Chapter 2

Human Population Grows Up

Joel E. Cohen

The decade ending in 2010 spanned three unique, important transitions in the history of humankind. Before 2000, young people always outnumbered old people. From 2000 forward, old people will outnumber young people. Until approximately 2007, rural people always outnumbered urban people. From approximately 2007 forward, urban people will outnumber rural people. From 2003 on, the worldwide *median* number of children per woman per lifetime at current fertility rates (the total fertility rate) was at or below the number required to replace the parents in the following generation, even though the declining *average* total fertility rate remained above the replacement level by as much as half a child per woman.

The century 1950–2050 marks three additional unique, important transitions in human history. First, no person who died before 1930 had lived through a doubling of the human population. Nor is any person born in 2050 or later likely to live through a doubling of the human population. In contrast, everyone 50 years old or older in 2010 has seen more than a doubling of human numbers, from 3 billion in 1960 to 6.8 billion in 2010. The peak population growth rate ever reached, about 2.1 percent a year, occurred between 1965 and 1970. Human population never grew with such speed before the twentieth century and is never again likely to grow with such speed. Our descendants will look back on the late-1960s peak as the most significant demographic event in the history of the human population, even though those of us who lived through it did not recognize it at the time.

Second, the dramatic fall since 1970 of the global population growth rate to 1.1 or 1.2 percent a year in 2010 resulted primarily from choices by billions of couples around the world to limit the number of children born. Global human population growth rates have probably risen and fallen numerous times in the past. The great plagues and wars of the

fourteenth century, for example, reduced not only the growth rate but also the absolute size of global population, both largely involuntary changes. Never before the twentieth century has a fall in the global population growth rate been voluntary.

Finally, the past half a century saw, and the next half a century will see, an enormous shift in the demographic balance between the more developed regions of the world and the less developed ones. Whereas in 1950 the less developed regions had roughly twice the population of the more developed ones, by 2050 the ratio will exceed six to one.

These colossal changes in the composition and dynamics of the human population by and large escape public notice. Occasionally, one or another symptom of these profound shifts does attract political attention. Proposed Social Security reforms in the U.S., however, often fail to recognize the fundamental aging of the population, while debates in Europe and the U.S. over immigration policy often overlook the differences in population growth rates between these regions and their southern neighbors.

In this essay, I will focus on the four major underlying trends expected to dominate changes in the human population in the coming half-century and on some of their long-term implications. The population will grow bigger, more slowly, more urban, and older. Of course, precise projections remain highly uncertain. Small changes in assumed fertility rates have enormous effects on the projected total numbers of people, for example. Despite such caveats, the projections do suggest some of the problems that humanity will have to face over the next fifty years.

Rapid but Slowing Growth

Although the rate of population growth has fallen since the 1970s, the logic of compounding means that current levels of global population growth are still greater than any experienced prior to World War II. The first absolute increase in population by one billion people took from the beginning of time until the early nineteenth century. The increase from 6 billion people in 1999 to 7 billion people expected in 2011 will take twelve years. By 2050 the world's population is projected to reach 9.1 billion, plus or minus 2 billion people, depending on future birth and death rates. The anticipated increase from 6.1 billion in 2000 to 9.1 billion in 2050 equals the total population of the world in 1960, which was 3 billion people.

In short, rapid population growth has not ended. Human numbers increased from mid-2009 to mid-2010 by roughly 75 million people annually, the equivalent of adding another U.S. to the world every four

years. But most of the increases are not occurring in countries with the wealth of the U.S. Between 2005 and 2050 population will at least triple in Afghanistan, Burkina Faso, Burundi, Chad, Congo, Democratic Republic of the Congo, East Timor, Guinea-Bissau, Liberia, Mali, Niger, and Uganda. These countries are among the poorest on earth.

Virtually all population growth in the next forty years is expected to happen in today's economically less developed regions. Despite higher death rates at every age, poor countries' populations grow faster than rich countries' populations because birth rates in poor countries are much higher. In 2009, the average woman bore nearly twice as many children (2.7) in the poor countries as in the rich countries (1.7 children per woman).

Half the global increase to 2050 will be accounted for by just nine nations. Listed in order of their anticipated contribution, they are India, Pakistan, Nigeria, Democratic Republic of the Congo, Bangladesh, Uganda, the U.S., Ethiopia, and China. The only rich country on the list is the U.S., where roughly one-third of population growth is driven by a high rate of immigration. In contrast, fifty-one countries or areas, most of them economically more developed, will lose population by 2050. Germany is expected to drop from 83 million to 79 million people, Italy from 58 million to 51 million, Japan from 128 million to 112 million and, most dramatically, the Russian Federation from 143 million to 112 million. Thereafter Russia's population is projected to be slightly smaller than Japan's.

Slowing population growth everywhere means that the twentieth century was probably the last in human history in which younger people outnumbered older ones. The proportion of all people who were children aged four years and younger peaked in 1955 at 14.6 percent and gradually declined to an estimated 9.3 percent by 2010, whereas the fraction of people aged sixty years and older increased from a low of 8.1 percent in 1960 to 11.0 percent in 2010. In around 2000 each group constituted about 10 percent of humanity. Now and henceforth the elderly have the numerical upper hand.

This crossover in the proportions of young and old reflects both improved survival and reduced fertility. The average life span grew from perhaps thirty years at the beginning of the twentieth century to about sixty-eight years in 2010. The more powerful influence, however, is reduced fertility, which adds smaller numbers to the younger age groups.

The graying of the population is not proceeding uniformly around the globe. In 2050 nearly one person in three will be sixty years or older in the more developed regions and one person in five in the less developed zones. But in eleven of the least developed countries—

Afghanistan, Angola, Burundi, Chad, Democratic Republic of the Congo, Equatorial Guinea, Guinea-Bissau, Liberia, Mali, Niger, and Uganda—half the population will be aged twenty-three years or younger.

If recent trends continue as projected to 2050, virtually all of the world's population growth will be in urban areas. In effect, the poor countries will have to build the equivalent of a city of more than one million people each week for the next forty years at least.

Although long-term demographic projections to 2050 and beyond are routine, economic models are not well developed for long-term projection. They are vulnerable to unpredictable changes in institutions and technology and to shifts in the dominance of regions and economic sectors. Most models do, however, predict that the world will become richer. In the brightest scenarios, the ratio of income per person in industrial nations to that in developing nations could drop from an estimated 16 to 1 in 1990 to between 6.6 to 1 and 2.8 to 1 in 2050. These gains are not assured. Other models predict stagnating poverty.

Projections of billions more people in developing countries and more elderly people everywhere, coupled with hopes of economic growth especially for the world's poor, raise concerns in some quarters about the sustainability of present and future populations.

Beyond Human Carrying Capacity

In the short term, our planet can provide room and food, at least at a subsistence level, for 50 percent more people than are alive now because humans are already growing enough cereal grains to feed 9 to 11 billion people a vegetarian diet. But as demographer-sociologist Kingsley Davis observed in 1991, "There is no country in the world in which people are satisfied with having barely enough to eat." The question is whether 2050's billions of people can live with freedom of choice and material prosperity, however freedom and prosperity may be defined by those alive in 2050, and whether their children and their children's offspring will be able to continue to live with freedom and prosperity, however they may define them in the future. That is the question of sustainability.

This worry is as old as recorded history. Cuneiform tablets from 1600 B.C. show that the Babylonians feared the world was already too full of people. In 1798, Thomas Malthus renewed these concerns, as did Donella Meadows in her 1972 book *The Limits to Growth.* While some people have fretted about too many people, optimists have offered reassurance that deities or technology will provide for humankind's well-being. Early efforts to calculate earth's human carrying capacity

assumed that a necessary condition for a sustainable human society could be measured in units of land. In the first known quantitative reckoning, Anton van Leeuwenhoek estimated in 1679 that the inhabited area of earth was 13,385 times larger than Holland and that Holland's population then was about one million people. Assuming that "the inhabited part of the earth is as densely populated as Holland, though it cannot well be so inhabited," he wrote, "the inhabited earth being 13,385 times larger than Holland yields . . . 13,385,000,000 human beings on the earth," or an upper limit of roughly 13.4 billion.

Continuing this tradition, in 2002, Mathis Wackernagel, an author of the "ecological footprint" concept, and his colleagues sought to quantify the amount of land humans used to supply resources and to absorb wastes. Their preliminary assessment concluded that humanity used 70 percent of the global biosphere's capacity in 1961 and 120 percent in 1999. In other words, by 1999, people were exploiting the environment faster than it could regenerate itself, they claimed, a situation they considered clearly unsustainable.

This approach has many problems. Perhaps the most serious is its attempt to establish a necessary condition for the sustainability of human society in terms of the single dimension of biologically productive land area. For instance, to translate energy use into land units, Wackernagel and his colleagues calculated the area of forests that would be needed to absorb the carbon dioxide produced in generating the energy. This approach fails for energy generation technologies that do not emit carbon dioxide, such as solar panels, hydropower, or nuclear plants. Converting all energy production to nuclear energy would change the dilemma from too much carbon dioxide to too much spent nuclear fuel. The problem of sustainability remains, but biologically productive land area is not a useful indicator of it.

Other one-dimensional quantities that have been proposed as ceilings on human carrying capacity include water, energy, food, and various chemical elements required for food production. The difficulty with every single index of human carrying capacity is that its meaning depends on the value of other factors. If water is scarce and energy is abundant, for example, it is easy to desalinate and transport water; if energy is expensive, desalination and transport may be impractical. Attempts to quantify earth's human carrying capacity or a sustainable human population size face the challenge of understanding the constraints imposed by nature, the choices faced by people, and the interactions between them.

Some of the constraints imposed by nature are dealt with elsewhere in this volume. Here I will draw attention to the questions of human choice involved in assessing sustainability. What will humans desire and

what will they accept as the average level and distribution of material well-being in 2050 and beyond? What technologies will be used? What domestic and international political institutions will be used to resolve conflicts? What economic arrangements will provide credit, regulate trade, set standards, and fund investments? What social and demographic arrangements will influence birth, health, education, marriage, migration, and death? What physical, chemical, and biological environments will people want to live in? What level of variability in population size and other demographic characteristics will people be willing to live with? (For example, if people do not mind seeing human population size drop by billions when the climate becomes unfavorable, they may regard a much larger population as sustainable when the climate is favorable.) What level of risk are people willing to live with? (Are mud slides, hurricanes, or floods acceptable risks or not? The answer will influence the area of land viewed as habitable.) What time horizon is assumed? Finally, and significantly, what will people's values and tastes be in the future? As anthropologist Donald L. Hardesty noted in 1977, "A plot of land may have a low carrying capacity, not because of low soil fertility but because it is sacred or inhabited by ghosts."

Most published estimates of earth's human carrying capacity uncritically assumed answers to one or more of these questions. In my book *How Many People Can the Earth Support?* I collected and analyzed more than five dozen of these estimates published from 1679 onward. Those made in just the past half a century ranged from less than 1 billion to more than 1,000 billion. These estimates are political numbers, intended to persuade people, one way or another: either that too many humans are already on earth or that there is no problem with continuing rapid population growth. Scientific numbers are intended to describe reality. Because no estimates of human carrying capacity have explicitly addressed the questions raised above and have taken into account the diversity of views about their answers in different societies and cultures, no scientific estimates of sustainable human population size can be said to exist. Too often attention to long-term sustainability is a diversion from the immediate problem of making tomorrow better than today, a task that does offer much room for science and constructive action. Let us therefore briefly consider two major demographic trends, urbanization and aging, and some of the choices they present.

Boom or Bomb?

Many major cities were established in regions of exceptional agricultural productivity, typically the floodplains of rivers, or in coastal zones and

islands with favorable access to marine food resources and maritime commerce. If the world's urban population roughly doubles in the next half a century, from 3 billion to 6 billion, while the world's rural population remains roughly constant at 3 billion, and if many cities expand in area rather than increasing in density, fertile agricultural lands around those cities could be removed from production, and the waters around coastal or island cities could face a growing challenge from urban waste. Right now the most densely settled half of the planet's population lives on 2 to 3 percent of all ice-free land. If cities double in area as well as population by 2050, urban areas could grow to occupy 6 percent of land. Withdrawing that amount mostly from the 10 to 15 percent of land considered arable could have a notable impact on agricultural production. Planning cities so they avoid consuming arable land would greatly reduce the effect of their population growth on food production, a goal very much in the urbanites' interest because the cities will need to be provisioned.

Unless urban food gardening surges, on average each rural person will have to shift from feeding herself (most of the world's agricultural workers are women) and one city dweller today to feeding herself and two urbanites in less than half a century. If the intensity of rural agricultural production increases, the demand for food, along with the technology supplied by the growing cities to the rural regions, may ultimately lift the rural agrarian population from poverty, as happened in many rich countries. At the same time, if more chemical fertilizers and biocides are applied to raise yields, the rise in food production could put huge strains on the environment.

For city dwellers, urbanization threatens frightening hazards from infectious disease unless adequate sanitation measures supply clean water and remove wastes. Yet cities also concentrate opportunities for educational and cultural enrichment, access to health care, and diverse employment. Clearly, if half the urban infrastructure that will exist in the world of 2050 must be built in the next forty-five years, the opportunity to design, construct, operate, and maintain new cities better than old ones is enormous, exciting, and challenging.

Urbanization will interact with the transformation of human societies by aging. Cities raise the economic premium paid to younger, better-educated workers, whereas the mobility they promote often weakens traditional kin networks that provide familial support to elderly people. An older, uneducated woman who could have familial support and productive work in agriculture if she lived in a rural area might have difficulty finding both a livelihood and social support in a city.

After 2010, most countries will experience a sharp acceleration in the rate of increase of the elderly dependency ratio—the ratio of the num-

ber of people aged sixty-five and older to the number aged fifteen to sixty-four. The shift will come first and most acutely in the more developed countries, whereas the least developed countries will experience a slow increase in elderly dependency after 2020. By 2050 the elderly dependency ratio of the least developed countries is projected to approach that of the more developed countries in 1950.

Extrapolating directly from age to economic and social burdens is unreliable, however. The economic burden imposed by elderly people will depend on their health, on the economic institutions available to offer them work, and on the social institutions on hand to support their care.

Trends in the health of the elderly are positive overall, despite severe problems in some economies in transition and in regions afflicted by AIDS. The rate of chronic disability among elderly Americans, for example, declined rapidly between 1982 and 1999. As a result, by 1999, 25 percent fewer elderly Americans were chronically disabled than would have been expected if the U.S. disability rate had remained constant since 1982.

Because an older person relies first on his or her spouse in case of difficulty (if there is a spouse), marital status is also a key influence on living conditions among the elderly. Married elderly people are more likely to be maintained at home rather than institutionalized compared with single, widowed, or divorced persons.

The sustainability of the elderly population depends in complex ways not only on age, gender, and marital status but also on the availability of supportive offspring and on socioeconomic status—notably educational attainment. Better education in youth is associated with better health in old age. Consequently, one obvious strategy to improve the sustainability of the coming wave of older people is to invest in educating youth today, including education in those behaviors that preserve health and promote the stability of marriage. Another obvious strategy is to invest in the economic and social institutions that facilitate economic productivity and social engagement among elderly people.

No one knows the path to sustainability because no one knows the destination, if there is one. But we do know much that we could do today to make tomorrow better than it would be if we do not put our knowledge to work. As economist Robert Cassen remarked, "Virtually everything that needs doing from a population point of view needs doing anyway."