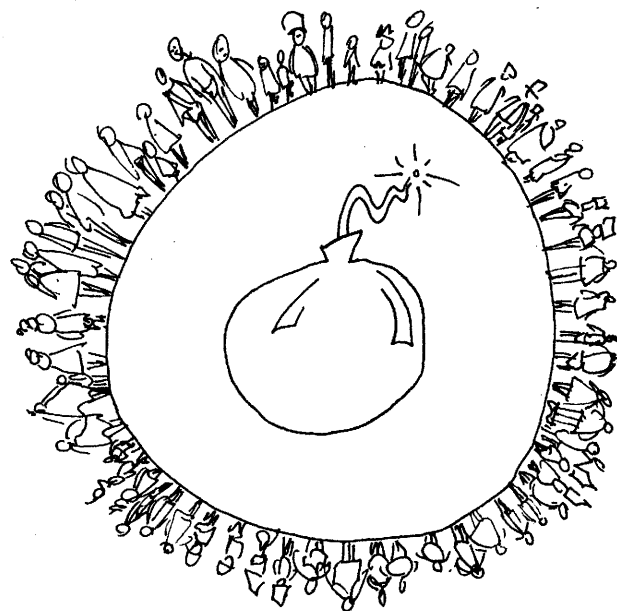


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Population: The Ultimate Environmental Health Issue



The Population Bomb

Population biology is a science in itself. Studies of animal, plant, and microorganism populations have yielded some concepts and insights that can be applied to human populations. However, application of these studies' findings to human populations is an inexact science, and predictions are always highly controversial. Interest in the dynamics of the human population arises from concern about its continuing growth and its increasing impact on the environment.

All organisms tend to produce more offspring than would be needed to maintain a stable population. Pressures from the environment, such as

availability of food and prevalence of predators, tend to limit the survival of those offspring. The difference between the birth rate and the death rate is the population's rate of growth.

Studies of organisms newly introduced into a closed environment have shown two general patterns of population growth: the S curve and the J curve, illustrated in Figure 24-1. Both patterns start out with a rapidly expanding population, but they differ in their response to environmental limitations. In the more common S pattern, environmental pressures increase gradually as the population approaches the number known as the

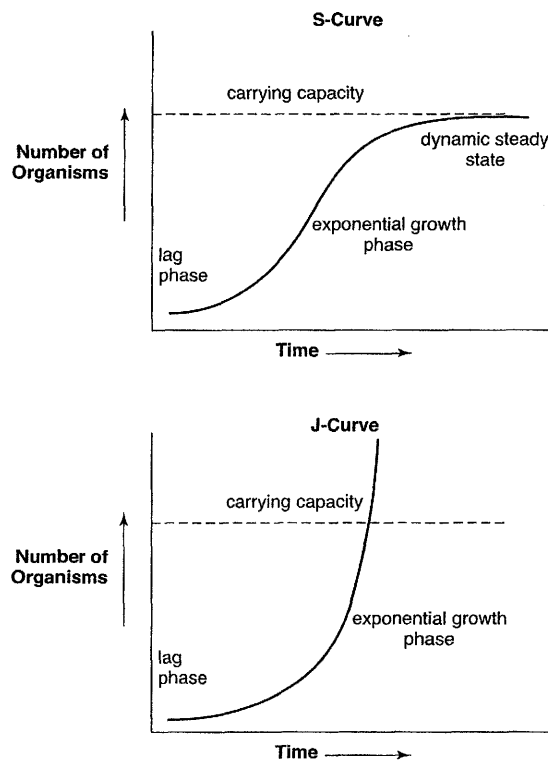


Figure 24-1 Patterns of Population Growth

Source: Reprinted from: *Our Global Environment: A Health Perspective*, 4th ed. (p. 51) by A. Nadakavukaren with permission of Waveland Press, 1995.

carrying capacity—the number of organisms that can be supported in a given environment without degrading that environment. In the J pattern, the population expands rapidly past the carrying capacity and then crashes, because once the carrying capacity is exceeded, the environment is degraded, and the carrying capacity is reduced. For example, the J pattern is seen in lemmings and locusts, species famous for huge population explosions followed by massive numbers of deaths when the food supply is exhausted.¹

It is not yet clear whether the human population is growing in an S or a J pattern. The world population has grown steadily, with minor irregularities, for the past million years, with a major surge beginning about 200 years ago. About that time, when the population of the earth was about one billion, the British clergyman and economist Thomas Malthus raised an alarm that population growth was outpacing the food supply; he predicted that the resulting crowding would lead to famine, war, and disease. However, Malthus's dismal predictions did not come about, and his warnings were discredited. Progress in agricultural technology and migrations from highly populated areas in Europe to the open spaces of the Americas and southern Africa relieved pressures on populations, allowing the expansion to continue.¹

In 1968, when the world's population was 3.5 billion, Paul Ehrlich, an American ecologist, published *The Population Bomb*, a best seller that repeated and expanded upon Malthus's warning.² Perhaps in part due to the attention paid to Ehrlich's book, the rate of the world's population growth has slowed since then, from an all-time high of 2.1 percent per year between 1965 and 1970 to about 1.2 percent in 2002.³ There is a tremendous momentum to population growth, however, and the numbers continue to increase dramatically. In 1990, when the population had reached 5.3 billion, Ehrlich and his wife, Anne, published another book, *The Population Explosion*, arguing that many of his dire predictions have already begun to be realized.⁴ And in 2004, with the world's population at 6.4 billion, they published *One with Nineveh*, which further examines the consequences of overpopulation and the linked problems of overconsumption and political and economic inequity—consequences that include the prospect of increasing terrorism.⁵

Most environmentalists and public health experts agree with Ehrlich. However, like Malthus, he has his detractors. There are pro-growth advocates—mostly economists—who argue that human ingenuity will always find ways of overcoming any problems created by crowding. In

response, the Ehrlichs quote Kenneth Boulding: "Anyone who believes exponential growth can go on forever in a finite world is either a madman or an economist."⁴(p.159) Some of the world's major religions oppose population control measures, making it easier for politicians to listen to growth advocates and simply ignore the problems created by overpopulation.

It is very difficult to predict what the future population of the world will be. There are indications, as the Ehrlichs point out, that environmental pressures opposing population growth are increasing, especially in developing regions of the world. There are also indications that international family planning efforts are paying off in slowing growth rates in many parts of the world. The United Nations predicted in that, if current trends continue, the population will reach 9.3 billion in 2050 and stabilize just after the year 2200 at somewhat under 11 billion.⁶ It is not clear, however, if the earth's carrying capacity is large enough to support that many people. If not, irreversible forces may be building for a sudden J-type population crash. By the time the Ehrlichs would be proved right, it would be too late to do anything to prevent the disaster.

PUBLIC HEALTH AND POPULATION GROWTH

Public health has had a major role in bringing about the dramatic growth in the world's population over the past several decades. Public health improvements—clean water, immunization, pest control measures, inexpensive oral rehydration treatment of diarrheal diseases—in developing countries have led to major declines in death rates, especially among children. According to the United Nations Children's Fund (UNICEF) the number of children who die before reaching their fifth birthday declined by almost 60 percent since 1960.⁷ Because birth rates remained constant, populations grew rapidly in the developing countries.

In developed countries, which instituted public health measures over a period of many decades in the nineteenth and twentieth centuries, birth rates tended to fall in response to falling death rates, a process known as the "demographic transition." The fall in birth rates is a rational response to parents' knowledge that their children are likely to survive to adulthood. In an industrialized, urban society, children are an economic liability—expensive to feed, clothe, and educate.

In the developing world, however, many public health measures were introduced by international agencies over a short period of time after

World War II. International aid for population control efforts has not been as generous. This is, in part, because of cultural resistance to contraception within some societies; and, in part, because of the religious and political controversy surrounding family planning, especially in the United States, which has limited the amount of aid this nation provides.

Because of continued high birth rates, the public health in many developing countries is now, ironically, threatened by the crowding that has resulted from public health improvements. In all parts of the world, there has been a trend toward urbanization, because rural areas whose main industries are agricultural do not need the increasing numbers of workers. This trend has been most marked in developing countries, where migrants from rural areas flock to the cities. From 1950 to 2004, the percentage of people living in cities increased from 29 percent to 48 percent.^{1,8} According to the World Bank, Africa is becoming urbanized at the rate of 5 percent a year; the annual rate of urbanization in Asia is almost 4 percent.⁹ Governments struggling to provide adequate drinking water and sewage services to their citizens cannot keep up with the influx. Many of the migrants settle on the outskirts of the cities in shantytowns totally lacking in water and sanitation. Others are completely homeless, simply living on the streets.

These conditions threaten to reverse all the progress in public health made through earlier efforts. Cholera and other diarrheal diseases are rampant in these third-world slums. Malaria, measles, whooping cough, and diphtheria are also common. Polio is still a threat in Africa, as discussed in Chapter 9. Cases of tuberculosis and AIDS are surging. In sub-Saharan Africa, 7.5 percent of the adult population is HIV positive, and in some of these countries, prevalence is shockingly high: 38.8 percent in Swaziland and 37.3 percent in Botswana. The number of children orphaned by AIDS was estimated at fifteen million in 2003.⁷ In fact, AIDS has dwarfed all other public health problems in Africa. Life expectancy in several countries in southern Africa has fallen by twenty years, and the rate of population growth has dropped to almost zero, not because of low birth rates as in developed countries, but because death rates are almost equal to birth rates. The United Nations predicts that the population of Botswana will fall by 43 percent between 2004 and 2050.⁸

The desperate conditions in third-world urban slums lead to the disruption of traditional lifestyles and the breakdown of normal social constraints, including sexual and parental restraints. Prostitution is common; children are abandoned to fend for themselves. These were the conditions that are believed to have led to the origin of AIDS as an epidemic threat

(see Chapter 10), and they contribute to the continuing disaster of the epidemic. Such conditions may be the breeding ground for other emerging infections in the future. These conditions also encourage crime and violence. Even if, as predicted, population growth rates continue to decline, 95 percent of the two or three billion people added to the world in the next twenty-five to fifty years will be in the poorest countries, and most of that growth will occur in cities.¹

Even the United States and other developed countries are affected by some of the pressures described above, although the rate of population growth in this country is under 1 percent, and in Japan and most European countries, it is close to zero. The American population is becoming increasingly urban, with over 75 percent living in communities with more than 2,500 residents.¹ Sixteen percent of children live in families with incomes below the poverty line; a high percentage of these children live with both housing and food insecurity.¹⁰

The United States is also affected by the social consequences of population growth in developing countries. Highly publicized problems with illegal immigrants from Mexico and Central America are linked with poverty and social problems caused by population growth in those countries. As conditions in those areas become more crowded and desperate in the future, the pressures on people to seek less crowded, more prosperous surroundings will increase, making it more difficult for the United States to remain isolated. As discussed in Chapter 10, infectious diseases have no respect for political boundaries. With international travel and commerce so rapid and widespread, Americans are at risk from diseases imported from anywhere in the world. Furthermore, as discussed in the following section, human population growth threatens to change the environment of the entire globe, posing health threats that no one could escape, even if the nation's borders were sealed.

GLOBAL IMPACT OF POPULATION GROWTH— DEPLETION OF RESOURCES

The carrying capacity of the earth—the population size that the earth can support without being degraded—is determined by a number of factors, some of which can be altered by technological intervention and human behavior. These factors, which are related, include the availability of fresh water, the availability of fuel, the amount and productivity of

arable land, and the amount and disposition of wastes, both biological and technological. There are signs that the carrying capacity is already exceeded in some parts of the world: as the environment is degraded, the size of the population that can be supported shrinks, leading to further environmental degradation and a vicious circle of hunger, disease, and death.

The supply of fresh water, which is basic to human life, is one of the factors that limits the earth's carrying capacity. Water is essential for drinking, cooking, and washing. It is also used for agriculture, irrigating dry fields to grow the increasing amounts of food required by expanding populations. Water is a renewable resource, due to cycles of evaporation and precipitation, but the rate at which water supplies are renewed is fixed. Only a small percentage of the water on earth is suitable for human use: while there are methods of removing the salt from sea water, the technology is expensive and uses large amounts of energy. Pollution resulting from the use of fresh water supplies for disposal of wastes also renders potential sources of water unsuitable for human use.

Availability of fresh water is highly variable according to geographic area and precipitation patterns. In drier parts of the world, especially the Middle East, water rights become volatile international issues because some countries depend on water sources that originate beyond their borders. For example, the Nile flows into Egypt from Ethiopia and Sudan, and the flow of the Tigris-Euphrates into Syria and Iraq may be altered by dam construction in Turkey.

In the United States, water supplies have been sufficiently plentiful so that Americans are accustomed to lavish consumption, watering lawns, washing cars, and filling private swimming pools, even in relatively dry areas of the Southwest. The annual per capita use of water in the United States, including industrial usage, is more than seventy times higher than it is in Ghana.¹¹ An example of wasteful practices is the draining of the Ogallala Aquifer, the world's largest underground water reserve, which underlies portions of six southwestern states. The water accumulated during the last ice age and cannot be replenished. Yet it is being used, among other things, for industry and irrigation, attracting people to the area who will be left literally high and dry when the water runs out.

The amount of fresh water on earth is theoretically sufficient to support a population of twenty billion people if evenly distributed.¹¹ Many countries have taken steps to conserve fresh water supplies and clean up the pollution. In poorer, drier countries, however, the available water is

insufficient to support the growth in population that is occurring. The lack of water for cooking and washing, and the pollution of drinking water with human and industrial wastes, is already harming the public health. According to a 1997 United Nations report, one-third of the world's population, mostly in Africa and south Asia, lives in regions with water shortages, and that number will grow to two-thirds by 2025.¹

Predictions about the earth's carrying capacity have most often centered on food, attempting to estimate the limits of agricultural productivity. Malthus's warnings were built on concerns about limited growth in food supplies, which nevertheless continued to grow rapidly for almost two centuries. Now, unhappily, it is beginning to look as if Malthus may finally be proven right.

With increasing populations needing greater amounts of food, the amount of land used for agriculture grew quickly during the period between 1850 and 1950. Then, despite continued population growth, the expansion of arable land slowed down and ceased altogether in the late 1980s.¹² Food production continued to keep pace with population growth during the 1960s and 1970s, however, because of the "green revolution," the development of genetic strains of wheat and rice that yielded harvests two to three times greater than conventional strains. Crop yields also grew because of increasing use of fertilizers, irrigation, and chemical pesticides.

Such increases in yields are unlikely to continue, however, because of water shortages, depletion of soil, and the development of resistance by pests to chemical pesticides. The amount of land under cultivation worldwide has declined in the past decade, in part because of spreading urban centers, in part because the soil is depleted of nutrients or has become salty from irrigation. Erosion of topsoil due to overgrazing and poor agricultural practices has contributed to the loss of arable land.¹² The demand for agricultural land for farming has led to widespread clearing of forests, although forested land may be only marginally suitable for cultivation. Deforestation also occurs as a result of people gathering wood for fuel. The need by growing populations for firewood for cooking and, in colder climates and mountainous regions, heating as well, has resulted in vast treeless areas around towns and villages throughout Africa, Asia, and Latin America. The loss of forests increases soil erosion and contributes to catastrophic flooding in areas subject to monsoons.

Population growth has also caught up with the seemingly limitless supply of food from the sea. Fish catches increased dramatically between 1950 and 1989 but have declined since then. The United Nations Food and

Agriculture Organization has concluded that 70 percent of the major fish species are either fully exploited or overexploited. Pollution of coastal waters has also contributed to the decline of harvests, especially those of shellfish. On the bright side, the practice of aquaculture is growing rapidly, and in 2000 one out of every four fish eaten worldwide was raised on a fish farm.¹

GLOBAL IMPACT OF POPULATION GROWTH— CLIMATE CHANGE

Perhaps the most threatening effect of population growth is that it is beginning to change the composition of the earth's atmosphere, with potentially drastic consequences. As discussed in Chapter 20, the depletion of the ozone layer, which protects the earth's surface from ultraviolet radiation, is known to increase risks of skin cancer, melanoma, and cataracts. It may also have a harmful impact on plant and animal life.

Although international agreements have led to policies effective in slowing and possibly even reversing damage to the ozone layer, there is less hope of preventing climate change caused by other human activities. Alteration in the relative concentrations of the four major constituents of air—nitrogen, oxygen, argon, and carbon dioxide—is causing global warming due to the "greenhouse effect," in which the energy of sunlight is absorbed by carbon dioxide in the air and turned into heat rather than radiating back into outer space.

The balance of atmospheric gases has been maintained over the millennia by the photosynthetic activities of green plants, which take up carbon dioxide and release oxygen. The reverse process occurs during combustion of wood, coal, oil, and gas: oxygen is consumed and carbon dioxide is released. Since the beginning of the Industrial Revolution, with the ever-increasing use of fossil fuels, the levels of carbon dioxide in the atmosphere have been rising. The trend is made worse by the loss of photosynthetic action that accompanies widespread destruction of forests through logging and, worse, by the burning of vegetation, including tropical rain forests, to clear land for agriculture and human settlement. Green plants are being lost from the ocean also, through poisoning of phytoplankton by pollution of the seas. The concentration of atmospheric carbon dioxide has grown by nearly 30 percent since the beginning of the Industrial Revolution and is expected to double by about 2100.^{1,13} Other

gases also contribute to the greenhouse effect, especially methane, which is released by microbial activity in the intestines of cattle and in paddy fields where rice is grown.

Although the evidence was strongly disputed for many years, it is becoming increasingly clear that global climate change has begun: the earth's average temperature has risen by almost a full degree Fahrenheit over the past century, as seen in Figure 24-2. Predictions for the year 2100 range from three to eight degrees Fahrenheit higher than today.¹³ The implications for human health are complex and far-reaching and entail a certain amount of speculation. Oceans will rise, inundating coastal towns and cities, displacing as many as 20 percent of the world's people.¹⁴ Precipitation patterns will change, and the intensity of storms and hurricanes will increase. Food supplies will be affected, as optimal temperature and rainfall conditions for agriculture shift northward and marginally dry lands turn to desert. Insect pests will become more active, adversely affecting crops even further. Already, glaciers are melting, coral reefs are dying, the Antarctic ice sheets are disintegrating, species extinction is accelerating, and sea levels are rising.

As temperate zones become hotter, vector-borne diseases that now plague tropical regions will enlarge their territory, spreading even to industrialized countries. Mosquitoes that carry the dengue and yellow fever viruses and malaria parasites threaten to move northward into the

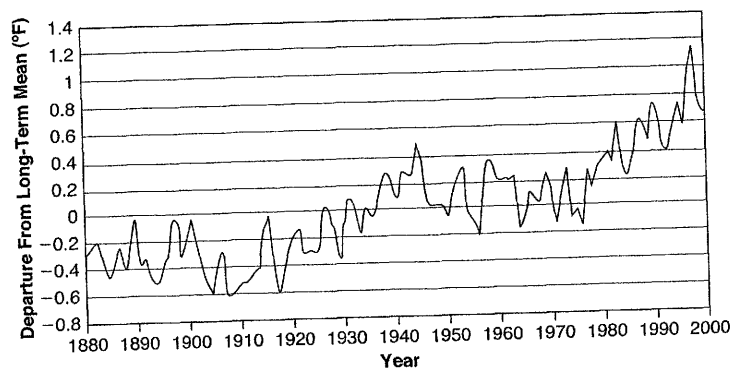


Figure 24-2 Global Temperature Changes (1880-2000)
Source: U.S. National Climatic Data Center, 2001.

United States from Central America. A warmer climate may be responsible for the emergence of hantavirus infections, described in Chapter 10, in the United States, and the 1991 outbreak in South America of epidemic cholera, the first seen in the Western hemisphere in more than a century.¹ Extreme heat waves, such as the ones that occurred in Chicago in 1995 and in Europe in 2003, greatly increase the risk of death, especially among elderly city dwellers.

Prospects for slowing the process of global warming appear dim, in part because population pressures in developing countries contribute to continuing deforestation but, more importantly, because the United States and other industrialized countries contribute disproportionately to the production of greenhouse gases, as seen in Figure 24-3. The United States, with less than 5 percent of the world's population, contributes over 20 percent of the world's greenhouse emissions. By contrast, India has 17 percent of the people in the world while contributing only 5.5 percent of the world's greenhouse emissions.^{7,15} The high per capita production of carbon dioxide is part of the affluent life style, one that poorer countries strive to emulate and may begin to achieve if they can control the growth of their populations.

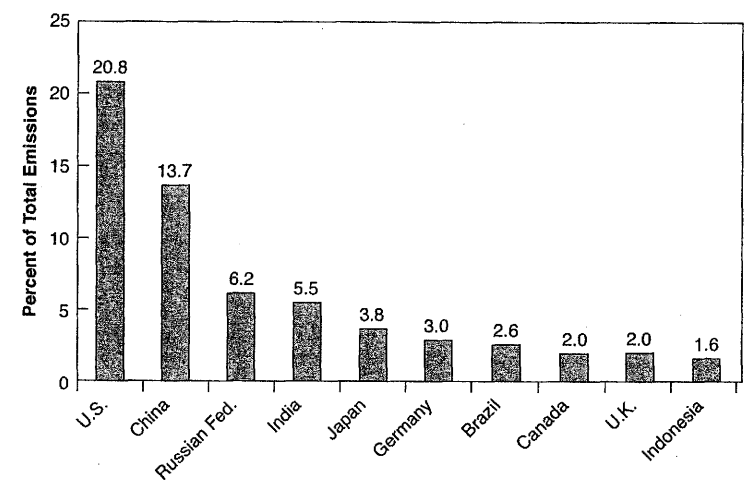


Figure 24-3 Top 10 Greenhouse Gas Emitters
Source: Data from World Resources Inst.

However, that hope is countered by the probability that environmental damage caused by the continued rise in the earth's temperature will cause increases in human suffering, especially in the poorest countries.

Recognizing the dangers of global climate change, delegates to the United Nations' Earth Summit in 1992 negotiated an agreement that called for voluntary reductions in greenhouse gas emissions. It soon became obvious, however, that the nations were failing miserably at achieving any reduction in emissions, and negotiations were resumed in 1997 in Kyoto, Japan. At that conference, representatives from 171 nations agreed on mandatory reductions, with individualized goals for each country. The United States was assigned the goal of reducing its emissions to 7 percent below 1990 levels by 2012. The Kyoto Protocol was to become legally binding after being ratified by fifty-five countries representing 55 percent of the 1990 emissions.¹

Prospects for ratification by the U.S. Congress looked bleak even when Bill Clinton was president, but upon the election of George W. Bush, it was clear that the United States would not participate. President Bush withdrew the nation from the Kyoto Protocol soon after he was inaugurated. He has rejected evidence that global warming is occurring, to the extent that political pressures forced all reference to climate change to be removed from a major Environmental Protection Agency report on environmental quality.¹⁶ (See Chapter 2.) In 2004, Russia became the 121st nation to ratify the Kyoto Protocol, allowing it to take effect in early 2005. However, without the participation of the United States, the world's leading emitter of greenhouse gases, the treaty is unlikely to make much difference. Even if all the signatories meet their targets, the achievement will be only a small step toward reducing the impact of climate change.¹⁷

DIRE PREDICTIONS AND FRAGILE HOPE

At its current rate of growth, the world's population is expected to double in forty-nine years. Some countries are growing much more rapidly: The Congo, for example, is predicted to have twice the current number of people in as little as twenty-two years; Nicaragua also has a doubling time of twenty-two years and Nigeria's is twenty-three years. In contrast, the doubling time of the U.S. population is 116 years, while that in Japan is 318 years. As discussed in the Prologue, in Russia, as well as in several European countries, the population is shrinking.¹

Many third world countries are already suffering from shortages of natural and economic resources, including limited agricultural land and a lack of nonagricultural employment. Such regions may have already passed a threshold of irreversibility. The speed and magnitude with which populations are outstripping the available resources are unprecedented in history. The result is expected to be an increase in migrations and violent conflicts. Already, wars and civil violence are being fought over scarce resources such as water, farmland, forests, and fish. Some analysts predict a total breakdown in the social fabric of the planet.¹⁸

If there is any hope for saving the earth from the direst of these predicted fates, it must come from control of population growth. Unfortunately, international agreement on this issue is exceedingly difficult. Three United Nations conferences on population have been held at ten-year intervals, most recently in 1994; all were fraught with ethical, religious, and political controversy. Rich countries blame poor countries for the destruction of natural resources, while poor countries blame the rich for profligate consumption. Poor countries demand help from the rich, which attach unwelcome conditions to the aid they provide. Opposition to contraception by Roman Catholic and Muslim authorities, as well as the incendiary politics of abortion in the United States, obstruct rational attempts at limiting population growth.

Although the 1994 conference held in Cairo was as contentious as the two previous meetings, a consensus emerged on a new approach to population policy, one that focused on individual rights, especially women's rights, including their right to make reproductive decisions. The conference produced a twenty-year "Programme of Action" that included, among other goals, education for women.¹⁹ Educated women prefer fewer children, and they have more bargaining power in the family and in society, studies have shown. Thus the optimum path to a world population that is within the earth's carrying capacity and to the development of resources in a sustainable way may be achievable by the relatively uncontroversial measure of providing girls in the developing world with a basic education.²⁰

The United States is sheltered from some of the realities of the population problem because of the nation's relative isolation from the most crowded regions of the planet. However, Americans cannot afford to be complacent about the dangers posed by world crowding. Global warming, air and ocean pollution, and loss of biodiversity are environmental effects of overpopulation that are certain to affect public health in the United States,

even if the nation could close its borders to all international travelers. Without global population control, other public health efforts would ultimately be a losing battle.

Population control cannot be imposed by force, however. As Paul and Anne Ehrlich point out in their most recent book, *One with Nineveh*, stabilization of the world's population is closely tied to modernization and economic viability of the poorest countries.⁵ This agrees with the conclusions of the 1994 Cairo conference, and it is the goal that the United States and other developed nations should be striving toward. The Ehrlichs quote Lester Pearson, former prime minister of Canada and president of the United Nations General Assembly, "A planet cannot, any more than a country, survive half slave, half free, half engulfed in misery, half careening along toward the supposed joys of almost unlimited consumption. Neither our ecology nor our morality could survive such contrasts."⁵(p.234)

CONCLUSION

The earth's human population has been growing rapidly and continuously for centuries. While the rate of growth appears to be slowing, the science of population biology suggests that a disastrous population crash is possible, a result of environmental pressures.

Paradoxically, public health measures such as clean water, immunization, and pest control have contributed to population growth by saving lives. While improved life expectancy has led to a fall in birth rates in industrialized countries, in the developing world population control efforts have not kept up with other public health efforts. The resulting crowding threatens to reverse the advances that have been made in public health. Migrants from rural areas, in search of jobs, settle in urban shantytowns that lack adequate drinking water and sewage services. These conditions lead to frequent epidemics of infectious diseases, and the accompanying social breakdown contributed to the rise of the AIDS epidemic. The AIDS epidemic in turn is so severe in parts of Africa that it has put a stop to population growth in those countries.

Many analysts believe that the carrying capacity of the earth—the population size that the earth can support without being degraded—is being reached. Factors that limit carrying capacity include the availability of fresh water, the availability of fuel, the amount and productivity of arable land, and the amount and disposition of wastes. Fresh water is

already in short supply in some parts of the world, and many sources of fresh water are being degraded by pollution with human and industrial wastes. Arable land is being depleted through overcultivation and erosion. Deforestation is occurring on all continents, and even the sea is being depleted of fish.

In addition to the impact of resource shortages on human populations, overpopulation is bringing about global climate change. Increased atmospheric concentrations of greenhouse gases brought about by human activities are causing warming of the earth's surface. This in turn causes melting of the polar ice caps and a rise in ocean levels. Weather patterns may already be changing. Warming of temperate zones may account for the recent emergence in the United States of a number of infectious diseases formerly confined to more tropical regions. At an international conference in Kyoto, Japan in 1997, an agreement was reached for countries to reduce their greenhouse gas emissions. However, President Bush has tried to cast doubt on the evidence for global warming, and he has withdrawn U.S. support for the Kyoto Protocol.

The United Nations has held three conferences on population, all fraught with ethical, religious, and political controversy. Rich countries and poor countries blame each other for the problems that result from overpopulation and overconsumption. At the third United Nations conference, held in Cairo in 1994, a new approach to population control was agreed upon. This consensus builds on evidence that education and empowerment of women lead them to choose smaller families and brings a fragile hope that stabilization of the population may be achieved by helping the poorest nations to modernize and become economically stronger.

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PART VI

Medical Care and Public Health