WORLDWATCH REPORT 183

Population, Climate Change, and Women's Lives

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On the cover: A family on their parched land in Niger.
Photograph © IFAD/David Rose

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Acknowledgments

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About the Author

Robert Engelman is Vice President for Programs at the Worldwatch Institute and author of *More: Population, Nature, and What Women Want* (Island Press, 2008). Formerly a newspaper reporter covering politics, health, science, and the environment, Robert has served on the faculty of Yale University and written for numerous newspapers, magazines, and scientific journals. Prior to joining the Worldwatch Institute in 2007, he served as director of the population and environment program and later vice president for research at Population Action International (PAI) in Washington, D.C. His 1994 report for PAI, *Stabilizing the Atmosphere: Population, Consumption and Greenhouse Gases*, was among the earliest publications to examine the population-climate link.

Summary

The growth of population is a major factor behind climate change today. Human-caused climate change is fundamentally an imbalance of scale, as people release heat-trapping gases into Earth's atmosphere faster than the oceans and living things can remove them. This imbalance stems from both the explosion of technologies made possible through the combustion of fossil fuels since the late 1700s and the more than sevenfold increase in human numbers since that time.

The size of today's population and its continued growth also put at risk the social and institutional resilience needed to adapt successfully to the impacts of climate change, ranging from sea-level rise to more extreme weather events. Slower population growth followed by a gradual decline in population size would facilitate future reductions in greenhouse gas emissions and help societies adapt to the changes in climate that are now all but inevitable, since (due to the long lag times built into the climate system) they will be the product of emissions that we failed to cut in past years and decades.

Despite its key contribution to climate change, population plays little role in current discussions on how to address this serious challenge, particularly at the governmental level. Although many policymakers would welcome slower population growth, there is a concern that policies to slow growth will violate the right of couples to determine their own family size. Moreover, population is associated with sensitive issues including sexuality, contraception, abortion, migration, and religion. As a result, the debate on climate change tends to focus on the role of human technologies and their economic foundations, rather than on critical human numbers and behaviors.

Yet population dynamics are neither predetermined nor inevitable. Slower population growth and more socially beneficial age distributions based on lower fertility are near-certain outcomes of the development of human capacities. A large share of population growth today results not from reproductive self-determination but from its opposite: unintended pregnancies. Assuring that all pregnancies are welcome would by itself significantly slow population growth. Education for women, which reduces desired family size and fertility, would slow growth further, as would efforts to ease social pressures on women to have early and frequent pregnancies. Together, these steps would result in a gradually declining world population within a few decades.

In crafting policies, population change should be viewed as one element of the historic effort to bring women into equal standing with men. Women and children in poverty are among the most vulnerable to the impacts of climate change, despite their disproportionately low contribution to the problem. Removing the obstacles that hold back more than 3 billion potential agents of change—women and girls—is both pragmatic and necessary.

Women manage a broad range of consumption and production decisions that reduce greenhouse gas emissions. As farmers and foresters, they pull carbon out of the atmosphere and sequester it in soils and vegetation. Through cooperative and future-oriented approaches to leadership, as well as a tendency to manage risk more conservatively than men do, they contribute powerfully to social resilience and can help societies adapt to climate change. Increasingly, women also are acting directly on climate change as policymakers and negotiators.

Summary

These contributions can advance more powerfully and quickly as women approach legal, economic, and behavioral equality—including sexually and reproductively—with men. The strategies to bring this about this fall into three categories:

- Eliminating institutional, social, and cultural barriers to women's full legal, civic, and political equality with men;
- Improving schooling for all children and youth, and especially increasing educational attainment among girls and women; and
- Assuring that all women and their partners have access to, and full freedom to use, reproductive health and family planning services so that the highest proportion possible of births results from parents' intentions to raise a child to adulthood.

Making significant progress in all of these areas will require educating the public and policymakers about the real foundations of population change. It also will require concerted action to improve women's status, maternal and child health, and access to comprehensive, client-focused family planning services—all while vigilantly protecting the right of women to make their own decisions about childbearing. If we achieve this—and also tackle climate change seriously and directly, recognizing that no human being has more right than any other to alter the global commons of the atmosphere—we will accelerate the transition to population dynamics that help sustain a supportive climate for humanity's future.

The Climate So Far

Climate change is a natural and ongoing feature of Earth's history. Humans, however, can influence the climate in ways that gain force as societies grow more populous, develop new technologies, and use energy and natural resources more intensively. The predicament we face today is that all of these aspects of human growth and behavior are joining forces to cause a warming of Earth's climate beyond any naturally occurring. Given the vast momentum of the climate system and the continued rise of both population and net greenhouse gas emissions, the risk is consistently growing of a greater and more hazardous warming to come.

Human influence on climate is often seen as relatively recent, as an unintended byproduct of unleashing the power of fossil fuels during the Industrial Revolution. But people likely have been influencing climate for thousands of years. By driving into extinction the large, plant-eating mammals that thrived in the Americas until 13,000 years ago, paleo-Indian hunters may have nudged down global temperatures just as the planet was rebounding from the last ice age. Giant herbivores such as mammoths and sloths produced copious amounts of heat-trapping methane through their digestion and manure, and their sudden exit may have resulted in significantly lower levels of this important greenhouse gas.

Researchers at the University of New Mexico estimate that this prehistoric extinction spasm could explain anywhere between 13 and 100 percent of the reduction in methane observed in ancient glacial ice cores just before the centuries-long cold snap known as the Younger Dryas.[1*]

* Endnotes are grouped by section and begin on page 36.

Although the range of this finding is wide, it suggests that by wiping out an entire class of large-mammal prey, even relatively small human populations deprived the atmosphere of enough methane to cause global temperatures to fall.

An even larger, longer-term change in atmosphere and climate may have resulted from the emergence of agriculture. William Ruddiman, a University of Virginia paleoclimatologist, has argued that the dawn of intensive farming 8,000 years ago unleashed so much carbon dioxide through the clearing of forests for new farmland that CO_2 concentrations reversed a natural downward trend and increased enough to raise global temperatures.[2] (See Figure 1.) Three thousand years later, methane concentrations, too, suddenly turned upward after a long decline. The most logical explanation for this, Ruddiman argues, is the expansion of wetland rice cultivation and the domestication of methane-producing livestock.

Even when human populations were much smaller, some human activities may have affected atmospheric greenhouse gas concentrations—and, as a result, global climate. But these early climatic changes would have occurred gradually, over centuries, with a less sudden and dramatic influence than humans exert today. World population is believed to have been fairly stable at about 300 million people from the birth of Jesus to the year 1000 A.D.[3] By contrast, the changes in atmospheric composition today are obvious and undeniable, with some 6.8 billion people burning fossil fuels, relying on mechanized food production, and altering Earth's landscape for food and shelter.[4] (See Figure 2.)

While absolute certainty is rare in science, climatologists find that the human-driven change in atmospheric composition is a far more likely

Figure 1. A Prehistoric, Human-caused Jump in Carbon Dioxide and Methane Concentrations?

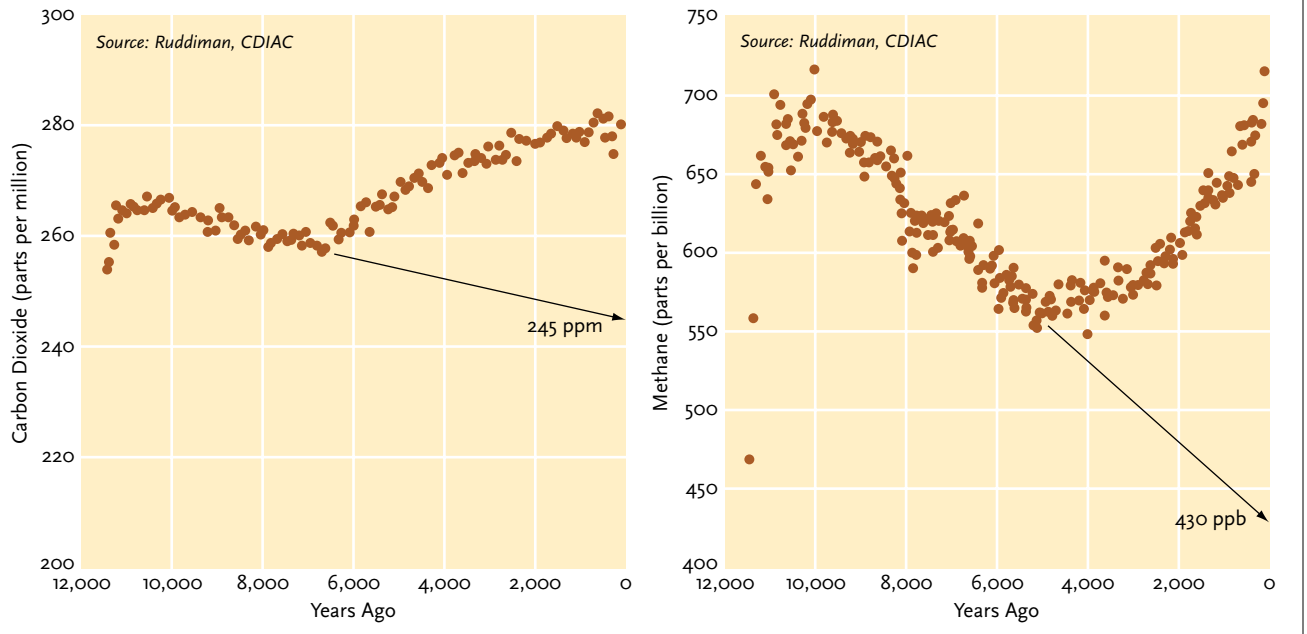
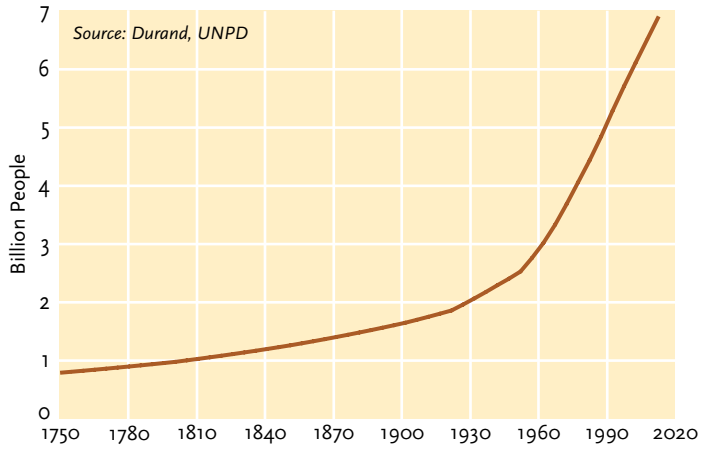


Figure 2. World Population, 1750–2010



cause of the last century's warming trend than any natural forces.[5] The reasons are not hard even for non-scientists to understand.

Greenhouse gases absorb and then re-emit radiation from Earth's sun-warmed surface in rough proportion to the complexity of their molecular structure and their abundance in the atmosphere. Human activities have increased the concentrations of many greenhouse gases well above their natural levels, raising world temperatures above what they otherwise would be. And people have introduced many new sources of greenhouse gases, from refrigerants and fire retardants to chemicals for specialized cleaning and medical uses. Although the atmospheric concentrations of these gases are much lower than that of carbon dioxide, many of them are much more powerful trappers of heat. Climatologists estimate that the added effect of all human-caused emissions to date is roughly the same as if the sun had increased its heating power by some 1 percent since pre-industrial times.[6]

Scientists also are certain, from natural records of past atmospheric composition, that greenhouse gas concentrations began to grow significantly around the late 18th century, when the Industrial Revolution began. This growth accelerated between the mid-20th century and today.[7] (See Figure 3.) Chemical analysis of atmospheric CO_2 makes clear that the additional load in the atmosphere over the last 260 years stems mostly from the combustion of fossil fuels—coal, petroleum, and natural gas—that people have been using in increasing quantities during this period.[8] (See Sidebar 1, page 10.) A smaller share of CO_2 emissions—historically about 20 percent but now perhaps lower due to recent growth in fossil fuel combustion—has its origins in deforestation and land degradation.[9]

In analyzing the forces behind the rapid

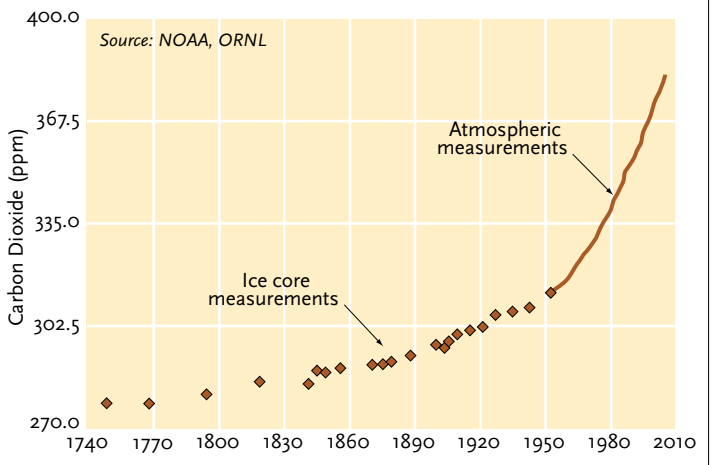
growth in emissions, which is distributed unevenly among regions and economies worldwide, scientists often apply an equation called the Kaya identity. Developed more than two decades ago by Japanese energy economist Yoichi Kaya, this equation calculates the magnitude of emissions change over time as the combined product of changes in four underlying factors: population, economic output (gross domestic product per capita), energy intensity (energy use per unit of gross domestic product), and carbon intensity (CO_2 emissions per unit of energy use).[10] The Intergovernmental Panel on Climate Change (IPCC) applies the Kaya identity for its own scenarios of future climate change.[11]

Population projections are essential components of these scenarios, but for various reasons the IPCC has relied to date on decade-old projections of human numbers, rather than the most recent estimates available from the International Institute of Applied Systems Analysis (IIASA, an Austrian think tank) and the United Nations Population Division. Even so, updating these projections would likely not alter the IPCC's fundamental conclusion that current world population growth is a consistent force that is multiplying human affluence and reliance on fossil fuels and therefore contributing to higher emissions of fossil fuel-based carbon dioxide.[12] (See Figure 4, page 11.)

The IPCC's views on the importance of population growth to CO_2 emissions growth are echoed in other scientific statements going back at least to 1987, when Norman Newell and Leslie Marcus identified a "nearly perfect" 99.8 percent correlation between the growth in world population and atmospheric CO_2 concentrations over the quarter century from 1958 to 1983.[13] Five years later, an expert panel convened by the U.S. National Academy of Sciences—one of several affirming the likelihood that human activities are raising global temperatures—noted: "The more people there are in the world, the greater is the demand put on resources to provide food, energy, clothing and shelter for them. All these activities necessarily involve emissions of greenhouse gases."[14]

However, correlation is not causation. Until recently, little data-driven research has explored

Figure 3. Atmospheric Concentration of Carbon Dioxide, 1744–2007



deeply just how and how much demographic change influences climate change. It has been easy for critics to dismiss the demographic case by pointing out that population tends to grow fastest in the least-developed countries that have the lowest per capita emissions of fossil fuel CO_2. Niger, for example, has the highest documented average fertility rate in the world, at seven children per woman.[15] It also had a documented per capita fossil fuel CO_2 emission rate in 2007 of less than one half of one percentage point of U.S. per capita emissions.[16]

But the implication that gross differences in per capita emissions make population growth irrelevant to emissions growth is flawed on several counts. One is that population grows in the United States, too—albeit more slowly than in Niger. Another is that per capita emissions will inevitably change during the lifetimes of babies born yesterday, not to mention in the lifetimes of their descendants. Currently, per capita emissions are level or declining in wealthy countries while surging in some large developing ones, as these populations develop economically.

As recently as 1990, for example, the average person in China emitted just 2.2 tons of fossil fuel CO_2, while the average American emitted almost nine times more, at 19.5 tons.[17*] In recession-year 2009, by contrast, U.S. per capita

* Units of measure throughout this report are metric unless common usage dictates otherwise.

Sidebar 1. Population and the Rise of Fossil Fuels

If the long history of human population growth were a film, most of the discussion today would be about a few frames: how population has changed in the past decade or two, and how it might change again between now and 2050. Although historians sometimes touch on demographic change in their analyses of the past, few probe its influence in the evolution of the technologies and consumption patterns so important to greenhouse gas emissions.

The very development of fossil fuels—starting with the use of coal in England in the late Middle Ages and Renaissance—owes much to the impact of rising population and energy consumption in northern Europe. Cultures around the world noted and made use of coal's powerful heating capacities thousands of years ago (it fired baths in Roman Britain), but the material was dirty, hard to light, and had to be dug up. Wood, by contrast, was cleaner, easier to ignite, and as close as the nearest tree. Only in the 16th century—when Europe's growing population had depleted the continent's forests for farms and iron smelting—did coal mining and combustion begin on a large scale.

Three centuries later, the story was similar for petroleum. Oil was valued initially as a lamp fuel and wax component when it became obvious that there were not enough whales in the oceans to meet growing demand for illumination and candle wax. And the use of natural gas surged after the first two decades of the 20th century, when German chemists Fritz Haber and Carl Bosch invented a process for combining methane from natural gas with atmospheric nitrogen to produce ammonia, the main ingredient of artificial fertilizer. Industrialization of the process came in time to replace *guano*, a natural fertilizer based on the droppings of seabirds that could not keep up with exploding food demand as the 20th century advanced. Today, the Haber-Bosch process, still dependent on natural gas, makes the difference between an adequate diet and malnutrition for a third or more of the world's population.

The pattern is consistent across all three of these explosions of fossil fuel consumption and applies to countless other technological advances: populations grow, with impacts often multiplied by rising per capita consumption, until a critical resource scarcity looms. Innovators invent new ways to unlock resources hitherto unavailable, facilitating improvements in diets and living standards—and, as a frequent outcome of these improvements, stimulating more population growth. Had the world's population retained the stability that characterized it throughout the First Millennium, life would be very different—and no doubt shorter and less comfortable for most. But it is safe to say that human-caused climate change would hardly be an issue.

Source: See Endnote 8 for this section.

emissions shrank to 17.2 tons, while Chinese emissions nearly tripled to 6.1 tons, thanks to two decades of a roaring economy.[18] The U.S.-China emission gap shrank correspondingly by more than two-thirds, to a multiple of 2.8.[19]

Even so, consumption differences among populations remain important. Despite its shrinkage, for example, the U.S.-China gap is still large enough to weaken U.S.-based arguments that the two nations have comparable obligations to cut their emissions in tandem. It is unlikely that atmospheric stability will ever be achieved without dramatic reductions in the per capita emissions of the world's high-emitting populations. Yet the higher the global population rises, the more difficult it will be for wealthy and poor populations alike to achieve per capita emission levels that are compatible with both equity and atmospheric stability. (There is no reason to worry, however, that the trend toward smaller families will make it any harder to reduce per capita emissions; see Sidebar 2.[20])

"If we are heading for a regime of ultimately equal per capita emissions entitlements around the world, then total world population size becomes a decisive factor," notes Wolfgang Lutz, leader of IIASA's World Population Program. "If by the end of the century world population declines to 6 billion then the entitlements can be twice as high per person as compared to the case of a further increase to 12 billion. Both [of these figures] are within the range of plausible future world population paths."[21]

One error in arguing that the gross differences in per capita emissions undermine the influence of population in emissions change is that the two forces inevitably work together to boost global greenhouse gas emissions. Moreover, developing countries are hardly pitted against industrialized ones, although the structure of the United Nations negotiating process encourages this way of thinking. Population, in fact, is growing in most wealthy countries, especially those where per capita emissions are fairly high, such as the United States, Australia, Canada, and the United Kingdom. In both the United States and the developed world as a whole, per capita emissions have been roughly stable for the last three decades, leading some

Figure 4. Population's Consistent Impact on Growth in Carbon Dioxide Emissions

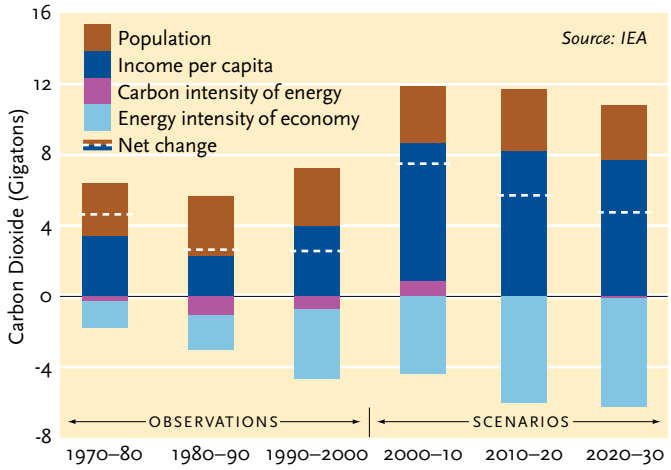


Figure 4 illustrates the influence of four forces on greenhouse gas emissions over time: population, per capita income, the carbon (CO_2) intensity of energy, and the energy intensity of economic activity. Forces shown above the zero-gigaton line in the chart (such as population, shown in brown) are contributing to emissions growth. Forces shown below the line (such as the energy intensity of economic activity, shown in light blue) contribute to emissions shrinkage. The net magnitude of the total of all four forces in a given time period determines how much emissions grow or shrink overall (dashed line in each bar). As the brown rectangles illustrate, world population growth consistently accounted for about three gigatons of net annual growth to the emissions total during each decade shown. (By comparison, the contributions of the other three forces have varied more widely over time.)

Sidebar 2. Small Families, Big Consumers?

One counterargument to the importance of population in climate change is the suggestion that reducing family size further around the world will raise per capita consumption and hence emissions, offsetting any population-related savings in future emissions growth. The apparent global correlation between small families and higher per capita income offers this argument some merit—at first glance.

Among the questions to raise is whether fertility decline itself directly spurs per capita income growth. Economists and demographers have never agreed on this point, and the links between fertility and income appear to depend on conditions and circumstances unique to each population. In the United States, fertility rates were barely more than two children per woman during the depths of the Great Depression of the 1930s and 40s and then rose to nearly twice that in the economically and demographically booming years after World War II. Similarly, fertility has been large in recent times in some oil-producing states where per capita income is quite high. Over the past few decades, fertility has fallen dramatically in countries as varied as Iran, Bangladesh, and Cuba without obvious corresponding increases in consumption or emissions.

In one area, at least, research going back to 1995 does suggest that smaller families may lead to higher emissions: housing. Larger living spaces per person are highly correlated with smaller households, and homes are heated and (in many cases) cooled no matter how many people dwell in them. So strongly did reductions in household size appear to boost emissions that demographers with IIASA's World Population Program suggested that, "A divorce may cause more carbon dioxide emissions than an additional birth."

The flaw in this reasoning is the impact on long-term changes in emissions. Call it the offspring effect: births lead to more births across generations, and absent physical or biological limits population could grow in theory to any future size. Divorces, by contrast, do not beget a next generation of divorces, nor can per capita household size grow indefinitely. It is hard to imagine, for example, everyone in a stable world living alone in houses that double in size every few decades.

The offspring effect has powerful long-term impacts. Studies that combine varying population and economic scenarios find that even under the assumption of rising per capita emissions associated with economic development and a smaller population size, the leveling off of population overwhelms any increases associated with development and boosted consumption. There may be an even more important point, however: ultimately the link between prosperity and high per capita emissions needs to fade away to adequately address human-caused climate change. An interesting research question would be whether future scenarios of population growth would be likely to hinder or facilitate that essential delinking.

Source: See Endnote 20 for this section.

Sidebar 3. Beyond Fossil Fuel CO_2: Other Greenhouse Gases

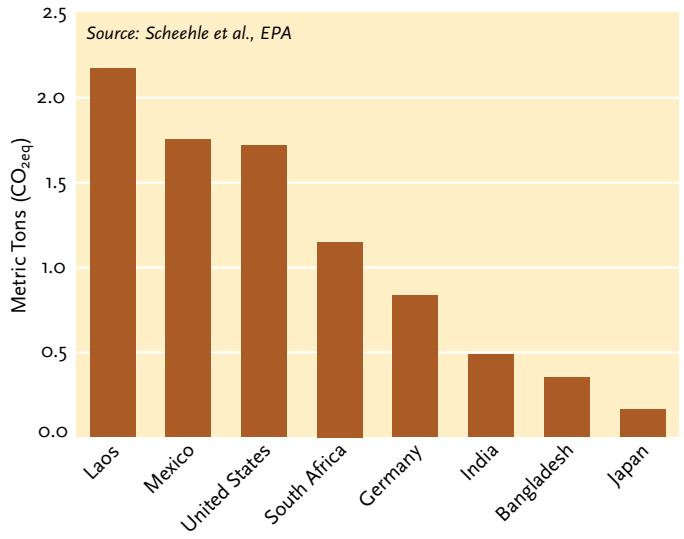
Fossil-fuel combustion is the human activity most responsible for raising global temperature averages. It is also the best documented source of greenhouse gases, and it correlates powerfully with industrialization, development, and affluence. But emissions of carbon dioxide from a different source—deforestation and other changes in land use—are more evenly distributed among the world's population. So are emissions of methane from wetland rice cultivation, livestock, natural gas production, landfills, and other sources. On a per capita basis, methane emissions show an irregular pattern that is not closely correlated to a country's level of development or economic wealth. (See Figure 5.)

Collectively, these two categories of emissions—methane and land-related carbon dioxide—contribute nearly a quarter of all added heat-trapping capacity to the global atmosphere. An even more striking similarity across income groups may apply to emissions of "black carbon"—soot from fossil fuel and biomass burning—which is not a gas but is a potentially powerful contributor to global warming. Based on one analysis, average per capita emissions of black carbon in the United States and Canada are essentially equal to those of Latin America, at 1.2 kilograms per person per year. Averages across Europe, Asia, and sub-Saharan Africa are also similar, but at half that level.

Authoritative historic country-by-country data are lacking for most of the dozens of greenhouse gases. Without such data, no comprehensive database of human contributions to the heat-trapping capacity of the atmosphere is possible. If one could be assembled, however, it would suggest narrower gaps in per capita emissions worldwide than tend to be assumed in climate discussions. This is hardly an argument for dismissing the towering importance of bringing down the highest per capita greenhouse gas emissions first and fastest. But when all emissions sources are on the table, it does strengthen the argument that population growth matters to emissions growth.

Source: See Endnote 23 for this section.

Figure 5. Per Capita Methane Emissions, Selected Countries, 2005



analysts to argue that population growth explains most or all of recent emissions growth in that region.[22]

The available data, too, tend to skew analysis of population dynamics in human-induced climate change. Good data exist only for the activity that contributes the overwhelming majority of CO_2 emissions: combustion of fossil fuels. Data are less accessible for other leading sources of climate-altering emissions, including deforestation and changes in land use; methane and the nitrogen oxides associated with fertilizer use and food production; industrial greenhouse gases; and so-called "black carbon."[23] (See Sidebar 3.) It is quite possible that more thorough analyses of emissions of the full range of greenhouse gases worldwide would narrow the extreme wealth-based gaps so often cited in the population-climate debate.

A thorough monitoring of the sources and life cycles of all greenhouse gas emissions—taking into account their global warming power and atmospheric lifetimes—would tell us much more about population and climate interactions. Researchers are continually filling gaps in inventorying emissions, even to the point of considering the greenhouse gases that enter the atmosphere directly from human bodily functions.[24] (See Sidebar 4.) But we are a long way from having the information needed for a more thorough analysis. The most we can say today, with some quantification, is that achieving a low rather than

a high trajectory of world population growth would reduce future emissions significantly from what they otherwise would be.

Reports from developing-country governments indicate that population matters not only to greenhouse gas emissions, but also to the towering challenge of adapting to the climatic changes that are already under way. Even if climate were not changing, food and energy insecurity, water scarcity, forest loss, the extinction of species, and the decline of fisheries would continue to highlight the influence of population change on natural resources and the environment. Countries that are already grappling with the non-climatic implications of growing populations will find it that much harder to build their resilience against the impacts of current and future climate change.

For many analysts, the main reason to draw attention to these connections is their implications for action. But where does acting on population fit into considerations about what to do about climate change? And what does it mean to "act" on population? Ultimately, there is no effective way to act directly on population—it cannot be controlled because, much as some governments have tried, human beings themselves cannot be controlled. Rather, at United Nations conferences from the late 1960s through the mid-1990s, most governments have insisted that reproduction—the main factor in population growth given generally stable modern life expectancy—is properly the realm of parents and those who would be parents.

In 1994, at the International Conference on Population and Development in Cairo, Egypt, the world's nations agreed that any efforts to influence population change should be based on human rights and gender equality, beginning with the fundamental right of women and couples to determine for themselves when and when not to have a child. This principle is more than an aspiration. The history of the international family planning movement over the last few decades demonstrates that women who can make choices about their lives choose later pregnancies and fewer of them. These global downshifts in fertility and family size have been bending downward the arc of world population growth since 1970, leading to the possibility that continuation of the trend will soon end that growth altogether.[25] (See Figure 2, page 8.)

The relationship of fertility choices to population opens up yet a third aspect of the

Sidebar 4. We Are Carbon

The findings may not say much about population's impact on climate change, but a recent calculation of a "human carbon budget" for the United States at least illustrates the scale of human influence. Based on food consumption data, a group of U.S.-based researchers found that Americans as a group take into their bodies 17.2 million tons of carbon each year, about the weight of 8 million average automobiles.

The U.S. population then expires—mostly in exhaled breath, but also in feces, urine, flatulence, and sweat—15.2 million tons of carbon as carbon dioxide each year. The researchers, led by Tristram West of the Oak Ridge National Laboratory in Tennessee, could not directly account for the other 2 million tons but assumed that most of it made its way into the atmosphere either as CO_2 or methane within a year of being consumed. That amounts to the release of at least 57 million tons of heat-trapping carbon dioxide, about 1.2 percent as much as Americans emit through the combustion of fossil fuels.

Women consume and expire less carbon than men in proportion to their lower average body weight, the study found. Kilo for kilo, however, the sexes do not appear to process carbon differently. "Increases in population and personal body mass result in some small annual increase in (U.S.) carbon stocks," West and his colleagues wrote. They estimated that the actual carbon contained in human bodies weighed 60,000 tons in 1790, when the United States was home to about 4 million people. By 2006, when the U.S. population surpassed 300 million, the country's human carbon mass had grown to 5.4 million tons. The researchers even accounted for the release of carbon from cadavers, either rapidly through cremation or gradually through embalmment and burial.

The findings would offer a novel twist on "human-caused climate change"—except that this human carbon contributes next to nothing to the balance of greenhouse gases in the atmosphere. Essentially, all human food comes originally from plants that absorbed carbon dioxide out of the air while growing, so everything we expire merely offsets this earlier absorption. Nonetheless, the researchers noted, the "impact on the spatial distribution of carbon dioxide uptake and release across regions and continents is significant. Humans are using, storing, and transporting carbon about the Earth's surface. Inclusion of these carbon dynamics in regional carbon budgets can improve our understanding of carbon sources and sinks."

Source: See Endnote 24 for this section.

©IFAD/Louis Dematteis

The Alvarado family pose in front of their home in El Salvador.

climate-population linkage (beyond reducing emissions and adapting to coming climate change) that until recently has gone mostly unexplored: the experience and circumstances of women, and how these relate both to population and to climate change.[26] Slowing the growth of population thus joins a series of justifications (moral and otherwise) for committing political will and financial resources to assuring that half the world's people can fully develop their capacities. Through slowing growth and other benefits, supporting women's efforts to manage their own lives and improving their status will in turn elevate the well-being of all of the world's population—with Earth's climate representing one aspect of this. And the most effective way to do all this is by making sure, to the extent possible, that women and men everywhere realize their own childbearing intentions, including timing, spacing, and number of children.

Half the Sky—Plus

Climate-change skeptics would have a hard time convincing Leucadia Quispe that global warming is a hoax perpetrated by environmental radicals and grant-hungry scientists. In her six decades of life, the Bolivian farmer has watched the Huayna Potosi glacier above her Andean village melt away to a mere patch of summit ice and snow. Nearby Chacaltaya glacier, once home to the world's highest and only tropical ski slope, disappeared entirely in 2009.

Now that the glacier-fed streams no longer course down the mountain slopes, Leucadia rises each morning at 4 a.m. and lugs five-liter containers of water from ever farther away.[1] Meanwhile, most of the men of Leucadia's village and seven of her eight children have scattered to other parts of Bolivia, "because," she says, "there is no way to make a living here." The reasons for such migrations are complex; however, environmental degradation related to climate change is likely a contributing factor—and is expected to play an even greater role in the future.[2] (See Sidebar 5.)

Much of the environmental degradation that many attribute to climate change actually has other roots. Water scarcity often owes more to decades of steadily rising human demands on finite supplies. Soil degradation stems from unsustainable use more often than from temperature jumps or shifts in precipitation. The trend toward greater loss of life and property from natural disasters appears mostly unrelated to climate change—so far—but stems more directly from population growth, which drives people to occupy land that is vulnerable to weather extremes, and from economic growth, which raises property values.[3]

But when glaciers that draped mountain peaks for thousands of years slip away in a decade or two, that is global warming. And often it is women like Leucadia Quispe who feel its sting most sharply. Just as often, it is women who are taking action to improve life for themselves and their families in the face of a changing climate—or who are working directly to keep human-induced climate change at bay.

Ville Miettinen

High and dry: the ski lodge at Chacaltaya glacier, Bolivia.

"Women," an ancient Chinese proverb states, "hold up half the sky." The image takes on new meaning in the context of an atmosphere so overloaded with heat-trapping gases that it threatens human well-being and potentially our future existence. Neither women, gender, nor population are mentioned in any of the treaty language on human-caused climate change—not in the UN Framework Convention on Climate Change, and not in that convention's Kyoto Protocol. Among the ironies of that omission is that women tend to be more affected by the impacts

Sidebar 5. Migrating in a Warming World

The interaction between climate change and migration is topical but poorly understood. To estimate how many people are migrating today because of climate change would imply certainty both about the impacts of current climate change and about what motivates migrants to set out for new homes. Various estimates have been made for the number of people already displaced by environmental changes (which could include the impacts of climate change), with 25 million among the most quoted figures.

Few researchers have probed whether or to what extent migration might influence greenhouse gas emissions. If people find jobs and livelihood abroad, for example, they may contribute more greenhouse gas emissions than if they had remained jobless at home. (A 2008 study by the Center for Immigration Studies estimated that while U.S. immigrants emitted 18 percent less CO_2 on average than native-born Americans, they emitted four times as much in the United States as they would have if they had remained in their home countries.) And the roughly $300 billion that migrant workers send to their home countries each year might also fuel emissions-intensive consumption and development in migrant-sending countries.* But reliable data on these relationships may prove impossible to assemble.

Considerably more work has gone into estimating the likelihood of international migration that might be caused, or at least encouraged, by future impacts of climate change. Based on projected increases in sea level alone, for example, tens of millions of people might need to relocate by the end of the 21st century. The developing world's dozens of populous coastal cities are likely to be most vulnerable, as settlements expand through homegrown population increases as well as through rural-to-urban migration to inexpensive or poorly titled land near the mouths of rivers. In 2006, U.K. economist Nicholas Stern projected that 200 million people would be driven from their homes by 2050 due to environmental change, although this estimate is not limited to the impacts of climate change. (The pace of future population growth logically will influence the eventual number of environmental or climate-related migrants.)

The possibility that such magnitudes of people will be pushed to relocate by the impacts of climate change raises an ethical question for high-emitting populations: Given their greater historical responsibility for human-caused climate change, might wealthier industrialized countries be obligated to accept within their borders at least some of those forced to look for new homes by such obvious impacts of climate change as sea-level rise? Technically, environmental change does not meet international criteria for determining whether someone is a refugee and thus may claim protection in another country. But the skewed balance between those who most cause climate change and those who most feel its impacts may prompt a rethinking of the concept of refuge. Climate-privileged countries may be under pressure to weigh the plights, and the rights, of a whole new category of huddled masses.

Source: See Endnote 2 for this section.

of climate change than men, even while arguably contributing less to the atmospheric overloading. Moreover, the importance of women and the autonomy they exercise may be far greater to the climate's future than most experts and negotiators on climate change—who have been until recently overwhelmingly male—have realized.

The greater vulnerability of the poor to climate change has long been recognized as a fundamental moral problem, the more so because the world's poorest populations tend to be least responsible on a per capita basis for emissions of fossil fuel CO_2 and perhaps most other greenhouse gases. The impacts of climate change are all but certain to exacerbate existing gaps in income and well-being. Among the poor, however, women have problems unique to their reproductive and cultural roles.

In Africa and much of the rest of the developing world, women make up the larger share than men of the agricultural workforce. They are more likely than men to be working domestically rather than in the formal economy, more likely to be collecting wood and carrying water, and much more likely to be caring for children and other family members, making it hard for them to manage or outrun the calamities that climate change brings. These may be floods, storms, or civil conflict stoked by droughts and crop failures. Girls are much more likely than boys to drop out of school to help their mothers. That extends into the future the cycle of deprivation and gender inequality.

* All dollar amounts are expressed in U.S. dollars unless indicated otherwise.

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One of the best examples of women's frequently disproportionate vulnerability comes from a disaster unrelated to climate change: the 2004 Indian Ocean tsunami, which was so deadly it reversed world population growth for a day.[4] Many women died in their homes, surprised by a giant wave that had merely lifted the boats of their fishermen husbands out at sea. Weighted down by heavy clothing, women were more likely than men to drown on shore. Never having learned to swim or to climb trees despite living along wooded coastlines, many girls and women lacked key survival skills that helped their male relatives survive. Women often did not fare much better after the water pulled back to the sea. The social tensions that flared after the catastrophe contributed to sexual violence at unprecedented levels. As often happens following a natural disaster, many relief efforts missed women while reaching men in communities.[5]

The tsunami's impact on women followed patterns that are common to natural disasters from all causes and that are also likely to apply to climate change. Based on data from natural disasters that affected 141 countries from 1981 to 2002, economists Eric Neumayer and Thomas Plümper found that women were more likely than men to die during and after such catastrophes.[6] Moreover, they found, this mortality gender gap was worse when the disaster was more severe and when populations were poorer.

Some of women's greater vulnerability to disaster may relate to basic biology. Many women are pregnant at any given time, for example, and less physically able to escape or survive natural or human threats. On average, women have less upper-body muscular mass than men, putting them at a further disadvantage in such circumstances. But the dominant source of women's higher vulnerability, Neumayer and Plümper concluded, was not biological or physical but social and cultural—"built into everyday socioeconomic patterns" that favor men and provide them with opportunities that women lack or can seize only with effort.[7] While it is hard to say whether any particular storm, flood, drought, or civil conflict is caused or exacerbated by human-induced climate change, it is safe to conclude that social differences will leave women more likely than men to suffer the impacts that occur, absent major change.

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Members of a women's group tend neem seedlings in their nursery, Andhra Pradesh, India.

"Disasters make existing inequalities even worse," Marijke Velzeboer-Salcedo, a gender specialist with the World Health Organization, told the *Washington Post* after the earthquake in Haiti in January 2010. "Those who are stronger and more powerful, whether physically or psychosocially—or both—are going to have better access to scarce resources. But when women are deprived of resources, entire families are likely to be deprived, too."[8]

Yet, despite the barriers thrown in their way, women often defy victimhood and contribute where they can to the resilience of communities and societies. Women farmers in Malawi gather in clubs to share ideas and information on seeds and cultivation techniques that can take advantage of erratic rainfall and eroded soils.[9] Similar women's associations in peri-urban areas of Mali pool resources to gain access to small plots of

Sidebar 6. The Benefits of Family Planning

Even leaving aside its important role in slowing population growth, family planning offers synergistic benefits to women, their families, and the communities in which they live. For women, spacing pregnancies reduces the probability of dying as a result of pregnancy and childbirth. The World Health Organization (WHO) estimates that 100,000 maternal deaths per year, out of a total of about 530,000, could be prevented if all women who want no more children could stop childbearing.

By preventing unwanted pregnancies, family planning also reduces high-risk pregnancies (those associated with the youth, age, or ill health of the mother, for example) and the need for abortion. Some contraceptives also reduce the likelihood of disease transmission and protect against certain cancers.

Family planning saves children's lives as well. Nearly one in ten of the 8.8 million annual deaths of children under five could be prevented merely by providing contraceptive services to couples who seek it, according to the WHO. The probability of infant and child death falls significantly when women give birth no more often than every two years, when they have passed through adolescence, and when they have no more than four children. Adequate birth spacing alone could prevent between a fifth and a third of all deaths of children in some countries in Latin America and North Africa, according to the WHO.

From a family and community perspective, family planning helps reduce the emotional and economic burdens of parenthood, allowing couples to have the timing of childbearing and the family size they want and can afford. This helps assure that families can provide their children adequate food, shelter, health care, and educational opportunities. By allowing women to choose the timing of pregnancy, contraception also frees them to participate more broadly in educational, economic, and social life and hence enhances their contribution to their communities and nations.

Source: See Endnote 23 for this section.

land for gardening.[10] A group of women in Bangladesh, meeting after their chicken coops had been destroyed yet again by rising waters, worked with the humanitarian group CARE to switch operations altogether—to raising ducks.[11]

Beyond adapting to climate change impacts, women help lower CO_2 concentrations in the atmosphere. Farmers (most of whom are women, in Africa and elsewhere in the developing world) "store" carbon through building up the humus content of their soils and by planting trees and sustaining groves and forests. In India, women were the original treehuggers, launching in the early 1970s the Chipko movement that aimed to preserve trees threatened by logging. Later in the decade, Kenyan veterinary anatomist Wangari Maathai founded the Green Belt Movement to mobilize women to reforest degraded land in her country. Studies have since shown that countries in which women's and environmental nongovernmental organizations (NGOs) are active tend to have less deforestation than countries in which such activism is rare or absent.[12]

There are even intriguing hints that women may contribute fewer emissions than men on a per capita basis. Some surveys find that women are more likely to alter their personal behavior for environmental reasons, with men more likely to rely on governments, business, or shifts in technology to solve environmental problems. Various studies have found that women tend to eat less meat in proportion to their body size than men, they travel in cars and airplanes significantly less, and they are more likely to seek out green products. But sample sizes in these studies are small and involve one or at most a few countries. Moreover, it is not clear in cases where women eat less meat or travel less often whether this comes from real behavior differences, or merely financial ones.[13]

"Women are men without money," economist and Nobel laureate Paul Samuelson once said.[14] But whether that is true in consumption and environmental behavior remains to be seen. Few would claim such gender identity in business and policymaking. Research conducted during the recent global economic slowdown suggests that corporations with high proportions of women leaders weathered the downturn better than male-dominated companies, perhaps because their leaders tended to avoid the most dangerous risks and to focus on long-term corporate well-being.[15] In country after country, women are closing the gender gap in education (comprising more than half of college students in the United States, for example) and are taking on occupations that were once the sole province of men—from foot soldiers to beer tasters.[16]

Until recently, the share of female scientists and negotiators working on climate change—in research institutions, at international conferences, and elsewhere—was typically well under 25 percent. But these proportions have grown in recent

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years as women's and environmental organizations have pressed for better gender balance in addressing climate change at national and global levels.[17] For example, Costa Rican climate negotiator Christiana Figueres recently took on the job as executive director of the UN Framework Convention on Climate Change secretariat, the agency responsible for guiding the development of a new global agreement on climate change.[18]

Women's differing perspectives, their work with natural resources, their experience adapting to environmental change, and their disproportionate vulnerability to natural disasters are among the many reasons for dismantling barriers that block their full participation in society and equal standing with men. Women not only hold up half the sky, they contribute more of the hands and minds needed to grapple with a problem—climate change—that it is now too late to fully prevent or solve. It would be foolish to ignore those hands and minds, yet we remain a long way from taking full advantage of women's capacities.

The barriers to women's engagement in climate change are to varying degrees educational, economic, political, and cultural. And, especially for many women of low incomes, they are also reproductive. Bearing and raising a child often exacts a price on other opportunities that women might seize, from running ahead of a tidal wave to running for political office. Having the easy availability of family planning services and being able to choose and use contraceptives appropriate to their circumstances can help woman choose, as men do, among opportunities for self-fulfillment.

As Gloria Feldt, author and former president of the Planned Parenthood Federation of America, puts it, "if a woman can't own her body, including whether and when to give it over to childbearing, she has no power to determine anything else about her life."[19] The IPCC's most recent assessment of climate change implies this relationship between reproductive choice and self-determination in its single mention of reproduction, noting that the "disproportionate amount of the burden endured by women during rehabilitation [from weather-related disasters] has been related to their roles in the reproductive sphere."[20]

But this burden can go well beyond the issue of pregnancy and its frequency. Like men, women have two hands, but in many cases there are more than two other hands reaching out to hold them. Women comprise 100 percent of the world's childbearers, and they are also overwhelmingly the care providers for the 27 percent of humanity under the age of 15.[21] Women's mobility and options are often undermined by the caretaking burdens of large families—families grown large not because of women's own childbearing aspirations or intentions, but because of a lack of access to reproduc-

Figure 6. Average Births per Woman and Contraceptive Prevalence, 173 Countries, 1995–2002

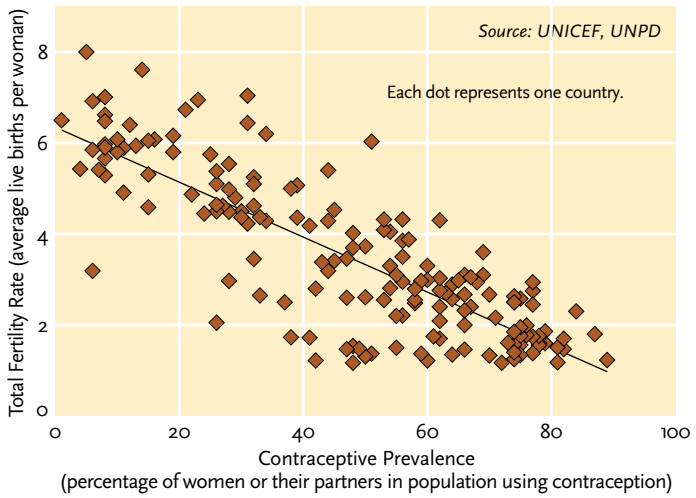


Figure 7. Average Number of Children per Woman by Completed Education Level Worldwide

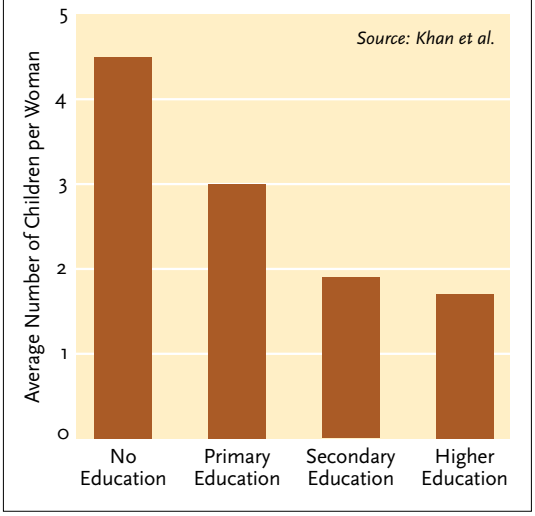
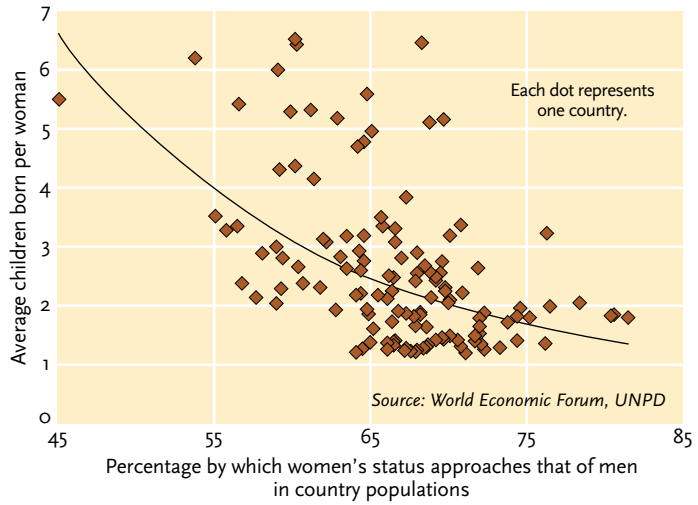


Figure 8. Correlation Between Status of Women and National Fertility Rates



tive health and family planning services.

Today, an estimated 215 million women want to avoid pregnancy but are not using effective contraception.[22] Yet the last four decades of family planning experience document that when women and their partners can use these services in confidence and good health, they have children later in life, and fewer of them. When easy access to contraceptive options combines with schooling for girls and relative equality with men, the correlation with small family size is especially powerful—and at the same time, the health of women and their children improves.[23] (See Sidebar 6, page 18, and Figures 6, 7, and 8.)

Put simply, what is good for women is also good for fertility decline and for slowing population growth. And that, in turn, is good for slowing and adapting to human-caused climate change. The importance of this three-way connection between women, population change, and climate change is vital to the future of sustainable emissions. And it is just as vital to societies' adaptability to the rapid human-caused change that is now only beginning to make itself known.

Sustainable Emissions

In a story told by U.S. President John F. Kennedy, a man asks his gardener to plant a tree. But the gardener objects, saying that the tree is slow-growing and won't mature for 100 years. "In that case there is no time to lose," the man replies. "Plant it this afternoon."[1]

Population is a bit like the tree, and attitudes about gradual population growth are often like that of the gardener about the tree. Expansion in human numbers plays a minor role in most environmental problems from one year to the next, but a large role over decades and centuries. In one sense, the world's population today has already grown so large that balancing global economic prosperity with a stable climate and environment seems next to impossible. In another sense, with humanity expanding by 79 million people per year and with the world's poor justifiably reaching for the comforts that the rich take for granted, there is no time to lose.[2]

What is needed immediately is global action to slash greenhouse gas emissions as quickly as possible. Only a swift worldwide transition to low-carbon technologies, hyper-efficient energy use, and the movement of carbon from the atmosphere into trees and soils could halt and then reverse the growth of emissions and concentrations any time soon. Even if we could hold current atmospheric concentrations steady, with carbon dioxide now at 385 parts per million (ppm) compared to 280 ppm in 1750, Earth's average surface temperature could surpass a cumulative increase of 2 degrees Celsius above the pre-industrial average—a level that scientists see as a potential tipping point for climate catastrophe.[3]

Climate negotiators assume that no feasible change in demographic direction is likely to play much of a role in addressing this challenge. Population, however, does occasionally emerge in climate discussions. Before the 2009 UN climate conference in Copenhagen, Denmark, the European Union tabled a proposal suggesting that population trends be considered among the characteristics used to determine a country's emissions reduction targets. Turkey, a developing country, tabled a comparable proposal.[4] Australia's prime minister defended a carbon-cutting proposal, which some criticized as unambitious, by noting that the commitments made would outpace those ventured by European governments on a per capita basis when Australia's more rapid population growth was taken into account.[5] And China has at various conferences boasted that its one-child population policy has spared the world hundreds of millions of tons of carbon in the atmosphere.[6] (See Sidebar 7.)

Mark Forman

An only child in China.

Sidebar 7. China's Population Policy and Climate

The government of just one country—China—seems willing to talk about population as an important factor in climate change. But what it says proves awkward even for the many non-Chinese who believe that the linkage is important.

China's vast population and surging economy have led in recent years to the world's highest national emissions of carbon dioxide from fossil fuel burning. On a per capita basis, however, each of China's 1.3 billion people emits far less than Americans and Europeans do. Chinese officials frequently call attention to this per capita emissions gap in climate negotiations. They sometimes go further, claiming that their own national population policy has spared the world massive greenhouse gas emissions that otherwise would have occurred. The slowing of China's population growth from 1978 to 2007 "converts into a reduction of 1.83 billion tons of carbon dioxide emission in China per annum at present," Zhao Baige, vice minister of China's National Population and Family Planning Commission, told reporters at the Copenhagen climate conference in December 2009.

The country's current population policy, instituted in 1979, calls on most Chinese couples to limit their reproduction to a single child. In practical terms, exceptions to this rule and the option of paying a fine for an additional birth mean that the policy is not really the "one-child policy" it is commonly called. The policy is nonetheless seen elsewhere in the world as coercive and a violation of the principle that parents, rather than governments, should decide the size of families.

Does a coercive population policy thus save the world greenhouse gas emissions? There is no question that the growth rate of the Chinese population slowed between the institution of the policy and today, falling from roughly 1.5 percent a year in the late 1970s to 0.6 percent today. In that sense, Zhao Baige's calculation appears to be a straight calculation based on an estimated 400 million births that would have occurred had the earlier growth rate remained steady, multiplied by a 2007 Chinese per capita fossil fuel CO_2 emission of about 4.6 tons per person. (International estimates are somewhat higher and have climbed considerably just in the last three years.)

But a closer look raises questions about how much credit the "one-child" policy can claim for the reduction in population growth. China's fertility decline has been unexceptional given the experience of other developing countries, especially in Asia. With an average of nearly six children per woman in the late 1960s, China's average family size declined to less than three by the late 1970s—before the one-child policy was instituted. It has since fallen to below 1.8 children per woman (demographers dispute the precise current level), but it is still not clear that the government's policy is the only or even the primary cause of this further decline. Both Taiwan and Hong Kong, with their own ethnic Chinese populations, achieved nearly one-child fertility rates without a coercive policy—although it helps that neither has anything like China's proportion of rural and indigenous populations.

When asked, during a 2010 visit to Washington, D.C., to name the major cause of China's recent fertility decline, several members of the country's National Population and Family Planning Commission agreed on the answer: "social change for women more than the government's policy." Where restrictions on family size have been eased in recent years, fertility increases have been modest at best, suggesting that there is little pent-up demand by couples for more births than the government permits. No doubt a variety of factors are at work in the slowdown of China's population growth since 1979. But both Chinese and non-Chinese demographers who analyze China's fertility tend to agree that it is unlikely that Chinese women would still be bearing an average of three children each had the country's government never instituted a restrictive population policy.

Source: See Endnote 6 for this section.

Such mentions of population's role in climate-altering emissions sometimes make news, but they do not make policy—or even policy debate. Even when policymakers are discussing their own countries' populations, the overall topic evokes blame of others—particularly of high-fertility groups or of women—and suggests an argument that "population control" is a needed remedy for climate change. Analysts in low-emitting nations often point to studies such as one by the World Resources Institute that indicates that between 1850 and 2002, countries that we now call "developed" (and that now have relatively low fertility) contributed 76 percent of cumulative fossil fuel CO_2 emissions.[7] Analysts in high-emitting nations note that greenhouse gas emissions in developing countries, many with still-high fertility, overtook those of developed countries in 2005 and now make up 54 percent of the total.[8]

In arguing that population matters to climate,

then, it is important to be precise about claims. In this case, the claims are twofold:

Humanity ultimately will need to end the long growth of greenhouse gas concentrations while preserving a reasonable amount of "atmospheric" or "carbon" space to which all humans logically have an equal right. Future human societies will find it much easier to maintain emissions at levels that are both equitable and climate-sustainable under lower scenarios of world population size. In the shorter term, achieving a feasible lower path of population growth than the one demographers currently expect could mean a savings in annual emissions by mid-century comparable to those that would stem from major shifts toward low-carbon energy. Although researchers have explored less rigorously the connection of population growth to climate change adaptation and resilience, it is safe to assume that there would be substantial benefits in this area as well.

The only acceptable way to slow global population growth is as an outcome of improving the well-being of women worldwide. At UN conferences dating back to 1968, the world's nations have agreed that women and their partners have the sole right to determine the number and spacing of pregnancies and family size. As women and men have gained access to contraception, family size has fallen by nearly 50 percent worldwide since the early 1960s, and population growth has slowed proportionally. It is a social revolution that remains incomplete, however, with an estimated two in five pregnancies worldwide still unintended.[9] What is needed today is much more effort to make sure that women and their partners can choose from a full range of options in life, including whether and when to have a child—along with vigilance to assure that coercion plays no part in that decision.

Either of these two claims—that population matters importantly to the magnitude of future emissions, and that assuring that women can determine the timing and frequency of their childbearing is the only basis for influencing global population growth—is of course subject to debate. But accepting the second claim makes it easier to accept the reasoning behind the first.

The fact that some populations emit much more fossil fuel CO_2 than others on a per capita basis argues for international agreements that take these differences into account and that promote emissions "convergence" at the low levels that climate stability will require.[10] (See Sidebar 8.) British economist Nicholas Stern estimated in 2008 that "global average per capita emissions… will—as a matter of basic arithmetic—need to be around two tons [of CO_2-equivalent] by 2050," based on a projected world population of about 9 billion.[11] A major challenge to generating public excitement about this idea, however, is that current global emissions exceed that number in every major region—from about three tons per person in South Asia to 26 tons in the United States and Canada—and average about eight tons worldwide.[12]

Stern's "basic arithmetic" would be altered, however, if world population never reached 9 billion people in 2050 but leveled off before then at 8 billion. In that case, the needed sustainable global per capita emission could be 2.25 tons—still less than the lowest-emitting region today, but with an extra margin that could make a difference. Then imagine if world population drifted down from 8 billion people in this low population scenario—or, alternatively, continued to grow past 9 billion in the high one. These are in fact the most recent low- and medium-variant population projections of the UN Population Division, which revises global estimates and projections every two years.[13] Under the low scenario, Stern's needed global per capita emission would actually grow larger, and hence easier to sustain. Under the low-growth scenario, the needed per capita emission would continue to shrink to ever less reasonable levels.

The exercise of imagining per capita emissions that converge under different population scenarios has the advantage of showing how important world population size would be in a climate regime that might eventually win the support of low-emitting nations. In that sense, it may be more promising and less contentious than the more common approach to calculating population-growth impacts on emissions growth based on the Kaya identity described earlier. Research work based on the Kaya identity nonetheless has been consistent for nearly two decades in finding

Sidebar 8. Population and Climate Equity

Even before conferees at the 1992 Earth Summit in Rio de Janeiro signed the UN Framework Convention on Climate Change, some analysts began making the case that global action to slow climate change should be based on equalizing per capita emissions. These are the actual emissions for which each human being is responsible. The alternative route, the one that the world's nations have been debating ever since, is to shrink national emissions totals by agreed-on percentages from a base year such as 1990.

Despite the political momentum behind adjustments in national emissions, the ethical and practical logic behind a focus on per capita emissions is strong. Even the politics make some sense. What low-emitting country, after all, would agree to a limit on its overall emissions that would cap its citizens' individual ones at lower levels than those of high-emitting countries?

The reality of current climate politics, however, makes any framework based on per capita emissions all but unthinkable. Some influential developing countries are nonetheless raising their voices on behalf of the concept. Meeting on climate change in Rio in July 2010, ministers of China, India, Brazil, and South Africa issued a statement saying that "a global goal for emission reductions should be preceded by the definition of a paradigm for equitable burden sharing," and argued that "equitable access to carbon space must be considered in the context of sustainable development, the right to which is at the heart of [a future] climate change regime."

Industrialized-country leaders such as Angela Merkel, chancellor of Germany, and John Prescott, former deputy prime minister of the United Kingdom, also have endorsed the principle of aiming for global equity in per capita emissions. A future global climate agreement might, for example, include a uniform global price applied to greenhouse gas emissions, based on their global warming power in comparison to carbon dioxide—with an equal value applied to equivalent amounts of CO_2 removed from the atmosphere and sequestered securely for long periods of time. Such a sequestration benefit could be a source of income for farmers and foresters, many of them women, who integrate carbon into farm soils and long-lived trees. While a globally uniform carbon price might seem at first glance unfair to the world's poor, the unfairness could be turned into a net benefit by paying out individual dividends drawn from the emissions revenue.

Ultra-low emitters might receive further compensation from a global climate mitigation fund in proportion to the amount their per capita emissions are below climate-sustainable levels. Such a fund would be financed by payments from higher emitters levied in proportion to the amount their emissions exceed the threshold. Both groups would thus have financial incentives to reduce their emissions, with full freedom to improve their well-being with a mix of emissions of their choosing. The result would be a global transfer of wealth, anathema to many people, but one that the wealthy could limit personally by reducing their greenhouse-related consumption. And no wealthy person could claim an immutable right to any greater consumption level than the world's average. A separate climate adaptation fund might be funded proportionally based on historic emissions of long-time high emitters.

"The populations of the industrialized countries do not have a natural right to per-capita emissions many times greater than those of the developing countries," note the authors of a proposal by the German Advisory Group on Global Change, a group of research scientists advising the German government. Their proposal, published just before the Copenhagen climate conference, would allocate country-level emissions from 2010 to 2050 based on a uniform annual per capita emission for everyone in the world—initially 2.7 tons of CO_2 but shrinking to 1 ton by mid-century. As higher-emitting countries exhausted their allocation, they would have to purchase emissions rights from lower-emitting countries, promoting an approach to low and equalized per capita emission by 2050.

The advisory group's proposal contained a conceptual landmine for reproductive rights, however. Countries' allocations of emissions rights would be based on their population size in 2010 and would not be adjusted for population change after that. To adjust the allocation, the group reasoned, could tempt governments to increase their allocations by encouraging their populations to grow. By freezing the allocations, however, the proposal could encourage anxious governments to try coercive means to keep precious per capita allocations from shrinking disproportionately in fast-growing populations.

Finding a path that respects reproductive rights between these opposite population-control incentives could become yet another future challenge in drafting an equitable and enduring climate change mitigation agreement.

Source: See Endnote 11 for this section.

that lower trajectories of population growth powerfully depress future greenhouse gas emissions.

In 1992, demographer John Bongaarts calculated that the growth of global population would account for 35 percent of all growth in CO_2 emissions between 1985 and 2100, and that the growth in developing-country populations would account for 48 percent of emissions growth in these countries.[14] World Bank economist Nancy Birdsall in the same year looked at shorter time periods and considered what emissions savings could be achieved by "feasible" reductions in population growth. She calculated savings in fossil fuel CO_2 emissions of 10 percent by 2050 and savings in deforestation CO_2 emissions of 6 percent by 2037.

Ten years later, energy specialist Jeffrey Skeer refined Birdsall's approach by defining "feasible" reductions in population growth as those that would result from the prevention of unintended births. If this prevention resulted in a global fertility rate of 2.1 children per woman, Skeer calculated, the resulting lower population growth would save about 1.8 billion tons of fossil-fuel CO_2 emissions per year in 2050, compared to the then-current UN medium-variant population projection. Moreover, since the gap between Skeer's low population projection and the UN's medium one would grow with time, these annual emissions savings (which assumed no technology or consumption changes) would quadruple by 2150, eliminating 7.3 billion tons of fossil fuel CO_2 per year.[15]

Varied analyses in more recent years have produced comparable results. Researchers with Oregon State University reversed the lens of averted future emissions and calculated the "carbon legacy" of today's average U.S. mother by projecting the fossil fuel CO_2 emissions of her expected descendents under current demographic trends, holding projected individual emissions rates steady. The researchers calculated this legacy to be nearly six times higher per childbirth than for a woman's own lifetime emissions.[16] Pursuing similar reasoning, a study commissioned by the U.K. NGO Optimum Population Trust found family planning "more cost-effective than most low-carbon technologies" in mitigating CO_2 emissions between 2010 and 2050.[17]

Most of these analyses have proved unconvincing to climate experts because the analyses use calculations and models that are less sophisticated and interactive than those on which climate scientists tend to rely for their own scenarios of emissions. A more ambitious long-term study, published in the *Proceedings of the National Academy of Sciences* in October 2010, used an "integrated assessment model" to consider ways in which population changes might affect other influences on emissions change, such as economic growth.[18] The half-dozen researchers, representing U.S. and European organizations, took as their baseline the emissions scenarios published by the IPCC in 2000 and considered how these might fare under a variety of long-range population projections. The study considered the impacts on emissions to 2100 not just of population growth, but also of two other key demographic variables: population aging and urbanization.[19] (See Sidebar 9.)

Jenny Erickson

A hybrid in his future? Driver's ed in the United States.

The researchers found that the UN's low population growth path would yield significant emissions savings over the coming century in comparison to the medium, and most often cited, growth path. By 2050, annual fossil fuel CO_2 emissions would total 5.1 billion tons less globally in the low path than the medium, while by the century's end they would be 18.7 billion tons lower. (The researchers also found that population aging, a nearly inevitable outcome of fertil-

Sidebar 9. Other Population Dynamics: Aging and Urbanization

In addition to population growth, two other types of population change enter into the population-climate debate (although arguably with less import): population aging and urbanization.

Aging, the gradual rise in the average age of a population due to lengthening life expectancy and lower birth rates, may slightly reduce per capita emissions, at least based on studies in the United States, India, and China. This is because older people consume less than the young, are less likely to commute and travel, and contribute less to rapid economic growth. Older populations have relatively fewer people in their prime earning years, presumably thus dampening overall national economic productivity.

Some aging populations—such as those of Japan and several eastern European countries—are also characterized by a net decline in numbers. These are among the few countries for which the International Energy Agency projects lower greenhouse gas emissions in 2030 than in 2008. Amid high governmental concern about the economic and social challenges of population decline in such countries, one benefit is that any future national commitments to reduce emissions will be easier to honor.

Urbanization, in contrast, may contribute to per capita emissions increases, even though concentrating people in cities generally makes travel and transport more efficient and less likely to lead to high emissions per individual resident. However, urban labor forces, such as the young generally, are engines of economic growth within a country. While strong economies and high greenhouse gas emissions remained linked, population changes that contribute to economic growth contribute to higher emissions through that mechanism, and vice versa.

Both aging and urbanization are necessarily self-limiting. Any population with a truly old median age would eventually shrink to non-existence through too little reproduction. And urbanization can only proceed until entire populations live in cities. In reality, both demographic processes will slow long before such limits are in view. Absent environmental and social constraints, however, the potential of population growth to boost greenhouse gas emissions would face no limits at all.

Source: See Endnote 20 for this section.

ity decline as well as longer life expectancy, could account for up to a 20 percent reduction in emissions, chiefly by reducing the supply and productivity of labor and, all else equal, thus hampering economic growth and its attendant emissions in some regions.)[20]

For comparison, the sum total of annual fossil fuel CO_2 emissions in the world today is about 23 billion tons. Annual emissions savings today would be just short of 4 billion tons of CO_2 if deforestation were eliminated globally or if the fuel efficiency of 2 billion cars were doubled from 13 kilometers per liter of gasoline to 26.[21] This comparison does not imply that acting on population growth is an alternative to ending deforestation or improving energy efficiency to cut CO_2 emissions. It does, however, support the claim that slowing population growth is one of a number of promising actions for mitigating climate change. Best, of course, would be to apply as full a range of such options as are feasible and consistent with human rights—especially those that offer multiple benefits beyond slowing climate change.

A related study from the Center for Global Development found that the costs of family planning and girls' educations efforts needed to achieve the population-related savings projected in the 2010 U.S.-European study were on the low end of the range of projected costs for mitigating greenhouse gas emissions.[22] Similarly, a study from the Washington, D.C.-based Futures Group concluded that simply meeting the needs of reproductive-age couples for contraception in most of the world's countries would bring population close to the UN low population projection by 2050.[23] The population comparison is inexact because the Futures Group and U.S.-European studies involve a different selection of countries. But the former's findings suggest that the low population projection could be achieved simply by helping couples achieve their own reproductive intentions.

The results of these and similar studies are unsurprising, given their reliance on the basics of the well-accepted Kaya identity and the logic that a future with fewer people will be one with lower greenhouse gas emissions, all else equal. But just as unsurprisingly, the research findings elicit discomfort even among advocates for expanded reproductive health and family planning. Although most of the researchers involved try to be careful in their language, the findings themselves seem to imply that averting future births is somehow a "solution" to the problem of human-caused climate change, or at least a preferred alternative to reducing consumption or shifting to low-carbon technologies. Those who object to the claim that a less populous world will have

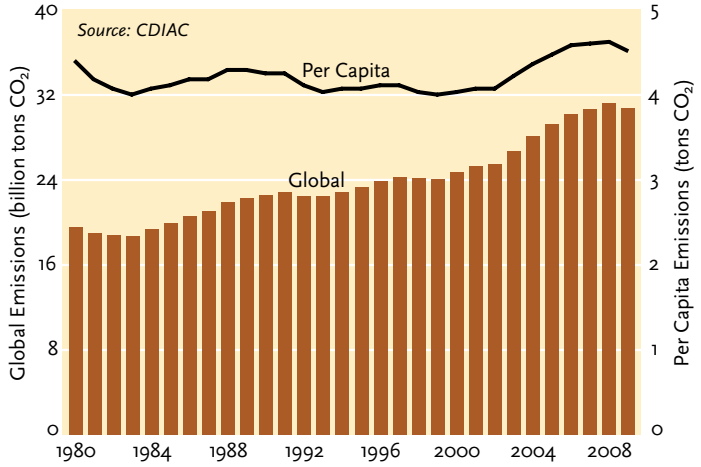
lower emissions tend to argue that consumption is the more important climate change force, given that rapidly growing populations currently have far lower per capita emissions than slowly growing or declining populations.[24]

But countries with rapid population growth today may experience slow or no population growth in the future. At that time, however, they will have a larger population and, as likely as not, higher per capita emissions than now. This sequence has replayed throughout recent history, first in industrialized countries and more recently in China. Moreover, the gap in per capita emissions has shrunk significantly in recent years—declining in wealthy industrialized countries (whether due to the economic slowdown in these countries or longer-lasting fundamentals, or both) while rising in many developing ones, notably the huge (and still growing) populations and dynamic economies of India and China. In 2009, CO_2 emissions fell 7 percent in Russia and among the developed countries of the Organisation for Economic Co-operation and Development (OECD). But they rose 9 percent in China and 6 percent in India, with more modest increases in other developing countries, effectively canceling out the emissions decline in the industrialized world.[25]

Such countervailing trends may have contributed to the relative stability of global per capita fossil fuel CO_2 emissions since the late 1970s. These per capita averages actually declined slightly from 1980 until 2002 while total global emissions grew, feeding perceptions that global population growth was the major factor in global emissions growth over the long term. Since 2003, however, global per capita emissions have risen to the highest levels ever recorded—a useful reminder that individual consumption and global population are always working together to influence the emissions total.[26] (See Figure 9.) Global averages also obscure more complex dynamics among nations and subpopulations, and to the extent that these can be unraveled, the role of population growth is often found to be more nuanced than initially thought.

Nonetheless, there seems no reason to doubt the consistent research finding that slowing the growth of world population would significantly slow the growth of future global emissions of most greenhouse gases. Achieving the UN's low population growth trajectory, in comparison to its medium one, could be expected under most economic scenarios—as the October 2010 study suggests—to lead to a similar magnitude of emissions reductions. It would serve as one or more of the "stabilization wedges" proposed by Princeton University scholars Stephen Pacala and Robert Socolow to be used collectively to avoid a doubling of CO_2 concentrations from their preindustrial levels.[27]

Figure 9. Global and Per Capita Emissions of Fossil Fuel and Cement Carbon Dioxide, 1980–2009



Each of these wedges acts like the slow-growing tree in the story of the man and his gardener. The energy-related technologies that Pacala and Socolow describe, however, would stop yielding emissions-savings dividends after the mid-century benchmarks were achieved. New "stabilization wedges" would then need to be invented and applied. Population that declines gradually after the middle of the century, rather than growing into the indefinite future, as the UN medium projection does, could yield emissions savings that would increase indefinitely.

Another way to visualize this is to imagine what would have happened if contraception had never become as popular as it is today, its use having grown by more than 75 percent per decade since the 1960s.[28] Had fertility remained at an average of five children worldwide per woman (its level in the early 1960s,

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instead of falling to half that average today), world population by now would be approaching 9 billion, the number many demographers now foresee for mid-century.[29] Whatever the precise links between population and climate, we would be much closer to key climate tipping points—or already well past them—under those circumstances.

The relationship between population and greenhouse gas emissions would be less sensitive and easier to see if the world's governments could arrive at an approach to emissions reductions that recognized equal per capita rights to emit and that aimed at a global convergence of actual per capita emissions at sustainably low levels. At some point, when the world's nations take seriously the need to cap global greenhouse gas emissions and then bring them down equitably toward negligible net levels, the role that population growth plays in limiting individual emissions will become much more obvious.

Given the hardened stances of national governments that now block an effective global climate agreement, however, it may be more immediately practical to work for a better public and policymaker understanding of how population growth slows most effectively—that is, through expansion of opportunities for women and a steady increase in the proportion of births that result from their active intention to have a child.

Thriving Amid Change

The months surrounding the 2009 Copenhagen climate conference witnessed a spate of reports, news articles, and Web commentaries on population as a "forgotten factor" in human-caused climate. "When It Comes to Pollution, Less (Kids) May Be More," the *Washington Post* headlined in September 2009.[1] "Climate Change: Calling Planet Birth," the (London) *Guardian* offered five months later.[2] In November 2009, the Associated Press, *Wall Street Journal*, BBC radio, National Public Radio, and other news outlets reported or commented on a UN Population Fund report that traced connections between women, population, and human-caused changes in the global climate.[3]

Perhaps more surprising than the news coverage itself, women columnists from Ellen Goodman in the *Boston Globe* to Kavita Ramdas, writing for the Inter Press Service, accepted the link between childbearing and climate as valid and important. "What if we can lighten the burden on the planet while widening the chances for women?" Goodman asked. "That's my kind of [carbon] offset."[4] Ramdas, president of the Global Fund for Women, agreed with Goodman's offset metaphor, adding that "when girls and women have greater access to...not just the 3 R's...but also the 3 C's—courage, contraception, and choice—their improved health leads to positive community outcomes, including economic growth and sustainable development."[5]

The scientific case that population growth matters to global emissions of heat-trapping gases is well established in the Kaya identity, the work of the IPCC, and a consistent trail of findings over the past two decades. Statements like those of Goodman and Ramdas show that prominent women's voices can lift not only in acknowledgment of the scientific reality, but also in support of policies that link it to women's well-being. This sentiment is still far from universal, however. Some of the (mostly male) delegates at the Copenhagen climate conference were quick to reject family planning as relevant to climate change, while some writers and advocates on gender and women's issues suspect that efforts to link the two disguise agendas designed to undermine the interests of women or developing countries or both.[6]

Yet another element to the population-climate connection emerged in 2009 with the finding that the vast majority of least-developed nations reporting to the United Nations on climate change adaptation strategies specified population growth, density, or pressure as a leading constraint. It was hard for low-income nations to manage the impacts of climate change, according to the environmental ministries that produced these reports, given the challenges that governments face in accommodating large and growing populations. This unexpected mention of population by developing-country governments suggested a less controversial approach to its connection with climate change, as an issue related to the resilience of nations rather than a strategy to reduce greenhouse gas emissions.[7]

And indeed this approach may have facilitated early stirrings of governmental action on the connections between population growth, the lives of women, and climate change. At the climate conference in Copenhagen, for example, the government of Denmark announced a contribution equivalent to US$5.9 million to UNFPA's efforts to provide family planning and reproductive health services in emergency settings. "Population growth puts tremendous pressure on a sus-

tainable management of natural resources, which indicates an indirect link between climate change and women's sexual and reproductive health and rights," noted Ulla Tørnæs, minister of development cooperation, in announcing the move.[8]

In the United States, the Senate Appropriations Committee early in 2009 approved legislative language directing that international family planning assistance be allocated to "areas where population growth threatens biodiversity or endangered species or exacerbates human vulnerability to the effects of climate change."[9] Several months later, 77 members of the House of Representatives called on the leadership of the House Appropriations Committee to boost spending levels for international family planning assistance, based in part on the argument that "family planning and reproductive health should be part of larger strategies for climate change mitigation and adaptation. Slower population growth will make reductions in global greenhouse emissions easier to achieve, and reduce the scale of human vulnerability to the effects of climate change. Further, integrated models of population, health and environment activities can be applied to climate change adaptation and to efforts to increase the resilience of local communities to climate change."[10]

Anita Khemka/USAID

An urban health worker in India monitors childrens' and womens' health, and provides contraceptives.

The impacts of population growth on resilience and adaptability are hardly limited to developing countries, although the link has gone mostly unexplored in industrialized ones. One finding is unsurprising and yet may stand for much broader connections: population growth is lengthening the time it takes to escape from severe hurricanes, at least in four Florida counties in the St. Petersburg area that funded research on hurricane evacuation times. The study concluded that it would take two and a half days for all residents to flee a major hurricane in 2010, more than five hours longer than the same process would have required in 2006. A major reason for the longer escape time, the study concluded, was the population growth that occurred in the area between the two study years.[11]

The idea that slowing the rise of population growth can boost social resilience to climate change of all kinds is consistent with research literature that for two decades has explored the effects of population growth on a wide range of environmental and natural resource issues well beyond climate change. Indeed, one of the most obvious but rarely expressed aspects of the population-climate linkage is that the impacts of human numbers are cross-cutting. The same individual whose activities cause emissions of carbon dioxide and methane into the air also uses water, occupies a dwelling that covers land, and consumes a range of goods that produce environmental impacts throughout their life cycle. All of these human activities can deplete or degrade water supplies, biological diversity, forests, fisheries, and soils.

These other interactions have impacts that undermine the healthy functioning of nature and human well-being regardless of whether the planet's climate changes. A landmark study in 2009 of Earth's nine most critical physical and biological systems concluded that human activities have already exceeded safe "planetary boundaries" in three of them: climate change, biodiversity, and the cycling of nitrogen between Earth's surface and atmosphere. These are global systems, but it is not hard to see how population growth can weaken the resilience of countries to the impacts of climate change by contributing to local and regional scarcities of fresh water, overuse of farm soils, or the spread of substandard housing on land vulnerable to earthquakes and

other natural disasters.

Lack of water, in particular, is sometimes assumed to be the product of climate change in places where it would be occurring even with little change in temperature or rainfall. Recent studies of both sub-Saharan Africa and the southeastern United States concluded that population growth itself was the more likely cause of drought and water scarcity in the two regions than climate change.[12]

These are precisely the kinds of impacts mentioned in least-developing country reports to the UN on adaptation to climate change, but in reality they represent constraints to development whether the climate changes or not. In both industrialized and rapidly developing countries, the growth of population acts as a spur to sprawl, more costly housing, snarled vehicular traffic, and the loss of wetlands and other nature-dominated expanses. These become not only barriers to climate change adaptations but impediments to economic growth, to functioning ecosystems, and to human well-being. The public's current attention to the hazards of climate change may remind us that the 79 million people that humanity gains each year push us further toward a potentially catastrophic future warming. But a more holistic and realistic view would include the continual interplay between growing consumption and population as a long-term and expanding risk to many aspects of human interaction with the natural systems on which our well-being depends.

There is a natural tendency in analyzing such problems to see them as conflicts between the powerful and the weak, whether as corporations against consumers, men against women, or (particularly in climate change) industrialized countries against developing countries. There are certainly aspects of humanity's environmental dilemmas that fit such narratives well and satisfy our tendency to sort the world's complexities in terms of good and evil. The growth of our own numbers fits awkwardly if at all into such stories. We take it for granted in the background of our lives, and it stems from a process hard to see as problematic: more births of new people than deaths of existing ones, the long-term result of more than two children per woman surviving to their own parenthood. The populations of almost all countries are growing, and stable or declining populations grew for centuries in the past and only recently reversed course.

Even those analysts who argue that consumption is the more important climate linkage often mention growth in the number of consumers, which itself has everything to do with population.[13] Today, after decades of globalization amid economic growth, most of humanity has entered the "consumer society." Not all, of course. But even those whom we cannot call consumers—the 1.4 billion people who live on less than $1.25 a day (based on 2005 data)—are greenhouse gas emitters, albeit on individual scales that may scarcely register next to the per capita emissions among wealthy populations.[14]

The emissions of the poor in all likelihood will need to grow for development to proceed, but later in the century all per capita emissions will need to converge at levels lower than even the lowest of the regional averages on the planet today. How populous the world is at the end of the century will largely determine just how low these "leveled" per capita emissions will need to shrink to sustain a climate with which humanity can live in the 22nd century and beyond. In ways that the least-developed countries' UN reports on climate change adaptation point to, future population size will also influence the resilience of all countries to the impacts of climate change.

The influence of population dynamics in climate change thus emerges not as an "us-against-them" problem but squarely as an "us" problem, characterized in part by the number of *us*. Realizing this can lead to strategies that respond not to fear but to hope, not to blame but to the development of human capacities and the elevation of human dignity.

What might that look like? In dealing with human numbers, the first and most important realization is that they are fundamentally "out of control"—and there is no way to change that and no reason to try. Confusion on this point is perhaps the major reason that policymakers steer clear of population when addressing issues as important as climate change or human development itself. This confusion was clear in a 2009 U.K. paper proposing a new approach

for addressing climate change: "For reasons of political feasibility as well as of efficiency [our strategy] focuses on energy intensity and carbon intensity and not on population and wealth," wrote a group of mostly British academics proposing global climate policies. "Population control policies are always politically explosive and so too would be attempts to reduce general wealth or to curb wealth creation."[15]

Leaving aside the issue of reducing wealth, it makes sense to examine the concept of "population control policies." Outside of China and perhaps Vietnam, there really are none existing or contemplated—and with good reason. At the UN International Conference on Population and Development in 1994 in Cairo, almost all the world's governments agreed to a new paradigm on population based not on control but on returning control over reproduction to women and their partners. Unfortunately for the climate debate and countless others, few outside the small circle of people who work on these issues have learned about the paradigm or absorbed the importance of the historic shift.

In Cairo, governments rejected the idea of population growth reduction targets and embraced in their place commitments to improve the reproductive health of populations, to promote women's autonomy and well-being, and to respect reproductive rights. Women and their partners, not governments or anyone else, thus choose whether, when, and how often to have a child. Governments have a different role to play: making sure that family planning services of reasonable quality are available to all who seek them and helping to empower women so that they have the knowledge, education, livelihood, and personal autonomy to direct their own lives, including their reproduction.

This is anything but a feel-good alternative to actually acting on population growth. It is itself action on population growth. The use of effective contraception has exploded, and fertility has fallen by half, since the international family planning movement first gained the backing of some governments in the 1950s. And these outcomes have not resulted from coercive programs, although examples of coercion indeed have tarnished the history of national population policies. Rather, they are part of an unheralded social revolution, the spread of more options for women, and the popularity of personal management of the timing of childbearing.

In every country where a range of contraceptive options exists for all women and their partners—plus the option of safe and legal abortion for when contraception fails, as it sometimes does—women have on average roughly two children or fewer.[16] Nearly half of the world's population now lives in countries where such fertility rates are the norm.[17] And, absent net immigration, these rates ultimately lead to population stability or shrinkage.

This is not to suggest that all women want to have small families. Population dynamics are not based on such extreme and often-mentioned examples as single California mother Nadya Suleman, whose octuplets resulted from in-vitro fertilization, or Jim Bob and Michelle Duggar of Arkansas, whose 19 children have made them U.S. television celebrities.[18] Population dynamics are the collective product of demographic averages, which include wide variations in fertility. In most industrialized countries and more than a few developing ones, many women reach the end of their reproductive age having given birth to no children or just one. (The figure in the United States is nearly one in five women.[19]) That leaves demographic room even in a replacement-fertility population for many women who bear more than two children.

Nor is fertility an issue of wealthy countries versus poor ones. Despite the availability of sophisticated health services in industrialized countries, in 2008 an estimated 47 percent of pregnancies were unintended in the developed world, compared to 40 percent in developing countries.[20] Nearly half of unintended pregnancies end in abortion. Even so, if all births resulted from a conscious intention to raise a child to adulthood, global fertility rates (now slightly more than 2.5 children per woman) would almost certainly shrink below replacement fertility levels worldwide. This, in turn, would end and then reverse world population growth, although with no further fertility reductions the process would require several decades.[21]

There are many barriers to a world in which

all births resulted from intentions to parent. Among them is the opposition of many influential religious leaders to reproductive autonomy for women. This religious opposition is a subset of cultural momentum from earlier eras, when population growth seemed adaptive in a difficult and uncertain world. Bringing population into the debate on climate change may, in fact, be one way to help cultures catch up with the reality that it is now the scale of human activity, more than any natural force, that jeopardizes our well-being and survival.

In the first decade of the 21st century, the fertility levels of many developing countries stopped falling, as they had been in the late 20th century.[22] The reasons for this are unclear, but it may be no coincidence that between 1995 and 2007 foreign assistance from industrialized countries to developing countries for family planning services fell by more than half, from $723 million to $338 million annually.[23] Some of the stall in fertility decline may stem—as William Ryerson, president of the Population Media Center in Burlington, Vermont, has argued—from a persistent pronatalist bias in some cultures. That leaves many women intent—to save their reputations, marriages, or even lives—upon having large families even if frequent pregnancy is harmful to their health and limits other life options. Ryerson's organization has focused its work on radio programming that educates listeners on the value of using family planning, with results that document increased contraceptive use and lower fertility.[24]

It is likely that education and open discussion about the relation of population to environmental sustainability can play a constructive role in shaping reproductive decision making. Studying a lobster-fishing village in Quintana Roo, Mexico, geographer David Carr of the University of California at Santa Barbara found that cultural attitudes about childbearing had changed as the lobster resource declined. The use of contraception was universal, and the community's birth rates were comparable to those of such low-fertility countries as Italy, Estonia, and Russia. The villagers Carr interviewed told him they had adjusted their family size intentions, so much lower than those of their parents, out of an awareness that they needed to preserve the fishing resource for their children.[25]

Larger and more dispersed environmental threats, such as climate change, probably do not have this effect, even among educated populations, although a few young people speak up for the idea of voluntary childlessness for the sake of the environment.[26] (See Sidebar 10.) In 18 of the 24 wealthiest countries—from the United States and the United Kingdom to the Netherlands and New Zealand, average fertility actually increased in the years following 2005. "How much has our silence around population growth contributed to the emergence of this [new] demographic stage?" writer Julia Whitty asked in a cover article in the magazine *Mother Jones*.[27]

Donald Judge

Fearful of the immediate future: a family outing on the Vltava River in the low-birth rate Czech Republic.

All of this underlines the need for cultural and educational transformation that raises awareness about the seriousness of environmental change and how reproductive decisions—in combination with the capacity to put these decisions into effect—influence these. Such a transformation no doubt will take time, but particularly in the case of climate change time may be the scarcest natural resource of all. Among the most encouraging signs is that groups, leaders, and voices in the reproductive health and women's rights communities are speaking up, as Kavita Ramdas did, about the value of their work in promoting climate sustainability.

Sidebar 10. Change We Can Make on Population and Climate

What might it mean to actually *act* on the connection of population to climate change? For "skeptical environmentalist" Bjørn Lomborg, the link is dire—but apparently not actionable. It may not be possible to hold Earth's temperature increase to 2 degrees Celsius (3.6 degrees Fahrenheit) above preindustrial levels, as the world's nations agreed to try to do at the 2009 Copenhagen climate conference, "without drastic action," Lomborg wrote, "like cutting the world population by a third."

Others choose less drastic action closer to home. Blogger Lisa Hymas writes for the environmental Web site Grist on the idea of going child-free for the sake of helping the planet, using the acronym GINK—globally inclined, no kids—to describe people like herself. Terri and Jay Chadney from Portland, Oregon, integrate their concerns for the environment into a different childrearing model—with three adopted children joining their single biological child. "I know the planet is full of people," Ms. Chadney told the *Portland Tribune*.

Multiplied by millions, individual decisions like those of Ms. Hymas and the Chadneys could lead to a world population not "cut" by a third but drifting lower in direct response to the realized childbearing intentions of women and their partners. Such personal reproductive decisions—when backed by the information and means to put them into effect—already have braked population growth to half the speed of 40 years ago. The state of the environment may have played at best a minor role so far in this epic shift, but there is no reason to discourage people who are making plans to parent from taking into consideration the well-being of the world around them.

Beyond personal reproductive choices is the need to encourage greater discussion in all societies about population, sexuality, gender relations, and the standing of women, and the connections of all of these to climate change and other aspects of environmental and social sustainability. Policymakers need encouragement to demonstrate political will in supporting and funding reproductive health services for all, removing obstacles that hold women back in comparison with men, and improving access to education—including education about population, reproduction, and the environment.

For three days in late September 2010, the United Nations General Assembly was scheduled to review the progress of the UN's "Millennium Development Goals," or MDGs, in bringing about quantifiable social, health, and environmental progress in developing countries by 2015. The important connections between improving the health and well-being of women (underlined in MDG 5) and improving environmental sustainability (MDG 7) have until now received little attention—but could and should in the four years now remaining to achieve the MDGs.

The Intergovernmental Panel on Climate Change embarks in late 2010 on its *Fifth Assessment Report*. A planned chapter in the report of Working Group 3, responsible for considering climate change mitigation, will cover "Sustainable Development and Equity." This is an obvious spot in the assessment to consider—more than the panel has in earlier reports—the population-climate connection. Working Group 2, responsible for considering vulnerability and adaptation to climate change impacts, has a similar opportunity. Given a broad range of topics for this working group—from freshwater resources to oceans and food security—the relationship of human population and feasible variations in its future dynamics should feature throughout this portion of the assessment.

Finally, there is the gathering in Cancún, Mexico, in December 2010 of the parties to the Framework Convention on Climate Change. Based on the recent past of this process, it is hard to have high expectations for progress on a global climate change agreement, let alone for a mention of population within it. The gathering at least offers another opportunity to engage debate and raise the profile not just of population in climate change, but of per capita emissions equity as a basis for a future agreement. Just as importantly, issues of gender and women's lives have moved forward in the most recent climate change negotiating conferences. To address the need for gender equality and support for women's resilience in the face of climate change is itself, however indirectly, to address the future of human population and its influence.

Source: See Endnote 26 for this section.

Experiments to bring media and public attention to the population-climate linkage are also under way. In December 2009, the Optimum Population Trust launched a program called PopOffsets designed to draw contributions from CO_2 emitters to selected family planning programs in the United Kingdom and Madagascar.[28] The initiative had raised about £10,000 ($14,000) for the family planning programs by mid-2010, not much in terms of what such pro-

grams require. Moreover, by implying that high emitters can atone for their sins by paying for someone else's contraception, it contributed to perceptions that those who worry about population and climate change simply want to transfer blame from their own consumption. Yet the initiative at least stoked debate on these issues in the United Kingdom.

Simply improving the understanding of the connections between population and climate change could prove useful in building the case for improvement in the lives and status of women worldwide, a worthy objective and perhaps all that should be asked of or expected from the linkage for now. As long as the global debate over climate change remains stuck on the question of which nations move first to reduce their emissions, there is little chance that population will be seen as much more than a rhetorical cudgel in the blame game.

When nations get serious about avoiding dangerous transformation of the global climate, however, the interplay of technology, economy, consumption, and human numbers will be at the heart of the needed global pacts. Once understood, women's autonomy and access to family planning, and the smaller populations to which these lead, will stand out among the resources most needed in a world in which climate and the human presence are perpetually in tension.

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Population, Climate Change, and Women's Lives

Most of today's nearly 7 billion human beings are likely to experience climate volatility that is unprecedented in human history—even as they contribute to further climate changes through their daily activities. Yet population's connection to climate change rarely surfaces in international negotiations or public debates about how to reduce greenhouse gas emissions and build social resilience to the impacts of climate change.

Humanity has overstressed the climate system by dangerously overloading the atmosphere with heat-trapping gases. But to what extent is this an expression of the growth of our numbers, which have multiplied sevenfold since the early days of the Industrial Revolution? To what extent is it more a reflection of human activities—and our changing consumption patterns—irrespective of population's growth? Should countries with higher average per capita emissions be more responsible for addressing climate change?

Evidence suggests that lower population growth trajectories would enhance countries' efforts to adapt to climate change impacts, and could lead to major future emissions savings that would build powerfully with time. Best of all, climate-friendly population strategies are also people-friendly, relying on the empowerment of women and their partners to make their own decisions about their lives and, in particular, about if and when to bear a child.

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