

Special Series: 7 Billion



Population 7 Billion

There will soon be seven billion people on the planet. By 2045 global population is projected to reach nine billion. Can the planet take the strain?

By Robert Kunzig

Photograph by Randy Olson

One day in Delft in the fall of 1677, Antoni van Leeuwenhoek, a cloth merchant who is said to have been the long-haired model for two paintings by Johannes Vermeer—"The Astronomer" and "The Geographer"—abruptly stopped what he was doing with his wife and rushed to his worktable. Cloth was Leeuwenhoek's business but microscopy his passion. He'd had five children already by his first wife (though four had died in infancy), and fatherhood was not on his mind. "Before six beats of the pulse had intervened," as he later wrote to the Royal Society of London, Leeuwenhoek was examining his perishable sample through a tiny magnifying glass. Its lens, no bigger than a small raindrop, magnified objects hundreds of times. Leeuwenhoek had made it himself; nobody else had one so powerful. The learned men in London were still trying to verify Leeuwenhoek's earlier claims that unseen "animalcules" lived by the millions in a single drop of lake water and even in French wine. Now he had something more delicate to report: Human semen contained animalcules too.

“Sometimes more than a thousand,” he wrote, “in an amount of material the size of a grain of sand.” Pressing the glass to his eye like a jeweler, Leeuwenhoek watched his own animalcules swim about, lashing their long tails. One imagines sunlight falling through leaded windows on a face lost in contemplation, as in the Vermeers. One feels for his wife.

Leeuwenhoek became a bit obsessed after that. Though his tiny peephole gave him privileged access to a never-before-seen microscopic universe, he spent an enormous amount of time looking at spermatozoa, as they’re now called. Oddly enough, it was the milt he squeezed from a cod one day that inspired him to estimate, almost casually, just how many people might live on Earth.

Nobody then really had any idea; there were few censuses. Leeuwenhoek started with an estimate that around a million people lived in Holland. Using maps and a little spherical geometry, he calculated that the inhabited land area of the planet was 13,385 times as large as Holland. It was hard to imagine the whole planet being as densely peopled as Holland, which seemed crowded even then. Thus, Leeuwenhoek concluded triumphantly, there couldn’t be more than 13.385 billion people on Earth—a small number indeed compared with the 150 billion sperm cells of a single codfish! This cheerful little calculation, writes population biologist Joel Cohen in his book *How Many People Can the Earth Support?*, may have been the first attempt to give a quantitative answer to a question that has become far more pressing now than it was in the 17th century. Most answers these days are far from cheerful.

Historians now estimate that in Leeuwenhoek’s day there were only half a billion or so humans on Earth. After rising very slowly for millennia, the number was just starting to take off. A century and a half later, when another scientist reported the discovery of human egg cells, the world’s population had doubled to more than a billion. A century after that, around 1930, it had doubled again to two billion. The acceleration since then has been astounding. Before the 20th century, no human had lived through a doubling of the human population, but there are people alive today who have seen it triple. Sometime in late 2011, according to the UN Population Division, there will be seven billion of us.

And the explosion, though it is slowing, is far from over. Not only are people living longer, but so many women across the world are now in their childbearing years—1.8 billion—that the global population will keep growing for another few decades at least, even though each woman is having fewer children than she would have had a generation ago. By 2050 the total number could reach 10.5

billion, or it could stop at eight billion—the difference is about one child per woman. UN demographers consider the middle road their best estimate: They now project that the population may reach nine billion before 2050—in 2045. The eventual tally will depend on the choices individual couples make when they engage in that most intimate of human acts, the one Leeuwenhoek interrupted so carelessly for the sake of science.

With the population still growing by about 80 million each year, it's hard not to be alarmed. Right now on Earth, water tables are falling, soil is eroding, glaciers are melting, and fish stocks are vanishing. Close to a billion people go hungry each day. Decades from now, there will likely be two billion more mouths to feed, mostly in poor countries. There will be billions more people wanting and deserving to boost themselves out of poverty. If they follow the path blazed by wealthy countries—clearing forests, burning coal and oil, freely scattering fertilizers and pesticides—they too will be stepping hard on the planet's natural resources. How exactly is this going to work?

THERE MAY BE SOME COMFORT in knowing that people have long been alarmed about population. From the beginning, says French demographer Hervé Le Bras, demography has been steeped in talk of the apocalypse. Some of the field's founding papers were written just a few years after Leeuwenhoek's discovery by Sir William Petty, a founder of the Royal Society. He estimated that world population would double six times by the Last Judgment, which was expected in about 2,000 years. At that point it would exceed 20 billion people—more, Petty thought, than the planet could feed. “And then, according to the prediction of the Scriptures, there must be wars, and great slaughter, &c.,” he wrote.

As religious forecasts of the world's end receded, Le Bras argues, population growth itself provided an ersatz mechanism of apocalypse. “It crystallized the ancient fear, and perhaps the ancient hope, of the end of days,” he writes. In 1798 Thomas Malthus, an English priest and economist, enunciated his general law of population: that it necessarily grows faster than the food supply, until war, disease, and famine arrive to reduce the number of people. As it turned out, the last plagues great enough to put a dent in global population had already happened when Malthus wrote. World population hasn't fallen, historians think, since the Black Death of the 14th century.

In the two centuries after Malthus declared that population couldn't continue to soar, that's exactly what it did. The process started in what we now call the developed countries, which were then still developing. The spread of New World crops like corn and the potato, along with the discovery of

chemical fertilizers, helped banish starvation in Europe. Growing cities remained cesspools of disease at first, but from the mid-19th century on, sewers began to channel human waste away from drinking water, which was then filtered and chlorinated; that dramatically reduced the spread of cholera and typhus.

Moreover in 1798, the same year that Malthus published his dyspeptic tract, his compatriot Edward Jenner described a vaccine for smallpox—the first and most important in a series of vaccines and antibiotics that, along with better nutrition and sanitation, would double life expectancy in the industrializing countries, from 35 years to 77 today. It would take a cranky person to see that trend as gloomy: “The development of medical science was the straw that broke the camel’s back,” wrote Stanford population biologist Paul Ehrlich in 1968.

Ehrlich’s book, *The Population Bomb*, made him the most famous of modern Malthusians. In the 1970s, Ehrlich predicted, “hundreds of millions of people are going to starve to death,” and it was too late to do anything about it. “The cancer of population growth...must be cut out,” Ehrlich wrote, “by compulsion if voluntary methods fail.” The very future of the United States was at risk. In spite or perhaps because of such language, the book was a best seller, as Malthus’s had been. And this time too the bomb proved a dud. The green revolution—a combination of high-yield seeds, irrigation, pesticides, and fertilizers that enabled grain production to double—was already under way. Today many people are undernourished, but mass starvation is rare.

Ehrlich was right, though, that population would surge as medical science spared many lives. After World War II the developing countries got a sudden transfusion of preventive care, with the help of institutions like the World Health Organization and UNICEF. Penicillin, the smallpox vaccine, DDT (which, though later controversial, saved millions from dying of malaria)—all arrived at once. In India life expectancy went from 38 years in 1952 to 64 today; in China, from 41 to 73. Millions of people in developing countries who would have died in childhood survived to have children themselves. That’s why the population explosion spread around the planet: because a great many people were saved from dying.

And because, for a time, women kept giving birth at a high rate. In 18th-century Europe or early 20th-century Asia, when the average woman had six children, she was doing what it took to replace herself and her mate, because most of those children never reached adulthood. When child mortality declines, couples eventually have fewer children—but that transition usually takes a generation at the

very least. Today in developed countries, an average of 2.1 births per woman would maintain a steady population; in the developing world, “replacement fertility” is somewhat higher. In the time it takes for the birthrate to settle into that new balance with the death rate, population explodes.

Demographers call this evolution the demographic transition. All countries go through it in their own time. It’s a hallmark of human progress: In a country that has completed the transition, people have wrested from nature at least some control over death and birth. The global population explosion is an inevitable side effect, a huge one that some people are not sure our civilization can survive. But the growth rate was actually at its peak just as Ehrlich was sounding his alarm. By the early 1970s, fertility rates around the world had begun dropping faster than anyone had anticipated. Since then, the population growth rate has fallen by more than 40 percent.

THE FERTILITY DECLINE that is now sweeping the planet started at different times in different countries. France was one of the first. By the early 18th century, noblewomen at the French court were knowing carnal pleasures without bearing more than two children. They often relied on the same method Leeuwenhoek used for his studies: withdrawal, or coitus interruptus. Village parish records show the trend had spread to the peasantry by the late 18th century; by the end of the 19th, fertility in France had fallen to three children per woman—without the help of modern contraceptives. The key innovation was conceptual, not contraceptive, says Gilles Pison of the National Institute for Demographic Studies in Paris. Until the Enlightenment, “the number of children you had, it was God who decided. People couldn’t fathom that it might be up to them.”

Other countries in the West eventually followed France’s lead. By the onset of World War II, fertility had fallen close to the replacement level in parts of Europe and the U.S. Then, after the surprising blip known as the baby boom, came the bust, again catching demographers off guard. They assumed some instinct would lead women to keep having enough children to ensure the survival of the species. Instead, in country after developed country, the fertility rate fell below replacement level. In the late 1990s in Europe it fell to 1.4. “The evidence I’m familiar with, which is anecdotal, is that women couldn’t care less about replacing the species,” Joel Cohen says.

The end of a baby boom can have two big economic effects on a country. The first is the “demographic dividend”—a blissful few decades when the boomers swell the labor force and the number of young and old dependents is relatively small, and there is thus a lot of money for other things. Then the second effect kicks in: The boomers start to retire. What had been considered the

enduring demographic order is revealed to be a party that has to end. The sharpening American debate over Social Security and last year's strikes in France over increasing the retirement age are responses to a problem that exists throughout the developed world: how to support an aging population. "In 2050 will there be enough people working to pay for pensions?" asks Frans Willekens, director of the Netherlands Interdisciplinary Demographic Institute in The Hague. "The answer is no."

In industrialized countries it took generations for fertility to fall to the replacement level or below. As that same transition takes place in the rest of the world, what has astonished demographers is how much faster it is happening there. Though its population continues to grow, China, home to a fifth of the world's people, is already below replacement fertility and has been for nearly 20 years, thanks in part to the coercive one-child policy implemented in 1979; Chinese women, who were bearing an average of six children each as recently as 1965, are now having around 1.5. In Iran, with the support of the Islamic regime, fertility has fallen more than 70 percent since the early '80s. In Catholic and democratic Brazil, women have reduced their fertility rate by half over the same quarter century. "We still don't understand why fertility has gone down so fast in so many societies, so many cultures and religions. It's just mind-boggling," says Hania Zlotnik, director of the UN Population Division.

"At this moment, much as I want to say there's still a problem of high fertility rates, it's only about 16 percent of the world population, mostly in Africa," says Zlotnik. South of the Sahara, fertility is still five children per woman; in Niger it is seven. But then, 17 of the countries in the region still have life expectancies of 50 or less; they have just begun the demographic transition. In most of the world, however, family size has shrunk dramatically. The UN projects that the world will reach replacement fertility by 2030. "The population as a whole is on a path toward nonexplosion—which is good news," Zlotnik says.

The bad news is that 2030 is two decades away and that the largest generation of adolescents in history will then be entering their childbearing years. Even if each of those women has only two children, population will coast upward under its own momentum for another quarter century. Is a train wreck in the offing, or will people then be able to live humanely and in a way that doesn't destroy their environment? One thing is certain: Close to one in six of them will live in India.

I have understood the population explosion intellectually for a long time. I came to understand it emotionally one stinking hot night in Delhi a couple of years ago... The temperature was well over

100, and the air was a haze of dust and smoke. The streets seemed alive with people. People eating, people washing, people sleeping. People visiting, arguing, and screaming. People thrusting their hands through the taxi window, begging. People defecating and urinating. People clinging to buses. People herding animals. People, people, people, people. —Paul Ehrlich

In 1966, when Ehrlich took that taxi ride, there were around half a billion Indians. There are 1.2 billion now. Delhi's population has increased even faster, to around 22 million, as people have flooded in from small towns and villages and crowded into sprawling shantytowns. Early last June in the stinking hot city, the summer monsoon had not yet arrived to wash the dust from the innumerable construction sites, which only added to the dust that blows in from the deserts of Rajasthan. On the new divided highways that funnel people into the unplanned city, oxcarts were heading the wrong way in the fast lane. Families of four cruised on motorbikes, the women's scarves flapping like vivid pennants, toddlers dangling from their arms. Families of a dozen or more sardined themselves into buzzing, bumblebee-colored auto rickshaws designed for two passengers. In the stalled traffic, amputees and wasted little children cried for alms. Delhi today is booming different from the city Ehrlich visited, and it is also very much the same.

At Lok Nayak Hospital, on the edge of the chaotic and densely peopled nest of lanes that is Old Delhi, a human tide flows through the entrance gate every morning and crowds inside on the lobby floor. "Who could see this and not be worried about the population of India?" a surgeon named Chandan Bortamuly asked one afternoon as he made his way toward his vasectomy clinic. "Population is our biggest problem." Removing the padlock from the clinic door, Bortamuly stepped into a small operating room. Inside, two men lay stretched out on examination tables, their testicles poking up through holes in the green sheets. A ceiling fan pushed cool air from two window units around the room.

Bortamuly is on the front lines of a battle that has been going on in India for nearly 60 years. In 1952, just five years after it gained independence from Britain, India became the first country to establish a policy for population control. Since then the government has repeatedly set ambitious goals—and repeatedly missed them by a mile. A national policy adopted in 2000 called for the country to reach the replacement fertility of 2.1 by 2010. That won't happen for at least another decade. In the UN's medium projection, India's population will rise to just over 1.6 billion people by 2050. "What's inevitable is that India is going to exceed the population of China by 2030," says A. R. Nanda, former

head of the Population Foundation of India, an advocacy group. “Nothing less than a huge catastrophe, nuclear or otherwise, can change that.”

Sterilization is the dominant form of birth control in India today, and the vast majority of the procedures are performed on women. The government is trying to change that; a no-scalpel vasectomy costs far less and is easier on a man than a tubal ligation is on a woman. In the operating theater Bortamuly worked quickly. “They say the needle pricks like an ant bite,” he explained, when the first patient flinched at the local anesthetic. “After that it’s basically painless, bloodless surgery.” Using the pointed tip of a forceps, Bortamuly made a tiny hole in the skin of the scrotum and pulled out an oxbow of white, stringy vas deferens—the sperm conduit from the patient’s right testicle. He tied off both ends of the oxbow with fine black thread, snipped them, and pushed them back under the skin. In less than seven minutes—a nurse timed him—the patient was walking out without so much as a Band-Aid. The government will pay him an incentive fee of 1,100 rupees (around \$25), a week’s wages for a laborer.

The Indian government tried once before to push vasectomies, in the 1970s, when anxiety about the population bomb was at its height. Prime Minister Indira Gandhi and her son Sanjay used state-of-emergency powers to force a dramatic increase in sterilizations. From 1976 to 1977 the number of operations tripled, to more than eight million. Over six million of those were vasectomies. Family planning workers were pressured to meet quotas; in a few states, sterilization became a condition for receiving new housing or other government benefits. In some cases the police simply rounded up poor people and hauled them to sterilization camps.

The excesses gave the whole concept of family planning a bad name. “Successive governments refused to touch the subject,” says Shailaja Chandra, former head of the National Population Stabilisation Fund (NPSF). Yet fertility in India has dropped anyway, though not as fast as in China, where it was nose-diving even before the draconian one-child policy took effect. The national average in India is now 2.6 children per woman, less than half what it was when Ehrlich visited. The southern half of the country and a few states in the northern half are already at replacement fertility or below.

In Kerala, on the southwest coast, investments in health and education helped fertility fall to 1.7. The key, demographers there say, is the female literacy rate: At around 90 percent, it’s easily the highest in India. Girls who go to school start having children later than ones who don’t. They are more open to contraception and more likely to understand their options.

SO FAR THIS APPROACH, held up as a model internationally, has not caught on in the poor states of northern India—in the “Hindi belt” that stretches across the country just south of Delhi. Nearly half of India’s population growth is occurring in Rajasthan, Madhya Pradesh, Bihar, and Uttar Pradesh, where fertility rates still hover between three and four children per woman. More than half the women in the Hindi belt are illiterate, and many marry well before reaching the legal age of 18. They gain social status by bearing children—and usually don’t stop until they have at least one son.

As an alternative to the Kerala model, some point to the southern state of Andhra Pradesh, where sterilization “camps”—temporary operating rooms often set up in schools—were introduced during the ’70s and where sterilization rates have remained high as improved hospitals have replaced the camps. In a single decade beginning in the early 1990s, the fertility rate fell from around three to less than two. Unlike in Kerala, half of all women in Andhra Pradesh remain illiterate.

Amarjit Singh, the current executive director of the NPSF, calculates that if the four biggest states of the Hindi belt had followed the Andhra Pradesh model, they would have avoided 40 million births—and considerable suffering. “Because 40 million were born, 2.5 million children died,” Singh says. He thinks if all India were to adopt high-quality programs to encourage sterilizations, in hospitals rather than camps, it could have 1.4 billion people in 2050 instead of 1.6 billion.

Critics of the Andhra Pradesh model, such as the Population Foundation’s Nanda, say Indians need better health care, particularly in rural areas. They are against numerical targets that pressure government workers to sterilize people or cash incentives that distort a couple’s choice of family size. “It’s a private decision,” Nanda says.

In Indian cities today, many couples are making the same choice as their counterparts in Europe or America. Sonalde Desai, a senior fellow at New Delhi’s National Council of Applied Economic Research, introduced me to five working women in Delhi who were spending most of their salaries on private-school fees and after-school tutors; each had one or two children and was not planning to have more. In a nationwide survey of 41,554 households, Desai’s team identified a small but growing vanguard of urban one-child families. “We were totally blown away at the emphasis parents were placing on their children,” she says. “It suddenly makes you understand—that is why fertility is going down.” Indian children on average are much better educated than their parents.

That's less true in the countryside. With Desai's team I went to Palanpur, a village in Uttar Pradesh—a Hindi-belt state with as many people as Brazil. Walking into the village we passed a cell phone tower but also rivulets of raw sewage running along the lanes of small brick houses. Under a mango tree, the keeper of the grove said he saw no reason to educate his three daughters. Under a neem tree in the center of the village, I asked a dozen farmers what would improve their lives most. "If we could get a little money, that would be wonderful," one joked.

The goal in India should not be reducing fertility or population, Almas Ali of the Population Foundation told me when I spoke to him a few days later. "The goal should be to make the villages livable," he said. "Whenever we talk of population in India, even today, what comes to our mind is the increasing numbers. And the numbers are looked at with fright. This phobia has penetrated the mind-set so much that all the focus is on reducing the number. The focus on people has been pushed to the background."

It was a four-hour drive back to Delhi from Palanpur, through the gathering night of a Sunday. We sat in traffic in one market town after another, each one hopping with activity that sometimes engulfed the car. As we came down a viaduct into Moradabad, I saw a man pushing a cart up the steep hill, piled with a load so large it blocked his view. I thought of Ehrlich's epiphany on his cab ride all those decades ago. People, people, people, people—yes. But also an overwhelming sense of energy, of striving, of aspiration.

THE ANNUAL meeting of the Population Association of America (PAA) is one of the premier gatherings of the world's demographers. Last April the global population explosion was not on the agenda. "The problem has become a bit passé," Hervé Le Bras says. Demographers are generally confident that by the second half of this century we will be ending one unique era in history—the population explosion—and entering another, in which population will level out or even fall.

But will there be too many of us? At the PAA meeting, in the Dallas Hyatt Regency, I learned that the current population of the planet could fit into the state of Texas, if Texas were settled as densely as New York City. The comparison made me start thinking like Leeuwenhoek. If in 2045 there are nine billion people living on the six habitable continents, the world population density will be a little more than half that of France today. France is not usually considered a hellish place. Will the world be hellish then?

Some parts of it may well be; some parts of it are hellish today. There are now 21 cities with populations larger than ten million, and by 2050 there will be many more. Delhi adds hundreds of thousands of migrants each year, and those people arrive to find that “no plans have been made for water, sewage, or habitation,” says Shailaja Chandra. Dhaka in Bangladesh and Kinshasa in the Democratic Republic of the Congo are 40 times larger today than they were in 1950. Their slums are filled with desperately poor people who have fled worse poverty in the countryside.

Whole countries today face population pressures that seem as insurmountable to us as India’s did to Ehrlich in 1966. Bangladesh is among the most densely populated countries in the world and one of the most immediately threatened by climate change; rising seas could displace tens of millions of Bangladeshis. Rwanda is an equally alarming case. In his book *Collapse*, Jared Diamond argued that the genocidal massacre of some 800,000 Rwandans in 1994 was the result of several factors, not only ethnic hatred but also overpopulation—too many farmers dividing the same amount of land into increasingly small pieces that became inadequate to support a farmer’s family. “Malthus’s worst-case scenario may sometimes be realized,” Diamond concluded.

Many people are justifiably worried that Malthus will finally be proved right on a global scale—that the planet won’t be able to feed nine billion people. Lester Brown, founder of Worldwatch Institute and now head of the Earth Policy Institute in Washington, believes food shortages could cause a collapse of global civilization. Human beings are living off natural capital, Brown argues, eroding soil and depleting groundwater faster than they can be replenished. All of that will soon be cramping food production. Brown’s Plan B to save civilization would put the whole world on a wartime footing, like the U.S. after Pearl Harbor, to stabilize climate and repair the ecological damage. “Filling the family planning gap may be the most urgent item on the global agenda,” he writes, so if we don’t hold the world’s population to eight billion by reducing fertility, the death rate may increase instead.

Eight billion corresponds to the UN’s lowest projection for 2050. In that optimistic scenario, Bangladesh has a fertility rate of 1.35 in 2050, but it still has 25 million more people than it does today. Rwanda’s fertility rate also falls below the replacement level, but its population still rises to well over twice what it was before the genocide. If that’s the optimistic scenario, one might argue, the future is indeed bleak.

But one can also draw a different conclusion—that fixating on population numbers is not the best way to confront the future. People packed into slums need help, but the problem that needs solving is

poverty and lack of infrastructure, not overpopulation. Giving every woman access to family planning services is a good idea—"the one strategy that can make the biggest difference to women's lives," Chandra calls it. But the most aggressive population control program imaginable will not save Bangladesh from sea level rise, Rwanda from another genocide, or all of us from our enormous environmental problems.

Global warming is a good example. Carbon emissions from fossil fuels are growing fastest in China, thanks to its prolonged economic boom, but fertility there is already below replacement; not much more can be done to control population. Where population is growing fastest, in sub-Saharan Africa, emissions per person are only a few percent of what they are in the U.S.—so population control would have little effect on climate. Brian O'Neill of the National Center for Atmospheric Research has calculated that if the population were to reach 7.4 billion in 2050 instead of 8.9 billion, it would reduce emissions by 15 percent. "Those who say the whole problem is population are wrong," Joel Cohen says. "It's not even the dominant factor." To stop global warming we'll have to switch from fossil fuels to alternative energy—regardless of how big the population gets.

The number of people does matter, of course. But how people consume resources matters a lot more. Some of us leave much bigger footprints than others. The central challenge for the future of people and the planet is how to raise more of us out of poverty—the slum dwellers in Delhi, the subsistence farmers in Rwanda—while reducing the impact each of us has on the planet.

The World Bank has predicted that by 2030 more than a billion people in the developing world will belong to the "global middle class," up from just 400 million in 2005. That's a good thing. But it will be a hard thing for the planet if those people are eating meat and driving gasoline-powered cars at the same rate as Americans now do. It's too late to keep the new middle class of 2030 from being born; it's not too late to change how they and the rest of us will produce and consume food and energy. "Eating less meat seems more reasonable to me than saying, 'Have fewer children!'" Le Bras says.

How many people can the Earth support? Cohen spent years reviewing all the research, from Leeuwenhoek on. "I wrote the book thinking I would answer the question," he says. "I found out it's unanswerable in the present state of knowledge." What he found instead was an enormous range of "political numbers, intended to persuade people" one way or the other.

For centuries population pessimists have hurled apocalyptic warnings at the congenital optimists, who believe in their bones that humanity will find ways to cope and even improve its lot. History, on the whole, has so far favored the optimists, but history is no certain guide to the future. Neither is science. It cannot predict the outcome of *People v. Planet*, because all the facts of the case—how many of us there will be and how we will live—depend on choices we have yet to make and ideas we have yet to have. We may, for example, says Cohen, “see to it that all children are nourished well enough to learn in school and are educated well enough to solve the problems they will face as adults.” That would change the future significantly.

The debate was present at the creation of population alarmism, in the person of Rev. Thomas Malthus himself. Toward the end of the book in which he formulated the iron law by which unchecked population growth leads to famine, he declared that law a good thing: It gets us off our duffs. It leads us to conquer the world. Man, Malthus wrote, and he must have meant woman too, is “inert, sluggish, and averse from labour, unless compelled by necessity.” But necessity, he added, gives hope:

“The exertions that men find it necessary to make, in order to support themselves or families, frequently awaken faculties that might otherwise have lain for ever dormant, and it has been commonly remarked that new and extraordinary situations generally create minds adequate to grapple with the difficulties in which they are involved.”

Seven billion of us soon, nine billion in 2045. Let’s hope that Malthus was right about our ingenuity.

Robert Kunzig is *National Geographic*’s senior editor for the environment

How Population Booms

As living conditions improve, a country enters successive phases of a process called the demographic transition. The death rate falls, but there's a lag before the birthrate falls too. The result: Population soars. Each phase is marked by a redistribution of the population's age groups, as shown in the pyramids at bottom.

PHASE 1: Preindustrial

Example: None since war-torn Rwanda in the 1990s

BIRTHRATE
High birthrate matches high death rate.

DEATH RATE
Disease, poor living conditions, and warfare lead to a high death rate that sometimes exceeds the birthrate.

POPULATION
A high birthrate and high death rate create a young population of fairly constant size.

PHASE 2: Boom Begins

Uganda, Nigeria, Angola

Birthrate remains high.

Better sanitation, health care, and food supply cause the death rate to drop.

Population booms as the death rate declines.

PHASE 3: Still Rising

India, Brazil, Bangladesh, U.S.*

Birthrate declines as women gain access to education and engage in family planning.

Population is still rising from Phase 2 boom.

Death rate continues to decline.

PHASE 4: Leveling Off

Japan, Russia, Italy, China

Population stabilizes as births and deaths come into balance.

Birthrate drops to replacement level or even below.

Death rate remains low or increases slightly due to older population.

POPULATION PYRAMIDS

Over 75 years old

40-45

20-25

0-5

A wide base and narrow top characterize populations with a high birthrate and high death rate.

As conditions improve, the death rate declines, and the pyramid tiers for older ages begin to fill out.

A population with fewer children emerges as the birthrate falls; life expectancy increases.

In an aging population, annual deaths may exceed births; without immigration, population may fall.

*THE U.S. HAS CHARACTERISTICS OF PHASES 3 AND 4: A RELATIVELY HIGH BIRTHRATE AS WELL AS AN AGING POPULATION.
MARIEL FURLONG, NGM STAFF
SOURCE: CARL HAUB, POPULATION REFERENCE BUREAU



**ENERGIZED
LANDSCAPE**

ENGLAND Glowing furnace bright at night, London became the world's largest city during the coal-powered industrial revolution, a tipping point for the steep rise of Earth's population. Wealthy countries use many times more resources per capita than poorer nations, but as global incomes rise, increased consumption may stress the planet more than population growth.

JASON HAWKES

By 2045 global population is projected to reach nine billion. Can the planet take the strain?

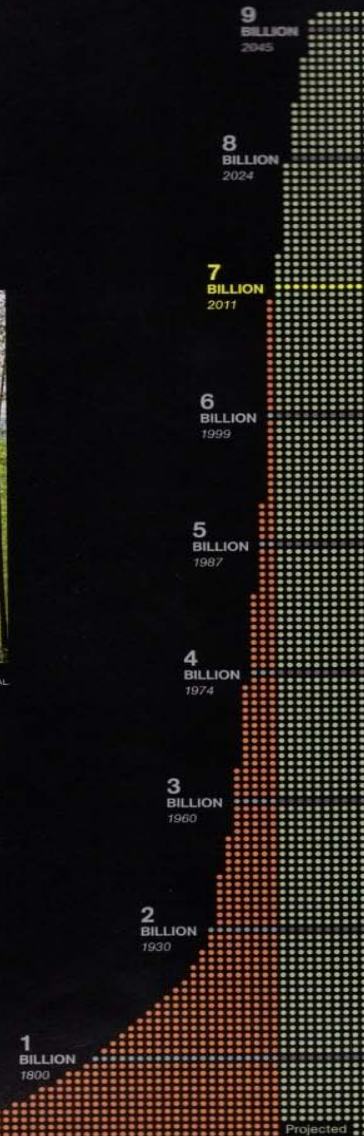
As we reach the milestone of seven billion people this year, it's time to take stock. In the coming decades, despite falling birthrates, the population will continue to grow—mostly in poor countries. If the billions of people who want to boost themselves out of poverty follow the path blazed by those in wealthy countries, they too will step hard on the planet's resources. How big will the population actually grow? What will the planet look like in 2045? Throughout the year we'll offer an in-depth series exploring those questions. The answers will depend on the decisions each of us makes.

SOURCES: POPULATION REFERENCE BUREAU AND UNITED NATIONS
PHOTO: FRITZ HOFFMANN

World population
200 MILLION
A.D. 1



RESOURCES THAT CAN BE REPLENISHED, LIKE CHINA'S BAMBOO, WILL BE CRUCIAL.





NEW AMERICANS

UNITED STATES Bundled newborns on September 1, 2010, are arranged for a portrait at Orlando's Winnie Palmer Hospital, the second busiest birth facility in the U.S. Unusual among industrial nations, the U.S. has a comparatively high fertility rate, due in part to the significant rate of teenage pregnancies and a steady influx of immigrants. By 2050 America's population is expected to top 400 million.

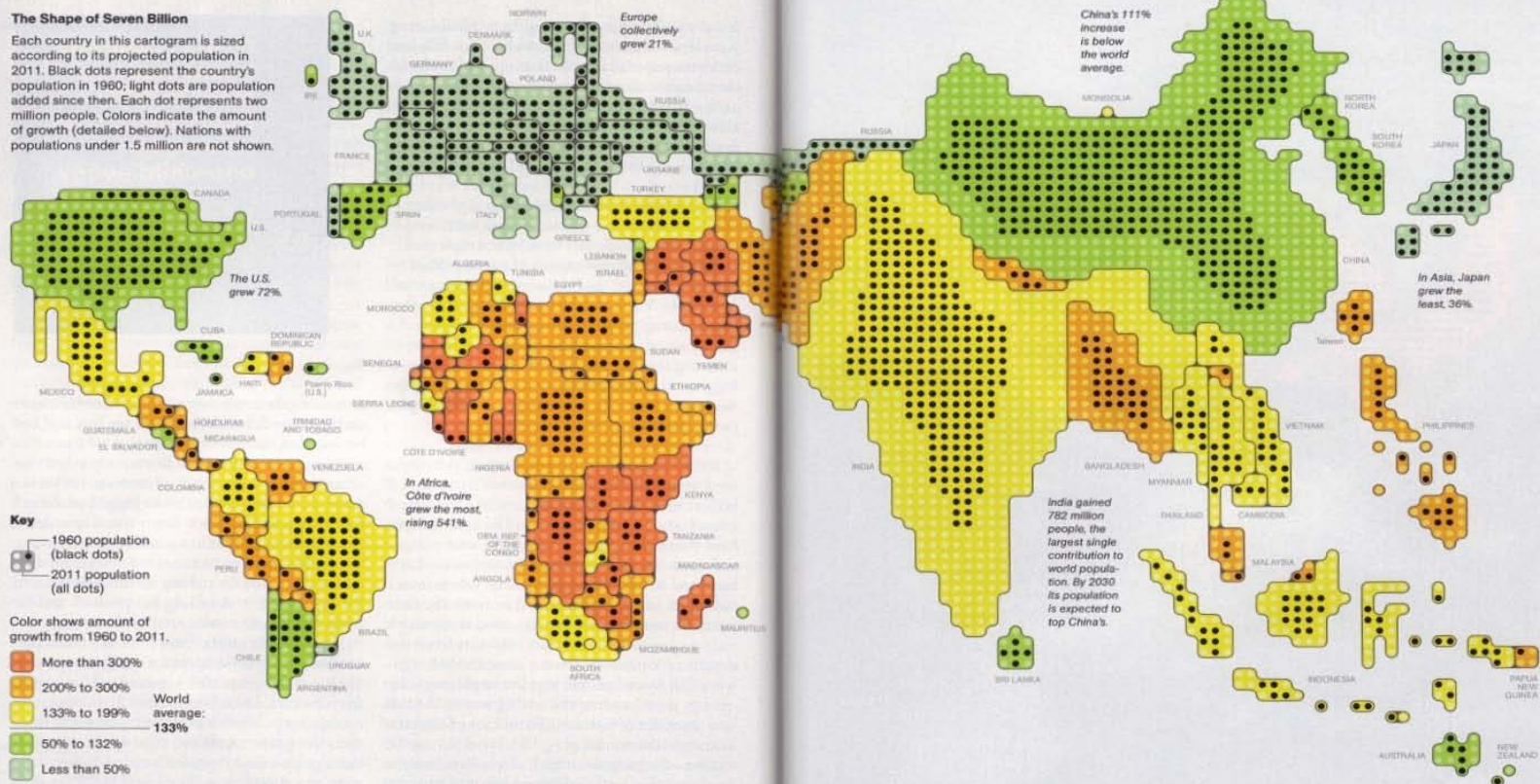
JOHN STANNMEYER

POPULATION

The less developed world will account for more than 95 percent of future population growth.

The Shape of Seven Billion

Each country in this cartogram is sized according to its projected population in 2011. Black dots represent the country's population in 1960; light dots are population added since then. Each dot represents two million people. Colors indicate the amount of growth (detailed below). Nations with populations under 1.5 million are not shown.

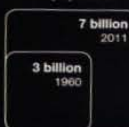


JOHN TOMARNO, NDM STAFF; CARTOGRAM: XMR PRODUCTIONS AND JOHN TOMARNO
SOURCE: UNITED NATIONS

There are more than twice as many people on the planet today as there were in 1960.

World population has never doubled this quickly before, but it is unlikely to double again. The era of explosive growth is expected to end by 2050, at more than 9 billion people, with an estimated range of 8 to 10.5 billion people.

World population



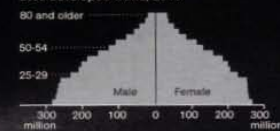
Youthful momentum

Age-distribution pyramids (right) show why the overwhelmingly young populations of developing countries will produce almost all the future population increase. Even with falling birthrates, the world's population is still growing by about 80 million people a year.

More developed world,* 2010



Less developed world, 2010



World population, 1950-2030



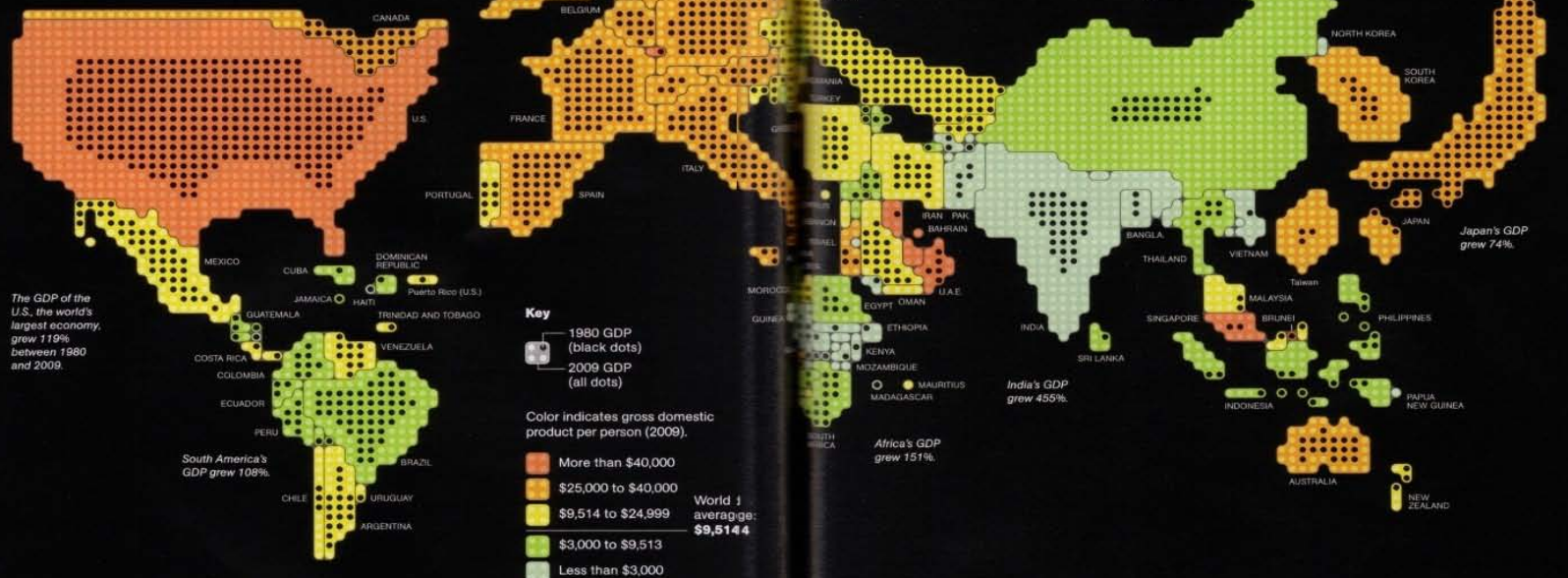
MORE DEVELOPED IS DEFINED IN THESE UN STATISTICS AS THE U.S., CANADA, EUROPE, JAPAN, AUSTRALIA, AND NEW ZEALAND.

CONSUMPTION

Wealthy nations use the most resources now, but emerging economies are catching up fast.

Appetites of the Seven Billion

How much impact does each country have on Earth's resources? One way to approximate a nation's consumption is to look at its gross domestic product (GDP)—the total production of goods and services in a year by its residents, firms, and government. In this cartogram, countries are sized according to their GDP for 2009. Black dots show GDP in 1980, or latest year available; light dots show growth since then. Each dot represents \$20 billion.* A country's color indicates its GDP per person (detailed in the key below).



*TO COMPARE THE GROSS DOMESTIC PRODUCT OF THE COUNTRIES ON THIS MAP, GDP WAS CONVERTED TO CONSTANT INTERNATIONAL DOLLARS USING PURCHASING POWER PARITY RATES. IN THIS CONVERSION AN INTERNATIONAL DOLLAR HAS THE SAME PURCHASING POWER THAT A U.S. DOLLAR HAS IN THE UNITED STATES.

The world's gross domestic product* more than doubled from 1980 to 2009.

Economic development in China and India accounts for much of the recent rise and will continue to drive it. Global economic growth, and the improved standard of living it offers, means that resources are being consumed at record levels.

World GDP



Demand on natural resources will continue to increase.

Earth's finite resources will be stressed both by rising prosperity and sheer numbers of people (graphs, right). The consumption of resources now enjoyed in the wealthiest nations will be difficult to sustain worldwide.

World population, 1950-2030



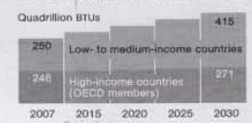
MORE DEVELOPED IS DEFINED IN THESE UN STATISTICS AS THE U.S., CANADA, EUROPE, JAPAN, AUSTRALIA, AND NEW ZEALAND.

World GDP, 1980-2030



RICH INCLUDES THE U.S. MORE DEVELOPED COUNTRIES PLUS CYPRUS, HONG KONG, ISRAEL, SINGAPORE, SOUTH KOREA, AND TAIWAN.

World energy consumption, 2007-2030



OECD MEMBERS ARE THE U.S. MORE DEVELOPED COUNTRIES PLUS CHILE, ISRAEL, MEXICO, SOUTH KOREA, AND TURKEY.



FAMILY OF MANY

KENYA In a Nairobi slum Mary Wanza, a single mother earning three dollars a day, makes porridge for ten children, some hers, others grandkids and orphans. Wanza, 41, gave birth to the first of seven at age 15. Fertility rates remain high in sub-Saharan Africa; Kenya's rate fell from eight to five births per woman between 1960 and 2000 but has since declined only to 4.6. The global average is 2.5.

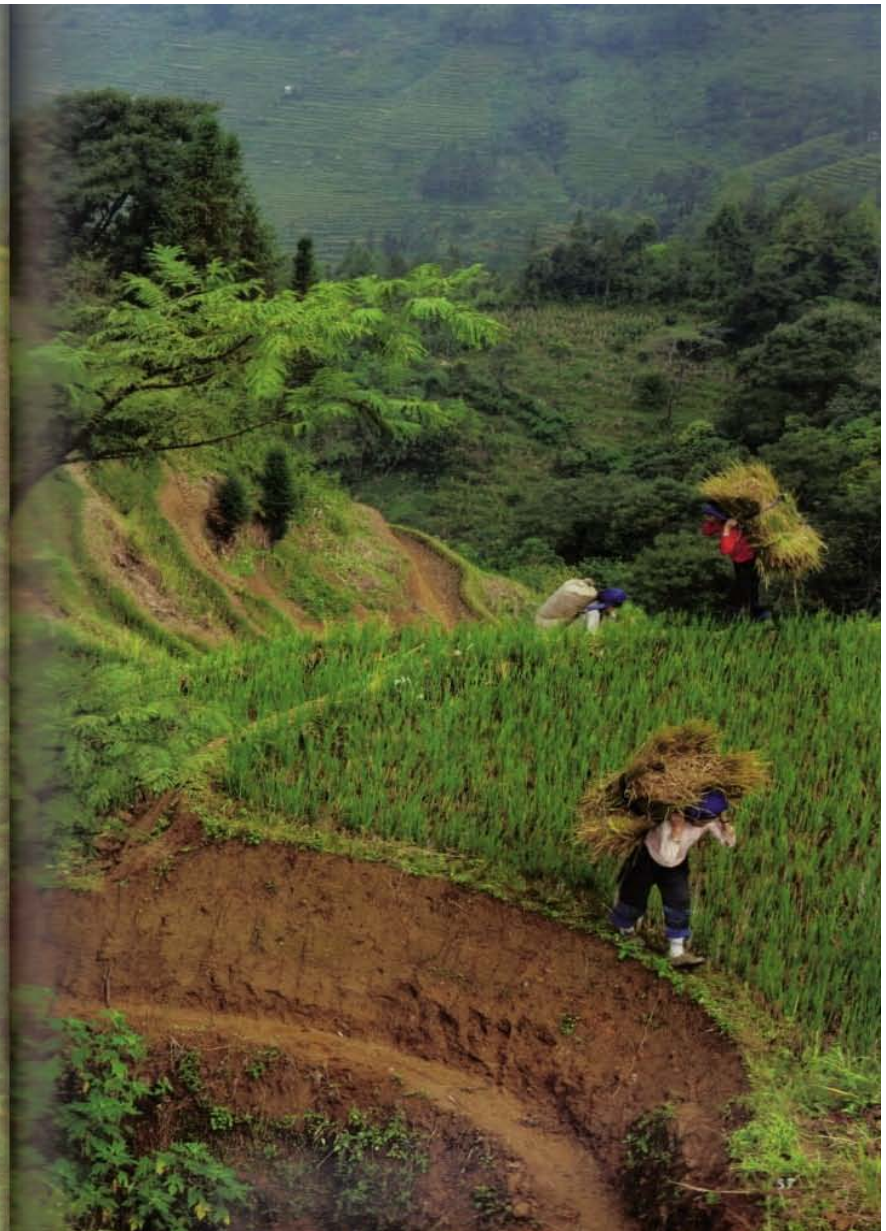
DOMINIC NASH



**TIME FOR ANOTHER
GREEN REVOLUTION**

CHINA Using every fertile inch, farmers harvest rice in the hills of Yunnan Province. High-yield seeds and ample fertilizer allow China to feed its billion-plus people on less than 10 percent of the Earth's arable land. Producing enough food as global population grows is possible, but doing so without exhausting finite resources, especially water, will be a challenge.

JIM RICHARDSON
NATIONAL GEOGRAPHIC STOCK

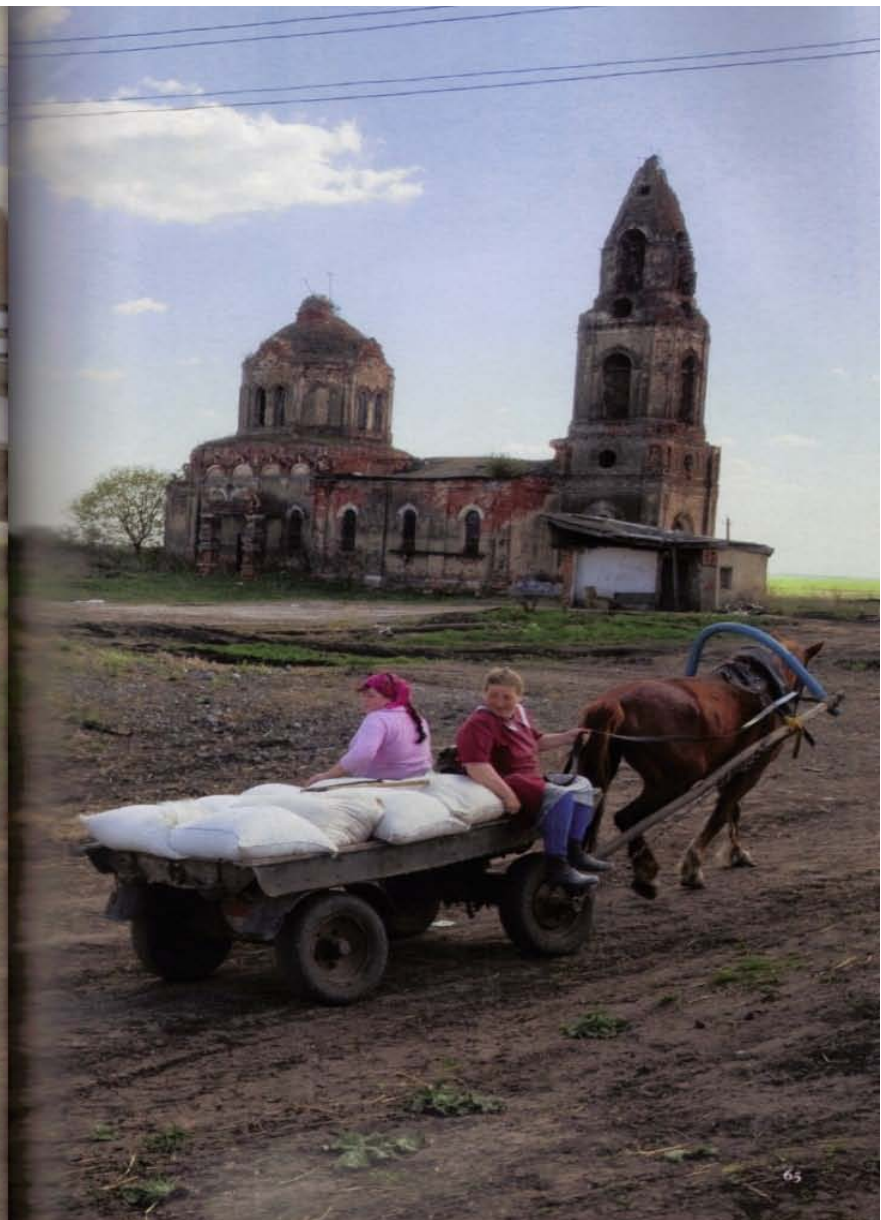


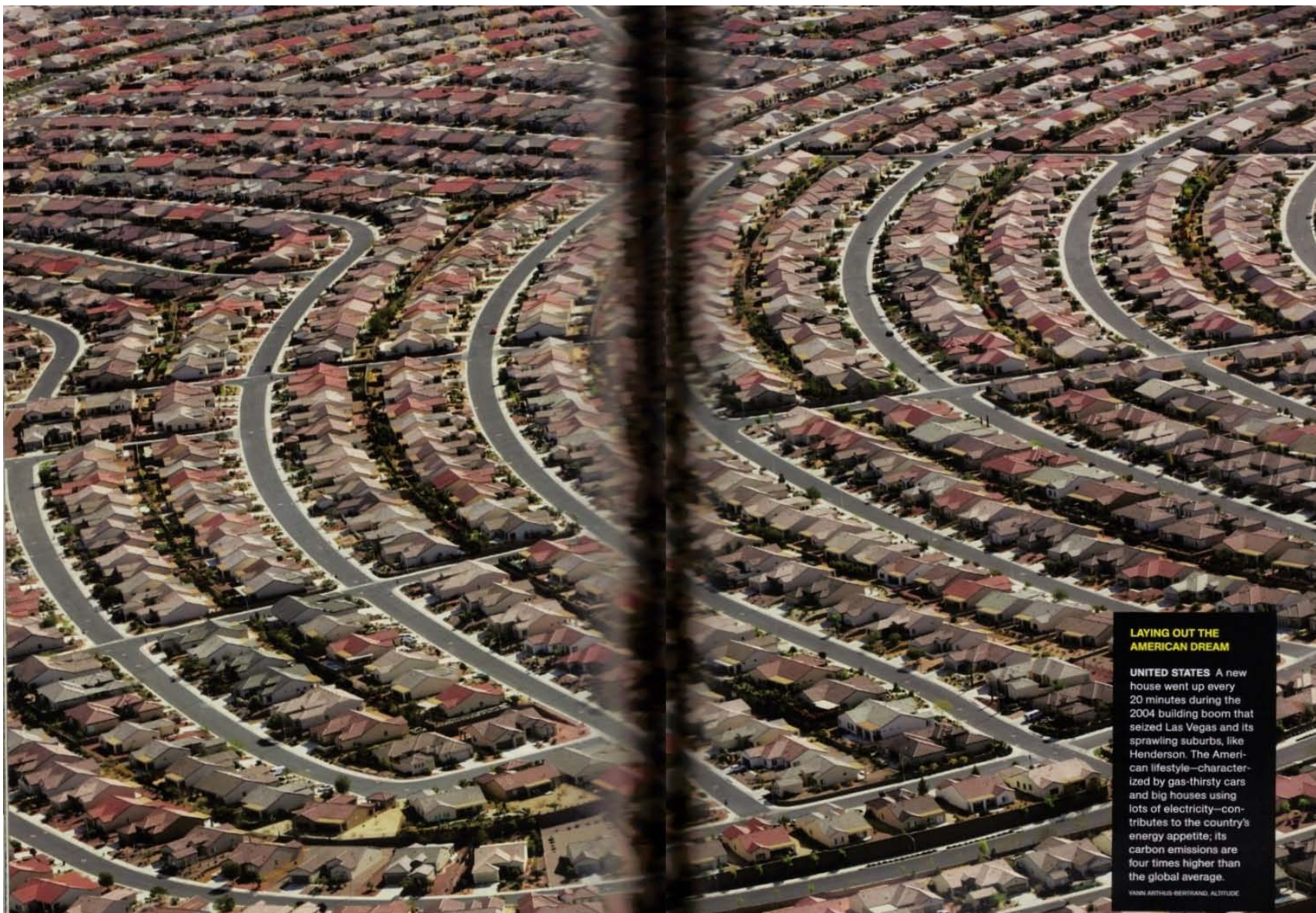


EMPTIED COUNTRYSIDE

RUSSIA Traffic is light—a horse cart with grain, a puppy in pursuit—on a road passing an abandoned granary and church in Novotishnevo, one of thousands of Russian villages depopulating as people move to cities and have fewer kids. To combat a low birthrate, the government has promised to pay \$11,500 to women who have a second child.

RANDY OLSON





LAYING OUT THE AMERICAN DREAM

UNITED STATES A new house went up every 20 minutes during the 2004 building boom that seized Las Vegas and its sprawling suburbs, like Henderson. The American lifestyle—characterized by gas-thirsty cars and big houses using lots of electricity—contributes to the country's energy appetite; its carbon emissions are four times higher than the global average.

FROM ARTHUR BERTRAND, ALTITUDE



LURE OF THE CITY

VENEZUELA Sharing a hillside with high-rise apartment dwellers, children dance at a shop in one of the squatter communities that ring Caracas, a city of three million. One in seven people on Earth lives in slums today. Providing them with better housing and education will be one of the great challenges facing a world of seven billion people and counting.

JONAS BENDIKSEN, MAGNUM PHOTOS