCREASINGLY CROWDED WORLD IS TO DESIGN LAND USE TO MEET MULTIPLE NEEDS. TREE-STUDDED COFFEE FIELDS IN COSTA RICA, FOR INSTANCE, BLEND NATURE AND AGRICULTURE FOR THE BENEFIT OF BOTH.

PHOTO ©ISTOCKPHOTO.COM/2TAMSALU

PHOTO COURTESY OF WILDAID

HOLD THE FINS

One promising example of conservation's shift from reactionary tactics to proactive agenda-setting is WildAid's campaign to squelch illegal wildlife trafficking by reducing demand for products derived from endangered species. Shark fin soup is considered a delicacy in China, where increasing affluence has intensified demand — even at $100 a bowl. Despite the fact that one-third of shark species are now endangered, each year up to 73 million sharks have their fins hacked off to fulfill demand for the soup. In one WildAid commercial, a shark-filled aquarium surrounds a room full of restaurant patrons with bowls in front of them. The camera pauses on a shark with a bleeding gash, then pans over the diners, their faces contorted in disgust. A narrator's voice says ominously, "What if you could see how shark fin soup is made?" The diners push away their soup bowls, and Chinese basketball star Yao Ming affirms WildAid's slogan: "Remember, when the buying stops, the killing can too." In another arm of the campaign, Chefs Against Shark Fin, Wolfgang Puck and Mario Batali, among others, publicly pledge to refuse shark fin and actively promote alternatives. These and other efforts are credited with a 50 percent decline in demand for shark fin in the past year, according to the Hong Kong–based Shark Fin Trade Merchants Association.

—by MONIQUE DUBOS

PHOTO BY AUSI PETRELIUS/CARE

DOUBLE-DUTY **DEVELOPMENT**

In the coastal village of Topa, in tropical northern Mozambique, it was once customary for men to cast their nets for fish while women tilled the family farms for staple crops cassava and maize. But overfishing and deteriorating reefs have made fish scarce, and erratic rainfall has made farming less reliable. The people of Topa needed a new way of doing business.

Enter the Primeiras e Segundas Program (P&S). Named for a nearby archipelago, P&S integrates the humanitarian efforts of CARE and the conservation work of the World Wildlife Fund to protect threatened ecosystems in the region while strengthening the human communities that depend on them.

Working through P&S, villagers obtained a legal registration with the government of Mozambique that allows them to maintain a fish farm on the beachfront, alleviating stress on wild fish populations. P&S also trains families to rotate crops and increase nutrient retention, leading to higher yields while reducing the adverse impact of agriculture on local ecosystems.

—*by MONIQUE DUBOS*

signaling surrender, though, the heart of this idea is about proactively orchestrating peace. It's about setting the agenda rather than reacting to it. The current approach, says Peter Knights, executive director of the conservation group WildAid, resembles the drug war, with law enforcement defensively responding to criminals' latest gambits. "You can't enforce your way out if there's a strong demand on the other side," says Knights, whose group works to stop the illegal wildlife trade by halting demand for products like ivory and shark fin rather than futilely attempting to curtail supply. By changing consumer preferences instead of trying to outmaneuver highly motivated poachers, WildAid is a model of the shift to a less-reactive version of conservation.

TRIAGE GONE RIGHT

Managing change means making painful decisions — even, sometimes, acknowledging that we can't save everything. How do we decide what to save and what to let slip away? And who has the right to decide?

These questions have always been contentious and uncomfortable. Even among scientists, there are value decisions at work. Back in 2002, Brian Bowen, a conservation geneticist at the University of Hawai'i at Manoa, published a paper laying out what he called "a tripolar debate" among subsets of biologists over whether conservation should strive to preserve genetic uniqueness, ecosystems or the potential for organisms to adapt and evolve. The answer, concluded Bowen, involved a synthesis of the three. "In order to be successful," he wrote, "conservation efforts must preserve the processes of life."

The power of preserving processes — biological, ecological, evolutionary — is another platform where conservationists can find common ground. Our best buffer against the impacts of global warming and development "is to safeguard the stage that will allow nature to evolve in the best way possible," says Jamie Williams, president of The Wilderness Society. Williams is convinced the future lies in creating "large, resilient ecosystems" that combine public and private lands, protected and working landscapes.

"We need to pay attention to species," Williams says, "but we're in a different world now. We need to look at where we can truly be successful on a meaningful scale, which means we might have to let some of the smaller things go."

Not long ago, it would have been heretical to hear a conservationist talk about letting some species vanish. But in the new, proactive world, consciously making such decisions is a whole lot better than letting them happen by default. How we choose remains an open question, yet it's increasingly apparent that we do in fact need to make choices.

In a recent article in *Scientific American,* journalist Michelle Nijhuis wrote about "conservation triage," chronicling a 2008 meeting of Wildlife Conservation Society researchers who'd gathered — with a psychologist on hand — to decide which species they should try to save. "We actually do a huge amount of triage now, but we do it really poorly, without planning in advance," says Tim Male, vice president of conservation policy at Defenders of Wildlife. "It's not about needs, it's about noise." Whichever patient in the hospital is screaming the loudest, Male says, gets the attention. "It's triage gone wrong."

Male helped organize a conservation triage workshop at this summer's International Congress for Conservation Biology, which he hopes will pave the way for a system of prioritization "beyond the fire drill of the day." The greatest value of explicit prioritization, he says, is letting people know exactly what they can achieve for a certain price. It answers the question, "If we add another million dollars, what's the outcome?"

While the conservation ideal may always be to save as many places, organisms and processes as possible, managing change means recognizing that trade-offs may be necessary — and engineering them in the smartest, most sophisticated way possible. "All in all, conservation is moving beyond the issue of individual species or individual places to larger landscapes," says Cristián Samper, president and CEO of the Wildlife Conservation Society. "This will be absolutely crucial as we go forward."

SYNTHETIC SURVIVAL

This past spring, in Cambridge, England, two groups of scientists eyed each other suspiciously as they poured their morning coffee. The occasion was a gathering of conservation biologists and synthetic biologists, strange bedfellows convened by conservation biologist Kent Redford and colleagues. Synthetic biology — the creation of new life forms — is still in its infancy. But along with the increasingly real likelihoods of bringing mammoths, passenger

PHOTO BY ZUMA PRESS, INC. / ALAMY

INTERCEPTING POACHERS AND TAKING POSSESSION OF THEIR PLUNDER IS A COMMON — BUT NOT ALWAYS EFFECTIVE — WAY TO COMBAT ILLEGAL WILDLIFE TRADE. IN A MORE INNOVATIVE APPROACH, CONSERVATION GROUPS ARE WORKING TO REDUCE CONSUMER DEMAND FOR PRODUCTS FROM PROTECTED SPECIES.

pigeons and the like back from oblivion, or of engineering organisms to be a better fit for the altered world they're inheriting, the field is spurring conservationists to an insistent form of soul-searching.

Introducing man-made organisms into natural systems is a notion that fills many ecologists and conservation biologists with horror, imagining the havoc these novel life forms might wreak. But here, too, there is opportunity to help set the course. Synthetic biology might unfold without any thought for the needs of natural ecosystems. Or its vast potential might be harnessed in the service of sustainability.

"Though these communities are strangers to each other now," wrote Redford and two co-authors in a paper published just before the meeting, "the work they do and the goals they pursue are in places complementary and in others conflicting but uninformed by each other."

No blueprint for a perfect planet emerged from the Cambridge confab, but Redford believes some seeds were planted. After a lot of "us" versus "them" posturing, by the end of the meeting both sides were excited about opportunities to collaborate. "They're tool-driven people by and large," Redford says of the synthetic biologists. "They develop new ways of doing stuff and then look for things to be done with them. We got to say, 'Well, could you help us do this? Or what about that?'"

ALL HANDS ON DECK

Whatever the approach, it's clear that enlisting new constituents is essential.

More and more, conservationists are partnering with farmers, looking for ways to trade ideas and manage food-producing lands as part of large, resilient ecosystems. "We no longer can afford to be about, we'll conserve this over here, you go do your stuff over there," says Hoekstra. "How could conservation and agriculture work together? What can they learn from each other? There are really sophisticated agricultural practices and technologies, so what might we adapt and apply to promote conservation and what from conservation could be applied to the world's farmland?"

Including sustainable development as a core conservation goal, and looking for all possible tools to achieve it, is another emerging area of common ground where future solutions certainly lie. One WWF project in Mozambique, for instance, marries conservation and human development through a partnership with the people-focused group CARE to promote local management of fisheries.

But 21st-century conservation also involves getting far-reaching buy-in, spreading the conservation ethic to emerging economies. "You really need support from everyone all over the world," says WildAid's Knights. "China is going to increasingly become a source of funding for international conservation projects. As a movement, we're still very focused on Washington and the U.S., but trade and power dynamics are shifting."

Convincing developing nations to consider sustainability as they grow looms large in Nordhaus's agenda, too. If you can't stop Mongolia from mining, the only solution is to help Mongolians balance their desire to mine with our desire to preserve ecologically vital steppe and other natural landscapes.

Enlisting new participants is also about considering psychology. Conservation biologists, like scientists in many fields, have long labored under the delusion that if they can just get people to understand the science, smart decision making will naturally follow. But science is often no match for the power of belief systems and self-reinforcing social groups. It's essential, says Redford, for conservation to begin integrating lessons from behavioral psychology, to better understand how people change their mindset — rather than continuing to "say the same thing even louder."

It's just one more attempt to engineer change rather than build barricades. As the world shrinks, effective conservation policy will need to set the course instead of simply steering the ship around obstacles. Fortunately, choosing that course may be less contentious than it seems, particularly since there's broad consensus that we need new maps. It's as good a starting point as any for the long voyage ahead. ⓔ

Hillary Rosner is an award-winning journalist who writes about science and the environment for the *New York Times, Wired, Scientific American, Popular Science* and many other publications. She was a 2010 Knight Science Journalism Fellow and a 2012 Alicia Patterson Fellow. She lives in Boulder, Colo.

TEACH YOUR CHILDREN

10 THINGS THE NEXT GENERATION WILL NEED TO KNOW TO THRIVE IN THE ANTHROPOCENE

BY MINDA BERBECO • ILLUSTRATIONS BY LAUREN HOM

I recently attended the wedding of two friends at the Norwegian Seamen's church in San Francisco. During the ceremony, the priest paused to reflect on the improbability of the circumstances that brought us together: What were the odds, he asked, of a Norwegian woman falling in love with a Scotsman and traveling to the other side of the world to marry, bringing together friends and family from three nations? Improbable, and yet there we were.

But perhaps even more unlikely were our surroundings: a church decorated with silver vessels and iron candelabras mined and manufactured thousands of miles away; gowns and suits made of synthetics and natural fibers sewn in Southeast Asia and Eastern Europe; drinks from Vietnam and South Africa; smartphones snapping pictures of the ceremony and immediately sharing the images with family and friends across the globe. The accessibility of all things from all places — that was what was most improbable.

Humanity is growing increasingly connected, with each local choice having a distinct footprint that reverberates across the planet. We recognize this trend, and we live it — but are we preparing the next generation for the world toward which it's leading us?

My newly married friends may someday have children, and those children will grow up in a continually changing, increasingly globalized world drastically different from the world in which any of us were raised. What are the new challenges they will need to overcome to care for this planet? What are the questions they will need to ask and answer? And how can we prepare them to do so? I would like to propose 10 things students of today and tomorrow should learn to be equipped to take care of the world they will live in as adults.

1

HOW DO WE FEED A GLOBAL COMMUNITY?

By 2030, the U.S. Census Bureau predicts the world population will pass 8 billion. That is roughly 1 billion more people to feed than today, many of whom will have grander expectations of the global food market than access to basic nutrition. Meanwhile, the introduction of genetically modified foods into more markets and the spread of industrial agriculture are changing the nature of food production itself. Today's children — tomorrow's adults — need to learn how food is really grown, managed and transported across the world. They need to learn what the impacts of those methods are. And they need to know why the system has evolved in this way so they can understand what feeding 8 billion people will need to look like, the impact of our food choices and the potential trade-offs with the environment that will need to be addressed.

2

HOW DO WE POWER A GLOBAL COMMUNITY?

Very little information about energy is taught in the classroom today, and too often lessons are coupled with an economic or political perspective, pitting human demand against environmental impacts. The 8 billion people of the future will all have energy needs, whether it's simply fuel for kitchen stoves or the expectation of regular international (or even intergalactic) travel. Students need to understand where energy comes from, the different forms it takes, how it's used, and the benefits, impacts and risks associated with different energy choices.

3

HOW DO WE SAFELY HYDRATE A GLOBAL COMMUNITY?

Just as they need to know the sources of energy and food, children need to learn about where their water comes from and about important sources of water for the global community. Moreover, it's essential they learn how water is transported and sanitized for consumption, how it is used in agriculture and energy, and its status as a depleted and unreliable resource in some regions. A basic understanding of water infrastructure will provide valuable context for addressing potential conflicts about water use and rights in the future.

4. HOW DO WE COMMUNICATE WITH A DIVERSE GLOBAL COMMUNITY?

As technology has allowed us to widen our community beyond city, state and even national borders, children need to learn about global cultures, religions and languages — not as a group of outsiders, but as part of a larger community with which we share air, water, food, minerals, energy and other global resources. It's critical they meet the challenge of cultural exchange and communication, creating a foundation for respectful collaboration in a truly integrated world.

6. HOW DO LOCAL CHOICES IMPACT THE REST OF THE WORLD?

Respect and appreciation for others (human and nonhuman) can help children make connections between local actions and global impacts. The direct study of the life sciences is key to understanding and valuing the connectivity of their community to global ecosystems, linking local behavior with its more remote repercussions. Children need to recognize that even a perceived positive behavior change such as the locavore movement can have impacts on communities elsewhere by shifting production, management and economic influences to different regions.

> **"Children need to learn about global cultures, religions and languages — not as a group of outsiders, but as part of a larger community with which we share air, water, food, minerals, energy and other global resources."**

5. WHAT OTHER ORGANISMS DO WE COUNT AS PART OF OUR COMMUNITY?

Children need to broaden their vision of community beyond the human population to include other organisms and ecosystems. Cross-species empathy can drive thoughtful decision making as children become more responsible for other living things. As caretakers of life, they can become engaged in protecting not just their own needs, but those of every living thing on our planet.

7. HOW CAN SCIENCE BE A TOOL FOR INFORMING POLITICAL, SOCIAL AND ECONOMIC DECISIONS?

Well-meaning teachers sometimes attempt to engage students in science by asking them to debate scientific concepts against political or social ideas — pitting environmental concerns against economic ones, for example. This juxtaposition has the potential to confuse students as they begin to see science not as a source of information, but as a rhetorical tool to outwit peers. They need to understand that quality, well-reviewed and hypothesis-based science has the opportunity to create a strong foundation for answering larger social challenges.

8 HOW CAN PROBLEM SOLVING AND SOLUTION-FOCUSED LEARNING BE USED TO OVERCOME CHALLENGES?

Problem solving is inherent to science, yet many educators overlook it in favor of either encouraging critical thinking through debate or sticking to rote facts. Meanwhile, many students are deterred from science, seeing it as being too limited or too complex. Science, engineering and math can provide powerful tools for problem solving and thus boost self-reliance, confidence and competence in tomorrow's adults.

9 HOW CAN WE USE CONNECTIVITY WITH THE GLOBAL COMMUNITY TO ENHANCE OUR UNDERSTANDING?

Greater and faster connectivity through transportation, media and the Internet has already greatly accelerated the dispersal of information and skills as ideas are more easily shared over longer distances and within shorter time periods. There are two key challenges to this connectivity, however. The first is ensuring that all communities have equal access to this global market of ideas. The second is ensuring that children are taught to discern quality information generated from trusted sources. Both increasing connectivity to all community members and encouraging thoughtful interpretation of material will strengthen children's understanding of the world.

10 HOW CAN WE USE DIPLOMACY TO ENACT CHANGE?

If children today learn about the realities of providing for 8 billion people on Earth, who those people are, the ecosystems they impact and how science can provide solutions to political, economic and environmental challenges, they can then use the greater connectivity of a global community to advance their understanding of — and enact — diplomatic decision making. By thoughtfully managing and cultivating international relationships, they will be able to facilitate just resolutions to the challenges that lie ahead while respecting all community members' needs.

At first it may seem an insurmountable burden to teach children all of the skills and information they need in order to take on these questions. But think of the world we live in today. Consider the unlikeliness of our emergence as a global community. Consider our connectedness. And consider our inherent ingenuity for problem solving. Then think about the value of teaching our children about all of this for a better tomorrow. Is there anything more important — and ultimately, more powerful — than addressing these realities, so they will be equipped to navigate the challenges of tomorrow?

The wedding I attended involved people from many nations — those attending, those providing the goods and those sharing the experience from afar. It impacted ecosystems around the planet as the guests traveled to attend, and were fed and dressed by our global community. As the world becomes even more connected, we have to ask: What will the leaders of the next generation look like? What will their lives include, and who will they impact? If today's children are to know how to manage these global challenges when they are adults, it is our duty to start teaching them now. ⓔ

Minda Berbeco is the programs and policy director at the National Center for Science Education and a visiting scholar at the University of California Museum of Paleontology. She holds a Ph.D. in biology from Tufts University, where she studied the impact of climate change on terrestrial systems.

GROUND

A startling new view of global groundwater reveals a need to reverse depletion trends. But how?

by CYNTHIA BARNETT

IMAGES ©ISTOCKPHOTO.COM/OKEA (GRASS AND SOIL) AND ©ISTOCKPHOTO.COM/NADDIYA (PEBBLES) | LAYOUT BY JEREMY NELSON

Stretching from the white limestone mountains of southern Turkey through the floodplains of the Tigris and Euphrates rivers into what is now northern Syria, Iraq and Iran, ancient Mesopotamia gave rise to some of the earliest irrigated agriculture, and then to the first cities in the world.

Now, 8,000 years after prehistoric farmers dug canals to water arid crops here, NASA satellites tracking global changes to freshwater resources reveal the same region that helped birth agricultural civilization is signaling one of the strongest warnings of its mortality.

Analyzing data from twin satellites that detect water mass by measuring changes in Earth's gravity, scientists say the Middle East lost 117 million acre-feet of freshwater between 2003 and 2009 — nearly enough to fill the Dead Sea. The researchers attributed about one-fifth of the loss to dwindling snowpack and drying soils, the result of drought. Surface water decreases from lakes and reservoirs made up another fifth. But groundwater pulled the biggest vanishing act. Sixty percent of the loss was pumped up and out of the region's fragile aquifers, with irrigation the primary drain.

"We've never been able to see, this clearly, the widespread nature of groundwater depletion," says Jay Famiglietti, director of the University of California's Center for Hydrologic Modeling at UC Irvine and lead investigator on NASA's Gravity Recovery and Climate Experiment groundwater studies. Now in its 12th year of orbit, GRACE offers an unprecedented view of global aquifer storage and the movement of groundwater — the least understood of all freshwater and source of nearly half the irrigation and drinking water in the world.

Northwest India is another region losing a troubling quantity of the water stored underground. In 2009, Famiglietti's team found that in just six years, the states of Rajasthan, Punjab and Haryana — the nation's wheat belt and home to 114 million people — had lost 88 million acre-feet of groundwater, twice the capacity of India's largest surface-water reservoir.

GRACE data also reveal shrinking aquifers beneath the North China Plain, North Africa, southern Europe and a quintuplet of hot zones in the United States. In a new analysis of total U.S. freshwater storage — all the surface water, snow, soil moisture and groundwater in the land — GRACE reveals five areas where groundwater pumping far outstrips the ability of aquifers to recharge. Some are well known: California's Central Valley, the southern High Plains Aquifer and Houston. Others, tucked into some of the nation's wettest corners, come as a surprise: a wide swath of Virginia and the Carolinas, and almost all of Alabama — home to Mobile, the rainiest major city in the continental U.S. While the groundwater losses in other parts of

WATER wake-up

CENTER-PIVOT IRRIGATION, INVENTED IN 1948, HAS ALLOWED FOOD PRODUCERS AROUND THE WORLD TO EXPAND TO ARID LANDS AND BOOST CROP YIELD — OFTEN AT A PRICE TO THE AQUIFERS THEY DRAW FROM.

BY ADOPTING XERISCAPING AND OTHER WATER CONSERVATION STRATEGIES, TUCSON, ARIZ., RESIDENTS HAVE REDUCED THEIR DAILY WATER DRAW FROM 200 GALLONS PER PERSON IN THE 1980S TO 130 GALLONS TODAY.

the world are spread across much larger regions, Famiglietti warns that America's hot spots "are right up there with the Middle East and India in terms of the rates of depletion."

EXPLOITED AQUIFERS

Trying to comprehend Earth's groundwater is like trying to fathom all the information on the Internet. And like the Internet, groundwater gives rise to a considerable amount of misinformation — from books that leave readers thinking of aquifers as "underground rivers" to the EPA's public Twitter feed, which not long ago repeated the common myth that the Great Lakes hold one-fifth of all the world's freshwater reserves.

In reality, groundwater does not flow so much as seep through porous rock, clay or sand aquifers, built up over millions of years under most of Earth's land. And while it's true that the Great Lakes hold one-fifth of the world's fresh, unfrozen *surface* water, all the freshwater we see — rivers, streams, lakes and wetlands — is a tiny fraction of all freshwater, less than 1 percent. Surface waters are just the hyperlinks — mostly connected, but not always — to vast and layered stores of freshwater below ground.

Throughout human history, this largely invisible water acquired a great mysticism as it bubbled up in wells and springs, sometimes deep and other times shallow, sometimes icy and other times hot. Its witching nature remains so enduring that the United States has a vigorous Society of Dowsers, and children still toss pennies into fountains to make a wish.

In a famous ruling in 1861, the Ohio Supreme Court codified the mystery when it declared the movement of water underground "so secret, occult and concealed" that it would be "practically impossible" to regulate. The case led to widespread adoption of the English common law rule of "absolute ownership" for groundwater in the United States, still practiced in some parts of the nation, such as Texas with its law of the biggest pump: Landowners could pump as much as they wanted from their own property, regardless of harm to neighboring wells and ecosystems.

While states — including Texas — and nations have made some attempts to manage groundwater in the 150 years since, the biggest pump represents the cardinal problem for groundwater in the United States and around the world. Aquifers may be mysterious, but they're not magic. Despite their vastness, they cannot maintain water if the rate of pumping exceeds that of recharge.

The most-exploited aquifers in the world are those in major agricultural regions that are slow to recharge. These include the Central Valley and High Plains in the United States, the Nile Delta of Egypt, and the Upper Ganges of India and Pakistan. A stress index published in 2012 in the journal *Nature* found that 20 percent of the world's aquifers are being overpumped, some massively so. The researchers, from McGill University in Montreal and Utrecht University in the Netherlands, found the Upper Ganges is being pumped more than 50 times its ability to recharge.

Scientists fear climate change and associated drought will worsen the picture. "With surface water disappearing because of climate change, groundwater increasingly becomes the water of necessity," says Oregon State University

"With surface water disappearing because of climate change, groundwater increasingly becomes the water of necessity,"

— MICHAEL CAMPANA, OREGON STATE UNIVERSITY

DRYLAND FARMING TECHNIQUES SUCH AS PLANTING DROUGHT-RESISTANT CROPS CAN HELP REDUCE THE DEMAND FOR GROUNDWATER IN VULNERABLE REGIONS.

professor Michael Campana, a hydrogeologist who has studied groundwater management for four decades. "It's a problem for aquifers, and a potential conflict for people."

USING LESS, BANKING MORE

The solutions to overdrawn aquifers are similar to those for overdrawn bank accounts. Foremost is reining in overconsumption. Cities and farmers alike have shown that we can live with less water. Facing severe groundwater depletion in the 1980s, residents of Tucson, Ariz., have managed to reduce their daily Big Gulp from 200 gallons per person in 1985 to 130 gallons today. At the same time, the city has transitioned away from mining the aquifer as its primary water source. Three-fourths of Tucson's water supply in 2003, groundwater now accounts for less than half — with the remainder drawn from the Colorado River and reclaimed sewer and industrial resources.

From the coastal plains of India to the High Plains of Kansas, meanwhile, some farmers are proving the power of local solutions. In Andhra Pradesh on India's southeastern coast, a project to put groundwater data and management into the hands of local farmers has led to reduced use — through diversified crops and water-saving irrigation — with no reduction to profit. Following a package of water management bills that passed the Kansas Legislature last year, irrigators in a section of the Northwest Kansas Groundwater Management District have approved a self-imposed 20 percent reduction in pumping from their shrinking aquifer in exchange for more flexibility in the way they use their water rights.

Replenishing aquifers is another potential solution. This summer, Georgia is testing a technological peace offering known as ASR — Aquifer Storage and Recovery — in its 20-year water war with Florida and Alabama. The idea is to drill a well into the Floridan Aquifer that underlies the region and draw water from it in rainy times, storing the extra water deeper underground. In dry seasons when farmers fire

BY **GRACE** WE SEE THE WATER of the EARTH

—by KIT STOLZ

FOR YEARS, says University of California, Irvine, hydrologist Jay Famiglietti, remote sensing of groundwater was regarded in the hydrologic community as "a Holy Grail."

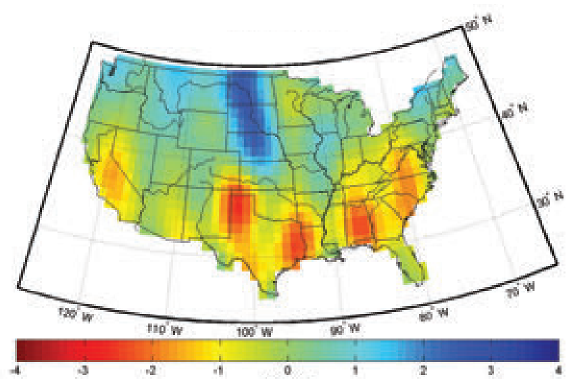
Famiglietti oversees the analysis of priceless data gathered by a pair of NASA satellites. Known as GRACE — for Gravity Recovery and Climate Experiment — the satellites measure groundwater at various locations beneath Earth's surface, amazingly, by observing each other, their distance apart and their relative speed.

Michael Watkins, a Jet Propulsion Laboratory researcher who helped design the mission with colleagues in Texas and Germany, says GRACE "puts a bathroom scale under the distribution of water on Earth."

The two satellites fly in a low polar orbit 311 miles above the Earth and about 140 miles apart, one behind the other. Because a greater mass exerts a stronger gravitational pull, the lead satellite speeds up ever so slightly when orbiting over a larger mass, such as Mount Everest, and pulls ahead of its follower. In space that slight separation can be measured "unbelievably precisely," says Watkins, down to the nanometer level.

As the satellites circle the Earth they compile a record of gravitational change. This turns out to be mostly a record of the mass of water, because water is constantly changing, whereas rock stays in place.

When launched in 2002, GRACE cost NASA $90 million, a low price in an era when research satellites can easily cost a half-billion dollars. A successor, GRACE-FO, is expected to launch in 2017.



GRACE DATA PAINT A STRIKING PORTRAIT OF REGIONS IN WHICH U.S. FRESHWATER RESERVES (LARGELY GROUNDWATER) HAVE INCREASED (BLUE) OR DECREASED (RED) SINCE 2003. AREAS OF CONCERN INCLUDE CALIFORNIA'S CENTRAL VALLEY, THE SOUTHERN HIGH PLAINS AQUIFER, DROUGHT-STRICKEN AREAS IN THE SOUTH AND THE UPPER MISSOURI RIVER BASIN REGION.

IMAGE COURTESY OF JAY FAMIGLIETTI AND CAROLINE DE LINAGE, UC IRVINE

GROUNDWATER *by the* **NUMBERS**

30.1
= percent of Earth's fresh-water that is groundwater

273
= estimated number of aquifers shared by two or more countries

70
= percent of drinking water that comes from groundwater in the European Community

60
= percent of European cities with population over 100,000 that are using groundwater faster than it's being recharged

25
= percent of rain falling on the U.S. that becomes groundwater

65
= percent of global groundwater use devoted to irrigation

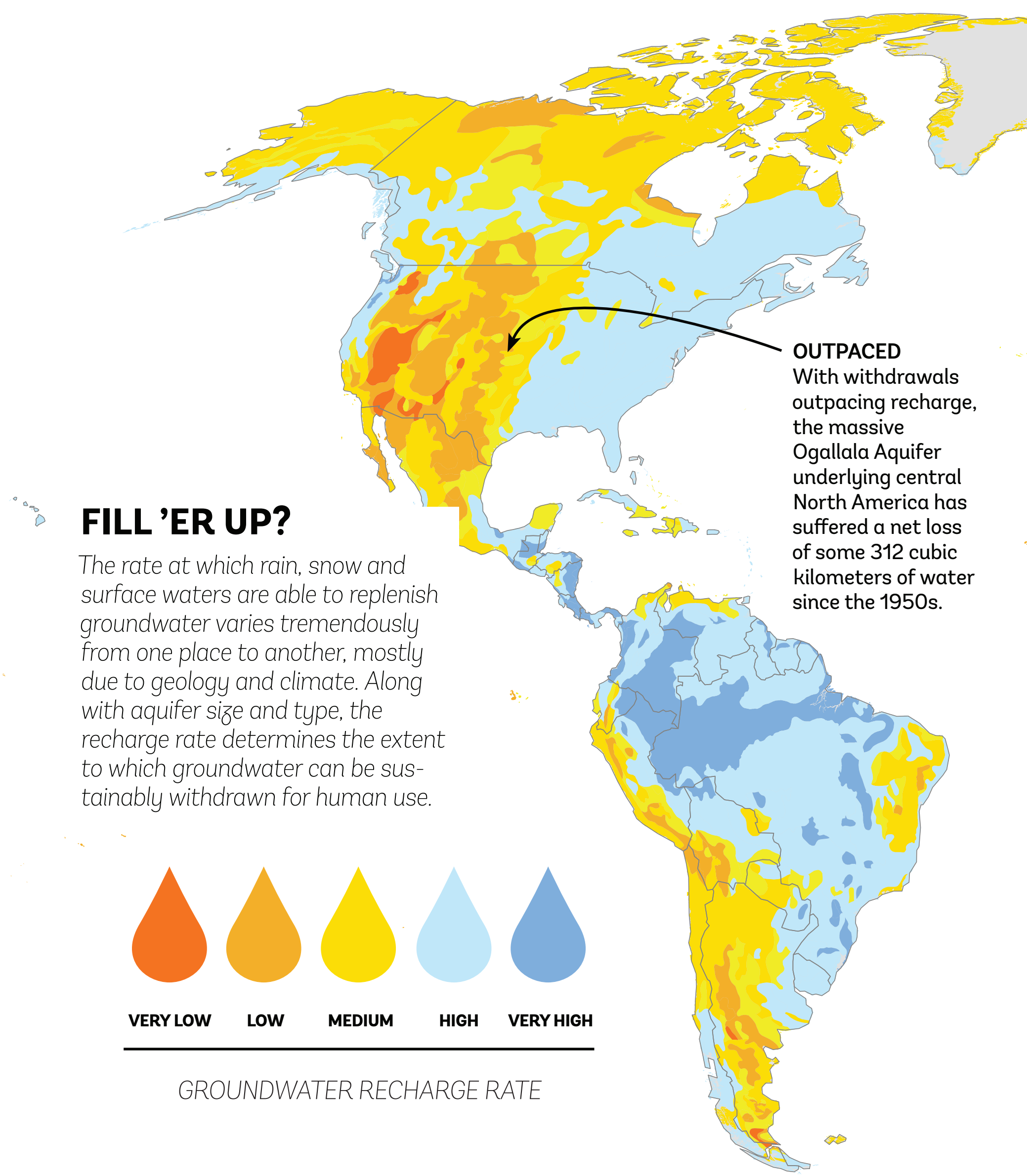
0.1
= annual groundwater recharge as a percent of total groundwater resources

up their pumps and the region's streams and rivers begin to choke, the reserved water would be drawn back up into the Floridan Aquifer to help increase the flow.

Georgia officials hope their demonstration will prove the potential of a water-sharing plan. But environmentalists worry the region hasn't done nearly enough to reduce water demand. And elsewhere ASR isn't always an option. While an estimated 1,900 ASR wells operate in the United States, some aquifers are too prone to contamination for the technology to be used.

David Pyne of ASR Systems, who is designing the Georgia project, says the idea of replenishing aquifers "is going to be vitally important here and around the globe" as aquifers continue to decline and as massive reservoirs fall out of favor due to costs and evaporative losses. Saudi Arabia is using aquifer storage to bank desalinated water during periods of low use and pump it back up when demand is high. Orange County, Calif., has a different twist. Its Groundwater Replenishment System purifies wastewater that used to dump into the Pacific Ocean, shoots it down into the aquifer, then uses it over and over again. The cycle requires far less energy than importing water from northern California or desalinating water from the sea.

Of course, any technology is only as good as the people and institutions managing the water. Aquifers storing injected water can be overtapped as readily as those holding native groundwater. Places such as California with scant statewide groundwater regulation can see the resource well managed in Orange County and exploited in the Central Valley, where overpumping continues to deplete aquifers, sink land and degrade water quality.



FILL 'ER UP?

The rate at which rain, snow and surface waters are able to replenish groundwater varies tremendously from one place to another, mostly due to geology and climate. Along with aquifer size and type, the recharge rate determines the extent to which groundwater can be sustainably withdrawn for human use.

TOUGH DECISIONS

Ultimately, solutions hinge more on leadership and ethics than pipes and pumps — and willingness to make tough decisions on behalf of the future. In some areas, for example, "we should consider retiring groundwater pumping," Campana says. "It's time to ask ourselves: Is it worth it to mortgage our future water supply to grow alfalfa?"

In Texas, economic incentives have helped convert irrigated cotton crops to native grasslands — in some cases funded by third-party businesses as a mitigation credit. When it comes to food, agricultural researchers predict dryland farming will become crucial to meeting the production demands of a growing world.

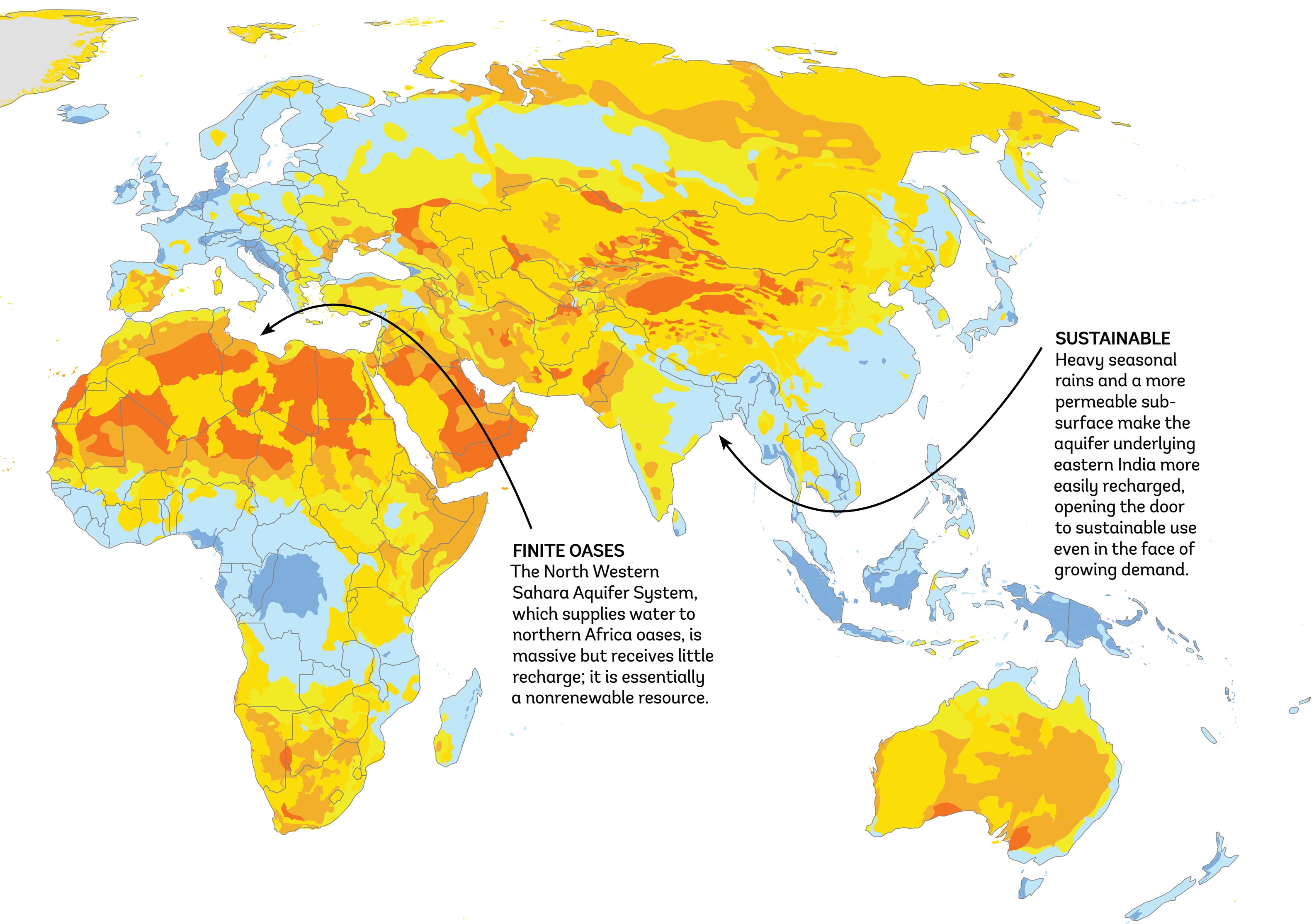
Geopolitical cooperation is the next act on an international stage that has featured shared rivers, but paid less attention to shared aquifers such as the Upper Ganges, which irrigates crops in both India and Pakistan. Argentina, Brazil, Paraguay and Uruguay have taken the unusual step of signing a transboundary agreement on the Guarani Aquifer before any conflicts have arisen; the plan is the first under the United Nations' new Law of Transboundary Aquifers.

The real test is whether people already in conflict can come to share and restore aquifers. Contrary to conventional wisdom, the Pacific Institute, which has tracked water conflict throughout human history, found that water has more often been a source of international cooperation than of war.

Crunching his satellite data, UC Irvine's Famiglietti hopes the clear new science on aquifers once considered "secret, occult and concealed" will help lead to sustainable groundwater management as depletion becomes impossible to deny.

"We can now see the aquifer being depleted, the river basin running out of water, even unauthorized releases," he says. A range of answers — technological, civil, policy and legal — are all "very much within grasp with vision and leadership. Inaction is not an option." ⓔ

Cynthia Barnett is a long-time journalist who has covered water issues from the Suwannee River to Singapore. The author of *Mirage: Florida and the Vanishing Water of the Eastern U.S.* and *Blue Revolution: Unmaking America's Water Crisis*, she is now at work on a human and natural history of rain.



MAP CREATED BY PEDER ENGSTROM AND KATE BRAUMAN OF THE INSTITUTE ON THE ENVIRONMENT'S GLOBAL LANDSCAPE INITIATIVE.
DATA PROVIDED BY BGR & UNESCO (2008): GROUNDWATER RESOURCES OF THE WORLD I : 25 000 000. HANNOVER, PARIS.

BLACK CARBON:
golden opportunity?

SOOT IS SECOND ONLY TO CO_2 IN CREATING CLIMATE-CHANGING CONDITIONS — AND OFFERS BIG HOPE FOR REDUCING THE THREAT.

by BROOKE JARVIS

IMAGES AND LAYOUT BY SARAH YOUNGQUIST

On many maps of the world, Greenland appears as a winter-white wedge floating in a dark blue sea. But in recent summers, some parts of Greenland would be better depicted in various shades of gray. Greenland is growing darker, even in areas covered in ice and snow.

This is a problem, and not just an aesthetic one. When light hits white, freshly fallen snow, it's bounced about by the snow's crystals, and most of its energy — up to 90 percent — ends up reflected away. But darkened snow and ice absorb more sunlight, warming ice sheets and speeding the rate at which glaciers melt. Between 2000 and 2011, glaciologist Jason Box estimates that darkened ice caused the Greenland ice sheet to absorb an extra 172 quintillion joules of energy — enough to double melt rates.

In one of the troubling feedback loops of the changing climate, dark ice is partially caused by the warmer Arctic summers climate change has brought us: More warmth means less fresh snowfall to cover areas of accumulated sediment, changes to the shape and size of ice grains that make them less reflective, and more liquid near the surface. It may also mean more habitat for dark microbes, which can contribute to the darkening of the ice sheets and therefore to the melting.

But warming isn't enough to explain all of Greenland's darkness. Another culprit is black carbon, better known as soot.

Black carbon is a by-product of burning biomass, coal, diesel and gas. It comes from, among other things, inefficient stoves, diesel trucks, campfires and fires in forests and savannas. Black carbon particles are most concentrated over cities, but wind carries them all over the world before they settle out of the atmosphere or are washed to Earth by precipitation. When they fall on the Arctic, they help turn bright snow gray — just as snowbanks on roadsides turn dingy by winter's end.

And black carbon's impact isn't confined to the Arctic. It also alters the atmosphere in ways we don't fully understand: affecting cloud cover, absorbing the sun's heat and warming the air. Recent studies have shown that black carbon has a complex but powerful impact on global climate change — and could offer an important opportunity for slowing it down.

BLACK CARBON'S CLIMATE ROLE

We've known for some time that black carbon plays a role in climate change, but such a complicated one that it's difficult to define or quantify. In January of this year, 31 scientists published the results of a four-year collaboration to analyze and synthesize what we know about black carbon's contributions in the *Journal of Geophysical Research: Atmospheres.* Their key finding? "We were underestimating warming via black carbon by a factor of two," says Patricia Quinn, an atmospheric chemist who contributed to the study.

Black carbon, in other words, is a much more important player in climate change than once thought. In fact, the study found that it is the second largest contributor after carbon dioxide, trapping more heat than methane, which was previously thought to be second.

Still, Sarah Doherty, a research scientist at the University of Washington who is lead author of the study, cautions that one of the study's main lessons is how difficult it is to disentangle the effects of black carbon from other emissions. The study leaves a large range of uncertainty in how much warming black carbon actually causes. One reason is that the same fires and factories that produce black carbon also produce other particulates and gases that actually have a cooling effect on the climate. "You can't just go and pluck black carbon out of the atmosphere and not affect other things," she says. "We need to make sure we're always thinking about this in a comprehensive way."

Black carbon's impact on snow and ice — not just in the Arctic but on mountain ranges from the Rockies to the Himalayas — is somewhat easier to pin down. "That's a very definite, instantaneous impact where you have this black stuff absorbing radiation and helping enhance the melting," says Quinn.

ARCTIC FEEDBACK LOOPS

In the summer of 2012, Box was on his way back to Greenland when he saw reports of record wildfires in his home state of Colorado on airport televisions. He wondered what impact soot from the fires — and others raging closer

THE HEALTH *connection*

Black carbon is not only bad for the environment; it's bad for us, too. According to the 2010 Global Burden of Diseases, Injuries, and Risk Factors Study, cooking with solid fuels — a major source of the tiny particles that include black carbon — is the fourth leading risk factor for disease burden globally, responsible for 3.5 million premature deaths each year. Another 3.3 million yearly deaths are attributable to outdoor air pollution, which includes black carbon given off by diesel-fueled vehicles and oil- and coal-fired power plants.

Long-term exposure to black carbon has been associated with a range of adverse health effects, including cardiopulmonary disease and death. Whether black carbon is toxic by itself or is instead associated with other toxic pollutants remains unclear. Toxicological findings show that black carbon may wreak damage by carrying chemicals of varying toxicity to sensitive targets in humans such as the lungs or circulatory system.

This much is clear, though: Interventions and policies that reduce human exposure to black carbon, such as those promoting the use of more efficient stoves, fuels and combustion engines, will directly benefit human health as well as the health of our environment.

—by JILL BAUMGARTNER

to the Arctic, including the largest tundra fire in history — might have on the ice sheets. He'd been studying changes in Greenland's albedo (the scientific term for the reflectivity of ice), but hadn't focused on the role of black carbon.

Just weeks later, Greenland was grabbing headlines: 97 percent of the surface of its massive ice sheet had melted to slush, with most of the melt occurring in just four days. The level of melting was so extraordinary, the NASA scientist who noticed it said in a statement, "I at first questioned the result: Was this real or was it due to a data error?"

It was real. And Box believes black carbon from increasingly common tundra wildfires may have played a role. This summer he will return to Greenland with a team of researchers to try to clarify what role black carbon from wildfires (which, in another feedback loop, are made worse by climate change) and other sources may have played. Box describes his Dark Snow Project as "a focused science collective" — a chance for scientists from a variety of disciplines to take a closer look at black carbon. They plan to drill short ice core samples and analyze the past role of black carbon, including layers from 2012 (though Doherty points out that it may be difficult to tell how much black carbon was deposited then, rather than deposited in earlier years and concentrated by the melting). "If we can get at the nexus between human activity and the reflectivity of the ice sheet, that's ultimately what we're after," says Box.

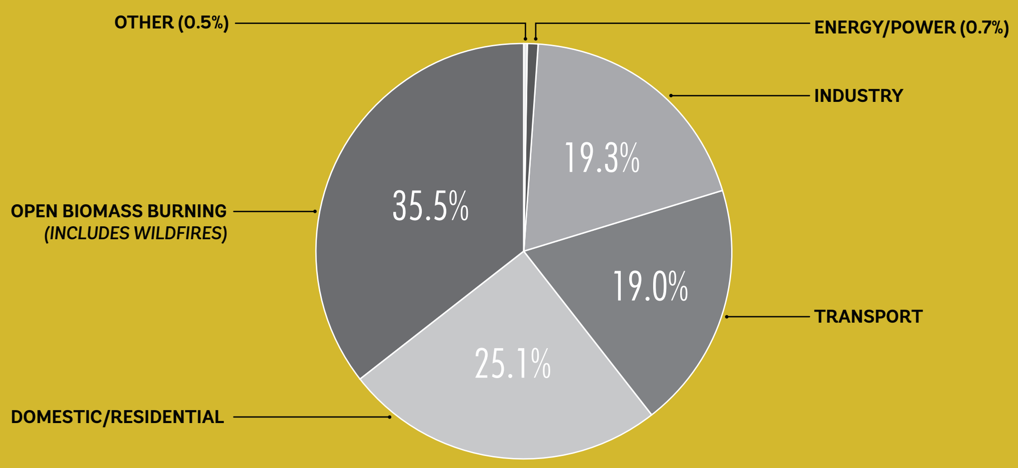
Understanding that nexus will mean trying to parse the complex interplay of shifting Arctic conditions — how changes in temperature, cloud makeup, albedo and even biology interact with each other, and how those interactions may create unexpected results. "Just in the last decade there have been a number of scientific epiphanies that make us realize that the climate system is more sensitive than we once had thought," explains Box. "These multipliers in the system — these feedback loops — that's how change happens in surprising ways."

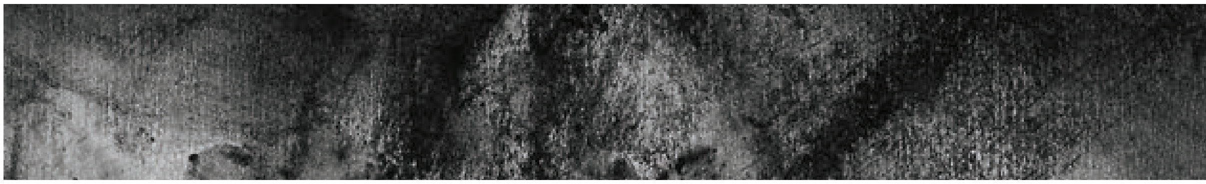
Which is why Marek Stibal, a glaciologist and geochemist based in Copenhagen, is joining the research team. "We like to think of the Greenland ice sheet as an ecosystem," he says. "If you talk to glaciologists, they usually don't appreciate the fact that it's a living thing. It has a biological component to it. It's not dead, it's not lifeless."

Stibal has shown that microbes growing on the ice are part of the reason it's darkening. Living on bright ice is a tough gig, so certain kinds

GLOBAL BLACK CARBON EMISSIONS

From 2000 (Source: United States Environmental Protection Agency)





of algae produce dark pigments to protect themselves from being harmed by too much solar radiation. "We think that the pigment is probably the adaptation that they evolved to survive in this environment," says Stibal. Microbes also create a gluelike substance that helps sediment stick to the surface of ice sheets and causes it to clump together, which can also speed melting.

And melting is just what microbes need to grow: Even microbes that survive on ice sheets depend on some liquid water. As more of the ice melts, more area is opened to microbial growth, meaning more darkening — and more melting. Before the record melt last summer, says Stibal, the largest zone with liquid water had been around 200,000 square kilometers. Suddenly, it was nearly the entire 1.7 million square kilometer ice sheet. "That's a huge difference, and there's a huge potential for biology to start feeding back into the system once it gets going," he says.

It's not yet clear whether the 2012 melt period was long enough for microbes to grow significantly, but anticipated future melts likely will be. "The more meltwater you will generate on the surface, the more algae you will get growing there, the more melting — and that's the feedback loop," says Stibal.

There may even be further feedback if microbes turn out to consume nutrients in black carbon, a possibility Stibal hopes to test this summer.

CHANCE FOR CHANGE

The good news is that black carbon's outsize influence may make it a powerful lever for combating climate change. While CO_2 can stay in the atmosphere for hundreds of years, black carbon is typically washed out by precipitation within days or weeks. By reducing black carbon emissions, "we'd get a much more rapid response in the warming than reducing something like CO_2," says Quinn.

Tackling climate change still demands a dramatic reduction in our CO_2 emissions — there's no getting around that fact. But the possibility of a quick impact means that reducing black carbon emissions may be a way to buy ourselves more time to deal with CO_2. Testifying before Congress on the subject of black carbon in 2010, Veerabhadran Ramanathan of the Scripps Institution of Oceanography observed that policymakers could "have a unique opportunity to witness the success of their mitigation efforts during their tenure."

Scientists are beginning to trace black carbon found in the Arctic back to its origins — following the wind patterns that delivered it or analyzing chemicals and gases that accompany it to find out what was burned to create it. The issue now, says Quinn, is "to figure out where the black carbon is coming from and what sources you should be mitigating to get the best results in the Arctic."

That was one goal of the recent study that looked at black carbon's role in climate change. Since different point sources of black carbon can have such varied impacts on the climate, its authors hoped to identify which ones contribute the most to warming and are therefore particularly urgent to target. Diesel fuel — used in trucks, tractors, construction equipment and elsewhere — emerged as the clearest offender. Inefficient cookstoves in the developing world are also a straightforward target. And reducing black carbon emitted in or near the Arctic (or other areas dominated by ice) is a clear gain, whether from oil flaring in Siberia or marine shipping.

The study points out a further complication: As with other contributors to climate change, reducing black carbon emissions involves political and economic issues that are just as complex as the science. Still, a number of international bodies are making commitments to address black carbon and other short-lived climate pollutants. And with the catastrophic impacts of the climate crisis bearing down on us, it's no small thing to be presented with a clear set of possibilities for quickly and significantly slowing warming.

Brooke Jarvis is an independent journalist who covers the interplay of politics, the economy and the environment. She has written for *Rolling Stone*, the *Atlantic*, the *Washington Post*, *Aeon Magazine*, the *Verge*, *Sierra Magazine* and *Yale Environment 360*, among others. A Tennessee native, she now lives on Puget Sound.

AN ORGANIC FARMER AND A GENETICIST WALK INTO A FIELD

For **Pamela Ronald** and **Raoul Adamchak,** genetic engineering and organic farming are both legitimate tools for pursuing sustainable agriculture.

BY DAVID DOODY | PHOTO BY PICO VAN HOUTRYVE

THE DEBATE AROUND genetically engineered crops and organic farming usually begins well beyond a point of no return. Heels dug in, opposing sides accuse one another of being anti-environment or anti-science, evil or ignorant. From there, what takes place is something closer to a schoolyard shouting match than adult discourse.

This is not usually a good — or very successful — place to start honest discussions looking to move conversations forward.

And it's not the starting point for Pamela Ronald, a University of California, Davis, plant geneticist, and Raoul Adamchak, a farmer who runs the student organic farm on campus. The two are co-authors of *Tomorrow's Table: Organic Farming, Genetics, and the Future of Food.* They are also married — a truly odd couple in a world divided by preconceived notions and decisions before discussions.

Debates pitting genetic engineering against organic agriculture focus on, among other things, what each camp feels is necessary to feed a growing population. Both claim to have science on their side when it comes to producing the amount of food needed in a way that will do the least harm to the environment. But where others see opposition, Ronald and Adamchak contend the two practices should be used in tandem toward the goal of sustainable agriculture.

"We both came into our respective fields because we're interested in ecologically based farming," says Ronald, who has successfully genetically engineered rice to tolerate prolonged periods of flooding, a problem in many parts of the world where rice is a dietary staple. "We believe that it's really a distraction to think about how the seed was developed. The issue is really whether a particular seed or farming practice can advance the goals of sustainable agriculture."

"The common ground was obvious to us," Adamchak says. "It isn't very difficult if you look at the overall goal of sustainable agriculture … and say, 'What's the best way to get there?' It was relatively easy for us to say, 'We should use the best technology and the best farming practices possible.' That seems to us a perfectly reasonable way of achieving the most sustainable agriculture possible."

Ronald and Adamchak met through mutual friends; both had already been active in their fields for many years. Ronald had worked on organic farms when she was younger, and Adamchak had studied entomology and agricultural development in graduate school — overlapping experiences that Ronald says allowed them to connect. In *Tomorrow's Table,* the two argue that any technology or farming practice is appropriate as long as it produces abundant, safe and nutritious food; reduces harmful environmental inputs; provides healthful conditions for farm workers; protects the genetic make-up of native species; enhances crop genetic diversity; fosters soil fertility; improves the lives of the poor and malnourished; and maintains the economic viability of farmers and rural communities.

Trouble begins, Adamchak says, when people abuse any one tool at the disposal of growers. "If you use an herbicide-tolerant plant and you spray Roundup year after year after year, it's not going to end well. You are going to get weeds resistant to Roundup." Instead, he says, such a genetically engineered plant is just one tool that can be used, but it "needs to be part of an overall, integrated weed management system." However, current guidelines defining organic farming do not allow organic farmers to use genetically engineered plants in their systems, so Adamchak is not able to use them on the UC Davis farm.

The discussion around genetically engineered crops has been hurt by oversimplification and generalization, according to Ronald. "People hear 'GMO' and they think, 'I don't want anything genetically modified,' but of course *everything* we eat is genetically altered in some way through crop domestication," she says. "You can't generalize about genetic engineering, whether it's good or bad. It's really the issue of the trait, the environment, the crop, the farmer."

Adamchak says the couples' differing expertise allows them to fill gaps in one another's knowledge. "We can give each other a reality check," he says. "If she starts talking about farming or [says] something that doesn't jibe with how I think farming happens, I can say, 'But, Pam, growers don't do that.' And if I'm talking about genetically engineered crops and I don't understand something or I misquote something, she can say, 'That's not done this way; it's done this way.'"

So, what *would* the future of food look like in a world in which genetic engineering and organic farming are both seen as legitimate tools for achieving sustainable agriculture?

"I think we'd have an all-of-the-above strategy," Ronald says. "You would develop [crop] varieties based on sustainable agriculture criteria rather than marketing criteria or an agenda pushed by somebody who has a conflict of interest." Adamchak, for his part, sees good in extending the core value of sustainable agriculture beyond organic agriculture, which makes up only about 1 or 2 percent of the cropland worldwide. "[We] need to get the vast majority of conventional farmers focused on the goals of sustainability," he says. "The ideal vision is for more ecologically based farming practices, [with] tools like genetic engineering to be used to impact those issues of sustainable agriculture, like soil erosion, pesticide use and fertilizer runoff."

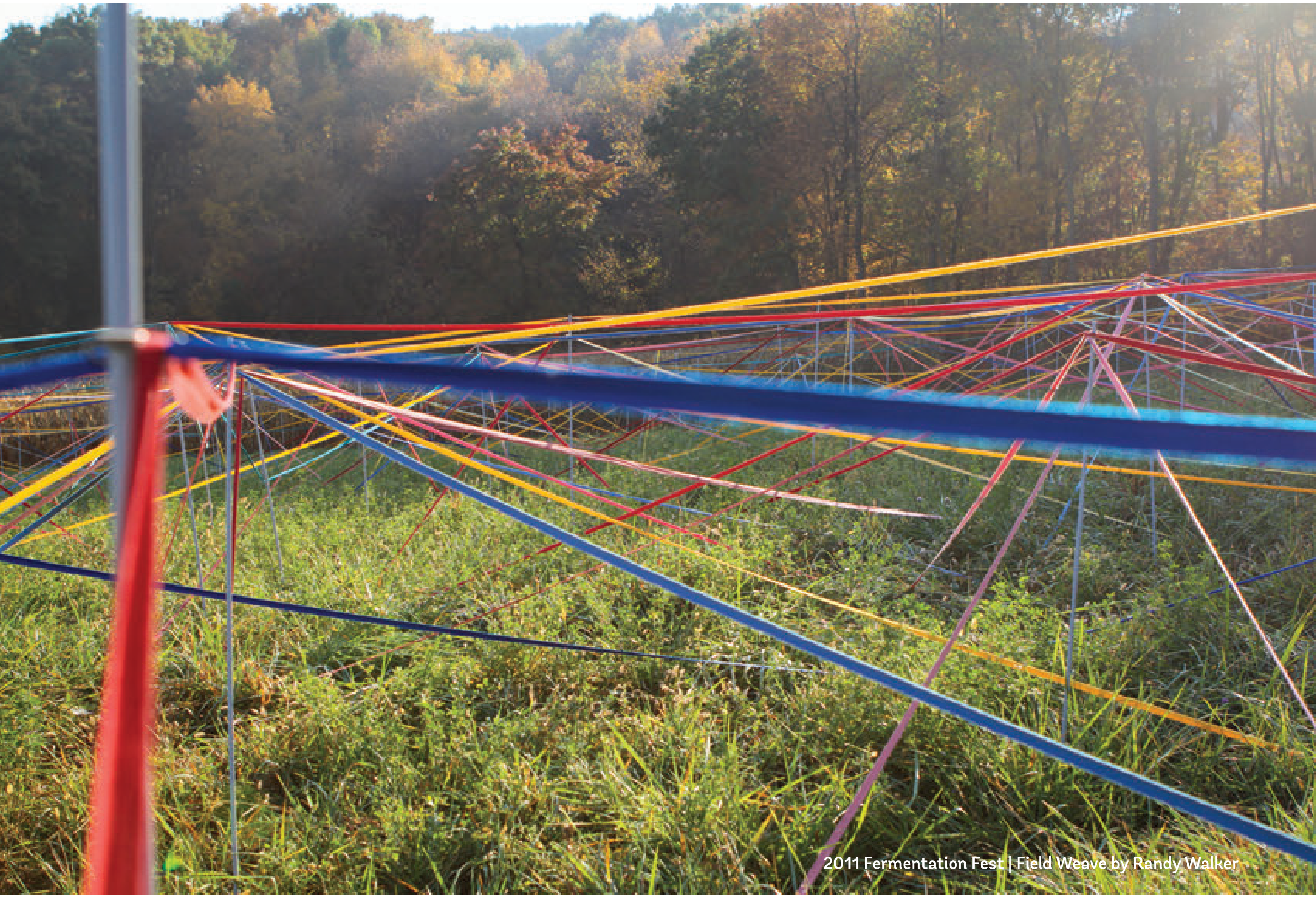
"**The common ground was obvious to us.** *It isn't very difficult if you look at the overall goal of sustainable agriculture … and say, 'What's the best way to get there?'"*

—Raoul Adamchak

PLACES, EVERYONE!

Creative placemaking has taken center stage in the world of community-engaged arts. Does it have a role in boosting sustainability, too?

BY STEPHANIE XENOS | PHOTOS BY ANN FOLEY



2011 Fermentation Fest | Field Weave by Randy Walker

IT'S AN IDEA SO COMPELLING that six banks, more than a dozen major foundations and a handful of federal agencies agreed to work together to make it happen. More than $26 million in grants have gone to 46 communities across the country in support of it over the past three years. A consortium called ArtPlace, created to manage the relationships and resources involved in the effort, has an additional $12 million loan fund at the ready to support the continued growth of existing projects.

What could inspire this level of commitment and collaboration? Something you may have never heard of — creative placemaking.

While there is no single definition of what it is, ArtPlace describes creative placemaking as "art, culture and creativity expressed powerfully through place" in an attempt to "create vibrant communities." Some argue it's a means for creating more sustainable communities, too.

Carol Coletta, who recently stepped down as director of ArtPlace to take a leadership role at the Knight Foundation, points out that in

Cabbage kneading demonstration with Adrienne Fox from Powerkraut

Roadside culture stand by Peter Flanary

many cases, creative placemaking efforts naturally dovetail with sustainable practices. "You're not using new resources, you're reinvesting in existing infrastructure," she says, "and you're probably not using up new land."

Case in point: the ArtPlace-funded Black Cinema House, a project of Chicago-based artist and urban planner Theaster Gates. Gates transformed an abandoned house on Chicago's South Side into a mixed-used space for film- and media-based artists of color using recycled timber from closed Chicago factories to reinvent the deteriorating structure. Drawing on undervalued cultural and material resources and giving them new life, Gates' project demonstrates the natural affinity between creative placemaking and sustainability.

There are rural examples, too. Rooted in the same Wisconsin soil where environmental icon Aldo Leopold made his famous observations about the natural world, Wormfarm Institute's annual Fermentation Fest and Farm/Art DTour uses art to spark interest and raise awareness of the value of rural spaces and sustainable practices. The fest at the ArtPlace-funded working farm celebrates "live culture in all its forms from dance to yogurt, music to sauerkraut." "We believe the emotional power of the arts brings to the sustainability conversation a complexity and context the subject requires," says Donna Neuwirth, Wormfarm's executive director.

The range of projects that fall under the umbrella of creative placemaking and the use of unconventional metrics such as "vibrancy" can make it difficult to pin down precise goals and specify outcomes. But the experimental tone is largely by design, according to creative placemaking maven Anne Gadwa Nicodemus, lead at Metris Arts Consulting in Pennsylvania. Creative placemaking represents a new way of thinking about the role of arts and artists in public life, emphasizing shared value and deep reciprocity rather than the intrinsic value of the arts or the notion of a creative class that drives economic development.

Ed Lebow, the director of the Public Art Program of the Office of Arts and Culture in Phoenix, Ariz., traces the roots of creative placemaking back to the post-WWII era, when rapid development sparked a growing concern for quality of life and more appealing public spaces. "Placemaking is a relatively new term for a very old practice," he says. Phoenix began bringing artists to the table decades ago, embedding them in discussions about infrastructure with planners, engineers, architects and even politicians, and the city's investment in creative placemaking as a development strategy has made it a case study in how to put theory into practice. Artists tend to "ask impertinent questions," Lebow says, and challenge assumptions about how things should look and work.

While not all placemaking is explicitly concerned with the environment, for Lebow and others in the vanguard of the movement, the connection is implicit. "You need your infrastructure to do more than one thing. If you get more function out of a space you potentially get more return on your investment," he says. "Economic, aesthetic and environmental sustainability are linked. The more communities understand that, the more it changes the way we view public design."

Stephanie Xenos is a Twin Cities–based arts writer with a special interest in visual arts as well as the intersection of art and environment. She is a regular contributor to *Mpls/St Paul* magazine and is currently hard at work on her first novel.

MINE OVER MATTER

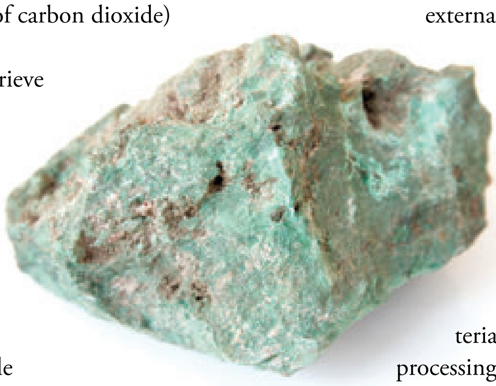
These days it seems as though just about every enterprise, from the corner store to multinational investment firms, is pursuing sustainability. Exactly what that means varies, but definitions seem to more or less be about meeting current needs (and wants) in a way that doesn't compromise the ability of future generations to do the same. One area where there is much debate around our ability to do so is in mineral extraction, which by its nature involves using nonrenewable natural resources. Can mining be done sustainably? **Saleem H. Ali,** director of the Centre for Social Responsibility in Mining at the University of Queensland, Australia, and **Jamie Kneen,** communications and outreach coordinator for MiningWatch Canada, provide two perspectives on that perplexing question.

BY MARY HOFF

"**THE TERM 'MINERAL'** is often used to define various naturally occurring materials extracted from the geological crust of the Earth. Yet, for questions of sustainability, we need to differentiate metallic minerals from nonmetallic ones, because 'renewability' for operational purposes will be defined by the level of entropy (or disorder) that mineral use will generate. The question of renewability from a chemical perspective is simply one of expending enough energy to bring back the material from a higher level of entropy to allow for reuse or recycling. Energy needed to counter the entropy created by the mineral's use is the main metric to evaluate whether that material's use is sustainable or not. From an operational perspective, metallic minerals are used in lower levels of entropy. That is why we are usually able to recycle them, whereas with minerals like coal, the use itself converts the material to such a high level of entropy (in the form of carbon dioxide) that it is essentially nonrenewable.

If we can design products that can retrieve minerals in usable form with relatively low energy expenditure and restorable environmental impact (particularly if the energy utilized for recycling is from renewable sources), then mineral usage is indeed sustainable. From an economic perspective, the extraction process of a finite resource from the Earth's crust can still lead to sustainable development so long as the capital generated is invested in building a diversified economy. This 'weak sustainability' aspect also applies to fossil fuel–extraction economies, thus deeming them nonrenewable but sustainable. Indeed, the natural resource base of some areas may necessitate mineral profits as the catalyst for a longer term development path. Rather than a simplistic rejection of minerals as 'nonrenewable,' environmentalists must be willing to grapple with the chemical, ecological and economic nuances of material extraction."

SALEEM H. ALI
DIRECTOR, CENTRE FOR SOCIAL RESPONSIBILITY IN MINING
UNIVERSITY OF QUEENSLAND, AUSTRALIA



"**MINING IS INHERENTLY UNSUSTAINABLE:** It is destructive to the biophysical environment, and its contributions to human well-being are uneven and often overwhelmed by the social and economic damage it inevitably inflicts. Mining must be drastically scaled back, not expanded. Where it is undertaken, it must be carried out carefully and conscientiously.

There is a theory that although itself unsustainable, mining growth can contribute to sustainability by providing raw materials for cleaner, more efficient and more prosperous human societies and generating wealth and employment that can serve as a 'bridge to sustainability.'

This theory, however, depends on fulfilling a set of conditions that are unrealistic given the global context: a profit-driven economic system, flawed accounting that treats collective and ecological goods as externalities, tax avoidance and financial secrecy, and weak governance relative to the power of extractive corporations. To the extent mining can be seen to have contributed to development, it is at a considerable ecological and human cost. The more comprehensive and thoughtful the plans for 'mining for development,' the clearer it is that such objectives are unattainable.

The path toward sustainability? We must reduce demand, reuse manufactured items and recycle materials. We must integrate the true costs of extracting and processing raw materials into decision making. We must place strict limits on where and how mining occurs. We must mine deposits at a slower pace to minimize environmental and socioeconomic disruption and maximize benefit. We must be able to identify ecologically and culturally sensitive areas as 'no-go' zones. Indigenous peoples must be able to exercise free, prior and informed consent, and mining must be subject to participatory and democratic decision making. We must not build mines that are likely to require 'perpetual care'— for example, for heavy metal or radioactive contamination.

We must place a real value on our precious geological resources, leaving them in the ground until they are truly needed and then extracting them with great care and respect."

JAMIE KNEEN
COMMUNICATIONS AND OUTREACH COORDINATOR
MININGWATCH CANADA

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WHERE THE WILD THINGS ARE (OR AREN'T)

The question of just how wild the American West should be is as much philosophical as it is biological. **BY LESLIE MACMILLAN**

SUSTAINABILITY IS DEAD

We need to remake the lexicon of sustainability if we are to move beyond preaching to the choir and gain serious mind share of the less interested masses. **BY PEGGY LIU**

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