

# momentum

Institute on the Environment • University of Minnesota

## ALL CONSUMING

Is the issue **POPULATION** or **CONSUMPTION** ... or both?



 environmental artists  
*show their stuff*



**THE EDUCATION EFFECT**  
Thriving Girls = Thriving World

**Policymakers to the rescue!**

*Population perspectives from* **TIM WIRTH, PAUL EHRLICH, BJØRN LOMBORG and HANS ROSLING**



### The Population Conundrum

**I can't seem to give a public presentation on environmental issues without someone in the audience standing up and asking, "But isn't the real problem overpopulation?"** Nine times out of 10, these people are white, older, of at least middle-class income and well educated. And, most of the time, they have several children of their own, and often many grandchildren.

At these moments, my irony detector is usually going off the scale.

But maybe they're right? Isn't population a huge problem? Surely the vast number of human beings now on the planet is an issue? Or are they looking for a convenient scapegoat, ignoring the possibility that our own patterns of consumption are the central issue instead?

Unfortunately, as with most important questions, there isn't a simple, single answer.

To start, let's be clear about one thing: global environmental problems are not caused solely by population growth. The number of people on the planet per se doesn't affect our climate, our ecosystems or our natural resources. It's how we *collectively consume and pollute* that impacts the environment.

Plus, a relatively small number of us are responsible for the vast majority of the globe's consumption, pollution, land and water degradation, and biodiversity loss. In the United States alone, our 4 percent of the global population accounts for roughly 25 percent of the world's fossil fuel use—about six times our share of the planetary pie.

And, for the most part, the richest nations of the world are not growing their population (except through immigration). Instead, we are increasing our use of resources as we desperately try to keep our consumer-based economies afloat.

So, are things that simple? Is the problem overconsumption by the rich, and not population?

No. Population growth is definitely contributing to our global problems too, but in a different way.

The world's poorest nations are not only home to some of the

fastest growing populations, but also often the most vulnerable to environmental, political and economic disruptions. While the people who inhabit them contribute relatively little to global environmental degradation, they will be the first to feel the impacts.

It's a one-two punch: The rich are rapidly increasing consumption and causing the lion's share of our planetary environmental problems, while the number of poor is growing, putting more people in harm's way and increasing human vulnerability to environmental disruption.

Yes, population *is* an issue. But so is overconsumption. The two are working in parallel, at opposite ends of the economic scale. It's a perfect storm.

As if that weren't enough, the world is adding a difficult twist: Sizable numbers of poor people are moving into the global middle class, dramatically increasing their consumption along the way. And here in the United States we can hardly complain: None of us has the right to deny poorer nations the right to develop, especially when their per capita consumption is still so much lower than our own.

So, in all of this doom and gloom, is there any good news?

Yes: Not too long ago, demographers were forecasting that global population by 2050 would reach 10 to 12 billion, instead of the 9 billion we expect today. And when I was a kid, people were talking about 15 to 18 billion. As population forecasts have been revised over the years, they have generally been revised downward.

Fortunately, population growth on a global scale appears to be slowing faster than anyone predicted as human welfare improves. The demographic transition appears to be working. People all across the world are choosing to have smaller families.

The bad news is that consumption appears to be still increasing rapidly, with no end in sight. So far there hasn't been negative feedback on consumption, telling us to slow down. The rich want to be richer. Big consumers want to consume even more. It's an endless treadmill, and no one knows how to get off. Instead of the "Population Bomb" of the 1960s, we now have an even larger "Consumption Bomb," and we don't know how to defuse it. This bomb may well define our relationship to the environment for the 21st century and beyond.

Going back to the people in the audience, how should I answer their question about population being the *real* problem in the global environment?

I will continue to give them the best answer I have: Yes. And no.

**Jonathan Foley**

A handwritten signature in black ink that reads "Jon Foley". The signature is stylized and cursive.

**Director, Institute on the Environment**  
[jfoley@umn.edu](mailto:jfoley@umn.edu)

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# momentum

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**director** JONATHAN FOLEY

**communications director** TODD REUBOLD

**interim editor** MARY HOFF

**art director** SARAH KARNAS

**webmaster** MICHELLE BEAMAN

**video producer** BETH M. ANDERSON

**contributors**

DAVID BIELLO, BRENDAN BORRELL, STUART BUTLER, EVE DANIELS, ALYSSA FORD, KATE KNUTH, DAVID MAHONEY, MAYWA MONTENEGRO, EMILY SOHN, STEPHANIE SZUREK, THOMAS THAM, SANTIAGO URQUIJO, STEPHANIE XENOS

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PHOTO: JOI ITO



◀ BRILLIANT WORDS

"There was a feeling in the '60s that something better was right around the corner. We didn't have a word for it or the vocabulary. I think that movement has returned."

Physician and philanthropist **LARRY BRILLIANT** during a June 15 Great Conversations talk on pandemics and the environment with IonE director Jon Foley. Hear the rest at [cce.umn.edu/Great-Conversations](http://cce.umn.edu/Great-Conversations)

"River banks made of plastic in Kathmandu, Nepal, a city crumbling under the weight of population ... My parents traveled there 36 years ago and the sacred rivers that run through the city were clear and full of fish ... now they are open sewers."

Congratulations to **NHARYAN FELDMANN** of Byron Bay, Australia, winner of *Momentum's* first photo contest. Photos were judged on relevance to the theme of population and consumption, originality, and quality. [facebook.com/UMNIonE](https://facebook.com/UMNIonE)

POPULATION IN PIXELS ▼



SUPERIOR IMPACT ▼



The effects of climate change are evident all around us—including in the world's largest lakes, as we see in the video series **LAKE SUPERIOR AND CLIMATE CHANGE**. University of Minnesota, Duluth, researchers are investigating impacts of changing climate on Superior and comparing data gathered there with those from other big lakes, including the deep-water basins of the East African Rift Valley. By studying similarities and differences across regions and geologic histories, scientists hope to better understand the impact of climate on ecosystems and predict major events such as droughts and floods. Learn more and watch the three-part series online. [youtube.com/UMNIonE](https://youtube.com/UMNIonE)

## The Long View Interview by TODD REUBOLD

**Representative, senator, undersecretary, president, doctor...** the diverse roles **TIMOTHY WIRTH** has held over the years make him one of the leading voices on global environmental and population challenges. He was first elected to the House of Representatives in 1974, became a U.S. senator in '87, outlined the "cap and trade" idea in '88 and helped guide U.S. foreign policy as part of the Clinton administration during the 1990s. As president of the United Nations Foundation since its inception in 1998, he oversees an international organization focused on the environment, women and population, children's health, peace, security, and human rights. Wirth recently took a break from saving the world to chat with *Momentum*.

### HOW DID YOU START OUT WORKING ON ENVIRONMENTAL ISSUES?

When I first ran for office, Earth Day had just happened and Richard Nixon was president and had been quite a good environmental president. It was just a natural thing to flow into working on environmental issues. I did it with much less intensity than I do now, though.

### GIVEN THE RECENT DEBATE OVER CLIMATE CHANGE, IS THERE A ROLE FOR GOVERNMENT IN SOLVING COMPLEX ENVIRONMENTAL AND POPULATION ISSUES?

Government should be able to do it, but unfortunately the current state of affairs is such that Congress is just out of touch with the 21st century. It's remarkable to me their inability to handle the climate issue or immigration or the budget or just about anything. So the action is all at the state, county and local level. And that's good because that's where America does its best anyway.

### WHAT COMES TO MIND WHEN YOU HEAR THE WORDS "POPULATION CRISIS"?

There are two parts to that question and two parts to the answer. One, obviously numbers and consumption patterns are directly related because the world is consuming more and more resources and more and more people are consuming high on the consumption chain. It's not just the U.S. anymore. There are 600 million people around the world in the last decade who have entered the middle class and are consuming at levels that look like the U.S., Japan or Europe. So that's one part of it.

The other part is that the population issue is also changing significantly. It's becoming more of a demographic issue. You have issues of an aging society, an urbanizing society, and significant issues of immigration. We really don't know how to handle any of those questions. The world is becoming more and more urban. Is that a good thing or not?

Finally the issue of immigration is going to be driven by climate change, and we haven't got very much of an idea how to deal with that. So there's a whole new package of demographic changes that have to be examined and understood.

**HOW DO WE AVERT A CRISIS?** The goal is to stabilize the world's population. If we're lucky we're going to stabilize at 8.5 billion people. That's still many too many for the carrying capacity of the earth and so we're going to have to change our consumption patterns significantly.

### WHAT ARE YOU MOST PROUD OF DURING YOUR TENURE AT THE UNITED NATIONS FOUNDATION?

I think what we've done is gotten the U.S. squared away in its relationship with the U.N. There was a period of time where the U.S. was a billion dollars in debt to the U.N. That debt has been paid off and the relationship is now stabilizing. So that's a very, very positive accomplishment. Our basic mission is to try to strengthen the U.N., so we work on climate and population and children's health issues and so on, but most important is getting the U.S.-U.N. relationship squared away, and that's been pretty successful.

### I UNDERSTAND YOUR ORGANIZATION HELPS SUPPORT ADOLESCENT GIRLS AROUND THE WORLD?

This is the most important demographic in the world. Whether girls stay in school or not, whether they delay the time of having children, become economic contributors in the world. This is terribly, terribly important, and we want to do everything we can to get the institutions of government to understand this especially important demographic.

**WHAT ARE YOUR HOPES FOR THE FOUNDATION?** I hope we're able to help the U.N. strengthen its capacity to deal



with population issues and energy questions, including climate change. We also have some very ambitious things we're trying to do related to adolescent girls in particular. So the areas of population, climate change, energy and adolescent girls are top of the agenda for our future. **Q&A**

Visit [unfoundation.org](http://unfoundation.org) to learn more about the United Nations Foundation.

## NISE Ideas

What do you get when you bring together thought leaders from 3M, the United Nations Foundation, Medtronic, the Science Museum of Minnesota, The Nature Conservancy, and two dozen other private sector, government and nongovernmental organizations with impact around the world? Ideas that make a difference, says

PHOTO: JOSH KOHANEK

IonE resident fellow Tim Smith, director of the **NorthStar Initiative for Sustainable Enterprise**. Smith launched NISE last winter as a resource for building research agendas with real-life environmental and social impact. The consortium has met twice so far and launched research projects related to improving material cycling and encouraging consumers to make sustainable choices. Check the IonE website for a midsummer announcement of the next batch of initiatives to hatch from this innovative idea incubator.



## Future Earth

We live in a time when humans are the dominant force for change on Earth. Exploring the emerging

Anthropocene through the eyes of sustainability science and design is the subject of four **Science Museum of Minnesota** exhibits to be installed on the University of Minnesota, Twin Cities, campus over the next year. First up will be a global snapshot of changes in land use over time, followed by a look at fracture-critical systems. The traveling exhibits are part of the museum's Future Earth Initiative, an NSF-funded program that also includes a permanent exhibit slated to open in summer 2011 at the downtown St. Paul museum.

# SPOTLIGHT

FROM THE CLASSROOM TO THE LAB, UNIVERSITY OF MINNESOTA



Abrupt changes in historical climate data will be the focus of IonE resident fellow **ARINDAM BANERJEE's** (Computer Science and Engineering) research under a new NSF CAREER grant. The highly competitive grant recognizes early career faculty with exceptional promise.

IonE resident fellow **MARC HILLMYER** (Chemistry), known for his work on sustainable polymers, has joined the ranks of distinguished McKnight university professors. Hillmyer also recently received U of M recognition for outstanding commitment to students and teaching.

Work on robotic sensors for environmental monitoring has earned IonE resident fellow **I. VOLKAN ISLER** (Computer Science and Engineering) a McKnight land-grant professorship.

IonE resident fellow **TOM JOHNSON** (Large Lakes Observatory, University of Minnesota, Duluth), an expert on sedimentary processes in large lakes, paleoclimatology and paleolimnology, has been named Regents professor by the U of M.

## Nature of Things to Come

The economic value of nature is the focus of research by the **Natural Capital Project**, a partnership of Stanford University, The Nature Conservancy, World Wildlife Fund—and, as of this June, the Institute on the Environment. The project works with public, private and nonprofit partners to develop tools for quantifying the value of services provided by healthy ecosystems and apply those tools to conserving natural resources. Initiatives are currently underway in California, China, Hawaii, Indonesia, Central America, South America and Tanzania. Visit [naturalcapitalproject.org](http://naturalcapitalproject.org) to learn more.

## Bright Futures

Three emerging leaders have been chosen fellows in the Initiative for Renewable Energy and the Environment (IREE)'s Global Energy Leadership Fellows program. **Jill Baumgartner**, a Ph.D. candidate in Environment & Resources and Population Health at the University of Wisconsin–Madison, is

interested in exploring policies for reducing use of solid fuels and inefficient cooking and heating technologies in developing countries. **Stephen Hawley**, who received his Ph.D. in electrical engineering and nanotechnology from the University of Washington, will work on systems for producing biohydrogen using cyanobacteria and wastewater in developing countries. **Matt Johnston**, a graduate of the environment and resources Ph.D. program at the University of Wisconsin–Madison, will conduct research related to establishing collaborations among developing countries in support of local bioenergy production.

## Meeting the Challenge

Boosting biogas production and improving freshwater access proved winners for the top two teams in the **Acara Challenge 2010**, an IonE-sponsored program that encourages entrepreneurship to help meet water and energy needs in India. Students

from the University of Minnesota and the Indian Institute of Technology Roorkee took first place in the clean energy contest by designing a business to provide affordable weekly maintenance for biogas units, helping improve indoor air quality and provide much-needed jobs in Indian communities. The clean water prize went to the University of Illinois at Chicago and Vellore Institute of Technology for a sun-driven system that can desalinate and purify 100,000 liters of water per day. Winning teams received support to attend a two-month summer institute focused on commercializing their ideas.



## PROFESSORS AND RESEARCHERS CONTINUE TO SHINE...

The U of M has recognized IonE resident fellow **ALEXANDRA KLASS** (Law School), an expert in environmental and natural resource law, for outstanding commitment to students and teaching.

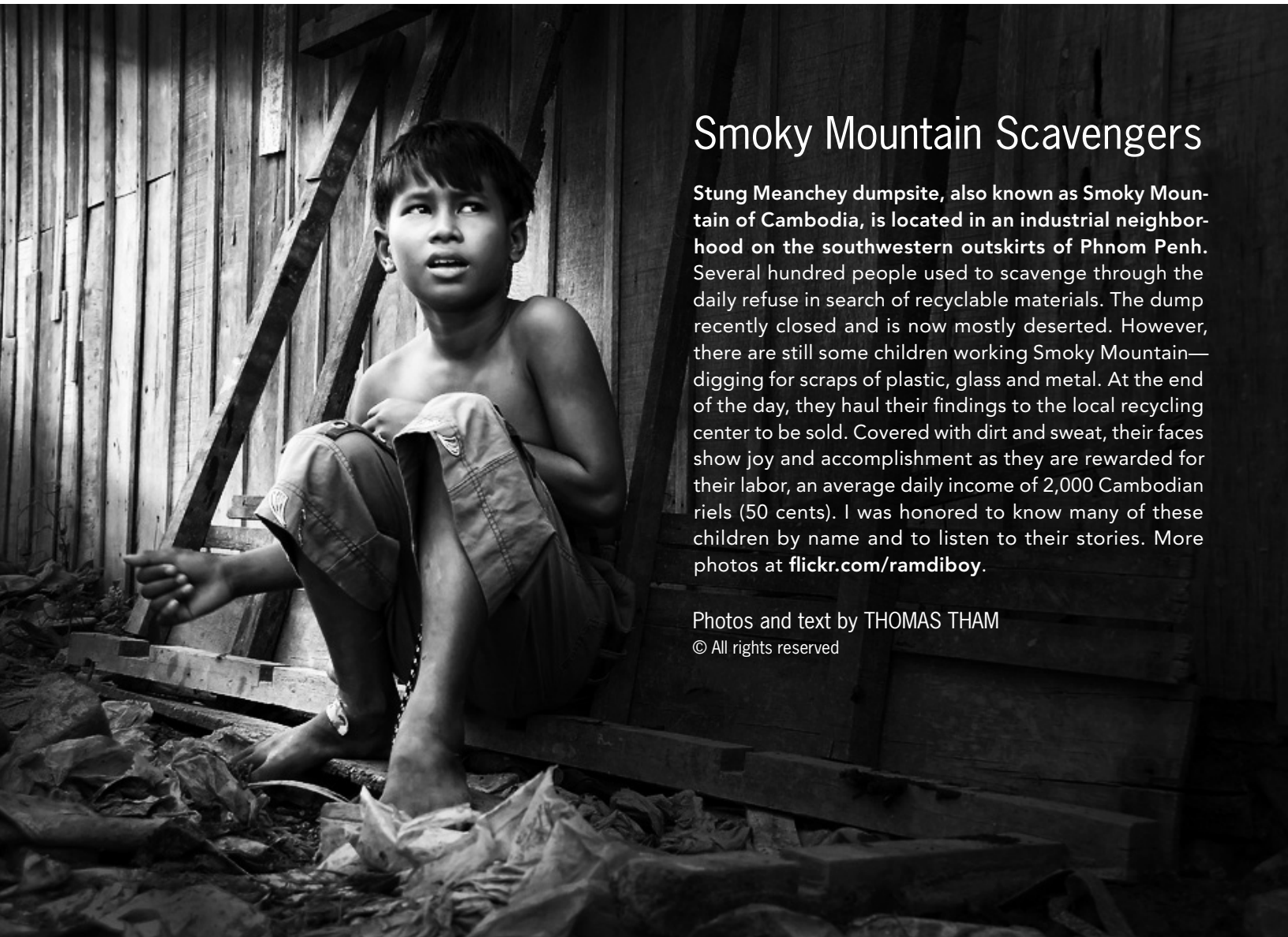
**NED MOHAN** (Electrical and Computer Engineering), recipient of numerous grants from the Institute's Initiative for Renewable Energy and the Environment (IREE), received the 2010 Utility Wind Integration Group award for leadership in power engineering and renewable energy curriculum development. In addition, the U of M recently honored Mohan for outstanding commitment to students and teaching.

Impacts of agricultural management on crop yield and global environmental change will be the focus of a highly competitive NSF graduate research fellowship awarded to IonE research assistant and conservation biology graduate student **NATHAN MUELLER**.

IonE resident fellow **STEPHEN POLASKY** (Applied Economics) has been elected to the National Academy of Sciences. Polasky's research includes ecosystem services, natural capital, biodiversity conservation, renewable energy and environmental regulation.

IonE resident fellow **JONATHAN SCHILLING**'s (Bioproducts and Biosystems Engineering) new DOE early career grant builds on IREE-funded research targeting brown rot fungi for their potential in deconstructing plant lignocellulose on route to bioproducts such as fuels and thermoplastics.

Decades of research on biodiversity, protection of endangered species and sustainable farming practices for renewable energy earned IonE resident fellow **DAVID TILMAN** (Ecology, Evolution, and Behavior) the 2010 Heineken Prize for Environmental Sciences—the top ecology award in the world—in April.



## Smoky Mountain Scavengers

Stung Meanchey dumpsite, also known as Smoky Mountain of Cambodia, is located in an industrial neighborhood on the southwestern outskirts of Phnom Penh. Several hundred people used to scavenge through the daily refuse in search of recyclable materials. The dump recently closed and is now mostly deserted. However, there are still some children working Smoky Mountain—digging for scraps of plastic, glass and metal. At the end of the day, they haul their findings to the local recycling center to be sold. Covered with dirt and sweat, their faces show joy and accomplishment as they are rewarded for their labor, an average daily income of 2,000 Cambodian riels (50 cents). I was honored to know many of these children by name and to listen to their stories. More photos at [flickr.com/ramdiboy](https://www.flickr.com/photos/ramdiboy/).

Photos and text by THOMAS THAM

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## Bomb Squad Interviews by GREG BREINING

In 1968, Paul Ehrlich warned in *The Population Bomb* that exploding population would cause widespread famine and resource depletion within 20 years. Hasn't happened—not yet. The Green Revolution staved off famine, and humans have proven resourceful, literally, in finding substitutes for scarce materials. • Now, with world population exceeding 6.8 billion and heading beyond 9 billion by 2050, will Ehrlich's predictions come true? Or was late economist Julian Simon correct in asserting that humans, even in ever-greater numbers, were the "ultimate resource" to innovate our way out of shortages? • We interviewed three authorities on environment and population: **EHRlich**, president of the Center for Conservation Biology and Bing professor of population studies at Stanford University; **BJØRN LOMBORG**, author of *The Skeptical Environmentalist* and director of the Copenhagen Consensus Center; and **HANS ROSLING**, professor of international health at Karolinska Institutet in Sweden and director of the Gapminder Foundation. Their edited remarks follow.

**GLOBAL POPULATION HAS BEEN UNSUSTAINABLE** for several decades. We're living on our capital, not on our interest. The deep, rich agricultural soils are disappearing at a much higher rate than they're being formed. Fossil groundwater is being pumped out at much-higher-than-recharge rate. The loss of populations and species of other organisms, the working parts of our life-support systems, are disappearing. All the trends are going in the wrong direction.

Every study that's been done shows that the state of wildlife and biodiversity is moving downhill rapidly virtually everywhere. Too many people think that the problem is loss of species. Well, before you lose species you lose their component populations, which is what deliver the ecosystem services. They are going at a horrendous rate. By the time people notice that a species is endangered, generally it is of little use to society in supplying any ecosystem services.

The biggest problems from my point of view from climate disruption are likely to be the change in precipitation patterns.

On a planet that already has more than a billion people hungry out of 7 billion, the changing precipitation patterns and additional heating will make agriculture very, very difficult.

The whole problem of the U.S. being superconsumers and the rest of the world trying to emulate them is a really difficult problem. Depending on whose numbers you read and what

assumptions you make, you'd need several more planets to support the number of people we have today at a U.S. lifestyle. My calculations, assuming no huge technological breakthroughs (of which there are no signs), indicate that we might be able support 2 billion people over the long term with a reasonable lifestyle.

» **PAUL EHRlich**

**IF EVERYONE WAS AT 2010 LEVELS OF EFFICIENCY**, with the dramatically increasing economic welfare of China and India, that would put an unsustainable pressure on the world. But that's not what we're expecting. We're expecting dramatic increases in efficiency in the use of virtually all resources.

The World Health Organization has estimated we can produce more food. Virtually all the increase in availability of food has not come from farming new land but from being able to get much more grain and produce from every hectare farmed.

Growing population is going to create more pressure on biodiversity and wildlife because most of the increase is going to happen in Third World countries, where very often you see unsustainable growth. If we want to focus on the solution, it has to be about making sure that people get rich faster. Rich people mostly live in cities where they have less of a footprint than in agricultural areas. Agriculture will increase in places where we already have production, in places that are not biodiversity hot spots.

Most of the energy resources we're using are products just as much of innovation as they are [of] physical resources. We have dramatically increased the availability of gas through cracking. And clearly we have enough coal for many hundred years. We're not going to run out anytime soon. Technology in the long run will overtake those concerns simply because we will find smarter and better technologies.

Barring being a very authoritarian state like China, telling people you can only have one child, there is very little you can do about population except to make sure you have good environment, you have better informed and richer citizens and better education of women.

» **BJØRN LOMBORG**

"It has to be about making sure that people get rich faster."

"All the trends are going in the wrong direction."

# BY THE NUMBERS »

**ALREADY 6.7 BILLION CREATE AN UNSUSTAINABLE** strain on the environment. But there's always been unsustainability. Why do people live in Sweden? Because the ecological use of Germany had become unsustainable 8,000 years ago. The hunting was gone. History is an endless list of unsustainable states.

A young student asked: Should we in the West let the poor in the developing world achieve the same material standard? As if it were a choice! There's no choice about these 9 billion, and they will work hard for a decent standard for their children. It's a fact. The promise is if child mortality is brought down in the whole world, family planning will be applied by all and world population will level off after 2050. But only if the poorest 1 to 2 billion fellow humans move into modernization.

Death is no longer able to control population (if you exclude nuke-mediated genocides), but two-child families can. The most forceful factors to achieve two-child families is good child survival, access to family planning, socioeconomic progress, and human rights for men and women to decide on family size. Urbanization is also good. All those things together yields two-child families.

I get scared by statements that we will be too many people.

I hear *lebensraum* [German for "living space"]. I hear the Nazis talking in the 1930s. We cannot kill people to save the environment. After all, human rights are more important than the environment, I say, and the environment can be cared for if the rich countries get serious about it! And it's not impossible! Professor Christian Azar coined the term *possibilist*. I'm neither optimist nor pessimist, I am a possibilist. Don't get too emotional: We can have a good world for 9 billion people if we get serious about making the right investments and regulations.

**"Human rights are more important than the environment."**

## » HANS ROSLING

**GREG BREINING** writes about science, travel and nature for *The New York Times*, *Audubon* and other publications. Among his recent books is *Super Volcano: The Ticking Time Bomb Beneath Yellowstone National Park*. His latest, *Paddle North: Canoeing the Boundary Waters-Quetico Wilderness*, will be published this fall.

### WORLD POPULATION (BILLIONS)

mid-2009:	6.810
mid-2025:	8.087
mid-2050:	9.421

### MOST POPULOUS COUNTRIES, 2009 (MILLIONS)

China	1,331
India	1,171
United States	307
Indonesia	243
Brazil	191
Pakistan	181
Bangladesh	162
Nigeria	153
Russia	142
Japan	128

### MOST POPULOUS COUNTRIES, 2050 (MILLIONS)

India	1,748
China	1,437
United States	439
Indonesia	343
Pakistan	335
Nigeria	285
Bangladesh	222
Brazil	215
Congo, Dem. Rep.	189
Philippines	150

Source: Population Reference Bureau  
2009 World Population Data Sheet

# WASTING CONSUMING



With population and per-capita consumption both on the rise, it's hard to believe humans' impact on Earth is sustainable.

## IS THE PROBLEM TOO MANY PEOPLE OR TOO MUCH CONSUMPTION?

by DAVID BIELLO

**TWO GERMAN SHEPHERDS** kept as pets in Europe or the U.S. use more resources in a year than the average person living in Bangladesh. The world's richest 500 million people produce half of global carbon dioxide emissions, while the poorest 3 billion emit just 7 percent. Industrial tree cutting is now responsible for the majority of the 13 million hectares of forest lost to fire or the blade each year—surpassing the smaller-scale footprints of subsistence farmers who leave behind long, narrow swaths of cleared land, so-called fish bones.

In fact, urban population growth and agricultural exports drive deforestation more than overall population growth, according to new research from geographer Ruth DeFries of Columbia University and her colleagues. In other words, the increasing urbanization of the developing world—as well as an ongoing increase in consumption in the developed world for products that have an impact on forests, whether furniture, shoe leather or chicken fed on soy meal—is driving deforestation, rather than containing it as populations leave rural areas to concentrate in booming megalopolises.

So are the world's environmental ills really a result of the burgeoning number of humans on the planet—growing by more than 150 people a minute and predicted by the United Nations to reach at

least 9 billion people by 2050? Or are they more due to the fact that, while human population doubled in the past 50 years, we increased our use of resources fourfold?

### PEAK HUMANITY

First and foremost, human population growth peaked long ago, according to demographer Joel Cohen of Rockefeller University in New York and others. The peak growth rate—a little more than 2 percent per year—occurred somewhere between 1965 and 1970, when the world's population was just 3.3 billion people, and has been dropping ever since, reaching a little over 1 percent today. In 1987, the number of people added to the planet each year topped out at 87 million, a number that is now down to roughly 78 million people per year. That means human population numbers will drop voluntarily for the first time ever in human history in the 21st century. A Baby Bust has replaced the Baby Boom.

The reason? Empowerment of women. A massive reduction in child mortality, combined with educated mothers pursuing their own advancement and in control of birth control, has helped to



drop the average human brood from over five children per woman of childbearing age to just 2.6 per woman today. As journalist Fred Pearce writes in his new book, *The Coming Population Crash*: “The

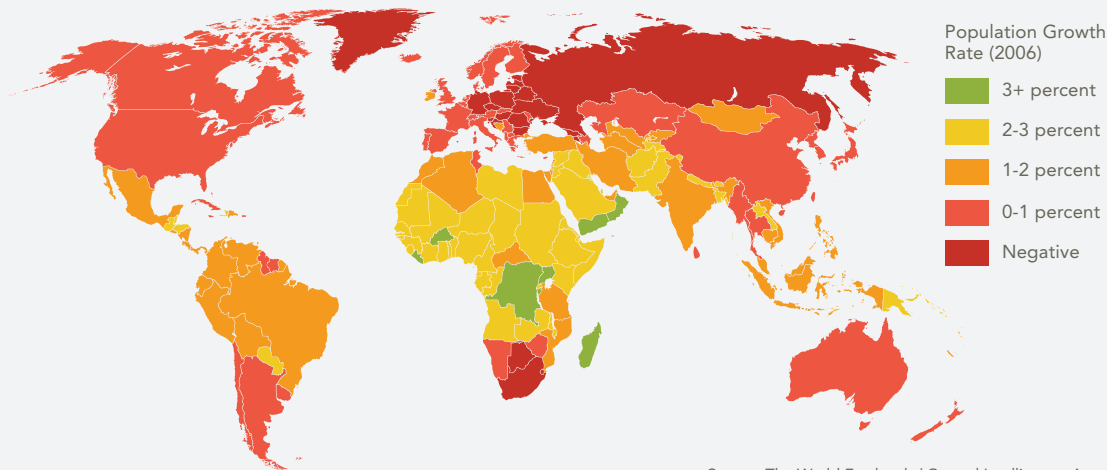
for the first (recorded) time in human history: Fewer than 10 percent of people alive today are under 4 years old, while those 60 and older now constitute more than 10 percent of the population. Birth

rates in countries such as Germany have fallen so far that populations are already shrinking.

Yet this demographic transition does not hold everywhere. While family planning has proven effective in the past in countries ranging from Thailand to Iran, funding for such programs has dwindled in recent years. Partially as a result, developing countries in eastern Africa—Kenya, Tanzania, Uganda and Zimbabwe—have seen populations begin to swell again in recent years.

## WORLD IN TRANSITION

Births, deaths, immigration and emigration—all influenced by health, nutrition, education, prosperity and more—create different patterns of population change in different places.



Source: The World Factbook / Central Intelligence Agency

population bomb is being defused. By women. Because they want to.”

In fact, the combination of increasing health (especially a greater proportion of babies surviving to adulthood), empowered women and falling birth rates may be the most important revolution to come out of the tumultuous 20th century. Those of us born between 1930 and 2050 will be among the privileged few to have ever witnessed a doubling of global population. It took from the dawn of humanity to the 19th century to achieve 1 billion people on the planet—an achievement that now comes roughly every few decades. And the 21st century will likely belong to the old, as elders outnumber youth

## CAPACITY UNKNOWN

The real question is, how many people can the planet sustain? As Cohen notes in his book *How Many People Can the Earth Support?*, microbiologist Anton van Leeuwenhoek calculated a carrying capacity of roughly 13.4 billion people back in 1679, based on the population density of his native Holland and its size relative to the rest of the globe. Modern guesses are hardly more scientific, ranging from as few as 1 billion (recently proposed by James Lovelock as



our likely number by 2100 thanks to catastrophic climate change) to as many as 1 trillion.

“These estimates are political numbers, intended to persuade people, one way or another: either that too many humans are already on Earth or that there is no problem with continuing rapid population growth,” Cohen writes.

As early as 1948, scientists began to link explosive modern population growth and catastrophe. Ornithologist William Vogt’s *Road to Survival* warned of impending demographic doom—as have numerous conservationists and environmentalists in the subsequent decades, perhaps most famously biologist Paul Ehrlich (*The Population Bomb*) or Donella and Dennis Meadows (*The Limits to Growth*). In Ehrlich’s case, observations of butterflies breeding so fast as to consume all available food—and then dwindling away—inspired him to predict the same fate for humans.

This is not a new idea, mind you. As early as 1600 B.C., when total population was less than 50 million, Babylonians worried that the world was too full of people, according to Cohen. The predicted human population of 2050—9 billion people—would have been inconceivable at that time.

## OUTPACING PESSIMISM

That’s because human ingenuity—whether through the waterworks of ancient Babylon or the more modern breeding of staple crops such as wheat for higher yields, known as the “Green Revolution”—has outpaced, so far, the pessimism of apocalyptic environmentalists.

Agronomist Norman Borlaug and colleagues created a strain of dwarf wheat that staved off famine for hundreds of millions in the 1960s and 1970s—increasing India’s harvest alone by nearly 170 percent in less than a decade. Yet “there can be no permanent progress in the battle against hunger until the agencies that fight for increased food production and those that fight for population control unite in a common effort,” Borlaug said in his acceptance

**HUMAN INGENUITY—WHETHER THROUGH THE WATERWORKS OF ANCIENT BABYLON OR THE MORE MODERN BREEDING OF STAPLE CROPS SUCH AS WHEAT FOR HIGHER YIELDS, KNOWN AS THE “GREEN REVOLUTION”—HAS OUTPACED, SO FAR, THE PESSIMISM OF APOCALYPTIC ENVIRONMENTALISTS.**



speech for the Nobel Peace Prize in 1970. “[Man] is using his powers for increasing the rate and amount of food production. But he is not yet using adequately his potential for decreasing the rate of human reproduction. The result is that the rate of population increase exceeds the rate of increase in food production in some areas.”

That demographic contradiction is nowhere more true than in many countries of sub-Saharan Africa, where a population of 800 million must subsist on local yields of 1 metric ton per hectare—one-third of yields in the rest of the developing world and one-ninth those of the U.S., Europe, Australia and other parts of the developed world.

Genetic modification might boost yields. Such technology is “critical for achieving the ecological intensification required to meet human food demand on a global scale,” says agronomist Kenneth Cassman of the University of Nebraska–Lincoln. And genetic modification may prove critical to meet the challenge of crop stress due to climate change, dwindling topsoil and billions more mouths to feed. But it is currently illegal in most of Africa, according to political scientist Robert Paarlberg of Wellesley College, and faces serious public concern and regulatory challenges in the U.S., Europe and other parts of the world.

Still, there is still plenty of room for improvement by more conventional means: the targeted application of fertilizer and the like. The Earth Institute’s Millennium Village of Sauri in Kenya has tripled yields even in the face of a crippling drought gripping the region, and Malawi doubled yields through fertilizer subsidies in just four years.

Nor is the growth of human population an unmitigated ill. After all, more people means more minds and hands devoted to solving the pressing problems of increasing yields, biodiversity loss and economic sustainability—as can be seen in many portions of Africa today. As economist Ester Boserup argued in the 1960s: Population growth may drive agricultural innovation, from the plow to Borlaug’s dwarf wheat, rather than the other way around.

## TEN THOUSAND TON CHILD

Yet apocalyptic biologists have a strong case as well. Fifty percent of all temperate grasslands and forests have disappeared, largely under the plow. More than 16,000 known species face extinction (785 have already been lost) and as many as 12,000 species unknown to science disappear each year, according to biologist E.O. Wilson of Harvard University. More than 90 percent of some commercial fish species, such as cod, pollock and haddock, are gone. Water tables around the globe plummet precipitously, thanks to human withdrawals for agriculture. And population growth to 9 billion people alone will add as much as 2 billion metric tons more of carbon dioxide to the greenhouse gas blanket smothering Earth.

*Continued on page 16...*

# MEATY ISSUE

BY BRENDAN BORRELL

**IN THE LEAD-UP TO CLIMATE TALKS** at Copenhagen last year, an activist in a black-and-white cow costume held up a cardboard speech bubble with a single word: “Burp.” To those who know that methane produced by livestock is a greenhouse gas four times as potent as carbon dioxide, the message was clear. Go vegetarian, meat is killing the planet.

The U.N. Food and Agriculture Organization has estimated that livestock generate 18 percent of greenhouse gases by weight worldwide, exceeding even those spewed out from the transportation sector. In addition to methane-laced burps, livestock produce manure that makes both methane and nitrous oxide as it breaks down. Clearing for livestock range is also a serious force behind the release of carbon reserves from tropical forests. Beyond greenhouse gas emissions, cattle have long been considered an inefficient use of land and other resources, contributing to a loss of biodiversity.

Then there are the doomsday predictions for the coming century as populations in developing countries in Latin America, Asia and Africa become increasingly carnivorous. An upcoming paper in the journal *Global Environmental Change* by ecologist Alexander Popp at the Potsdam Institute for Climate Impact Research combines socioeconomic data and population trends to estimate that agricultural greenhouse



gas emissions will almost double by 2055 if people in developing countries continue to increase the proportion of meat in their diets. So far, however, agriculture has largely escaped regulation under the Kyoto Protocol and under the now-stalled U.S. climate bill.

Despite all this, Popp and others stop short of advocating a diet of arugula for all. In the U.S. and Europe, people consume an average 78 kilograms of meat and 202 kilograms of milk per person each year. Fifty years from now, Africa and other developing countries will still have not even reached half of that per capita consumption, although total demand will be double that of developed countries. Therein lies the problem: How can we limit agricultural greenhouse gas emissions without slashing sustenance in parts of the world where soy and seafood are hardly a viable option? Certainly, Europe and the U.S. can stand to trim some of their animal-derived calories, but an equally important question is what changes need to be made to livestock production in the developing world.

Mario Herrero is a Costa Rica-born ecologist who has been based at the International Livestock Research Institute in Nairobi, Kenya, for the last 10 years and thinks deeply about the ethical and practical consequences of environmental policies. “Don’t think that a world without livestock would lead to reduced emissions,” he says.

“How are you going to plow your fields without tractors? What are you going to use as your source of fertilizer?” In some regions where the growing season is less than 90 days per year, growing crops is unfeasible—so a landscape without livestock is a village without food. Limiting livestock production could also lead to increased pressures on battered fisheries or wild animal populations. Herrero suggests greenhouse gas emissions could rise if East Africa’s migrating ranchers were replaced with native impala and elephants. In fact, termites contribute 25 percent of the methane in some areas, which suggests at the very least, that native ecosystems can’t be left out of the equation.

More important, cattle are the key to African and Latin American livelihoods. In addition to generating a significant source of income, they are a symbol of wealth, a predictable food source and a four-legged insurance policy. While crops are harvested just once or twice a year, cows can be milked every morning. And with extreme weather able to knock out an entire year’s crop, keeping a few extra cows alive can be a lifesaver.

In February, Herrero argued in *Science* for sustainable intensification using mixed crop-livestock systems. Rather than taking the path of massive livestock and poultry operations that are common in the U.S.—and growing more common in Asia—he believes it is possible to improve meat and milk production among traditional ranchers without increasing greenhouse gas emissions. For instance, it is better to have one cow that produces 3 liters of milk each

day, than three cows that produce 1.5 liters—the current average in Africa. “These animals will eat almost the same and they will produce almost the same methane, but you are multiplying your emissions by three.” Currently, residues from crops like corn and wheat are fed to cattle in developing countries. But because these crops were bred for grain production, the residues often have low energy content. By improving these “dual-purpose crops,” Herrero says it is possible to increase milk production by 50 percent.

Reducing greenhouse gases coming from emerging agricultural hot spots may also depend on changing cultural practices and bolstering financial stability. Andrew Mude, another ILRI researcher, has been working with the World Bank on a type of insurance policy for a diverse group of pastoralist ranchers. Pastoralists in Marsabit, a drought-stricken district in eastern Kenya, tend to keep unproductive animals as a security measure. With access to financial instruments, Mude believes farmers would no longer have to maintain as many extra animals, which would reduce their impact on the land and their greenhouse gas emissions.

On January 22, the institute enrolled its first farmers in a pilot program. Brenda Wandera, an agricultural economist and project manager with ILRI, says that it took a while to convince locals to

embrace the methods. “We came up with insurance simulation games, and used their pastoral systems to explain these concepts,” she says. After going from village to village, Wandera and Mude got 1,979 pastoralists to start paying premiums on a total of 311 camels, 2,559 cows, and 15,826 sheep and goats. Over the next year, the researchers will monitor satellite vegetation maps, which can be used to predict livestock mortality. If more than 15 percent of the cattle are predicted to die during a season, then the insurance policy will start to pay out.

Of course, none of these developments should make Europeans or Americans complacent about their own meat consumption. Popp, who

hails from southern Bavaria, says he grew up eating a lot of meat and still has a hankering for a good roast beef or beefsteak. But seeing the numbers coming out of his recent study has changed that. “Before I used to eat it once a day,” he says, “Now, I may just eat it once or twice a week.”

*What’s your take on the Great Meat Debate? Send your thoughts to [momentum@umn.edu](mailto:momentum@umn.edu). We’ll publish a sampler on Momentum’s website, [environment.umn.edu/momentum](http://environment.umn.edu/momentum).*

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**BRENDAN BORRELL** is a New York-based journalist who has written about science and the environment for *Smithsonian*, *Scientific American*, *The New York Times* and many other publications.



**CATTLE ARE THE KEY TO AFRICAN AND LATIN AMERICAN LIVELIHOODS. ... THEY ARE A SYMBOL OF WEALTH, A PREDICTABLE FOOD SOURCE AND A FOUR-LEGGED INSURANCE POLICY.**

TO MAINTAIN TODAY'S NUMBER  
OF CHRONICALLY MALNOURISHED  
OR OUTRIGHT STARVING  
PEOPLE—1 BILLION—IN 2050  
WITH A LARGER POPULATION AND  
PRESENT CROP YIELDS WOULD  
REQUIRE CLEARING 900 MILLION  
ADDITIONAL HECTARES OF LAND.

*Continued from page 14...*

“The inexorable increase in human numbers is exhausting conventional energy supplies, accelerating environmental pollution and global warming, and providing an increasing number of failed states where civil unrest prevails,” writes reproductive biologist Roger Short of the University of Melbourne in the introduction to a special issue of *Philosophical Transactions of the Royal Society B*—a journal from the U.K.’s Royal Society whose motto is “Take nobody’s word for it.”

Short goes so far as to call for a halt to future population growth. After all, the most profound way a U.S. citizen can impact climate change is to have fewer children, since every American child born today will add almost 10,000 metric tons of CO<sub>2</sub> to the atmosphere under current conditions—five times more than a Chinese child and 160 times more than a baby from Bangladesh. Having one fewer child would reduce a family’s greenhouse gas impact 20 times more than driving a Toyota Prius, using Energy Star appliances and other environmentally friendly lifestyle choices combined, according to researchers at Oregon State University.

## EATING AWAY

But the real problem today—as it has been since at least the time of Thomas Malthus—may be food. Simply to maintain today’s number of chronically malnourished or outright starving people—1 billion—in 2050 with a larger population and present crop yields would require clearing 900 million additional hectares of land. At most, there are an additional 100 million hectares to add to the 4.3 billion already under cultivation worldwide, according to Pedro Sanchez, director of the Tropical Agriculture and the Rural Environment Program at the Earth Institute.

“Agriculture is the main driver of most ecological problems,” says Sachs. “We are literally eating away the other species on the planet.” After all, humans now directly employ some 40 percent of the total land area of Earth.

Nor can the solution be found in the ongoing increase in nature reserves, which currently cover some 15 million square kilometers

of the planet. “There are desperately poor people surrounding many of these reserves,” Ehrlich says. “If I was there, I would shoot the hippo and eat it too.”

Concerns about population growth often boil down to concerns about too many of the wrong sort of people, as evidenced by recent efforts to tie environmental and anti-immigration efforts, such as an unsuccessful bid by nativist John Tanton to turn the Sierra Club against immigration. After all, governments from France to Australia pay their citizens to have babies in an effort to ward off the baby bust—and those efforts seem to be working. Women in developed countries are having more children again, according to demographer Mikko Myrskylä of the University of Pennsylvania. “Increases in development are likely to reverse fertility declines—even if we cannot expect fertility to rise again above replacement levels,” Myrskylä writes in *Nature*. “We expect countries at the most advanced development stages to face a relatively stable population size.”

That does not include immigration, of course, which some environmentalists decry as a threat to the sustainable future of the U.S. Yet the U.S. has only 80 people per square mile compared to 140 per square mile in Mexico, to take just one example. Immigration may actually reduce environmental pressures elsewhere—such as Haiti, where 760 people live for every square mile of countryside. And immigration remains the single most effective poverty alleviation program on the planet, according to economist Lant Pritchett of Harvard University. He argues that labor (i.e., people) should be as free to move internationally as capital (i.e., money).

## IT'S THE CONSUMPTION, STUPID

Ultimately, the problem isn't the number of people, necessarily. It's what those people do. The average American (just one of 309 million) uses up some 194 pounds of stuff—food, water, plastics, metals and other things—per day, day in and day out. We consume a full 25 percent of the world's energy despite representing just 5 percent of global population. And that consumerism is spreading,

whether it be the adoption of cars as a lifestyle choice in China or gadget lust in the U.S.

“Consumerism is now spreading around the world,” says Erik Assadourian, a senior fellow at the Worldwatch Institute. “Is this going to keep spreading? Or are countries going to start recognizing that this is not a good path?”

What's needed is the wholesale junking of the disposable life, Assadourian says, “a world where machismo is not connected to the size of a car but the fact that you don't have one at all.” That may not be all our fault. “We are not stupid, we're not ignorant, we don't even necessarily have bad values with respect to the environment,” says political scientist Michael Maniates of Allegheny College. “We're trying to do our best within cultural systems that elevate unsustainable choices.”

The world already grows enough food to feed 10 billion people—if we all ate a vegetarian diet, Cohen notes. Such lifestyle changes may prove unpalatable, transforming everything from how the dead get buried to gadgets that last a lifetime or more.

As simply put by the United Nations Millennium Ecosystem Assessment in 2005: “Human activity is putting such strain on the natural functions of Earth that the ability of the planet's ecosystems to sustain future generations can no longer be taken for granted.” In other words, we just might let the world go to the dogs.

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DAVID BIELLO is an award-winning journalist and associate editor at *Scientific American*. He has written on subjects ranging from astronomy to zoology and has been reporting on the environment and energy since 1999—long enough to be cynical but not long enough to be depressed.



# GIRL EMPO

ANITA GREW UP IN BIHAR, INDIA—a country where 57 percent of girls drop out of school between the ages of 6 and 16, and only 14 percent of young women between 15 and 24 have jobs. From an early age, Anita wanted more. At 5, she begged her parents to let her go to school. At 10, she started tutoring other kids for money. By 20, she had become a beekeeper, hired her brother and trained 20 other girls in her trade, and was earning enough to pay for college.

Anita is just one girl in one country, but her story is symbolic of something much bigger: Helping girls helps the whole world. If every girl living in the developing world were given an education, a voice and a chance, according to a growing body of evidence, there would be less disease, less poverty, less pressure on the environment from overpopulation and fewer deaths at tragically young ages.

This idea—that girls are a key part of solutions to economic and social problems—has been lurking in the shadows for decades. Now, it's going mainstream. U.S. secretary of state Hillary Clinton has made girls and women a focus of her foreign policy efforts. More than a hundred world leaders attended a workshop about girls during the World Economic Forum in Davos, Switzerland, earlier this year. And

*Continued on next page...*

PHOTO: S. BUTLER

A young girl with dark hair, wearing a white dress, is seen from behind, writing the word "POWER" in large, white, chalk-like letters on a dark, textured surface. The scene is dramatically lit from the side, casting a long, dark shadow of the girl and her hand onto the surface. The overall mood is one of empowerment and focus.

GROWING EVIDENCE INDICATES THAT BOOSTING THE STATUS OF GIRLS BENEFITS NOT ONLY INDIVIDUALS, BUT ALSO COMMUNITIES, COUNTRIES--AND THE WORLD.

BY EMILY SOHN

aid organizations are increasingly directing their efforts toward girls. The Nike Foundation, which has funded girl-focused projects since 2004, has even given the movement a name: “The Girl Effect.”

“We have increasing amounts of data to show that if we create more of an enabling environment for girls, we really can help to change their situation, and that’s where you start to see the ripple effects—how that helps households, communities and countries,” says gender expert Sarah Degan Kambou, interim president of the International Center for Research on Women in Washington, D.C. “Girls hold up half the sky.”

**THERE ARE MORE** than 600 million adolescent girls ages 12–18 living in developing countries, according to statistics compiled by the Nike Foundation. Of those, one in seven marries before age 15, and 38 percent become wives before age 18. Marriage often leads to motherhood, and both transitions inhibit adolescents from getting an education: Girls make up 70 percent of the globe’s 130 million kids who aren’t in school.

Just a penny out of every aid dollar goes to adolescent girls, says Michelle Chaplin, a New York-based program manager for BRAC, an international humanitarian and development organization. “They’re generally one of, if not the most vulnerable groups when it comes to developing countries,” Chaplin says, adding that it’s normal for 12-year-old girls to get pregnant in some cultures. “They’re sort of set up to repeat the same vicious cycle that their mothers went through.”

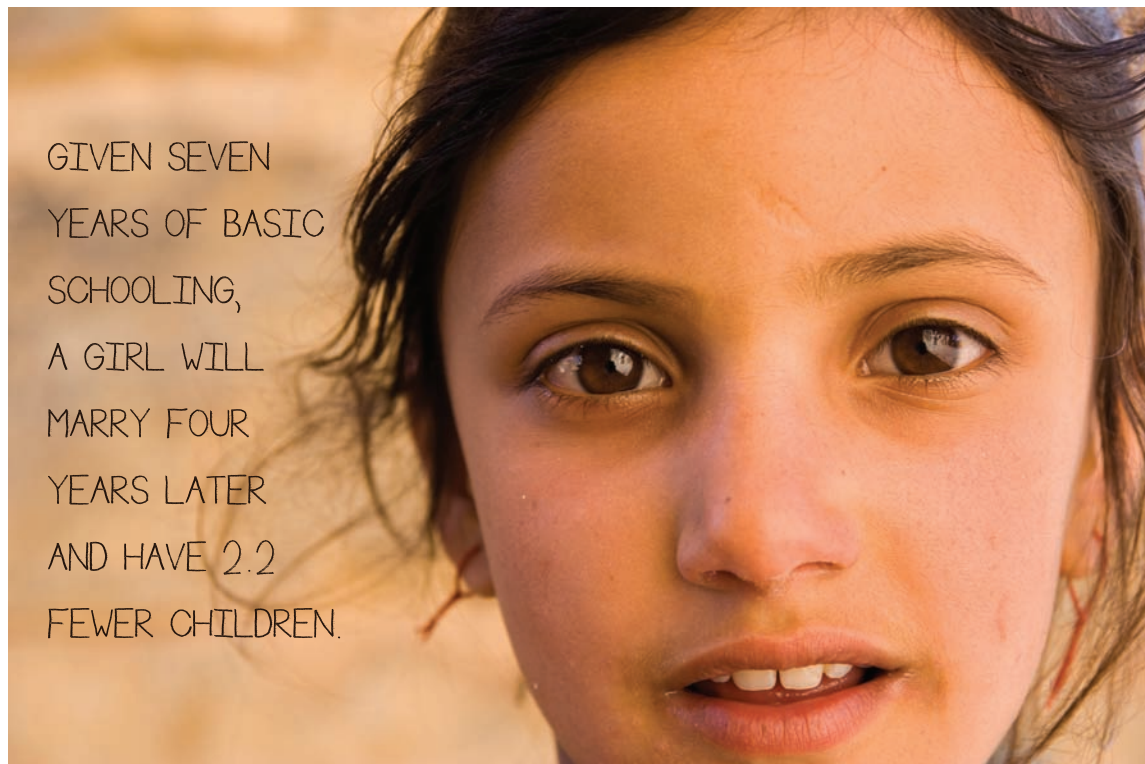
Vicious, indeed. In India, according to an ICRW survey, girls who married before

age 18 were twice as likely to report that their husbands beat, slapped or threatened them. Young brides often don’t even make it that far: Compared with a woman in her early 20s, a girl under 15 is five times more likely to die from childbirth, according to the Nike Foundation. Girls between 15 and 19 are twice as likely to die as the older group.

Part of the solution, Kambou says, is for developing countries to adopt legislation that protects women by, for example, prohibiting child marriage, granting rights in the event of a husband’s death or divorce, and giving girls national identity cards that allow them to apply for business loans. On a more grassroots level, experts say, educating girls in poor communities in Asia, Africa

difference, too, says Malcolm Potts, director of the Bixby Center for Population, Health and Sustainability at the University of California, Berkeley. In one of the most dramatic examples, Potts says, cultural shifts in Iran recently led to a rapid decline in how many kids women had: from an average of six to two children in villages, and from four to two children in cities.

“I have never seen a situation where we have given women information and technology and they have systematically misused it,” says Potts, co-author of *Sex and War: How Biology Explains War and Terrorism and Offers a Path to a Safer World*. As birth rates drop, he adds, so does pressure on the environment and the proportion of angry young men in a society. “If you want to make the



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PHOTO: SANTIAGO URQUIJO

and the Americas may be the best way to empower them to have smaller families and more options in life.

Given seven years of basic schooling, for example, a girl will marry four years later and have 2.2 fewer children, says the Nike Foundation, leading to fewer health problems and more opportunities. Offering access to family planning resources make a huge

world a safer place, respect women and give them choices.”

**SOME OF THE MOST** successful programs offer girls safe spaces of their own. In parts of Bangladesh, Tanzania and Uganda, for example, BRAC organizes girls’ groups that gather in the afternoon most days of the week. During some meetings, teens

and preteens simply play soccer, read books, or sing and dance. Other days, they learn about pregnancy prevention, HIV and the importance of education. The girls practice life skills, receive job training and sometimes get small business loans. Groups also address the attitudes of parents and community leaders—including boys and men.

The results of programs like these are striking. After five years of community-based work in India, ICRW measured a full year delay in a girl's average age of marriage—from 16 to 17. Girls who have been through BRAC programs, likewise, want to stay in school longer, Chaplin says. They have hope.

"When I went to visit one of the clubs in Bangladesh, all the girls were telling me they wanted to be doctors, lawyers and teachers," she says. "One girl wanted to be a pilot. If you asked a kid in rural Bangladesh who didn't have this opportunity, [she] might want to be a housewife, maybe work in her mother's store or tend the garden. The difference in aspirations is stark."

Once the world opens up to girls, the Nike Foundation says, they invest 90 percent of their income in their families, compared to the 30 to 40 percent that men contribute. From there, the benefits multiply. Increasing the number of girls who go to secondary school by 10 percent, according to the foundation, is associated with a 3 percent growth in a country's economy.

Even small changes make big differences. In a video posted on The Girl Effect's YouTube channel, a 17-year old Bangladeshi girl named Sanchita Rani Das explains how a \$60 loan allowed her to buy a calf, plant a vegetable patch and start making profits. Now, she is paying for her brother's education, covering some of her family's expenses and putting extra money into savings.

"I know that today's children are tomorrow's future," Sanchita says. "I am actually saving for my future."

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**EMILY SOHN** is a freelance journalist in Minneapolis whose stories have appeared in the *Los Angeles Times*, *Discovery News*, *Smithsonian*, *Health*, *Backpacker*, *Science News*, *U.S. News & World Report*, *Minnesota Monthly* and other publications.

## MISSING SISTERS

**In parts of the world, parents terminate pregnancies if they know they're expecting a girl, which has produced some drastically skewed gender ratios.** In regions of

China and India, where the situation is most extreme, anywhere from 108 to nearly 130 boys are born for every 100 girls. As a baseline, the ratio in the United States is 105 boys to 100 girls, for a variety of biological reasons. According to estimates, more than 80 million girls who should have lived in China and India were never born.

"A lot more boys are being born than girls," says Anju Malhotra, a population researcher at the International Center for Research on Women in Washington, D.C. **"It's very dramatic. And it's getting worse."**

Called the missing girl phenomenon, the practice of killing girl babies and fetuses dates back centuries not just in India and China, but also in Taiwan, Korea and other countries—mostly in East Asia but also on other continents, including, according to *The Economist*, in the Caucasus and the western Balkans. Some reasons are cultural: Men, for example, might be the only ones who can traditionally worship ancestors or perform funeral rituals. There are powerful economic reasons, too, with dowries that bankrupt families and traditions that compel women to care for the parents of their husbands instead of their own.

**From the moment she's born in cultures like these, a daughter becomes a burden to her family.**

Historically, parents killed baby girls after birth. Now, ultrasound machines and other reproductive technologies offer another option: abortion. In places with a strong preference for sons, young girls are also much more likely to die from neglect. They don't get the same nutrition, health care and vaccinations their brothers get, Malhotra adds.

To stop girls from going missing, India has instituted a variety of policies, from banning ultrasounds to putting money in the bank for people who birth daughters—plus extra cash if the girl remains unmarried by age 18. **Public relations campaigns offer slogans like, "My Daughter, My Wealth."** For its part, China hasn't budged on its one-child policy, but the country has made it illegal to find out the sex of a fetus without a medical reason, and it offers insurance and help with school and housing for families that have only daughters.

There is some hope in the experiences of Taiwan and South Korea. In these countries, sex ratios worsened as fertility rates dropped in the 1970s. But prospects there are getting better for girls now, possibly because women with fewer kids are working more, earning money and gaining rights, while benefiting from more progressive laws.

"When you have that kind of fundamental structural change in policy, so many doors open to women," Malhotra says. **"It really comes down to the value of daughters."**



# THE BIG ONE

The H1N1 (aka “swine flu”) outbreak of 2009 may not have lived up to the media hype in terms of overall fatalities, but it reminded us the next big pandemic might just be a super bug away.

Pandemics—infectious diseases that move through the human population and over large areas of the world—have occurred throughout history. The mere mention of words like Black Death, smallpox, cholera, tuberculosis, AIDS and malaria conjure up images of pain and suffering.

While advances in modern medicine are happening daily, the opportunity for new outbreaks is also increasing. Poor sanitation and lack of health infrastructures certainly play a role, but other factors compound the risk. As Katey Pelican, professor in the University of Minnesota’s College of Veterinary Medicine and part of a major new global health initiative sponsored by USAID, recently stated during a presentation at the Institute on the Environment, “People and animals are increasingly moving around the world, and in doing so we’re unknowingly moving an additional form of life, too. This is the micro-biome and we know very little about it.”

If we counted up all the people who are crossing international borders on an average day, they would represent the 10th largest country in the world. As more and more people and products criss-cross the globe by land, air and sea, the opportunities for global pandemics will increase.

Here we highlight some of the deadliest influenza outbreaks of the past century and a half, show the major modes of disease transmission, and reveal how a virus becomes a global pandemic.



## “SPANISH FLU” H1N1 1918-19

Originating in Kansas, the Spanish flu infected 20 to 40 percent of the global population and killed up to 50 million people, making it the deadliest flu pandemic in history.



## “SWINE FLU” H1N1 2009-PRESENT

A novel H1N1 virus mysteriously appeared in Mexico in 2009. While milder than first feared, the pandemic has been particularly deadly for children, young adults and pregnant women—particularly those with underlying medical conditions—and will likely continue through 2010.

## SHARING THE PAIN

Etiology—the branch of science dealing with the causes of infectious disease—recognizes the following five major modes of disease transmission:



AIRBORNE



WATERBORNE



BLOODBORNE



DIRECT CONTACT



VECTORS

Sources: World Health Organization, Centers for Disease Control, Center for Infectious Disease Research and Policy (University of Minnesota), Proceedings of the National Academy of Sciences

PAGE LAYOUT: TODD REUBOLD





### "RUSSIAN FLU" H2N2 1889-90

Approximately 1 million people died from the first flu pandemic for which detailed records are available. The outbreak reached the U.S. by rail and sea just 70 days after being identified in St. Petersburg, Russia.



### "ASIAN FLU" H2N2 1957-58

First identified in China, the Asian flu quickly became a pandemic causing nearly 70,000 deaths in the U.S. alone. The virus was especially deadly among elderly populations.



### "HONG KONG FLU" H3N2 1968-69

Emerging in Hong Kong in the late '60s, the H3N2 pandemic is estimated to have killed one million people worldwide. The virus that caused this outbreak continues to circulate today.

## SIX-STEP PROGRAM

The World Health Organization has developed a six-phase classification showing how a new influenza virus moves from a few initial infections to a full-blown epidemic.

- 1 Virus reported in animals, but no known human infections
- 2 Influenza virus jumps from wild or domestic animals to humans
- 3 Small number of people infected, but limited human-to-human transmission
- 4 Verified human-to-human level transmission able to cause community-level outbreaks
- 5 Human-to-human spread of the virus into at least two countries
- 6 Global pandemic declared once the virus spreads to at least one more country

## THE WILD KINGDOM

In recent years, 73 percent of emerging infectious diseases have been classified as zoonotic—meaning they originated in animal populations. And most have involved wild animals.

ZOONOTIC  
73%

OTHER  
27%



# SECOND HAND

[ ART THAT SPEAKS TO OUR RELATIONSHIP TO STUFF ]

by STEPHANIE XENOS

What does art have to say about the weight of an exponentially expanding world population? Can a work of art tell us something new about the sea of manufactured goods billions of us consume *and* discard? What exactly *is* our relationship to the natural world with all that stuff mediating the experience?

The use of found or manufactured objects in art goes back to Duchamp and the Dada movement at the turn of the 20th century. The Pop Art movement of the 1950s brought mass-produced goods (and culture) into the art vernacular, but the use of those materials persists in the work of artists whose work is explicitly about consumerism or the environment—and even some whose work isn't about the environment at all.

On one end of the spectrum are artists such as Joseph Beuys and Andy Goldsworthy, who use art to draw attention to the environment in surprising ways. These granddaddies of the environmental art movement use the landscape as a canvas for site-specific art made in reference to the environment and, quite literally, *of* elements in the environment. At the other end of the spectrum, Chris Jordan transforms abstract data—the number of tuna fished from the oceans each day, say—into large-scale images that manage to put into perspective the massive impact humans have on the environment without losing sight of the specific. Jordan photographed 1.14 million brown paper bags (the number used in the United States every hour, according to him). At first glance they resemble a dense forest of tree trunks. But up close, each individual bag is visible.

What about art that touches on consumption and the human footprint in a less obvious way? Artists with little stylistic common ground are turning to consumption not as subject, but as subtext. A growing number of artists are using the disposable stuff of everyday life in the industrial world—designer shoes, plastic water bottles, old books and cassettes, even Scotch tape—to put everyday objects in an unexpected and thought-provoking context.

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**STEPHANIE XENOS** is a freelance writer who lives in St. Paul, Minn. She writes a monthly visual arts column for *Mpls.St.Paul Magazine* and has contributed to a number of other publications, including the *Star Tribune* and *City Pages*.





## ELIZABETH SIMONSON

Elizabeth Simonson's site-specific installations are one of a kind even if the material they are made of is anything but. Simonson uses everyday objects and materials such as tape to compose large-scale sculptures that essentially create themselves as she applies layer after layer of a specific material. "From simple molecular structures to complex organisms, life grows blindly, motivated by one rule: creating self-sustaining structures that foster survival," Simonson says. "Inspired by this logic, I see my work as an aspect of nature."

That convergence of the organic and the manufactured suggests an impulse to reconnect with the natural world through art that co-opts the materials and objects all around us. And, in fact, Simonson's work is on exhibit at the University of Minnesota's Weisman Museum this summer in a show premised on the ordinary. The artist notes that part of the appeal of using everyday objects in her work is the transformation from everyday to extraordinary. "Seeing something really common like tape and then seeing it in this unrecognizable form is interesting," she says.

**Crush**  
*Tape on wall*

## JEANSHIN

Do you know where your discarded prescription bottles or those old trophies from fourth grade are? If you happen to cross paths with Jean Shin, they might be art. Shin's large-scale installations are made up of everyday objects collected from family, friends and the community. "When participants donate their objects," she says, "it comes with their identity, history and many stories." For one installation, *Everyday Monuments*, Shin collected trophies and carefully altered them to cast a heroic light on working-class occupations. In another, *Sound Wave*, she used old vinyl records to evoke "the inevitable waves of technology that render each successive generation of recordable media obsolete."

The artist, who exhibited her work at the Smithsonian American Art Museum last year, says her work reflects the consumerism and excess around us. But she doesn't see consumption as all bad. She takes the concept of message as medium to its logical conclusion by incorporating objects of different origin and with different associations, but fundamentally the same in their use and meaning. "When I collect thousands of single objects from a community, they speak to a collective consciousness. ... [T]hese materials are shown in a new context, connecting one story to another and suggesting larger relationships within our society."



Sound Wave | Melted 78 rpm records on wooden armature



## WILLIE COLE

“The first objects I used were hair dryers because I found 1,000 of them in an abandoned factory,” says artist Willie Cole. “I wasn’t specifically thinking about consumerism, but a pile of objects was inspiring.” Cole, whose work is collected by major museums such as the Museum of Modern Art and the Minneapolis Institute of Arts, creates work that incorporates African-American and African imagery with a nod to Marcel Duchamp and the Dada movement. But instead of a single urinal planted unapologetically in the middle of a gallery, say, Cole uses multiples of common objects to create his sculptures and prints.

Imagine a West African sculpture of black polished wood, only made of black designer pumps, and you’ll get a sense of how Cole turns the functional into something thought provoking. And even though the objects are in most ways identical, the relationship between human and human-made matters. “Everything we touch has a little bit of us on it. ... [M]ost of the objects I have used have been handled by humans,” says Cole. “The objects have a memory and a history of their own.”

**Ann Klein With a Baby in Transit**  
*Shoes, wires, washers and screws*

## BRIANDETTMER

New electronic gadgets—computers, phones, media devices, video game systems—are compelling in a way few other products can match. The desire to hear better, see more clearly and experience more fully drives development and arguably contributes to a cycle of planned obsolescence. As much as we love our iPod, we know we’ll love the next-generation version even more—even if that means mountains of e-waste. Brian Dettmer taps into this relationship with sculpture that doesn’t just recycle objects, but recycles meaning.

Dettmer reimagines analog, linear media for our decidedly digital, nonlinear reality. His media-based sculpture reflects our taste, our aspirations, our state of mind, even our dreams, if only for a moment. “I’m interested in the fact that everything living, or any material, contains recorded information about its origin, location and function,” Dettmer says.

The artist painstakingly carves images and words out of old books, and forms cassette and videotapes into organic shapes. “When I transform mechanical and plastic materials by hand and with heat, they naturally become organic,” he says. “It’s like a retreat to a more natural state.”

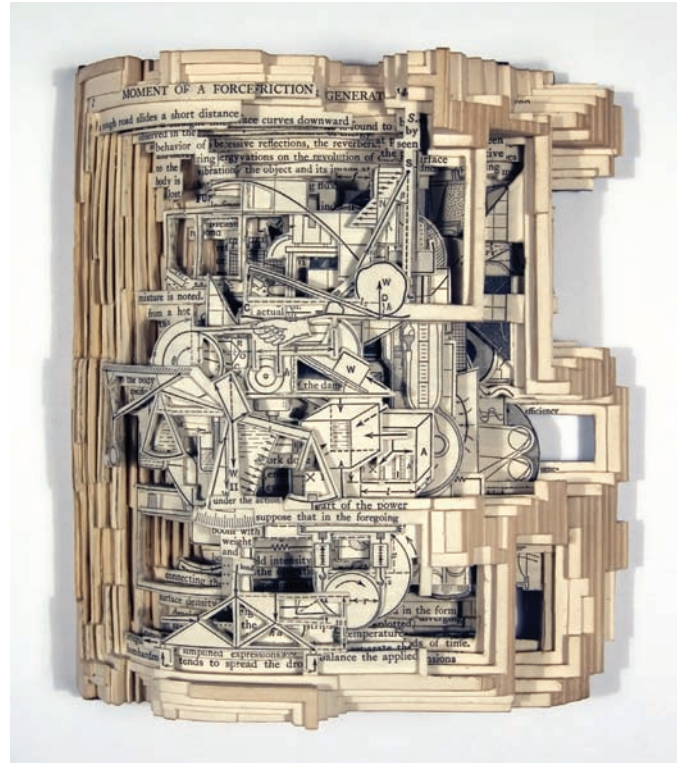


PHOTO: KINZ + TILLOU FINE ART

Physics | *Altered book*

## VAUGHNBELL

“Art, for me, is a way of asking the questions I am fascinated by, examining how we relate to our environment, and hopefully addressing it in a new way,” says artist Vaughn Bell, whose conceptual approach involves asking individuals to adopt some small bit of land, or experience a biome shrunk down to the size of a birdhouse. The Seattle-based artist doesn’t use mass-produced objects in her work, but rather starts from the world as we experience it and asks us to see the natural world bounded by our built environment. The point: to reconnect people to the natural world and create a bridge from what is to what could be.

“The irony of this is that we are always exerting a huge influence over our environment. Every time we turn on the lights or start the car we are exerting this influence,” says Bell. “I think art can make us aware of what we take for granted in terms of the way we interact with our environment. I also think art has the possibility to help us imagine a different scenario than the one we are currently in. At least, these are the roles that I think my work and the work of many other contemporary artists can play.”



PHOTO: KEVIN KENNEDICK

Village Green | *Acrylic biosphere containing native plants, soil, organic matter and water*

## ERICAPASCHKE

Erica Paschke has been incorporating found objects—stuff most would consider no longer useful—into her work for years. The recent college graduate and conceptual artist is interested in the way people view waste. A while back, news reports about the North Pacific Gyre, a huge garbage patch filled with plastic bags and other refuse floating in the middle of the ocean, caught Paschke’s attention. “I was thinking about all the plastic floating in the ocean,” says the artist. That line of thought inspired an installation, *Days*, made up of that ever-present artifact of everyday life—the plastic water bottle.

Paschke suspended 365 bottles from the ceiling—each with a message inside—to “symbolize the use of plastic every day and how we don’t really think about how it adds up.” The messages inside, which people are encouraged to retrieve, offer simple, actionable ideas for reducing our impact on the environment. Like a message in a bottle that’s washed up on shore, the call to action is urgent.



PHOTO: ADAM KIRSCH

Days | Plastic bottles, fabric, stamped ink, safety pins and fishing line

## Population Heroes

As population stabilizes, fiscal consequences call for a new kind of courage. by KATE KNUTH



Words used to describe population often verge on apocalyptic. Call in the superheroes to save the world from population! I like a good superhero, and I really like the idea of a caped, spandex-clad population protector. A decade into the 21st century, world population is on track to stabilize. Stabilization may not sound cataclysmic, but the political, financial and cultural ramifications are potentially disruptive. Can the world fulfill its population destiny gracefully? If so, how?

The demographic shifts resulting from a stabilizing population will alter the underpinnings of public finance and culture, posing serious political challenges. For more information about my home state, I contacted Minnesota state demographer Tom Gillaspay. He highlighted two key facts. First, the percentage of Minnesotans of working age peaks this year. Second, in 2020, the state will have more people over 65 than of school age. Details differ for each state, country and continent—Japan and Europe have already started to see these changes, while Africa will take awhile longer—but the essential problems of population stabilization are similar. Fewer workers will be available to meet the needs of more dependents, both young and old. Populations will be, on average, older than ever before.

The implications of these demographic changes for fiscal policy are huge. Pensions, social security, medical benefits and long-term care are promises societies make to older citizens. All are major drivers of government budget expenditures. The costs of these promises skyrocket as populations age. At the same time, slower workforce growth means relatively fewer taxpayers to keep up with budget

demand. It's the perfect fiscal storm. Even though the transition was forecast by demographers decades ago, most governments have not made the fiscal policy changes needed to weather it.

The necessary policy changes are theoretically simple, but politically volatile: raise taxes and reduce society's financial promises at the same time. Politicians don't often campaign on this reality-based version of fiscal responsibility. Greece is a recent example. Fiscal crisis, partially demographically driven, forced the country to raise taxes and lower benefits. Greek citizens did not cheer on their politicians for finally making sound fiscal policy. Instead, they demonstrated in the streets. Policymakers beware: Fiscal responsibility takes serious leadership and public buy-in.

The fiscal impacts of a stabilizing, aging population can be softened. Workers must become either more productive or more abundant. Effective, adequately funded education helps maximize worker productivity, and societies addressing a stabilizing population should prioritize education.

The only way to increase the number of work-aged people in the short term is immigration. Immigration may be politically sensitive, but countries that figure out how to attract hard-working, educated immigrants will transition into a stable population world more easily than those that do not. Societies may also choose to abandon GDP as the sole measure of economic success, instead focusing on measures of public or environmental health, education, equity, or happiness. However, the bottom line remains that governments will need to rebalance what they pay for and how they pay for it in light of shifting demographics.

It's the perfect fiscal storm.



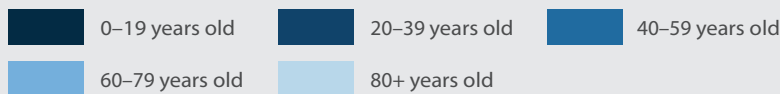
While changes in public finance resulting from stable population may be difficult, cultural changes could be fun. The world will have smaller families and more elders, catalyzing changes in social support systems. I have a stable-population-sized family. My seven immediate blood relatives (three generations) are important, but I also treasure my “family of choice.” These are the aunts and uncles, not related by blood, who helped raise me, and whom I will help support as they age. We are all richer for it. Society as a whole will be richer because of the offerings of elders: wisdom, experience and time. Older folks will work longer, and many could volunteer, strengthening our communities in the process. Cultures on a smooth demographic transition will create institutional supports, both public and private, to take care of children and seniors with fewer relatives, while simultaneously making the most of elders.

World population is on track to stabilize. Cultures that wish to adapt gracefully will need to manage the fiscal reality. After recounting a litany of impending economic crises and fiscal policy challenges, State Demographer Gillaspy commented, “It’s a time for heroes.” The world’s population transition will need superheroes, but their suits won’t be made of spandex. The heroes will be public leaders preaching about demography and economics, politicians bearing the scars of campaigns based on this fiscal reality, and an electorate willing to vote those politicians into office and help them govern. ★

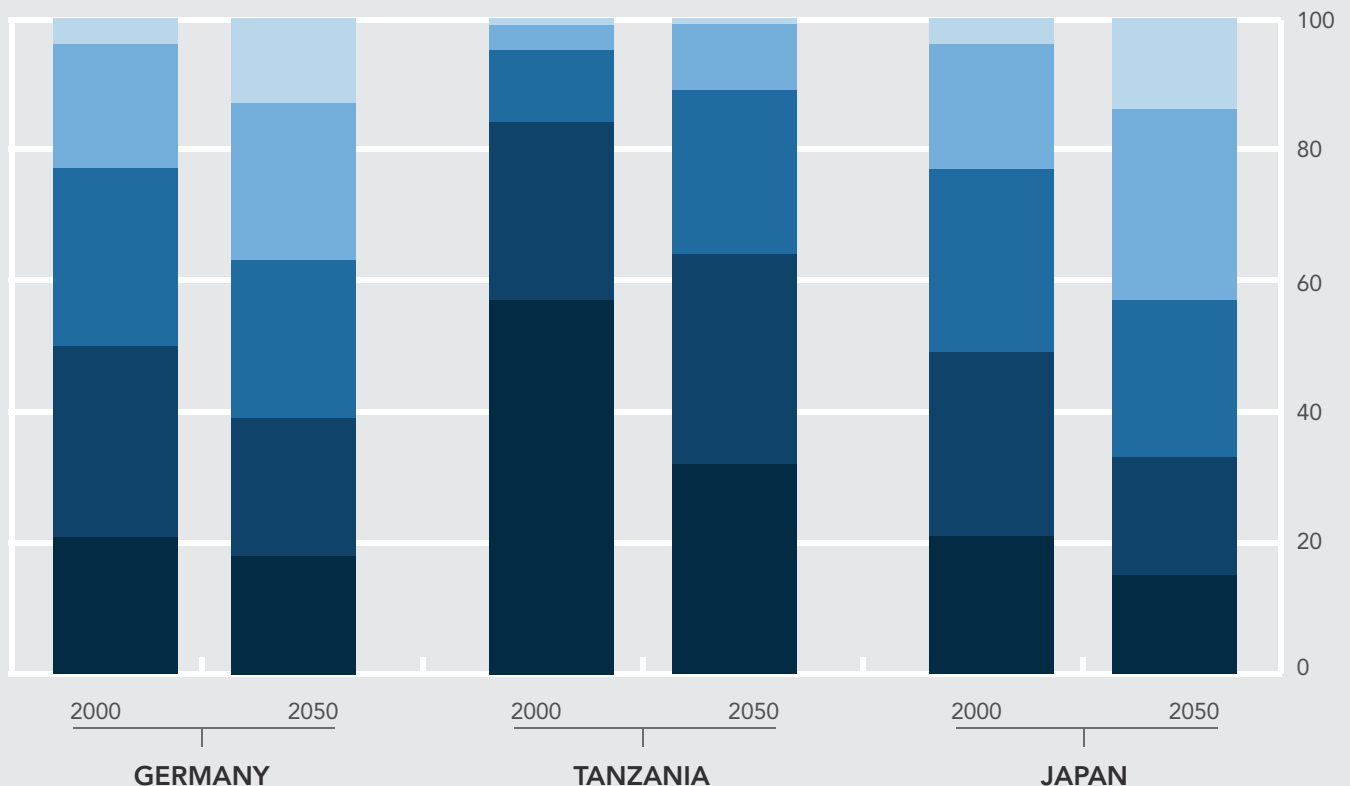
**KATE KNUTH** is in her second term in the Minnesota House of Representatives. She is a graduate research fellow at the Institute on the Environment and is pursuing her Ph.D. in conservation biology at the University of Minnesota.

### OLDER THAN EVER

Average age is increasing around the world, creating new challenges for politicians and policymakers.



### PERCENTAGE OF THE POPULATION



Source: U.S. Census Bureau

# The Revolution Will Be Quantified

How a database series is changing the way we see the world. by ALYSSA FORD

Historical demographers subsist on data—lots and lots of data. Data about how people work, procreate, worship and arrange themselves into households. Data about race, migration, literacy—everything down to whether they own a radio or happened to be sick on a certain day.

To get the data they need for their research, historical demographers go to extremes. Trent Alexander, a researcher at the Minnesota Population Center at the University of Minnesota, went digging through frozen boxes in a Kansas cave managed by the National Archives. Colleague Bob McCaa logged more than 200,000 air miles last year trying to convince foreign governments from Sudan to Ireland to allow the MPC to catalog and study their census data.

Historical demographers study how human populations evolve over time. Their goal is to get to the truth about what happened in our past—to affirm or destroy long-held academic narratives such as “changing family structures helped spark the Industrial Revolution” (they didn’t) and “social mobility has improved over time” (it hasn’t).

For those who study U.S. history from 1850 onward, the tool of choice is a database series called the Integrated Public Use Microdata System-USA, or IPUMS-USA. Launched by MPC director Steve Ruggles and his team in 1995, IPUMS-USA includes data on more than 150 million Americans who were recorded by the U.S. census at some point in the past 160 years. It’s the most complete demographic record of humanity ever assembled, anywhere. The older records provide storehouses of information: names, ages, occupations, military service. Records from less than 72 years ago are similar except that all identifying characteristics of the people have been removed.

Since its launch in 1989, IPUMS has attracted more than 30,000 registered researchers. In 2000, IPUMS-USA was joined by an international version, IPUMS-I. Another, IPUMS-CPS, includes data from the annual Current Population Survey.

“There’s really nothing like it in the world,” says Ruggles, who was dubbed “King of Quant” by *Wired* magazine in 1996 for his assertion that many of humanity’s mysteries could be solved if only one took the time to gather and analyze the numbers.

The introduction of IPUMS revolutionized historical demography. Even as late as the 1990s, researchers had to create and maintain their own data sets using birth records, census data and anything

else they could get their hands on. Simply building an accurate data set was so laborious that researchers might produce only a handful of studies in their lifetimes, and were limited to studying tiny areas, such as small neighborhoods.

“My advisor back in college had a room full of these punch cards that he was using for his data set,” says Alexander. “It was pretty insane.”

Academics were loath to share their data because it was so time consuming to build their own study tools, so there was no way for researchers to replicate each other’s findings. “If I didn’t believe your results, well, that was just too bad for me,” says Alexander. “There was a lot of mistrust in the field.” In the 1990s, a few for-profit companies started offering ready-made data sets: great for researchers who could afford them, not so great for anyone without a steady funding stream.

But IPUMS—massive, searchable, free and online—changed all that. Demographic historians were suddenly free to spend their time analyzing and writing instead messing around with punch cards and reel-to-reel tapes. In a single swoop, the playing field was leveled between low-paid graduate students and well-funded researchers. Most remarkable of all, demographic historians were no longer limited to neighborhoods or locales.

Of late, Ruggles is focused on adding depth and complexity to his creation. MPC recently received a \$2 million federal grant to bring the 1850s sample from 1 percent to 100 percent. Ruggles is working on adding a slave-owning census from 1850, as well as the mortality censuses from the 19th century. Another grant has a team of people retrieving data from original optical-scan census forms from 1960. Ruggles’ team had to dig out the forms from a frozen cave in Lenexa, Kansas, after a census bureau employee noticed that the computer record was missing 20 percent of Chicago—the second-largest city at that time. Shivering in National Archives–logoed parkas, Ruggles’ researchers gathered the forms from a storeroom called “The Icebox,” carefully thawed them and scanned them on specialized equipment.

“My goal is nothing less than collecting the world’s data,” Ruggles says. And when he says it, you believe him.

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ALYSSA FORD has written about environmental issues for *Utne Reader*, *Midwest Home*, *Experience Life* and other publications. She lives in a U.S. Green Building Council–certified eco-house in Minneapolis.

It’s the most complete demographic record of humanity ever assembled, anywhere.



## In Defense of Food

Keeping food safe from terrorist attack is the focus of the U of M-based National Center for Food Protection and Defense.

by DAVID MAHONEY



Along with the air we breathe and the water we drink, the food we eat serves as one of our most essential connections to the environment. That may help explain why a survey conducted a few years ago by University of Minnesota researchers found that, although respondents believed a terrorist attack on our food supply to be the least likely form of imminent terrorism, they also identified it as the one they would spend the most to prevent.

“Food is the one area in which consumers cannot take themselves out of the target population,” says Shaun Kennedy, director of the National Center for Food Protection and Defense, the University-based research consortium that funded the study. “Consumers inherently recognize that as long as they eat, they’re at risk.”

To illustrate how serious the potential threat of intentional contamination at any point in the food chain by biological, chemical or radiological agents could be, Kennedy points to the challenges food safety faces even before the specter of terrorism is raised.

“Due to Mother Nature and random stupidity, we have 76 million cases of foodborne illness a year, 325,000 hospitalizations, and 5,000 deaths,” he says. “If random accidents can have that much of an impact, think about how easy it would be to intentionally cause harm if you wanted to.”

Launched with a grant from the U.S. Department of Homeland Security in 2004, NCFPD has taken a multidisciplinary, farm-to-table approach to addressing food-focused terrorism. Experts from universities around the country fill the rosters of its research teams. Its industry work group comprises representatives of the nation’s leading food firms, including local heavy hitters Cargill, General Mills and Supervalu.

Food *safety* has been a prominent concern of government and industry since the publication more than a century ago of *The Jungle*, Upton Sinclair’s reality-based novel exposing the woeful conditions in Chicago’s stockyards. But food *defense* requires companies to take a different approach to their vulnerabilities.

“There’s a certain probability you’re going to have bacterial contamination during slaughter, so you can then calculate the return on investment from reducing that probability of contamination,” Kennedy says. “Intentional contamination of a food system is a deterministic event. I can’t give you a probability that someone’s going to penetrate your plant and contaminate your food system. So the return-on-investment calculation doesn’t work.” Yet, when faced with the possibility of a catastrophic contamination that

could threaten their very viability, many companies are willing to try to eliminate that eventuality, he says.

Some solutions are relatively simple: running background checks on employees, for example. Behavior monitoring is another practice more firms are adopting, says Kennedy: “If a person’s job is hanging chickens on a rail and they start asking lots of questions about quality assurance practices and where chemicals are stored, you might want to look into this guy.”

A more complex approach to addressing the threat of intentional food contamination has been developed by Eden Prairie-based BTSafety under the auspices of NCFPD’s event modeling research team, which brings together data from the center’s four other research groups (agent behavior, systems strategies, risk communication and education). The Consequence Management System allows companies and government agencies to simulate the likely consequences of a hypothetical food contamination event and assess how those consequences would be affected by changes in the scenario, such as increasing the amount of contaminating agent or altering the timing of a public announcement. The results

can be tracked on maps of the U.S. showing the movement of the contaminated product through the food distribution chain. A version of the Consequence Management System has been used by the Department of Homeland Security to assess the threat of attacks on the food supply for its integrated terrorism risk rankings, which help guide federal spending on biodefense-related research, development, planning and preparedness.

Kennedy believes our country’s food defense has improved since 9/11, if only because awareness has improved. For example, NCFPD staff members have been invited to provide sessions on what they’ve learned about modeling vulnerability and consequence in

food systems at the International Dairy Foods Association annual trade show in September.

“You wouldn’t have had that happen before,” he says. “Usually trade associations aren’t all that keen about inviting speakers to come in to talk about bad things that could happen to them and what they should do about it.”



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DAVID MAHONEY is a freelance writer who has contributed to a variety of national and regional magazines, including *Esquire*, *The History Channel Magazine*, *Delta Sky* and *Acura Style*.

## Food Fight by MAYWA MONTENEGRO

Last spring, political scientist **ROBERT PAARLBERG** sparked controversy with an essay in *Foreign Policy* claiming that organic, local and slow food movements provide the “wrong recipe for helping to feed those who need it most.” What kind of system can achieve global food security while limiting environmental impacts of food production? *Seed Magazine* invited Paarlberg and ecologist **M. JAHİ CHAPPELL** to debate the topic online. The following excerpts were adapted from the opening round. ▶ CHECK OUT the complete debate at [seedmagazine.com/content/article/food\\_fight\\_conclusion](http://seedmagazine.com/content/article/food_fight_conclusion)

“Hunger and food insecurity are rooted in poverty and lack of socioeconomic access to food, not insufficient food production or overpopulation. Alternative agriculture can provide sufficient food in a more sustainable manner than industrial agriculture.

Food production has, at best, an indirect relationship with feeding people. Around 78 percent of malnourished children in the developing world live in countries with sufficient national food availabilities. Hunger’s primary cause is widely summarized as poverty, but it would perhaps be more precise to term it a lack of socioeconomic or sociocultural access.

Many tend to agree that the answer to “industrial vs. organic food production” lies somewhere in the middle. I think the answer lies between the two in the same way Philadelphia is between New York City and Los Angeles—much closer to one than the other. I was one of the authors of a 2007 paper that found organic agriculture could produce sufficient food to feed the world.

We know that providing education, health and other social support to people, especially women, can dramatically lower hunger, inequality and poverty. Those of us concerned with food security should possibly be more concerned with addressing these issues, issues with little direct relationship to production method per se, most of all.”

### M. JAHİ CHAPPELL

Postdoctoral Associate and Provost’s Academic Diversity Fellow in Science & Technology Studies, Cornell University Currently Assistant Professor of Environmental Science and Justice at Washington State University–Vancouver

MAYWA MONTENEGRO is a science writer and editor at *Seed Magazine* in New York City. Her interests lie at the crosshairs of people and ecosystems—particularly in sustainable agriculture and the tensions between economic development and biodiversity conservation in the Global South.

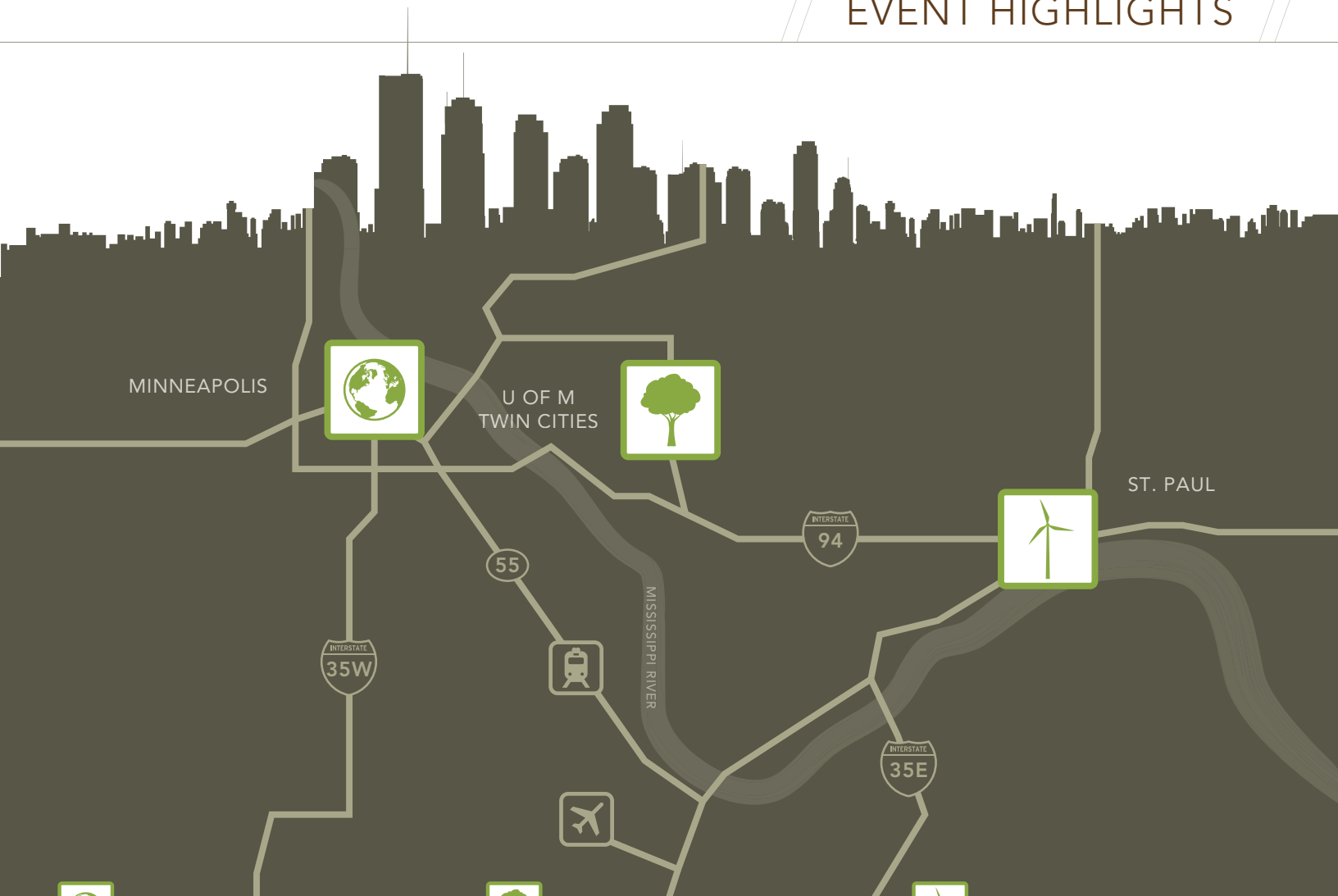
“Hunger is indeed rooted in poverty. Nonetheless, a majority of all hunger still comes from inadequate food production—because most of the world’s poor and hungry are farmers. Hundreds of millions in Africa and South Asia still lack the things farmers elsewhere have used to escape poverty: They lack seed varieties improved by scientific crop breeding, they have no irrigation, and they use almost no chemical fertilizers.

China and India managed to overcome their hunger problems by making investments in the productivity of small farmers. Hunger is worsening in Africa because farmers there have not yet experienced a comparable upgrade in farming techniques.

Organic techniques and agroecology have long been available, yet we have no example of any modern society feeding itself adequately using only these methods. Advocates for agroecology can point to a long list of techniques that work well (biological controls for pests, crop rotations and manuring, mulching and water-harvesting), yet these techniques always work best when combined with scientifically improved seed varieties and nitrogen fertilizer. There are no examples today of well-fed societies relying only on organic methods. Europeans and Americans have an abundant food supply precisely because they have rejected organic dogmas.”

**ROBERT PAARLBERG**  
Professor of Political Science,  
Wellesley College





## GLOBAL SUSTAINABLE BIOENERGY NORTH AMERICAN CONVENTION 2010

### Marquette Hotel, Minneapolis

Business leaders, policymakers and biofuels experts will gather **Sept. 14–16** to draft and ratify a continental resolution that will help shape the future of bio-energy. This North American convention is the final of five such events that have been held around the world—Africa, Asia, Latin America and Europe. Roger Thurow, author of the book *ENOUGH: Why the World's Poorest Starve in the Age of Plenty*, will deliver the keynote address on **Sept. 15**.

[environment.umn.edu/gsb](http://environment.umn.edu/gsb)



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### University of Minnesota, St. Paul

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[environment.umn.edu/news\\_events/events/frontiers](http://environment.umn.edu/news_events/events/frontiers)



## E3 2010

### RiverCentre, St. Paul

Learn about the latest advancements in renewable energy at E3 2010, a conference for pacesetters, policymakers, entrepreneurs and interested citizens coming up **Nov. 30**. Keynote speeches by energy policy expert Daniel Kammen and U.S. Department of Commerce assistant secretary Nicole Y. Lamb-Hale will set the stage for 15 energy, economic and environmental breakout sessions. An optional encore workshop on wind energy takes place **Dec. 1**.

[umn.edu/iree/e3](http://umn.edu/iree/e3)

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