Working Paper

Population and Development within the Ecosphere: A Bibliographic Essay

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WP-90-70
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IIASA

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PREFACE

Until as little as two decades ago, biologists, economists, politicians and the public generally saw population as setting sharp limits for the prosperity of mankind. The thought is expressed by every major classical economist after Adam Smith; to find dissent from it one has to drop down to figures like Godwin in England and Henry George in the United States, neither of them regarded as a deep thinker either in his own day or subsequently. Marx did oppose Malthus, but only as a central feature of his case against capitalism. Marx and Malthus agreed fully that under a market system a larger population is the major threat to welfare; in fact Marx was even more emphatic on the point than Malthus, and differed only in thinking he had found an alternative system under which this defect of the market could be circumvented. Textbooks of economics all showed diminishing per capita income with increased population, at least beyond a certain point of density that they agreed had been passed some time ago.

After a century and a half of virtual unanimity among those scholars whose opinions we respect a split appeared in the 1960s and 1970s. On the one side and placing less emphasis on controlling population in the interest of development are many neoclassical economists, some governments and some of the public in the developed countries; on the other side, expressing themselves even more strongly on the damage to welfare caused by dense population than did the 19th century economists, are biologists and other scientists, part of the public, most of the governments of the less developed countries.

The following brief review of the literature is offered as a preliminary to resolution of the difference. My limited objective will be fully attained if it does nothing more than present the two sides with impartiality. I tried to give space to each argument in proportion to its intellectual weight, not in proportion to my agreement with it. Indication of points at which I failed to maintain the knife-edge balance will be appreciated.

ABSTRACT

Biologists and intelligent lay writers are raising the alarm on what is coming if population continues to increase: exhaustion of soils and mass starvation, deterioration of the ecosphere to the point where it is not livable, or if not that then at the very best declining incomes and loss of the amenities and accomplishments to which this generation has become accustomed. On the other side neoclassical economics, that also has a lay following, provides optimistic comfort: with modern ingenuity, given scope and stimulus by the freeing of markets, all shortages will be overcome, all deterioration repaired. Not population, but artificial constraints on the market, are doing the damage. The present survey is concerned with the consequences of population change and takes for granted that once development occurs population will come under control.

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--Only the variables put into the
equation can emerge in the solution.

Are there too many people or too few? Stated in so general a form the question has no sense, and yet a large literature both contemporary and ancient puts forward unqualified general answers in one direction or the other. Some of the literature is in scientific journals in various fields; much more is in the popular press and magazines. The Brundtland Report (1987) and the Amsterdam Declaration (1990) are two of hundreds of recent documents expressing the sense of urgency in relation to population as well as to the deterioration of the environment; the National Academy of Sciences (1986) report sees few problems in either population or environment that cannot be solved by sound economic policies.

A worldwide controversy is going forward on the disasters that are pending--or not pending --with present rates of overall growth of the human population, yet because many disciplines are involved, and because proponents publish in different places, one feature of a debate is lacking: point by point presentation and rebuttal. Neither side takes the other seriously enough to answer its arguments in their own terms. We all want to be empirical but the most relevant facts are inaccessible to present observation: whether oil supplies will run out before they can be replaced by other sources of energy is indeed a matter of fact, but one only ascertainable over the course of future centuries. Even the facts that are to hand are subject to grossly different interpretations.

The major less developed countries themselves see population control as their main problem. President Soeharto of Indonesia declares that

> The primary objective of the Indonesian Government's policy is to reduce the rate of population growth... In the 1978 guidelines for state policy, priority was given to national family planning to curb fertility.

They see each birth now as one more educated young person looking for a job 15 or 20 years hence, and in the absence of resources and capital little prospect of finding one.

The discipline that is directly concerned with human population--demography--and that might logically be refereeing the debate, be helping to decide whether the alarm (McNamara 1984) is justified and what ought to be done, has on the whole avoided participation. Articles and papers on the nature of sustainable development, on carrying capacity, and on other concepts that the debate has thrown up, are not conspicuous in our journals and are seldom read in our professional meetings.

Meanwhile the outsider can only be surprised at the absence of civility in the style of discussion. Neither side sees the arguments of the other as rational. William Baumol of Princeton speaks of "many hysterical [sic] predictions about our environmental future" (back cover of Simon (1981)) and Harold Barnett of "popular press books with their whole array of crisis allegations." (same back cover). Says Simon (1981, p. 286):

> The *Limits to Growth* simulation...is not worth detailed discussion or criticism... [it is] public relations hype...[and the Club of Rome] scared many people with these lies.

And the same applies to other work, entirely unrelated to the Club of Rome: *Global 2000*'s (Barney 1981) conclusions are "almost wholly without merit and the method shoddy," says Simon. The only point in reminding the reader of the style of debate is to show the effect (use of words like "hysterical," "lies," "shoddy") of one discipline being unable to fit the other into its own schemes, or even to talk clearly about the other discipline. The language of economics has evolved in such a way as to provide no place for ecology, and that of ecology can find no way to express such economic concepts as substitution.

The following brief survey of a vast and scattered literature is designed to pose the question: how can we bring our science of demography to the point where it is relevant to what others think is the most pressing issue in the field in which we work?

THE ISSUES ARE NOT NEW

Even in the time of the classical economists the issues were by no means new. It takes little search to find them repeated over and over again through the centuries (Stangeland 1904; United Nations 1973; Petersen 1972). For Cicero (44 B.C.) as for other Roman writers who touched on the subject there could never be too many Romans--men who would conquer the lands on which they would maintain themselves, and women who would breed soldiers to conquer further lands.

By the time of the Mercantilists sentiment was still emphatically populationist, but now for reasons economic rather than military (Spengler 1942; Riley 1985). Jean Bodin (1576) put the matter succinctly and equally without qualification: "There is no wealth but men [sic];" at the worst they could be put to work making cloth or other goods tradeable for gold, and so add to the assets of the sovereign. (Still the Mercantilists spoke of the disorder and crime that they saw as resulting from denser population and the growth of cities.)

For 150 years the Malthusian proposition that population tends to outrun its food supply was the basis of all discussion of the matter. "Malthus was the father of demography," say Caldwell and Caldwell (1986, p. 4) among many others, and few fields have had so clear a parentage, based on so simple an idea. That proposition was expressed in its least qualified form in the first edition of Malthus's *Essay* (1798). (An easily accessible version with an insightful introduction is by Kenneth Boulding (Malthus 1967)). The first edition contains little statistical material and not much about the way real populations do in fact control their numbers to avoid impoverishing themselves, but plentiful data appear in the six later editions.

The harm that population growth can do to the general welfare is shown in Ricardo's (1821) exposition of rent, on a simple model in which with everything else the same additional people will necessitate the use of marginal lands, and the smaller returns that can be earned on these will become the standard returns for all workers, with correspondingly larger amounts going to proprietors. "Ronald Lee's (1980) estimates for pre-industrial England suggest that a 10 percent increase in population depressed real wages by 22 percent and raised rents by 19 percent" (Preston 1988, p. 3).

John Stuart Mill (1848) introduced the qualification that in secondary manufacturing increasing returns to scale would be the rule, but these could be obtained by international trade, so there was no need for any country to push its population to the point where scarce foodstuffs brought down the general standard of living. In fact small countries could well have an advantage. As Kuznets (1960, p. 32) says, "[T]he proper framework of social institutions...is an indispensable prerequisite for economic growth.... The distinctive advantage of small nations lies in this determinant of economic growth--not in technology of production." For Mill the diminished food per capita as population grew (successive mouths having the same need, and successive pairs of hands producing less) combined with the cheapening of secondary goods to set an optimum number for population, a concept that Sauvy (1963, Volume 1, pp. 50-54 and throughout) makes central to analysis of the effect of population on welfare, notwithstanding its static character.

An American radical who saw no limits to population was Henry George (1902, p. 141). George echoed Mill's observation about hands and mouths, but went the opposite way: "the new mouths...require no more food than the old ones, while the hands they bring with them can...produce more." On the other hand, Alfred Marshall (1961) anchors the economy firmly in its physical base. Thus a typical statement (p. 195): "Climate has a large share in determining the necessities of life." Marshall saw the economy as seated in the environment rather than floating above it.

The economist who railed most violently against Malthus was Karl Marx, in various places using arguments that he could not have meant seriously: "If Malthus is right the world was already overpopulated when there was one person on it" (Meek 1953, p. 59). Marx agreed completely with Malthus on the disadvantage of population in a market society, and this disadvantage underlay his argument for socialism. In population, as in some other matters, the Peoples' Republic of China was for a time loyally Marxist. "Population is not a problem under socialism," declared the head of the Chinese delegation at Bucharest. But as an example of ideological flexibility, just a few years later in 1983: "We must lay special stress on population control...late marriage and one child per couple," said Prime Minister Zhao Ziyang (quoted in Demeny 1985).

POST WORLD WAR II DEVELOPMENT ECONOMICS

In the 1960s the Harod-Domar (Domar 1957) model as applied to the LDCs assumed unlimited labor and disregarded land altogether, so in effect making capital the source of wealth. Twentieth century classics are Arthur Lewis (1955) and Gunnar Myrdal (1968), the former mainline economics, the latter more alert to social variables, both demonstrating the handicap constituted by dense and fast-growing population. Also somewhat old, but still widely read is the work of Benjamin Higgins (1979), which gives special attention to Indonesia. None of these books challenges the Malthus-Ricardo-Mill view that population growth beyond some moderate density (already passed in most of the

LDCs) is a clear drawback for individual welfare and for the economy as a whole. They all put population control in the forefront of the measures needed for development. As Frank Notestein expressed it:

> [T]he problems of economic development would be greatly simplified if the rate of population growth could be cut by a drastic reduction of fertility in the LDCs (Notestein 1975, p. 541).

Gunnar Myrdal's (1972, p. 211) expression was to the same effect:

> ...population increase is the key factor in the environmental problem. Natural resources have to be considered in relation to the population which is to be provided for.

CAPITAL SHORTAGE

Two books that took technical advance into account, and contributed some relatively solid numbers, were Coale and Hoover (1958) and Coale (1986). After showing that India was likely to be able to produce the food it needed for several decades ahead, they focussed on its limited capacity for capital accumulation. To oversimplify their argument, any increment of population would require tools and other capital at least equal to what its predecessors had used if it was to have the same livelihood, and this would require capital even before capital was used for the innovation in which development consists. "It is precisely in having more resources available for fruitful investment that we have found the principal economic advantage of reduced fertility" (p. 328). The Harod-Domar model is part of the background for this.

The methodology introduced by Coale and Hoover was to calculate the pace of development in India and Mexico on various assumptions of the rate of population growth. It is not easy to estimate how income will move with more people and how with fewer people, and yet it is only by estimating these for a particular territory that the question of too many people or not enough can be answered.

They apply a variant of the Cobb-Douglas production function, a model in which "the proportionate increase in national income is the weighted average of the proportionate increase in the labor force and the proportional increase in the stock of capital" (p. 325). Trials with a range of values of the weighting parameter turn out not to alter greatly the conclusion.

The Coale and Hoover argument held the field for most of twenty years. It was explained in every textbook, and was the rationale for large population programs by the United States and other countries. Lloyd Reynolds (1969), for example, reflects it: "The lower the rate of labor force increase, the smaller the development effort needed to shift the economy's center of gravity" (p. 776). But now, says Preston (1988, p. 2):

> [C]apital/labor ratios, like natural resources, have left the center stage of the debate...growth of capital stock has played a far smaller role in economic growth than had previously been believed.

What counts, on this view, is not the amount of capital but the abilities of people, human capital (Schultz 1961).

Such indifference to financial and physical capital is not to be found in the administrative circles of Brasilia or Jakarta. The view prevailing in such places is far closer to the Harod-Domar model than to the sudden turn from physical capital to human capital of neo-classical economics.

IS THE BIRTH RATE A POLICY VARIABLE?

The only discussion of the 1950s and 1960s was whether birth control programs could actually have an effect in the desired lowering of the birth rate. A series of writers, and especially Notestein (1945), described what Notestein called a demographic transition, in which the birth rate inevitably falls after mortality has fallen and development has reached a certain stage.

Notestein's demographic transition was taken so seriously by some, especially in the LDCs, that they asserted that there was no need for sponsored programs of birth control, whose instruments would come to be used only after development was well under way and not before. Needed therefore was large scale capital aid rather than population programs. As Indira Gandhi said, "Development is the best contraceptive," and "Are not poverty and need the greatest polluters?" (United Nations 1972, p. 18), phrases that for a decade or more rang across the continents.

Relevant here is the coherence of the family, its provision of old age security in particular. Few would disagree with Leibenstein (1957) in attributing the high fertility of traditional societies to the need of parents to secure their old age. Owning children is like any other kind of family saving such as owning a bank account or a house. (Much less often mentioned is the converse--that in industrial societies, that have old age pension systems, the birth rate is low because children are not needed for old age security.) When no other savings are possible one cannot talk people out of having children.

Work investigating the condition of population in the world and just how much difference birth control programs make is due to Berelson (1975) and Mauldin, of which an account is given in Ross and Mauldin (1988), and more recently in Mauldin (1990). A careful case study is Freedman, Takeshita, et al. (1969) on the decline of fertility in Taiwan. Briefly interpreted, all these studies showed that if there is no economic or cultural incentive to population control then sponsored programs providing contraceptives will do little (e.g., Sauvy 1963, Volume 2, p. 225); if there is full sophistication programs are obviously unnecessary. Many countries and groups within countries now fall between these two conditions, and in them the fall of the birth rate is indeed speeded by the availability of information and the instruments of contraception. Hermalin (1982), reviewing 8 studies, finds strong effects of programs everywhere. Siew-Ean-Khoo (1978) finds 48 percent of the fall in fertility attributable to program effects in Hong Kong, 64 percent in Malaysia. Notestein refers to meaningless debate between advocates of economic development, social change, and family planning: "All three are required, and no one is a substitute for another" (p. 541). Accepting that programs do make a substantial difference, the MDC development community agreed that population control was a crucial condition for development. This runs through the writings of Philip Hauser (1963), and Donald Bogue (1967).

Stephen Enke (1969) gave the most uncompromising expression to the argument: "One dollar in contraceptive aid does more for development than does $100 in steel mills," and his phrase circulated in the highest circles, right up to a speech of President Johnson (also Enke 1971). All this was in the 1960s; the argument had lost its hold by the 1980s as far as the U.S. administration was concerned.

Mason and Suits (1981) estimate the value of an averted birth. With a 15 percent discount rate the value is $215, similar to the Enke calculation. Since the costs of a child precede the benefits, the higher the discount rate the higher the net benefit of preventing the birth, and Mason and Suits find a range from $9934 to $90 as they go from a 20 percent to a 5 percent discount rate. One should use real rather than money rates of interest for this purpose, and even 5 percent could well be too high for an estimate of the real rate. The models all show that birth control programs pay off, but they also show a discouraging variation in results.

BUCHAREST AND MEXICO CITY

The view that population control is important for development, on which MDC demographers mostly at the time agreed, encountered opposition through the 1970s in many of the LDCs. The World Plan of Action of 1971, dominated by the LDCs, had started in this vein: "Of all things in the world, people are the most precious. Mankind's future can be made indefinitely bright" (Demeny 1985, p. 132). The opposition between the MDCs (the United States in particular) and the LDCs came to a head in 1974 in Bucharest.

Much has happened since the Bucharest Conference. In the MDCs it began to be asked whether family planning was needed at all, whether a larger population, either in particular countries or in the world as a whole, would be such a severe handicap to development. This fitted with a strong pro-birth, anti-abortion movement in American politics, especially in the years since 1980. By the time of the Mexico City Conference in 1984 (Demeny 1985), the protagonists had changed sides: the LDCs, beginning to experience some of the seemingly intractable problems of development, insisted on the importance of population aid programs, while the United States expressed uncertainty on the need for them, tended to stress the immorality of abortion, and talked much against coercion and in favor of the right of couples to have as many children or as few as they wanted.

NEO-CLASSICAL ECONOMICS

The contemporary populationist sentiment is expressed by Julian Simon (1982), who provides the most unqualified expression since Jean Bodin (1576) of the capacity of countries to tolerate indefinite numbers of people. Nothing is produced except by people; the more people the more production.

Underlying all this in its contemporary expression is a profound faith in technology. If technology spurred by the free market can liberate production from the land, and if the economy shifts towards tertiary industries that require little of either land or capital, then with labor as the sole productive agent both population and the economy can expand indefinitely. Writers (e.g., Herman et al. 1989) speak of dematerialization of the economy;

both the inputs and the outputs of production diminish in weight and volume. And Malthus' bugbear of food limits is postponed to far in the future in the FAO study of carrying capacity (Higgins et al. 1982) and Avery (1985) with a discussion of triticale and other new discoveries.

"Higher population density implies faster economic growth in LDCs....No relationship was found between the population growth rate and economic growth" (Simon and Gobin 1981, p. 299). "In the long run population growth has a positive effect on per capita income" (p. 227). Colin Clark (1978, p. 146) has for 40 years been arguing that there is a positive relation. Simon Kuznets (1966) assembled a unique collection of statistical data and showed that the role of both land and capital in economic growth was less than the classical economists had assumed.

For Kuznets (1966, 1967) population growth brings new labor force into cities in early industrialization and also increases demand. He shows the association of economic growth with population growth and its urban concentration, that in the early days provided both the masses of workers and the mass market for their product. He comments (1975) on the desirability of reducing fertility to accord with contemporary low mortality, but does not express any alarm about population increase. A comprehensive review that is sympathetic to the Kuznetsian viewpoint is Perlman (1981), like Kuznets giving minimal attention to environmental limits.

The uncertainty in contemporary economics is shown by quotes from J.R. Hicks (1971) within a few pages of each other: "Overpopulation through shortage of land is one of the great causes of the poverty there is in the world" (p. 65). He speaks of overpopulation as a "terrible possibility." On the other hand (p. 69): "It is not impossible that the slowing-up of population increase may have been one of the things responsible for the exceptional unemployment which occurred during the 1930s."

EFFECTS OF POPULATION ON INSTITUTIONS

Beyond this and in considerable part outside of economics is a further intellectual tradition that makes population a positive element in economic growth. It supposes that institutions are not fixed, but change as a function of population. This part of the story starts with Durkheim's (1893) study of the division of labor, in which he showed how individuals under increasing population pressure would shield themselves by finding some specialized activity. Just as species of plants and animals seek ecological niches in which they are sheltered from competition, so humans try to find occupational niches. Durkheim so explains the division of labor, regarded from the time of Adam Smith onward as the key to economic progress.

Extending this, Boserup (1981, 1987) presented evidence that population density in agricultural areas forces more productive systems of land tenure. She makes her point in terms of pressure setting up rules of private ownership, as does Preston (1988):

> [I]n the longer run [family planning programmes] reduce the incentives to establish the access rules for such resources that help guarantee their long-term availability (p. 8).

Clark (1967) uses similar arguments to suggest that the effect of population is positive. Yet the subject is complicated. Geertz (1963) showed that increasing density in Java resulted in a change of institutions all right, but it was in the direction of shared poverty, while the lightly settled other islands of Indonesia with their long fallow period lived better.

Albert Hirschman (1958) also speaks of the kinds of institutional changed impelled by population. With threatened Ricardian decline in standards of living, people will struggle to invent technologies and reorganize production and so avoid decline.

INSTITUTIONS FOR ORDERLY EXPLOITATION OF RESOURCES

Suitable institutions for the governing of natural resources became a preoccupation in the late 1960s. Those that are accessible to all are cared for by none, as Garrett Hardin said in a simple but influential article on "The Tragedy of the Commons" (1968, pp. 1243-1248). Population increase inevitably hastens the destruction of any commons--the grazing field of a village, or a nation's forests, or the ocean fisheries. If crowding brings into people's vision the greater effectiveness of private ownership of land, and they set up a system of land tenure, then their crowding will have brought a major benefit. Individual tenure to which the society is urged to move will provide incentives to economizing and to innovative methods of production (National Academy of Sciences 1986).

Everything depends on how people react to the prospective crowding. They could see what is coming and limit their numbers as do the hunting and gathering people of the Kalahari Desert (Howell 1979) and so avoid a population crisis. If Malthus had read Howell he would have cited the !Kung as a favorable example of the preventive check, applied at a low level of population density and of production. Durkheim (1893) could have cited them as an example of low level stability and stagnation.

FINITE LIMITING FACTORS: THE MODEL BUILDERS

The classical economic tradition of population study, concerned with the limits to land and hence to food supplies, sensing the impossibility of indefinite exponential increase, has now passed to scholars of other disciplines. Kahn and Wiener (1967) was among the first to attract attention with a model in which population was no great obstacle to economic growth. An early widely read exposition on the other side was sponsored by the Club of Rome (Meadows et al. 1972), and it was followed by Mesavoric and Pestel (1974) and other writers. A similar spirit animated a later investigation led by Barney (1981). International organizations, especially the ILO, came into this, and many models were built for, or in any case applied to, particular countries; among these the BACHUE models are the most often cited.

The acknowledged antecedent of the Club of Rome type model-building was Jay W. Forrester (1971). Population is central for Forrester. He has feedback loops in which population is respectively controlled by crowding, pollution, food supply, natural resources. Any one of these can bring the exponential population growth to a halt, indeed cause sudden and tragic collapse of population (Chapters 2 and 4). "The Malthusian thesis has been true and is at work at all times" (p. 27).

Forrester explains the suddenness of reaching "crisis level" by the property of an exponential, for instance one that doubles every 50 years (p. 3). "Even though nothing has changed in the underlying law which until then has governed growth... within one lifetime, dormant forces within the world system can exert themselves and take control" (p. 5); "food ...has been potentially sufficient throughout all of history," yet suddenly we have a "starvation crisis" (p. 7). Though conditions do not now appear exceptionally bright, yet in comparison with both past and future "we may now be living in a 'golden age'" (p. 11).

> There may be no realistic hope of the present underdeveloped countries reaching the standard of living demonstrated by the present industrialized nations....With four times as many people...their rising...could mean an increase of 10 times in the natural resource and pollution load on the world environment (p. 12).

A more restrained analysis is due to Revelle (1975). He takes up the population-carrying capacity of the world as a whole with some precise numbers, starting with the energy of sunlight, going through its transformation into primary (cereal) food energy, up to its availability for humans. His energy conversion process is modeled on that of an Iowa farmer, and he finds that potentially arable land on the planet is much larger than any contemplated population growth, but the actual use of that land depends on economic and social variables. Of value in the paper is its showing where the limits of nature end and the powers of human organization begin.

Says McNicoll (1981), "The age of dinosaurs among population-development models may be coming to an end." Arthur and McNicoll (1975) and McNicoll (1984) have an extended and useful review of such models. Warren Sanderson (1980) reviews seven economic-demographic models in some detail. McNicoll (1982, pp. 101-104) has an elegant exposition of Malthus as a successful modeler.

The work sponsored by the Club of Rome is subject to many questions, yet long after its techniques and specific results are forgotten, the Club of Rome will be remembered for calling public attention to neglected aspects of economic growth, for being in the van of what is now a worldwide ecological movement.

Meanwhile the more modest model-building of Lestaeghe (1989) deserves mention. He is especially interested in negative feedbacks that provide stability. One such is the Malthusian model. Other sorts of mechanisms include the polygamy of Africa, say in Botswana, occasioned by the fact that wives were needed in agriculture. In the 19th century the plow was introduced into Botswana, and marriage virtually ceased. Half of the women remained unmarried once they were no longer necessary in agriculture. They still had children; in fact the high fertility was virtually unaffected by the collapse of marriage; the delay of marriage is a means of birth control in some societies (for instance Europe, especially Ireland in the 19th century) but not in all societies.

CARRYING CAPACITY

The notion of carrying capacity is congenial to natural scientists at the same time as it is an irritation to social scientists. To biologists or agriculturalists used to studying the capacity of pasture lands to maintain livestock, observing famines in overcrowded parts of Asia through history, it seems natural to take it that beyond a certain point population in

a given area will bring misery. Not a little of this is implied in the early writings of Malthus. Those who sponsor this view tend to downplay trade, but even if trade is admitted there must be certain carrying capacity for the world as a whole, say those who write along this line. Thus a background paper by Kirchner to the World Bank's (1984) *World Development Report* starts:

> The carrying capacity of a particular region is the maximum population of a given species that can be supported indefinitely, allowing for seasonal and random changes, without any degradation of the natural resource base that would diminish this maximum population in the future. The concept of carrying capacity is familiar to biologists and wildlife managers....With modifications, it is also an important measure of the ability of regions to support human populations.

The economic viewpoint stands in sharp contrast to this, and one branch of the debate concerns food resources and the effects of MDC extravagance in converting the largest part of its grain calories into meat. D. Gale Johnson (1974) makes the point that conservation has no sense: If the industrial countries had held down their indirect grain consumption there would have been less produced, reserve stocks would have been smaller, and the institutions required to handle grain exports would not have existed. In brief, American extravagance in meat consumption results, through the market, in a reserve against famine elsewhere in the world.

The argument is unassailable on its terms, but the terms change drastically once the environment is brought in. The loss of soil and of water, the poisoning of streams with fertilizers and insecticides, are a different and more difficult matter.

ECOLOGY

We find biologists critical of the excesses of economic growth, sometimes opposing not only the excesses but economic growth itself. Some of this shows up in the April 1986 *Bulletin of the Atomic Scientists*, which contains a semi-popular discussion of population and other important matters by Ehrlich, Choucri, Djerassi, and others. The work by Ehrlich that attracted initial popular attention was *The Population Bomb* (1968), to which a recent sequel is *The Population Explosion* (1990). Scorned by demographers, such books have the respect of scientists in other fields. A somewhat offbeat economist, E.J. Mishan (1969), in effect joins the biologists, and so does Herman Daly (1977, 1989). Encyclopedic coverage of the field, no longer new, but still valuable, is Ehrlich et al. (1977).

The best known of the institutions that have committed themselves to monitoring the effects of population and economic growth on the biosphere is Lester R. Brown's Worldwatch Institute. It puts out an annual report on progress toward a sustainable society, of which the 1990 (Brown et al. 1990) edition is now available: Included in this is a global action plan, with a climate-sensitive energy strategy, an approach to maintaining forest cover, meeting future food needs, and stabilizing population.

Recognized for its authoritative studies aimed at knowledgeable though not necessarily professional audiences, is the World Resources Institute with its annual survey of resources (1990 and earlier years). Running out of minerals, especially metals, coal and oil, was the main ecological preoccupation of earlier generations; it now appears that these

minerals are more widespread than was thought and that in any case substitutes for them can be invented. A survey of this area is provided by Repetto (1985).

Herman Daly (1986) calls attention to the factor of scale, that is the heart of the distinction between the neoclassical and ecological views. We find anticipation of this in Coale and Hoover (1958):

> In the long run the size generated by indefinite growth becomes the dominant factor in the economics of population (Coale and Hoover 1958, p. 331).

In Forrester's (1971, p. 19) model "birth rate" and "death rate" are measured in absolute numbers of people per year, rather than in the ratio of this quantity to population that is the usual demographic definition of rate. The neoclassical economics of population might be true in a world that contains one billion people or less, the ecological view might be true of a world containing five billion or more. For most problems one would have to deal with smaller areas than the world as a whole, but whatever the area, absolute numbers and ratios lead to very different interpretations of trends. It is absolute totals that are bounded, if there are bounds, never ratios. What is troubling about much of the literature is the lack of any serious effort to assign numerical bounds to theoretical assertions.

A COMMITTEE WILL DECIDE THE QUESTION?

A seemingly practical way to resolve the differences indicated in the literature is to appoint a committee. Individual scholars may be eccentric; a committee ought to have a balanced view. The literature includes two series of committee reports.

Three widely-disseminated reports resulted from conferences of the American Assembly of Columbia University. The first was edited by Philip M. Hauser (1963). The second was a book edited by Jane Menken (1986), that showed the influence of the National Academy of Sciences (1986). A third book is now in press (Matthews 1990).

These three books present a remarkable sequence. The first gave the case for population control unselfconsciously, with no apologies, having in its background the then current work of Coale and Hoover; the second was much less sure of the importance of family planning; the third expresses certainty that an ecological catastrophe looms, and even the most energetic efforts at family planning may already be too late. In the second, that took the population crisis calmly, demographers were the major exponents; the third consisted largely of lay people--journalists, congressmen, industrialists, diplomats--as well as biologists and natural scientists.

Corresponding differences show among reports of committees of the U.S. National Academy of Sciences (NAS). The first were in 1971 (NAS 1971; Revelle 1971) that found in rapid population growth perhaps the most serious of all the handicaps to development. The much milder conclusion of the second (NAS 1986), based on economic considerations alone, was merely that economic growth would be somewhat faster with slower than with faster population increase. It found the main reason for birth control outside of economics: that people have the moral right to regulate the number of their children. So also thought Lenin:

> Lenin's concept of birth control as a human right had a lasting influence both upon socialist writings and health policies affecting fertility (United Nations 1973, Volume 1, p. 49).

A convenient summary of the second NAS report is provided by Preston (1988).

Evidently committees reflect the opinions dominant in the disciplines of their members at the time when the committees meet and report.

It is well to say that to determine the size of one's family is a basic human right, but what if people want many children and the population grows fast? What then about the right to a livelihood in exchange for work? We must try to balance at the margin the immorality of restricting births with the immorality of letting people starve (Demeny 1985).

EXTERNALITIES

Wherever mainline economics textbooks today recognize the ecology in which the economy is embedded, they consider its problems as examples of market failure, due to the existence of costs and benefits of production or consumption external to the decision-making firm or person, and show how costs and benefits can be internalized and so bring the problem within the scope of the market. Where externalities damaging to the environment arise they propose creating a market by selling transferable rights to pollute. Externalities are at the center of the discussion whether childbearing is a boon or a hindrance to the community. Samuel Preston (1988) says:

> The net balance of external effects [of the household's fertility] was not likely to be quantitatively large....It is difficult to make the case that other families suffer a net loss or gain from one family's childbearing (pp. 23-24).

Contemporary families may not suffer, but what about those a generation or two hence, when the effects of crowding appear?

Economic writings also mention, though with much more hesitation, the difference between market rates of discount and social rates. Operators in the market come and go and they borrow and lend for short-run purposes; the nation and society go on forever, and accepting that can make any positive rate of discount too high. One cannot afford to borrow at commercial rates to protect the future environment.

Should governments not take responsibility for the future if markets cannot do it? But governments seem to have an even nearer horizon than businessmen; if the latter cannot be responsible for the future even less can the former. These admittedly difficult matters find little place in textbooks, or in global economic analysis (for example of Tinbergen 1962).

RESOURCES

Barnett and Morse (1963) decried calls for husbanding of resources on a new and original ground. For them the uniformity of energy and matter are such that anything can be turned into anything else. This eliminates all possible limits; no quantitative restraints

or particular scarcities can appear in a world in which everything can be turned into anything else.

Among the few economists who have taken the exhaustion of resources seriously, with its implications for intergenerational equity, was Stanley Jevons, concerned with how England would maintain its large population (then about 25 million) when it ran out of coal. Since that particular worry turned out to be misplaced, he gets little credit, and for good enough reasons the need to control population is not usually nowadays argued from the limits of mineral resources. But certain non-mineral resources, especially water and soil, forests and fisheries, come under increasing pressure, and some of Jevons' argument on concern for the children and grandchildren of those now alive could well be transferred to them.

SUSTAINABILITY

A clear example of non-sustainability of short-run solutions is the use of chemical pesticides, that often are more effective against the predators on the pest than on the pest itself, and so result in increasing the pest they aim to control. Examples abound, first pointed out by American authors, among whom the pioneer was Rachel Carson (1962); Perring and Mellanby (1978) is a subsequent book on the same theme. After the pesticides most dangerous to man and least useful in controlling pests were banned in the United States, the producers turned to markets abroad, where only with some delay has suitably restrictive legislation been introduced.

Not the least of the elements that drive the use of pesticides is the growth of population. The same applies to fertilizers and weed-killers. We have built up population on the food output that these chemical means permit, and we cannot entirely stop their use, but only try to moderate their worst effects. Biologists are only now learning how they may be used with discretion in combination with biological controls.

In the same way the extinction of species results from population growth. It causes more land to be cultivated, more cultivated land to be taken over by urban municipalities, more trees to be cut down and forest species to be displaced. Animal and plant species come and go in the normal course of evolution, but never has the disappearance of species been as rapid as today. Writers in Elliott (1986) emphasize those disappearances caused by human activities, and the way that such activities simplify ecological systems and make the web of life less stable. More detail is provided in Ehrlich and Ehrlich (1983).

Specific effects of worldwide development in its present course on oceans, on forests, on deserts, are documented in a large section of the literature, for instance Borgese and Ginsburg (1978) and Repetto (1988).

DISAGREEMENT ON CLIMATE CHANGE

If neoclassical economics and demography are not agitated by prospective population growth, neither are they disturbed by the global warming and its incident disturbances that are forecast by climatologists.

Nordhaus (1990) says that "Most economic activity in industrialized countries... depends very little on the climate....[T]he impacts of climate changes on developed countries are likely to be small, probably amounting to less than 1 percent of national income over the next century." He says that "those calls to arms against global warming have been made without an attempt to weigh the costs and benefits of restraint." Nordhaus does not speak for himself alone; Robert Solow (1988) had an op. ed. article in the *New York Times* that said much the same.

To show how the danger is variously assessed, I quote John Maddox (1990) who asserts that the stakes are high: "Perhaps even comparable with the threat of nuclear war." That puts it altogether outside of the range of economic costs and benefits!

We have in all this one discipline against another, and such differences we have no formal way of resolving. The resolution, too difficult for the disciplines in question, is left to administrators and politicians. These are bound to make decisions, even if only implicitly in the policies they adopt.

CAN TECHNOLOGY RECONCILE ECONOMY AND ECOLOGY AND ALSO PROVIDE FOR ECONOMIC GROWTH?

One key to reconciling the economic and the ecological approach is technology. Some write the phrase "transfer of technology" as equivalent to "economic development," and both together as equivalent to "modernization." A summary is given in Johnston and Sasson (1986), whose chapter on Biotechnologies and Food Systems is especially relevant; changing from chemical controls to genetics could solve many problems. Finding or making food plant species that thrive on seawater would bring North African and other coastal arid lands back into production. The book contains an extensive bibliography, mostly dealing with the positive side of the technology that has developed since World War II. The standard multi-volume work that attempts to summarize all technologies is the *Encyclopedia of Science and Technology* (1982), of which the most recent annual update is the *Yearbook of Science and Technology* (1989).

Lester Brown (1975, pp. 15-24) shows that ordinary food supplies are tight and he encourages moves to non-animal shortenings, to margarine, to non-dairy whipped toppings and coffee whiteners, to soya-based meat substitutes. For Barry Commoner (1971) the present direction of technology may well solve every problem, but in doing so creates new problems that are even more difficult; we need to reverse direction, to seek softer and simpler technologies. A useful reference for this and other social aspects is Durbin (1980).

The most severe indictment of contemporary technology is its wasteful use of energy, and especially energy derived from fossil fuels. Carbon dioxide resulting from combustion is a main culprit in changing the constitution of the atmosphere. Barry Commoner, with others (1975), is among those who has shown effects of increasing energy use. In a series of books and papers he shows how inappropriate technology has generated waste and pollution.

Clearly technology is the cause of many of the present problems, and it is also the chief hope of solving them. Population also is the cause of problems, and its control the means of mitigating them. How then can responsibility for present difficulties be allocated; how much is due to population and how much to technology? When two factors operate

for good or for bad, sharing the credit or the blame is a difficult problem of imputation. Enormous effort went into determining how much of production was due to labor, land and capital respectively. The great classic on this was Schultz (1958), who shows the innumerable assumptions and decisions that have to be made to establish the imputation.

Imputing environmental problems to technology and to population requires a similar method. Ehrlich and Ehrlich (1990) do it with the decomposition E=PGT, where E is the environmental damage, the undesired output, P the population, G the Gross National Product per capita, and T the quantity and kind of technology used. One school will hold constant technology and income, and blame population for all problems; another will hold constant population and allocate the blame to technology or to income. It is fairer to take it that these three "production" factors are all operative; if they work independently we can operate a simple decomposition on readily available data, as Ehrlich and Commoner do, but that will not satisfy those who see the factors as interrelated. In particular high incomes are not possible without advanced technologies, and the most advanced technologies are not the most benign. And the scheme breaks down completely if dense population itself improves technology and raises income, as NAS (1986) seems at some points to argue. Those who find the evidence for such relationships meager will come back to the Ehrlich and Commoner decomposition.

DEVELOPMENT LITERATURE FOR PARTICULAR COUNTRIES AND AREAS

The richest part of the development literature is the monographs on specific areas, of which there are hundreds--for instance Shaw (1983) and Kelley et al. (1982), both dealing with the Middle East. The island of Mauritius is an instructive case because it is a bounded territory, that up to the 1960s was miserably poor, almost wholly dependent on exports of sugar to a world market in which prices had fallen to low levels, and with a rapidly increasing population. Since that time its economy has diversified and its population growth checked. Wolfgang Lutz of IIASA is undertaking a major study to find out why and how.

The World Bank is a particularly valuable source of data, not only in its annual *World Development Reports* but in the series of country monographs, usually written by distinguished scholars on the basis of actual examination. These are issued by reputable publishers, including the Johns Hopkins Press, and are an unsubstitutable contribution to the development literature. Some do and some do not emphasize population control.

UNBALANCED UNDERDEVELOPMENT

Case studies of particular areas show innumerable instances of disequilibrium--in food, in population, in rising wages--that price countries out of manufacturing. The most obvious disequilibrating force is population growth; Frank and McNicoll (1987) study Kenyan rural institutions in the face of averages of five or more children per woman surviving to adulthood. No agricultural inheritance system can last unchanged for many generations with the division of holdings that this implies.

The standard general literature shows how to devise policies that will keep GNP rising uniformly year after year, as far as possible in a semi-automatic process of balanced growth. Opposed to this history-free approach is some writing (Hirschman 1958;

Rosenstein-Rodan 1964) that sees imbalances as fruitful and proposes to take advantage of them, even to create imbalances deliberately.

For Leibenstein (1957) population is endogenous, determined within the model. A great shock is necessary to get development moving (technical progress, infusion of capital), and when it does get going population growth will fall. Until it gets going rational parents, who have no other way of securing their old age, give little attention to population programs that would persuade them to limit their families.

Various equilibria involving population numbers existed in past times. Before he had efficient stone tools man was in equilibrium with other primates and limited food supplies; after agriculture and urbanization he had to come into equilibrium with bacteria (McNeil 1976). At each point a preceding balance was disturbed by some (in itself desirable) innovation. Currently it is partial development that unbalances matters in a way to demand further steps in development.

Nature is in perpetual change anyhow, and changes effected by our industrial society are superimposed on other changes that would occur even if man were not present. With all the troubles, we must remember that as Sauvy (1963, Volume 1, p. 4) says, "Le propre du déséquilibre est de créer le mouvement." There is no question that movement is occurring, but are the conditions such that it is movement towards welfare or movement towards disaster? Economists and ecologists answer this question very differently.

UNEMPLOYMENT THREATENED BY RAPID POPULATION GROWTH

Much of the concern of the LDCs from Brazil to Egypt has revolved around employment, with increase of GNP thought of as a means to this rather than an end in itself. Every government fears an unemployed educated population. Huge debts incurred in the 1970s and 1980s were intended to purchase capital to employ urban citizens, now coming out of schools and colleges in the thousands. With the closing off of further loans, at least from the private banks of the United States and Germany, governments turned to inflationary financing of the employment of public servants. Thus population growth and the need to employ urban youth if civil order is to be maintained can be said to underlie indebtedness and inflation. Such a chain of reasoning lies behind Lester Brown's (1976) assertion of the connections between population growth and various social and economic problems, connections far beyond any that appear in current economics.

In the creation of the disequilibrium represented by the employment problem education has a major part. Increasing population, an increasing fraction of which has college training and corresponding expectations (Dore 1976), is a chief worry of many regimes in the LDCs. Up to the time of World War II cities were small, and the amount of higher education was kept down to what would be useful to the colonial powers. In that equilibrium population growth was moderate, education was for the few, and the population lived out its short lives doing manual work in the countryside. The literature divides between those few with a nostalgia for earlier times, and those who would go on to something better. Going back or going forward--no one thinks the present condition can persist, with many young people not well enough trained to push forward the development of their countries, and yet having too much training to be satisfied with actual employment possibilities.

Such disequilibria, having unequal impact among countries, exert powerful pressures for migration.

MIGRATION

There are a host of ways in which continued underdevelopment can threaten security, and not only in the LDCs. They would suffer first, of course: "Without raising their incomes we cannot prevent [tribal peoples] from combing the forest for food and livelihood; from poaching and from despoiling vegetation" (Indira Gandhi at Stockholm, 1972). But the trouble is exported to the MDCs.

Borders nowadays are permeable to unwanted immigrants, and we see these arousing a racist response in the United States, France, Britain and elsewhere. The MDCs, especially in their capacity of former colonial powers, still feel some responsibility for refugees, most of whom now are from LDCs, and these have given rise to severe moral dilemmas.

Simon (1982) proposed free and unselected (to avoid brain drain) migration from the LDCs to the MDCs, and pointed out the potential benefits of such movement to both sides, but especially the benefit of offsetting declining MDC births. The applause that Simon gets from the political right on his other views is more muted on immigration. A current issue of *Le Monde* (June 1990) analyzes how immigrants are threatening the traditional liberalism of the French right.

The moral case for allowing immigration is argued on the culpability of the presently developed countries for the plight of the LDCs. That culpability, continuing into the present, is presented by such authors as Raul Prebisch (1971), Gunder Frank and Paul Baron. Articles in this genre are reprinted in Wilber (1988). These say little about the need for population control, and much about opening the borders of the MDCs to trade and migration, controlling the multinationals operating in LDCs, offsetting the various advantages that the MDCs have through getting there first. Such writings have fewer readers today than they had 20 years ago.

SUSTAINABLE DEVELOPMENT

A minority of economists in good standing have been seriously preoccupied with environmental matters, and have produced important work on some of the hidden costs of growth. One of the earliest and most emphatic was E.J. Mishan (1969). Involved today in this aspect are Herman Daly (Daly and Cobb 1989), Bartelmus (1986), and Arizpe (1989). Valuable writings are contained in Dorfman (1977). The World Bank has confronted cries of protest against some of its projects, for instance in a special issue of the British journal *Ecology* (1986), and these have brought substantial changes in its aid policies.

For the Brandt Report (1980) the environment does count: everyone agrees on preserving peace and abolishing hunger, but many forget that survival also requires solving energy and environment problems. The dangers for the global environment derive above all from the growth of the industrial economies, but also from population. On the whole

the report gives little attention to programs for control of population as such, stressing that education and development generally will check the present rapid growth.

The ecological problems engendered by local urban growth by no means cease for countries that have attained the developed condition. An extensive discussion for the United States is contained in Scott (1975), while other aspects of planning, with special reference to English conditions, are taken up in Edington (1973) and Roberts (1986). The need to set up suitable international institutions appears in Clark (1989).

There is a case against rapid population growth that has nothing to do with environment and its limits. A long tradition of research and writing is based on the comparison of individuals born in large and those born in small families. Restrained couples produce children that do better in one way or another. A recent well-received book that presents the classical case and adds new evidence is Blake (1989). Intuition suggests that population pressures lead to war, but Choucri (1974, p. 60) finds "the direct link between density and violent behavior has been found to be weak," though "density does appear to have a substantial impact on international violence through a complex causal chain."

POPULAR ALARM AND THE CALM OF DEMOGRAPHERS

A bibliographic survey is not expected to take account of the popular media--newspapers, magazines, television--that today give an enormous amount of attention to population and environment. According to polls in various industrial countries as reported in the press, a large fraction of the public sees environmental issues as the most important there are. Writers on the ozone layer, global warming, desertification, acid rain, waste disposal, etc., keep telling us that growing populations are seriously aggravating the problems, and that at a certain point these cancel out any improvement in the quality of life that economic growth brings about.

I repeat that the participants in the debate do not offer point by point rebuttals and rejoinders of the opposition arguments. The economist's unlimited substitutions must at some point encounter the limits assumed by ecologists; the two cannot coexist in the same logical universe. Joint models incorporating both substitution and limits are needed and lacking. The human institution interacting with a biological resource (e.g., the world's fishing fleets vis a vis the fish population) needs more explicit study than it has had so far. The distaste for incorporating alien variables in the models of one's own discipline will have to be overcome.

The comments of some eminent demographers are highly critical of their own discipline. Thus Preston (1984): "the field lacks ideas," and in a review for the Ford Foundation, Jack and Pat Caldwell (1986) say that many programs to control population are divorced from the realities of developing countries.

The interpretation of statistics can be ambiguous in the debate that this paper describes. Is one arguing that population is coming under control? Then use rates, of birth, of natural increase, of net reproduction, all of which are declining. Is one arguing that the population is on a runaway course? Then use absolute numbers, that for the world as a whole will continue to increase for the next 40 years. Such selective use of numbers makes a travesty of the empirical analysis that is the great accomplishment of demography.

A quick summary of the history is that for 150 years the economic and the ecological viewpoints were expressed by the same scholars, who called their subject political economy, and their conclusions accorded with those of the educated lay public. Then a bifurcation occurred, with a more intense specialization in each of economics and ecology. After that bifurcation the two disciplines developed mutually incomprehensible languages.

Demography might seem to be the discipline that could referee the debate. Yet demographic practitioners are disinclined to let either popular views and concerns or the arguments of other disciplines determine their research agendas.

REFERENCES

Amsterdam Declaration. 1990. *Population and Development Review* 16(1), March.

Arizpe, Lourdes. 1989. *On the Cultural and Social Sustainability of Economic Development Models.* Paper presented at 25th Anniversary Symposium "The Next Decade: Interdependence in a Multipolar and Two-Track World Economy." Paris, France: OECD Development Centre.

Arthur, Brian W., and Geoffrey McNicoll. 1975. Large scale simulation models in population and development: What use to planners. *Population and Development Review* 1:251-265.

Avery, Dennis. 1985. US farm dilemma: The global bad news is wrong. *Science* 230:408-412.

Bach, Wilfrid, Jurgen Pankrath, and Stephen H. Schneider, Editors. 1981. *Food-Climate Interactions.* Dordrecht, Holland: Reidel.

Barnett, Harold, and C. Morse. 1963. *Scarcity and Growth: The Economics of Natural Resource Availability.* Baltimore, Maryland: Johns Hopkins Press.

Barney, G.O. 1981. *Global 2000: The Report to the President, Entering the 21st Century.* Revised edition. Seven Locks Press.

Bartelmus, Peter. 1986. *Environment and Development.* Boston, Massachusetts: Allen and Unwin.

Berelson, Bernard. 1975. *The Great Debate on Population Policy: An Instructive Entertainment.* New York: Population Council.

Blake, Judith. 1989. *Family Size and Achievement.* Berkeley, California: University of California Press.

Bodin, Jean. 1962 [1576]. *The Six Books of a Commonwealth.* Facsimile of English translation of *Les six livres de la republique*. Cambridge, Massachusetts: Harvard University Press.

Bogue, Donald J., Editor. 1967. *Sociological Contributions to Family Planning Research.* Chicago, Illinois: University of Chicago Press.

Borgese, Elisabeth Mann, and Norton Ginsburg, Editors. 1978. *Ocean Yearbook 1.* Chicago, Illinois: University of Chicago Press.

Boserup, Ester. 1981. *Population and Technological Change: A Study of Long Terms.* Chicago, Illinois: University of Chicago Press.

Boserup, Ester. 1987. Population and technology in preindustrial Europe. *Population and Development Review* 13(4):691-701.

Brandt, Willy (Chairman). 1980. *North-South: A Programme for Survival.* Mondadori: Independent Commission on International Development Issues.

Brown, Lester R. 1975. World population and food supplies: Looking ahead. In *Papers Prepared for the Bucharest Conference,* Volume 2, pp. 15-24. New York: United Nations.

Brown, Lester R. 1976. *Twenty-Two Dimensions of the Population Problem.* Washington, D.C.: World Watch Institute.

Brown, Lester R., et al. 1990 and annually. *State of the World 1990: A Worldwatch Institute Report on Progress Toward a Sustainable Society.* New York: W.W. Norton.

Brundtland, G.H. (Chairman, World Commission on Environment and Development). 1987. *Our Common Future.* Oxford, U.K.: Oxford University Press.

Bulletin of the Atomic Scientists. 1986. Special Issue: Population Growth 42(4).

Caldwell, Jack and Pat. 1986. *Limiting Population Growth and the Ford Foundation Contribution.* London: Frances Pinter.

Carson, Rachel. 1987 [1962]. *Silent Spring.* 25th Anniversary Edition. Boston, Massachusetts: Houghton Mifflin.

Choucri, Nazli. 1974. *Population Dynamics and International Violence.* Lexington, Massachusetts: Lexington Books.

Choucri, Nazli. 1986. Demographics and conflict. *Bulletin of the Atomic Scientists* 42(4):24-25.

Cicero, Marcus Tullius. 44 B.C. *De Re Publica.* Harvard University Press.

Clark, Colin. 1967. *Population Growth and Land Use.* New York: St. Martin's Press.

Clark, Colin. 1978. Population growth and productivity. *Research in Population Economics.*

Clark, William C. 1989. The politics of planetary management. *Environment* 31.

Coale, Ansley J. 1986. Population trends and economic development. In *World Population and U.S. Policy: The Choices Ahead,* edited by Jane Menkin. New York: W.W. Norton for the American Assembly.

Coale, Ansley J. and Edgar M. Hoover. 1958. *Population Growth and Economic Development in Low-Income Countries.* Princeton, New Jersey: Princeton University Press.

Commoner, Barry H. 1971. *The Closing Circle: Nature, Man, and Technology.* New York: Alfred A. Knopf.

Commoner, Barry, H. Boksenbaum, and M. Corr, Editors. 1975. *Energy and Human Welfare: A Critical Analysis.* 3 Volumes. New York: Macmillan.

Daly, Herman E. 1977. *Steady State Economics.* San Francisco, California: W.H. Freeman.

Daly, Herman E. 1986. Review of NAS report on population growth and economic development: Policy questions. *Population and Development Review* 12(3):582-585.

Daly, Herman E, and John Cobb. 1989. *For the Common Good: Redirecting the Economy Toward Community, the Environment, and a Sustainable Future.* Boston, Massachusetts: Beacon Press.

Demeny, Paul. 1985. Bucharest, Mexico City, and beyond. *European Journal of Population* 1(2/3).

Djerassi, Carl. 1986. Abortion in the United States: Politics or policy? *Bulletin of the Atomic Scientists* 42(4):38-41.

Domar, Evsey D. 1957. *Essays in the Theory of Economic Growth.* New York: Oxford University Press.

Dore, Ronald P. 1976. *The Diploma Disease: Education, Qualification and Development.* London: Allen and Unwin.

Dorfman, Robert. 1977. *Economics of the Environment: Selected Readings.* New York: W.W. Norton.

Durbin, P.T., Editor. 1980. *A Guide to the Culture of Science, Technology, and Medicine.* New York: Free Press.

Durkheim, Emile. 1978 [1893]. *De la Division du Travail Social.* 10th Edition. Paris, France: Presses Universitaires de France.

Ecology. 1986. Special Issue on Environment.

Edington, John M., and M. Ann Edington. 1973. *Ecology and Environmental Planning.* London: Chapman and Hall.

Ehrlich, Paul R. 1968. *The Population Bomb.* New York: Ballantine Books.

Ehrlich, Paul R., and Anne H. Ehrlich. 1983. *Extinction: The Causes and Consequences of the Disappearance of Species.* New York: Ballantine.

Ehrlich, Paul R., and Anne H. Ehrlich. 1986. World population crisis. *Bulletin of the Atomic Scientists* 42(4):13-19.

Ehrlich, Paul R., and Anne H. Ehrlich. 1990. *The Population Explosion.* New York: Simon and Schuster.

Ehrlich, Paul R., and John P. Holdren. 1975. Human population and the global environment. In *Population Debate* (World Population Conference), pp. 92-104. New York: United Nations.

Ehrlich, Paul R., Anne H. Ehrlich, and John P. Holdren. 1977. *Ecoscience: Population, Resources, Environment.* San Francisco, California: W.H. Freeman.

Elliott, D.K., Editor. 1986. *Dynamics of Extinction.* New York: John Wiley and Sons.

Enke, Stephen. 1959. *The Worth of Population Control to India: Some Money Measures and Incentive Schemes.* Santa Monica, California: Rand Corp.

Enke, Stephen. 1969. Birth control for economic development. *Science*, May 16.

Enke, Stephen. 1971. Economic consequences of rapid population growth. *Economic Journal* 80 (December).

Forrester, Jay W. 1971. *World Dynamics.* Wright-Allen Press.

Frank, Odile, and Geoffrey McNicoll. 1987. An interpretation of fertility and population policy in Kenya. *Population and Development Review* 13:209-243.

Freedman, R., and J. Takeshita, et al. 1969. *Family Planning in Taiwan: An Experiment in Social Change.* Princeton, New Jersey: Princeton University Press.

Geertz, Clifford. 1963. *Agricultural Involution: The Process of Ecological Change in Indonesia.* Berkeley, California: University of California Press.

George, Henry. 1902. *Progress and Poverty.* Fourth Edition. New York: Doubleday.

Godwin, William. 1964 [1796]. *Of Population: An Enquiry Concerning the Power of Increase.* New York: A.M. Kelley.

Hardin, Garett. 1968. The tragedy of the commons. *Science* 1162:1243-1248.

Hauser, Philip M., Editor. 1963. *The Population Dilemma.* New York: The American Assembly.

Hermalin, Albert I. 1982. Issues in the comparative analysis of techniques for evaluating family planning programs. In *Evaluation of the Impact of Family Planning Programmes on Fertility: Sources of Variance*, pp. 29-40. New York: United Nations.

Herman, Robert, Siamak A. Ardekani, and Jesse H. Ausubel. 1989. Dematerialization. In *Technology and Environment,* edited by Jesse H. Ausubel and Hedy E. Sladovich. Washington, D.C.: National Academy Press.

Hicks, J.R. 1971. *The Social Framework.* 4th Edition. Oxford, U.K.: Clarendon Press.

Higgins, Benjamin H., and Jean D. Higgins. 1979. *Economic Development of a Small Planet.* New York: W.W. Norton.

Higgins, G.M., et al. 1982. *Potential Population Supporting Capacities of Lands in the Developing World.* Rome, Italy: Food and Agriculture Organization.

Hirschman, Albert O. 1958. *The Strategy of Economic Development.* New Haven, Connecticut: Yale University Press.

Holling, C.S., Editor. 1978. *Adaptive Environmental Assessment and Management.* Chichester, U.K.: John Wiley.

Howell, Nancy. 1979. *Demography of the Dobe !Kung.* New York: Academic Press.

Johnson, D. Gale. 1974. *World Food Problems and Prospects.* Washington, D.C.: American Enterprise Institute.

Johnston, A., and A. Sasson. 1986. *New Technologies and Development.* Paris, France: UNESCO.

Kahn, Herman, and Anthony J. Wiener. 1967. *The Year 2000: A Framework for Speculation on the Next Thirty-Three Years.* New York: Macmillan.

Kelley, A.C., et al. 1982. *Population and Development in Rural Egypt.* Duke Press Policy Studies. Durham, North Carolina: Duke University Press.

Kuznets, Simon. 1960. Economic growth of small nations. In *Economic Consequences of the Size of Nations,* edited by E.A.G. Robinson. London: Macmillan.

Kuznets, Simon. 1966. *Modern Economic Growth, Rate, Structure and Spread.* New Haven, Connecticut: Yale University Press.

Kuznets, Simon. 1967. Population and economic growth. *Proceedings of the American Philosophical Society* 111(3):170-193.

Kuznets, Simon. 1975. Population trends and modern economic growth--notes towards a historical perspective. In *The Population Debate: Dimensions and Perspectives,* Papers of the World Population Conference, Bucharest, 1974, 2 Volumes, pp. 425-433. New York: United Nations.

Lee, Ronald. 1980. A historical perspective on economic aspects of the population explosion: The case of pre-industrial England. In *Population and Economic Change in Developing Countries*, edited by Richard E. Easterlin, pp. 517-556. Chicago: University of Chicago Press.

Leibenstein, Harvey. 1957. *Economic Backwardness and Economic Growth.* New York: John Wiley and Sons.

Lestaeghe, Ron J., Editor. 1989. *Reproduction and Social Organization in Sub-Saharan Africa.* Berkeley, California: University of California Press.

Lewis, W. Arthur. 1955. *The Theory of Economic Growth.* London: Allen and Unwin.

Maddox, John. 1990. *Nature* 346 (July 5).

Malthus, Thomas Robert. 1966 [1798]. *First Essay on Population 1798* (A Reprint in Facsimile). London: Macmillan.

Malthus, Thomas Robert. 1967. *Population: The First Essay* (Edited with an introduction by Kenneth E. Boulding). Ann Arbor: University of Michigan Press.

Marshall, Alfred. 1961. *Principles of Economics.* 9th Edition. London: Macmillan.

Mason, Andrew, and Daniel B. Suits. 1981. Computing the level and distribution of gains from fertility reduction. *Research in Population Economics.*

Matthews, Jessica T., Editor. 1990. *Preserving the Global Environment; The Challenge of Shared Leadership.* New York: W.W. Norton for the American Assembly.

McNamara, Robert S. 1984. Time bomb or myth: The population problem. *Foreign Affairs* 62(5):489-511.

McNeil, William H. 1976. *Plagues and Peoples.* Garden City, New York: Anchor Press.

McNicoll, Geoffrey. 1975. Economic-demographic models. In *Population Growth and Economic Development in the Third World,* edited by Leon Tabah, Volume 2. Dolhain: IUSSP, Ordina Editions.

McNicoll, Geoffrey. 1981. Notes on population development modelling and policy formation. In *Population and Development Modelling,* Proceedings of the UN/UNFPA Expert Group Meeting, Geneva, 24-28 September 1979, pp. 93-96. New York: United Nations.

McNicoll, Geoffrey. 1984. Consequences of rapid population growth: An overview and assessment. *Population and Development Review* 10(2):177-240.

Meadows, D.H, D.L. Meadows, J. Randers, and W.W. Behrens III. 1972. *The Limits to Growth.* New York: Universe Books.

Meek, R.L. 1953. *Marx and Engels on Malthus.* London: Lawrence and Wishart.

Menken, Jane, Editor. 1986. *World Population and U.S. Policy: The Choices Ahead.* New York: W.W. Norton for the American Assembly.

Mesavoric, M., and E. Pestel. 1974. *Mankind at the Turning Point.* New York: E.P. Dutton.

Mill, John Stuart. 1848. *Principles of Political Economy With Some of Their Applications to Social Philosophy.*

Mishan, E.J. 1969. *Growth: The Price We Pay.* Beekman Pubs.

Myrdal, Gunnar. 1968. *Asian Drama: An Inquiry into the Poverty of Nations.* New York: Twentieth Century Fund.

Myrdal, Gunnar. 1972. *Against the Stream.* New York: Vintage Books.

National Academy of Sciences. 1971. *Rapid Population Growth: Consequences and Policy Implications.* Baltimore, Maryland: The Johns Hopkins University Press.

National Academy of Sciences. 1986. *Population and Development.* Washington, D.C.: National Academy Press.

Nordhaus, William D. 1990. *Economist* (July 7), p. 20.

Notestein, Frank. 1945. Population: The long view. In *Food for the World,* edited by T.W. Schultz. Norman Wait Harris Memorial Fund Lectures.

Notestein, Frank. 1975. Population policy and development: A summary view. In *The Population Debate: Dimensions and Perspectives,* Papers of the World Population Conference, Bucharest, 1974, 2 Volumes, pp. 538-542. New York: United Nations.

Parikh, Jyoti K. 1988. *Sustainable Development of Agriculture.* Boston, Massachusetts: Martinus Nijhoff.

Parikh, Kirit S. 1988. *Towards Free Trade in Agriculture.* Boston, Massachusetts: Martinus Nijhoff.

Perlman, Mark. 1981. Population and economic change in developing countries: A review article. *Journal of Economic Literature* 19 (March):74-82.

Perring, F.H., and K. Mellanby, Editors. 1978. *Ecological Effects of Pesticides.* London: Academic Press.

Petersen, William. 1972. *Readings in Population.* New York: Macmillan.

Prebish, Raul. 1971. *Change and Development: Latin America's Great Task.* New York: Prager.

Preston, Samuel H. 1984. *Science* (September 7), p. 1003.

Preston, Samuel H. 1988. Are the economic consequences of population growth a sound basis for population policy? *Population Bulletin of the United Nations.*

Repetto, Robert, Editor. 1985. *The Global Possible.* New Haven, Connecticut: Yale University Press.

Repetto, Robert. 1986. *World Enough and Time: Successful Strategies for Resource Management.* New Haven, Connecticut: Yale University Press.

Repetto, Robert. 1988. *Forest for the Trees? Government Policies and the Misuse of Forest Resources.* World Resources Institute.

Revelle, Roger. 1971. *Rapid Population Growth: Consequences and Policy Implications.* 2 Volumes. Baltimore, Maryland: Johns Hopkins Press.

Revelle, Roger. 1975. Will the earth's land and water resources be sufficient for future populations? Volume 2, pp. 3-14. Bucharest: United Nations.

Revelle, Roger. 1976. The resources available for agriculture. *Scientific American* (September), pp. 165-178.

Reynolds, Lloyd. 1969. *Economics.* 3rd Edition. New Haven, Connecticut: Yale University Press.

Ricardo, David. 1821. The principles of political economy and taxation. Contained in *The Works and Correspondence of David Ricardo,* 1951-73, edited by Piero Sraffa. Cambridge: Cambridge University Press.

Ridker, Ronald. 1976. *Population and Development: The Search for Selective Interventions.* Baltimore, Maryland: John Hopkins Press.

Riley, James C. 1985. *Population Thought in the Age of the Demographic Revolution.* Durham, North Carolina: Carolina Academic Press.

Roberts, R.D., and T.M. Roberts, Editors. 1986. *Planning and Ecology.* London: Chapman and Hall.

Rosenstein-Rodan, P.N. 1964. *Capital Formation and Economic Development.* Cambridge, Massachusetts: MIT Press.

Ross, John A., and W. Parker Mauldin. 1988. *Berelson on Population.* New York: Springer Verlag.

Sadik, Nafis. 1990. Population: Time to invest in people. *People* 17(1).

Sanderson, Warren. 1980. *Economic-Demographic Simulation Models: A Review of Their Usefulness for Policy Analysis.* RR-80-14. Laxenburg, Austria: International Institute for Applied Systems Analysis.

Sauvy, Alfred. 1963. *Théorie générale de la population.* 2 Volumes. Paris: Presses Universitaires de France.

Sauvy, Alfred. 1969. *General Theory of Population* (tr. by C. Campos). New York: Basic Books.

Sauvy, Alfred. 1981. Population changes: Contemporary models and theories. In *Research in Population Economics,* edited by Julian L. Simon and Peter H. Lindert, Volume 3, pp. 225-238. Greenwich, Connecticut: JAI Press.

Schneider, S.H. 1989. *Global Warming: Are We Entering the Greenhouse Century?* San Francisco, California: Sierra Club Books.

Schultz, Henry. 1958. *The Theory and Measurement of Demand.* Chicago, Illinois: University of Chicago Press.

Schultz, Theodore. 1961. Education and economic growth. In *Social Forces Influencing American Education,* edited by N.B. Henry. Chicago, Illinois: National Society for the Study of Education.

Scott, Randall W., Editor. 1975. *Management and Control of Growth.* 2 Volumes. Washington, D.C.: Urban Land Institute.

Sen, Amartya K. 1981. *Poverty and Famines: An Essay on Entitlement and Deprivation.* Oxford, U.K.: Clarendon Press.

Shaw, R. Paul. 1983. *Mobilizing Human Resources in the Arab World.* Boston, Massachusetts: Routledge and Kegan Paul.

Shaw, R. Paul. 1989. Rapid population growth and environmental degradation: Ultimate versus proximate factors. *Environmental Conservation* 16(3):199-208.

Siew-Ean-Khoo. 1978. *Effects of Program Contraception on Fertility: A Comparison of Three Asian Countries.* Paper 54. Honolulu, Hawaii: East-West Population Institute.

Simon, Julian L. 1977. *The Economics of Population Growth.* Princeton, New Jersey: Princeton University Press.

Simon, Julian L. 1981. *The Ultimate Resource.* Princeton, New Jersey: Princeton University Press.

Simon, Julian L. 1982. A scheme to promote world economic development with migration. In *Research in Population Economics,* edited by J.L. Simon and P.H. Lindert, Volume 4. Greenwich, Connecticut: JAI Press.

Simon, Julian L., and Roy Gobin. 1981. The relationship between population and economic growth in LDCs. *Research in Population Economics* 2:215-234.

Simon, Julian L., and Herman Kahn. 1984. *The Resourceful Earth. A Response to Global 2000.* Oxford, U.K.: Blackwell.

Solow, A.R. 1988. Pseudo-scientific hot air. The data on climate are inconclusive. *New York Times* 138:A15(N), A27(l).

Spengler, Joseph J. 1942. *French Predecessors of Malthus.* Durham, North Carolina: Duke University Press.

Stangeland, Charles Emil. 1967 [1904]. *Pre-Malthusian Doctrines of Population.* New York: AMS Press.

Tinbergen, J. 1962. *Shaping the World Economy: Suggestions for an International Economic Policy.* New York: Twentieth Century Fund.

United Nations. 1972. *Environment Stockholm.* Geneva, Switzerland: United Nations.

United Nations. 1973. *Determinants and Consequences of Population Trends.* Especially Chapter 3, Population Theory, pp. 33-63.

Wilber, Charles K., Editor. 1988. *The Political Economy of Development and Underdevelopment.* New York: Random House.

World Bank. 1984. *World Development Report 1984.* New York: Oxford University Press.

World Bank. 1988. *World Development Report 1988.* New York: Oxford University Press.

World Resources Institute. 1990 and annually. *World Resources 1990-91.* New York: Basic Books.