The Long View: Population–Environment Dynamics in Historical Perspective

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Introduction

THE HUMAN POPULATION IS MOST CLEARLY RELATED to global environmental change through its historical pattern of growth in numbers and productivity. This pattern is now fairly well known, if not fully understood. It consists of thousands of years of variation producing exceedingly slow net increases in total population. Only the last three centuries show exponential growth. The recent growth is closely associated with the significant increase in human productivity that has accompanied the rise of urban industrial society. The recent exponential population growth is associated with two major energy transformations that extend back for about five centuries. One was the shift to sails, starting in the fifteenth century. More important for modern global change, however, was the shift to fossil fuels, beginning in the late eighteenth century.

There is an association between this rapid population growth and the full range of environmental changes that is coming to be known as *Global Change*. This includes atmospheric chemical changes related to global warming and ozone depletion; degradation of the environment, including deforestation and the release of toxins into the earth, water and air; and the destruction of species.

This paper provides a brief summary of the long historical trends that link population growth to environmental change. It begins with a review of the past millennium of population growth on a global scale. It then presents the underlying population dynamics that mark our modern period, the *demographic transition*, which helps to explain differential growth rates in major regions of the world.

A Thousand Years of Population Growth and Economic Development

Population growth. The relationship between population and the environment has always been a reciprocal one. A brief review of the history of the human population makes this abundantly clear. From its probable origins in East Africa, the human species took perhaps up to 500,000 years to spread throughout the world. Growth rates of the total population were usually very close to nonexistent, and for many local populations the growth must often have been negative.

Even this slow population growth, however, was accompanied by substantial environmental change. McNeill (1976) notes the elimination of large animals (mammoths, etc.) from much of the territory invaded by man the hunter. The domestication of animals and plants, beginning around 9000 BC, had a substantial impact on the environment in relatively small, sparsely settled and disconnected societies. The population–environment relationship was, however, certainly a two-way street. The emergence of agriculture in MesoAmerica and the Middle East at roughly similar periods suggests the importance of environmental change resulting from the recession of the glaciers. Over the next few thousand years, agriculture spread to many parts of the globe, often implying radical alterations in the environment. The most dramatic of these are seen in irrigation and terracing, which molded the land to produce great increases in plant yields. While these transformations produced pockets of relatively high population density and some periods of

substantial growth, the overall process was still very slow.

By the year 1000 AD the human species had come to number about 265 million. For the next 700 years the historic pattern of slow growth continued. Growth rates were kept low by high human mortality, usually in the range of thirty to forty per thousand population. A variety of mechanisms had evolved, however, to offset these high death rates, such that fertility rates in the best of times usually hovered around five or ten points above mortality rates.[1] Under these conditions, population growth was predominantly governed by mortality, which rose and fell with both social and environmental changes.

This pattern of high birth and death rates began to change about 300 years ago, when the world entered into a series of *demographic transitions*. Death rates began to decline as some populations began to experience a transition from infectious to degenerative diseases as the leading causes of death.[2] Falling death rates brought a period of rapid population growth, as birth rates remained high. This was then followed by declining fertility and lower population growth rates. This transition was completed in most of the more developed countries by the early part of the twentieth century and is now being experienced in much of the less developed world. The expectation today is that the demographic transition will be accomplished throughout the world by the middle of the next century.

For the world as a whole, the demographic transition has given us rising numbers and rising rates of growth for the three centuries from 1700 through 2000. The population of roughly 265 million in the year 1000 rose to about 610 million by 1700, to 2.5 billion by 1950, and is expected to reach 6.2 billion at the end of this century. The growth rates rose steadily from less than 0.1% five centuries ago to a peak of 2.06% in the period 1960 to 1965, when the population reached 3.5 billion. Since then the growth rate has declined to about 1.7% today, though it will continue to grow in absolute numbers for some time.[3] Not all of the world's regions have experienced these changes at the same time, however.

The different timing of these transitions in different world regions can be seen in detail from an examination of average annual growth rates, shown in Table 1. The low growth rates that were universal up through 1700 rose in the eighteenth century to 0.4% in Europe and Asia, and to 0.6% in the Americas. Asia retained that rate of growth and was joined by Africa in the nineteenth century, while Europe's growth doubled to near 0.8%, and the Americas reached levels twice that. Through the twentieth century, European growth rates declined slightly and those in North America rose through 1950 then declined. Africa, Asia, and Latin America showed high and rising growth rates throughout the century, and are only expected to decline in the next century.

United Nations projections place the world's total population at about 8.5 billion in 2025. Beyond that, projections become very uncertain, and much depends on what happens to human fertility in the near future. For ex-ample, if we were to reach replacement level (2.1 total fertility rate) by the year 2000, which is possible though highly unlikely, the world's population would rise to just over eight billion by the year 2100 and then level off or decline. If we do not reach replacement-level fertility until 2080, in 2100 we shall have almost fourteen billion people and still be growing rapidly.

This general pattern of centuries of slow growth and recently rising growth rates is illustrated in Figure 1.[4] It also shows the two energy transformations and the rise of urban society, to which we now turn.

Growth of population and output. What is most remarkable about this recent exponential growth in population is its association with continued rising per capita output. Both agricultural and industrial output have risen more rapidly than population throughout this past three hundred years. The phenomenon is especially remarkable in the past fifty years, when the population growth rates

Table 1. World population by region, 1000-2025 (in millions with average annual growth rates)

Year	1000	1500	1700	1800	1900	1950	2000	2025
Region								
World	265	423	610	902	1622	2515	6248	8466
(a.a %)		.09	.18	.39	.58	.87	1.84	.62
Europe	36	81	120	180	390	572	816	863
(a.a %)		.16	.20	.41	.77	.72	.71	.22
Asia	185	280	415	625	970	1375	3698	4890
(a.a %)		.08	.20	.41	.44	.70	2.0	.56
Africa	33	46	61	70	110	224	872	1581
(a.a %)		.11	.14	.14	.45	1.25	2.75	1.19
Americas	9	14	13	24	145	332	831	1093
(a.a %)		.09	-.01	.61	1.8	1.6	1.9	.55
L. America	8.6	13.2	11.8	18	66	164	537	760
(a.a %)		.09	-.05	.04	1.3	1.8	2.4	1.4
N. America	0.4	0.8	1.2	6	79	168	294	333
(a.a %)		.15	.20	1.6	2.6	1.5	1.1	.5
Oceania	2	2	2.25	2.5	7	14	30	39
(a.a %)		.09	.06	.10	.58	.87	1.54	.53

Source: McEvedy and Jones 1978. The average annual growth rates (a.a%) given are for the full period from the prior date shown.

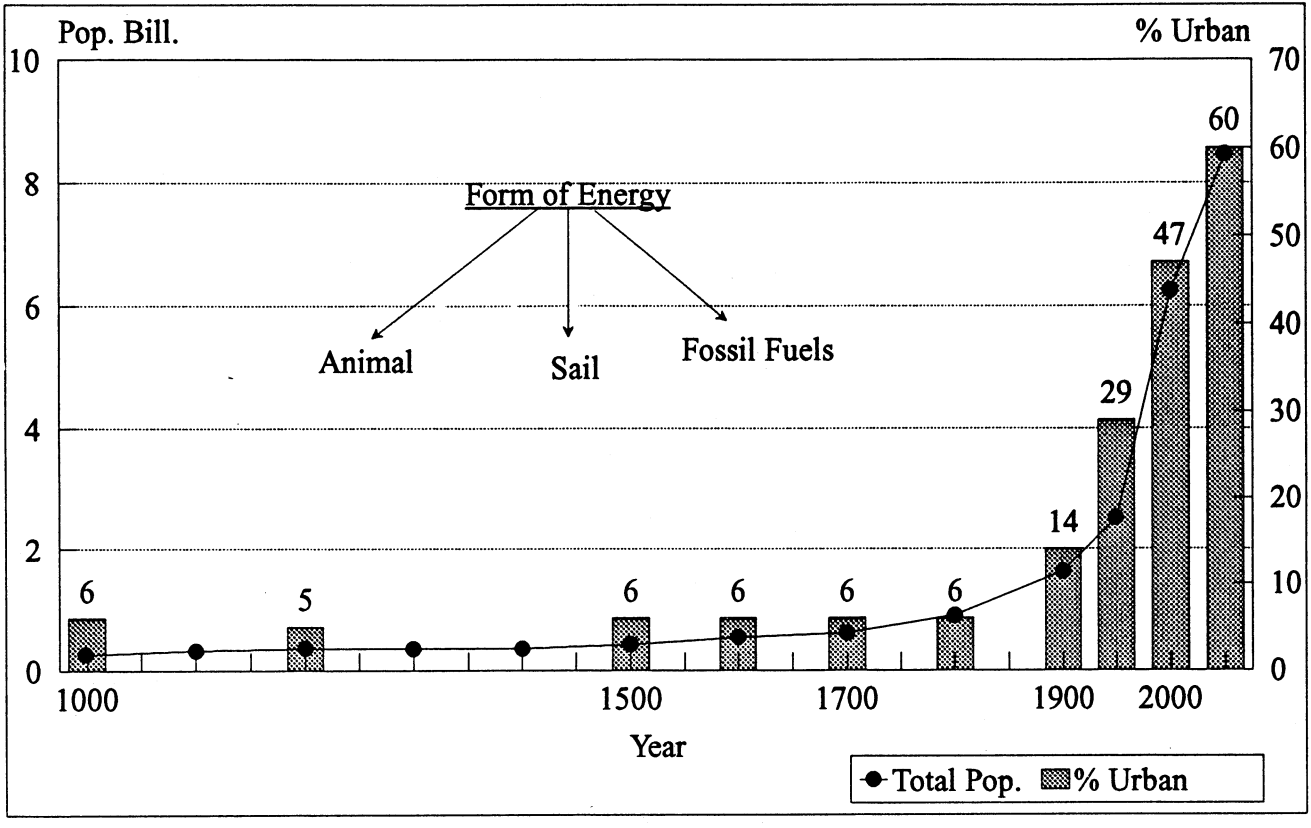


Figure 1. World population, energy, and urbanization, 1000-2025

have been so high. For at least the past fifty years annual increases in world cereal output, for example, have averaged over 3%, about one to two percentage points above world population growth rates.

The increase in output associated with rapid population growth is quite contrary to the gloomy predictions of Thomas Malthus. It is the result of the emergence of a new type of society: urban industrial society. The emergence of this new type of society was a consequence of two sequential revolutions in energy use: first the use of sails and then the use of fossil fuels.

Energy transformation I: Sails. The change from the oars of the Mediterranean galley to the sails of the Portuguese caravel occurred in the first half of the fifteenth century and represented a major development in naval architecture. The galley's one mast amidships was replaced with three-after, amidships, and forward. Oars were eliminated, the hull was raised farther out of the water and ultimately protected by guns rather than by swords (Cipolla 1965). The transition from oars and swords to sails and guns gave the West the technological capacity to "discover the seas."5

The transition began in 1415, when the Portuguese Prince Henry led a successful attack on Ceuta, giving them a permanent base in North Africa. From there the great Portuguese oceanic explorations pushed down the coast of Africa, turning the Bight of Benin in 1472, and rounding the Cape of Good Hope in 1488. Finally in 1498, Vasco DaGama reached the coast of India, linking for the first time Asia and Europe by sea.6 Just over a decade later, in 1511, the Portuguese captured Malacca, a major port and seat of Islamic learning for all Southeast Asia. A decade later Magellan reached the Philippines by sailing across the Atlantic and Pacific, then returned through the Indian Ocean for the first circumnavigation of the globe. Thus in this one brief century, from 1415 to 1521, the world was encompassed by ships at sea.

This technological advance transformed world trade and transportation routes, linking all the continents by the seas, in effect making the world a single integrated environment for the human population. Henceforth human transportation would permit the spread of all localized flora and fauna to other parts of the globe. It took the human population half a million years to spread throughout the world, finding ecological niches in which it could adapt to the environment and survive. In the last 500 years, the human species turned the entire globe into one environment, in which human activities would become paramount in changing that environment.

The transformation of trade routes between 1500 and 1600 brought a series of highly productive crops from the Americas to many part of Asia, Africa and Europe. Everywhere these new crops increased the carrying capacity of the land, thus permitting the human population to greatly increase its numbers.

If the impact of the discovery of the seas was positive for Europe and Asia, it was anything but that for the Americas. There a population of perhaps as many as 100 million had emerged, isolated from the micro-organisms existing with people throughout Asia, Africa and Europe. Because of an absence of autoimmunity, the Americas suffered disastrously from the external contact. Their populations were reduced to one tenth their pre-Columbian populations in less than a century. In some cases, as in the Caribbean, the entire native population was wiped out.

It is important to note that this discovery of the seas was only partly a technological transformation. Equally important were its political and social dimensions. Half a century before Vasco DaGama reached the coast of India, and a century before Magellan's circumnavigation, the Chinese launched five major naval expeditions into the Indian Ocean, reaching the East Coast of Africa. In 1400, Chinese naval technology was far more advanced than that of the West. The great nine-masted flagship of Admiral Zhang He, which made the last of the five African expeditions between 1403 and 1433, was five times the

size of the tiny vessels that carried DaGama, Magellan, or Columbus. It had water-tight compartments, double hulls, and a stern rudder, and was navigated by complex and accurate astronomical calculations. Thus the Chinese had the naval technology to discover the seas. They would also have had the capacity to people the West Coast of the Americas, and halt the western advance into Asia. In effect they had the technological capacity to make the world a Chinese world, rather than the Western world it became. The Chinese decision not to use its technological advantage for conquest of the seas was thus of momentous importance.

The full explanation of the Chinese refusal and the Iberian rush to oceanic conquest is quite beyond the scope of this review,[7] but an instructive contrast can be drawn between the two in the history of the interaction between human institutions and ecological forces. China has been a land-based empire since its inception. Powerful groups arose by using the state to mold the land, digging canals for transportation and managing water for irrigation, drainage, and flood control. The result was greatly increased agricultural production, which brought immense wealth to the empire. Given the great land mass of China and its openness to Mongol populations, much of the empire's wealth was used for *defense of the land.* Three major power groups emerged: the court and the Emperor, the Bureaucracy, and the merchants. The first two were constantly in conflict over the control of the state, and both were allied against the merchants, who were seen as a lowly but lucrative tax base for the empire. It is instructive to note that Admiral Zhang He was a Muslim and a eunuch, marking him a loyal personal servant of the Emperor and an outcast from the bureaucracy and the Chinese gentry. By contrast, Portugal, thrust out into the western seas and with a long coastline, made fishing and sea transport well-established activities. Further, in contrast to Admiral Zhang He, Prince Henry the Navigator, who promoted the Portuguese explorations, was a son of the Emperor, a protector of the Church, and financed by Lisbon merchants. In Portugal and Spain, Crown, Church, and merchants had built an alliance, first to wrest the peninsula from Islam, and then to continue that conquest to the seas. These institutional and geographical differences, far more than the technological differences, explain why the world is now a Western rather than a Chinese world.

For the next two centuries, the seas were used to begin to tie the world environment together into a single unit. A major product of this new integration was that the new crops from the Americas increased the carrying capacity of the earth in Asia, Africa, and Europe. Overall population growth rates rose to 0.18% in the sixteenth and seventeenth centuries, and to 0.39% in the eighteenth century. By 1800 the world's population was just under one billion. To raise growth rates to the higher modern levels, however, would require another form of energy.

Energy transformation II: Fossil fuels. It is the second energy transformation, to fossil fuels, that lies behind the rise of modern industrial society. This began slowly with the invention of the steam engine and the expansion of coal production at the end of the eighteenth century. It grew more rapidly with the invention of the internal combustion engine and the exploitation of oil and natural gas in the nineteenth century. It has now exploded into exponential growth of fossil fuel consumption in the twentieth century. Without coal and oil, steam and internal combustion engines, modern urban society as we know it would be quite impossible.

Even as late as 1700, the world's urban population accounted for less than 10% of the total population. There were some large cities, mostly in Asia, but the social organization of the human species was primarily rural and agrarian. Fossil fuels in transportation permitted high concentrations of populations in urban centers to be provided with food produced by others. Fossil fuels also permitted those urban populations to pro-

duce a surplus of goods that could be traded for food produced elsewhere. The use of fossil fuels would, however, increase the level of carbon dioxide and other greenhouse gases in the atmosphere, producing a marked human impact on the entire global environment.

Both of these energy revolutions stimulated increased population growth. The second has been especially important. It is considered doubtful that the world's population could have grown beyond one or two billion without the transformation to fossil fuels. If this is true, the link between population growth and environmental change is especially salient for today. The fossil fuel revolution produced massive increases in both human numbers and human production, and it is precisely through these numbers and productivity that the human population is having its remarkable, and destructive, impact on the environment.

Modern urban society and population growth. The Western World experienced rapid urbanization and industrialization in the nineteenth century. This was already evident in 1800, when London had a population of 865,000 and fully 10% of the population of England and Wales lived in cities of 100,000 or more; by 1900 this increased to 35%. For the world as a whole, the proportions in cities of 100,000 or more in 1800 was only 1.7%, rising to only 5.5% in 1900. England and Wales experienced the greatest spurt of urbanization between 1811 and 1851, with the U.S. following between 1820 and 1890. Thus by 1900 Europe and North America had become substantially urbanized, displacing Asia as the continent with the largest cities. Until 1800, for example, fifteen of the world's twenty-five largest cities were in Asia, with two more in the Middle East. In 1900, fourteen of the twenty-five largest were in Europe and North America (Chandler and Fox 1974).8

In the first half of the twentieth century, the economic growth and urbanization of the western world were spreading to Asia and Africa. By 1950 almost 30% of the world's 2.5 billion people lived in urban areas. In the more developed regions the level was 53%, and in the less developed world it was only 17%, or not much above the 10% that many societies had reached throughout history. By 2025, it is projected that over 60% of the world's population will live in urban areas, 80% in the more developed regions and almost 60% in the less developed.

While this massive transformation of the world community, the rise of urban industrial society, has been associated with the increase of population growth rates, it also contains conditions that lead to the slowing of population growth rates. To understand this phenomenon, we must turn to the major dynamic underlying modern population changes, the *demographic transition.*

The Demographic Transition: Past and Present

Figures 2 and 3 show the two variants of the *demographic transition*, or the move from high to low birth and death rates, that distinguish the more developed from the less developed countries. This can help us to understand some of the dynamics behind past and present population movements and can also serve as an introduction to the modern population policies that represent a revolutionary change from the past.

Figure 2 uses the experience of England and Wales to illustrate the demographic transition, which has now been completed in all of the industrialized countries. The transition began with high levels of mortality and fertility, which can be called the traditional condition of the human species throughout most of its earthly existence. Often death rates rose above birth rates to bring a period of absolute population decline. In the best of times, mortality declined and population increased, but this did not last long and overall the growth rates over long periods must have been only a little above zero.

In the early 1700s the death rate in England and Wales began a gradual and persistent decline, leveling out around ten per thousand in the early twentieth century. Fertility remained high until near the end of the nineteenth century, and then dropped rather rapidly to

Figure 2. Past demographic transition: England and Wales, 1700-1980

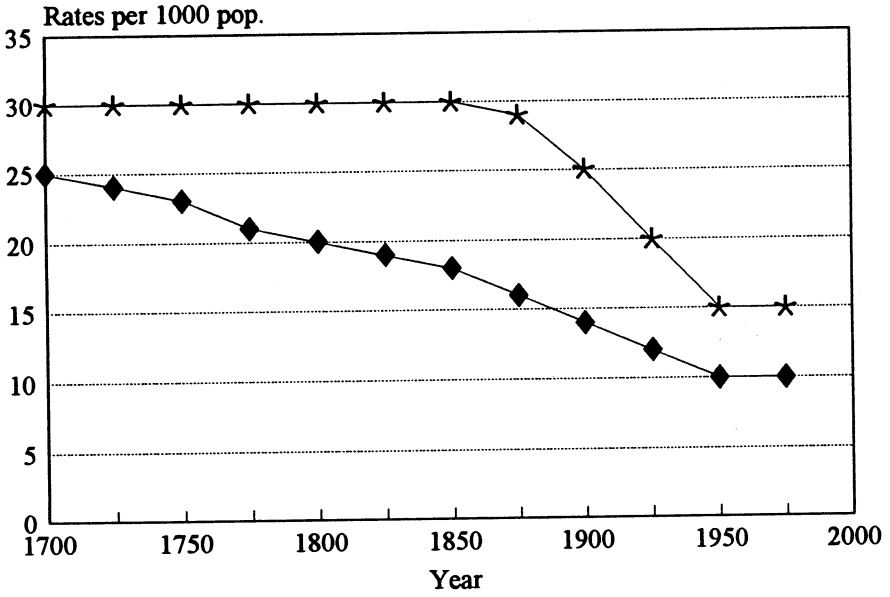
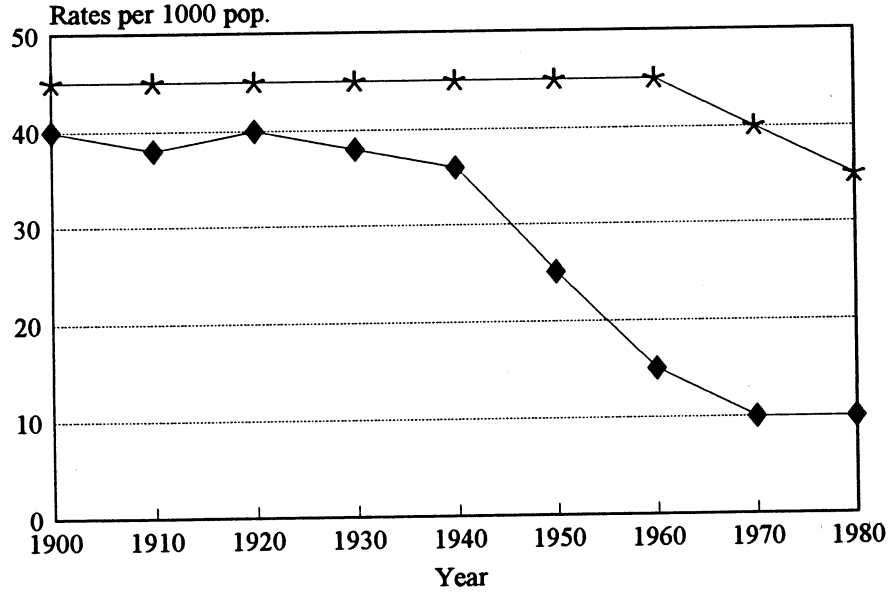


Figure 3. Present demographic transition: Africa, Asia, and Latin America



CBR = crude birth rate; CDR = crude death rate

CBR CDR

about fifteen, coming into line with low mortality. This transition, from high to low mortality and fertility, with an intervening period of rapid population growth, marked the transition from rural agrarian society to urban industrial society. While many details are obscured, the general pattern seems clear. Mortality declined through the combination of an epidemiological transition (McNeill 1976), a gradual rise in the earth's temperature (LeRoy Ladurie 1988), trade expansion through the seas, agricultural and industrial revolutions, and, to a far lesser extent, through improvements in medical technology. Only at the end of the nineteenth century did medical advances play much of a role in mortality declines.[9] Together these changes implied a slowly rising standard of living, or an increase in the carrying capacity of the land.

The decline in fertility came with the emergence and maturation of the new type of society: urban industrial society.[10] Perhaps the most important aspect of this transition involved the changing value of children and reproduction in what John Caldwell (1976) has called the transition from upward to downward net intergenerational capital flows. Children were transformed from economic assets to economic liabilities. This was, however, far from a simple change in the economic calculations made by individual families. It was, rather, a broad social and cultural change that moved rather quickly, after it began, through groups identified by language, culture or ethnicity. In the broadest sense, it was a change that we tend to call modernization.[11] With this change, fertility declined and came into line with low mortality rates. The demographic transition was completed. Every industrial society has now completed that transition, though there have been substantial differences in the timing and trajectories of the declines in birth and death rates.

That same transition appears to be taking place in the less developed countries of Asia, Africa, and Latin America (Figure 3), though there are considerable differences in the character of the change. First, the birth and death rates at the beginning of the transition were higher than those in Europe and North America.[12] Second, the recent decline of mortality has been much more rapid, and has been due to major advances in medical and public health technologies, which arose largely out of World War II. The development of antibiotic drugs, vaccines, pesticides, and fungicides all permitted new wide-spread health networks to reduce mortality from infectious diseases. Mortality declines that required a century or more in the past now took place in decades. Because of this rapid mortality decline, the population increase associated with this transition has been more rapid and of greater magnitude than that experienced in the past. Past transitions brought rates of 1 to 2% per year; current transitions have brought rates of growth of 3% and more.[13] Finally, the fertility declines that we now witness in the developing world are, in part, associated with a remarkable set of policy revolutions, from pro- to anti-natalism. In the industrialized world, past fertility declines often came *despite* the wishes and policy of government. Today, many governments in the less-developed world are *leading* the drive to fertility decline.

It is difficult to overemphasize the revolutionary character of these policy changes. Until 1952 virtually all governments throughout human history were pro-natalist. People were a resource, which translated into power. Governments taxed people, worked them, and sent them off to war. Thus governments have always tended to want more rather than fewer people. This led virtually all governments to be pro-natalist.[14]

This changed dramatically in 1952 when Japan and India became the first of the modern governments to announce official policies to limit population growth through limiting fertility. Since 1952 almost all developing country governments have followed. Throughout the world today, governments have launched, supported or permitted the formation of national family planning programs, to distribute the new contra-

ceptives and to disseminate the message of fertility control. There is no doubt that this combined technological and policy change is having a major impact on fertility reduction and population growth.[15]

Like the declines in mortality, both the policy changes and the current declines in fertility in the developing world have been greatly assisted by the development of a new contraceptive technology. It is highly unlikely that governments would have adopted wide-ranging fertility limitation programs, or that they could have been as successful as they have been, had there not been this technological innovation (Ness and Ando 1984). It is also important to note that the new fertility-limiting technology, like mortality-limiting technology, may be referred to as "bureaucratically portable." It can be set in the specialized hierarchic organizations that governments throughout the world have developed to administer their populations. This ties population environment interactions of the present closely to technology and human organization, especially to the rise and spread of modern bureaucratic organizations.

It seems quite likely that current fertility declines will continue, and will be driven by two major forces. One is the same urban-industrialization that in the past transformed children from assets to liabilities. This is often referred to as the "demand-side" (i.e., demand for fertility limitation) force in fertility decline. In addition, the expansion of national family planning programs, bringing a greater supply of the new contraceptive knowledge and methods, also works to depress fertility. There is considerable controversy over the relative impact of these "demand" and "supply" sides of the forces, but there is also agreement that the two together work more powerfully than either does alone.[16] The issue of policy implementation, specifically of the organization and management of modern family planning programs, has been dealt with extensively in the literature. It is evident that governments vary considerably in their willingness and ability to promote fertility limitation. This is related to something that can be called a political culture that greatly affects what a government can and cannot do (Ness and Ando 1984). Finally, there are powerful cultural forces that work directly through individual and family reproductive orientations, and these, too, profoundly affect both what governments can do and what individuals themselves will do to limit fertility.

Conclusion

In considering the impact of population and development on global environmental change, it is necessary to keep in mind the full range of global changes that are affected by human action. Population growth and economic development have resulted in massive increases in energy use, especially in fossil fuel consumption, and thus the increasing release of greenhouse gases into the atmosphere. They are also associated with massive deforestation and the destruction of many plant and animal species. This species destruction continues today, perhaps at increasing rates. The impact of this aspect of global change may be less readily apparent than the threat of global warming, and thus may have received less attention. In addition, urbanization and industrialization have the led to increased emission of toxic wastes in land, water and air. This aspect of environmental degradation has received more attention recently, but it has yet to become fully integrated into our views of global change. In effect, a wide range of human impacts on the environment must be more fully integrated into our views of global change if we are to understand the relation between population and environment. That integration is also necessary if we are to adjust our behavior sufficiently to ensure the continued survival of the human species, and perhaps of the entire global ecosystem as well.

We must recognize that population policies are some of the most conflictual we know of in the history of modern public policy. Population policies touch deeply held values of race and ethnic identity, human sexuality, gender roles, fundamental values of individual rights,

and of life itself. Wherever a state's population is ethnically divided, population policies will be faced with deep, primordial fears of population decline which accompany changing relative numbers of different ethnic groups. By contrast, many other environmental policies may be subject to at least some economically rational argument. Further, many environmental controversies can be resolved with scientific research and cost-benefit analyses. Many of the population controversies, however, are moral and ethical and cannot be resolved with scientific evidence or economic calculations. Although the world community as a whole has made massive strides in treating population issues with greater understanding, it still generates deep fears and conflicts. This situation will undoubtedly persist. Our task cannot be to provide the scientific evidence to resolve the population debates. It is, however, our task to provide the evidence and information that can make those moral and philosophical debates more fully informed.

Endnotes

1. Note this is *in the best of times.* Then, growth might have been as high as 0.5% per year, though usually only for relatively short periods. Even those growth rates implied a doubling time of 140 years, or about four generations (Coale and Watkins 1986, Cipolla 1974, Deevey 1960).
2. This is often known as the *epidemiological transition.*
3. This results from what is known as *population momentum.* When fertility and growth rates are high, many new babies will be born. Even if these new additions experience reduced fertility when they reach reproductive ages, their sheer numbers will keep population growing in total numbers.
4. McEvedy and Jones (1978) is used for these global figures to 1950, and the United Nations (1988) for the years 1950-2025. There is some dispute over the population of the Americas on the eve of the European conquest, which McEvedy and Jones place at 14 million. William McNeill (1976) places the number at 100 million. I am inclined to accept McNeill's figure, but have retained the McEvedy and Jones figure for consistency. There is more agreement after 1700 on the total numbers, but the implication of the difference concerns the extent of the demographic collapse of the American Indian population resulting from the European contact. It is not unreasonable to accept McNeill's judgment of a full decimation of the Amerindian population as a result of the impact of European diseases.
5. The term is J.H. Parry's (1974).
6. Boxer (1961) provides a succinct survey of the Portuguese expansion. Parry (1959) considers the broader European involvement.
7. Paul Kennedy (1987) has a good summary contrasting the Chinese and Western systems.
8. The five largest in 1900 were London, New York, Paris, Berlin, and Chicago.
9. The one major medical advance that precedes this is the discovery of a vaccination against smallpox that is dated about 1740. Until about 1800, however, the vaccination used smallpox itself, which often resulted in death, and was not widely accepted, especially in urban England and on the continent. At the turn of the century cowpox was used to vaccinate humans, with few serious side effects. This new form of vaccination then spread rather widely throughout the world during the 19th century.
10. See Coale and Watkins (1986) for a full review of the decline of fertility in Europe. This provides an exposition of the variety of economic, health, social, and cultural conditions that played a role in the fertility decline.
11. Cleland and Wilson (1987) make this point clearly for both past and present fertility declines. In both cases fertility declines tend to run along broad cultural, language, or ethnic lines rather than along clear class or income lines. The latter is more a part of the common perception and is also well articulated theoretically in what is called the new household economics of fertility. As Cleland and Wilson show, however, empirical support for this well-developed theory is weak or lacking altogether. Caldwell (1977, 1986, 1988) also makes this point for Africa and for comparisons with Asia and Africa.
12. This is probably related to differences in kinship patterns, but that discussion must be left to another time and place.
13. It may well be that the speed of mortality decline and the magnitude of population growth are the most powerful deleterious effects of the current transition. Ogawa and Suits, for example, have performed a simulation exercise for Japan's past 100 years of demographic transition. They simply assigned recent Asian mortality declines to Japan after 1870 and concluded that with the more rapid mortality decline and consequent higher population growth rates, Japan would not have been able to achieve the savings and investment rates necessary for its own economic take-off.
14. The logic of this statement requires a connecting argument. Governments that want more people can get them through conquest, encouraging immigration, and encouraging high fertility. All three have been

extensively used as government policies. Conquest has always been risky, however, and in the modern world promoting immigration also raises problems. In all societies, probably the safest and surest method of increasing, or sustaining population, is simply to encourage people to do what comes naturally—reproduce. Hence the near universality of pro-natalism as official government policy

15. It is also necessary, however, to note that the policy change is neither a sufficient or necessary condition for fertility decline. Policy changes have been made in Egypt, Kenya and the Philippines, for example, with little apparent impact on fertility. On the other hand, Brazil has had no real policy change, yet fertility has declined, largely because contraceptives and abortions have become much more widely available in that rapidly urbanizing society.

16. As in most discussions of current fertility decline, even this broad generalization requires some qualification. Bangladesh illustrates a case, especially in its experimental *Matlab* district, where fertility decline appears to come solely from contraceptive distribution, with no appreciable economic improvement. On the other hand, Brazil illustrates a case where economic development, and especially urbanization, have brought rapid declines in fertility in the near complete absence of any government efforts to distribute contraceptives. Burma also shows some fertility decline without economic development, and even with government attempts to limit the distribution of contraceptives. In this case, however, abortion appears to be the most generally used method of fertility limitation, usually with very high costs for women.

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