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The Need to Reassess the Role of the Population Variable in Global Development

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Today, 200 years after the publication of Malthus' essay on population, we tend to perceive global population and environment prospects quite differently than 20 years ago, i.e. 180 years after the Malthus publication. In this sense a 10 percent time lapse brought a significant change in the reading and the relevance of this particular publication.

In the 1970s thinking about future global population trends and the environment was heavily influenced by *The Limits to Growth* (Meadows et al. 1972), a report to the Club of Rome. It is based on an economic, demographic and environmental simulation model, called World3, which is applied to the world taken as a whole. Within five years this book sold over 3 million copies which makes it by far the best selling book in the field. Substantively, the model is almost perfectly Malthusian in the sense that it is built around the notion of exponential growth. This is contrasted to the assumption of strictly limited natural resources. The model begins with a fixed stock of non-renewable resources which are being depleted over time. Since there is no technological change in the non-renewable resource sector, nor any substitution between the resources, this process causes output to collapse. While moderate Malthusian models tend to predict that population growth would wipe out all productivity gains and keep the people at a subsistence standard of living, World3 – where such effects are reinforced through powerful positive feedback loops – goes even beyond Malthus, confronting us with the nightmare of an impending "sudden and uncontrollable decline" (Sanderson 1994).

World3 has been criticized heavily, and modelers have learned many lessons since the 1970s. One of the important lessons is that the world is much too heterogeneous to apply the same behavioral equations to different parts of the world under very different cultural, institutional, economic and environmental conditions. Another lesson is that the model should not be too highly integrated, which makes it a "black box" in which even a highly skilled user does not understand why the model produces certain results under certain conditions. Finally, an intersectoral model should also satisfy the sectoral disciplinary concerns by being based on the best scientific understanding in the individual fields. These justified criticisms of models of the type of World3 have led to a situation that during the 1980s, very little modeling of this sort was done and serious scientists went back to the safer areas of sectoral modeling in population, the economy and various environmental fields. It was not until the early 1990s that a new generation of intersectoral models was born (partly in association with the 1992 Rio Earth Summit), based on the understanding that after all in the real world the sectors depend on each other even though scientists like to consider them independently. These new models, such as the Population-Development-Environment (PDE) models developed at IIASA, try to accommodate the concerns described and are more modest in terms of geographical coverage (they tend to follow a case study approach) and in terms of integration of sectors (they tend to have a modular structure where the user can easily modify the linkages between the sectors).

At the level of global environmental concern, the emphasis has also shifted away from the depleting of nonrenewable resources to man-made interference into the natural system, most notably climate change, the ozone hole and decline in biodiversity. Air and water pollution as well as soil degradation are being recognized as important problems on a more local and regional scale. It is also being recognized that the interactions between the environment and the human population follow highly complex nonlinear mechanisms in which economic value and substitution as well as technological advance also play important roles which are not appropriately captured by the simple Malthusian paradigm.

As to world population trends the picture has also dramatically changed over the last two to three decades. Around 1970 the world population was growing at a record rate of 2 percent per year and the total fertility rate at the global level was around five children per woman. Due to the great mortality improvements during the 1950s and 1970s the net reproduction rate even peaked in 1965-70 at a level of 1.86 which may well be an all-time high for the human species on this planet. At this speed the population would have grown by 86 percent from one generation to the next or doubled in 35 years. Under such conditions it is no wonder that concern about the "population explosion" dominated our thinking. By today the total fertility rate of the world population has fallen to almost half that level and more than one-third of the world population is below replacement level. Due to the momentum of population growth, however, the growth rate is still at 1.3 percent per year. This dramatic change has also shifted the focus of our concerns from population size to population age structure, one aspect of the population variable that was hardly anticipated by Malthus.

A probabilistic outlook of future global population growth and aging

The most common way of thinking about future population prospects is to calculate one future path that is considered most likely according to our present anticipation of future fertility, mortality and migration trends. But this gives the users no information about the degree of uncertainty involved in these calculations and it also cannot distinguish between anticipated trends that are robust and those that are very sensitive to alternative assumptions.

There are two traditional ways to deal with uncertainty. One is to present alternative scenarios (of unknown probability) which demonstrate the outcomes of alternative combinations of assumptions. The other is to present high and low variants (which are typically based on high versus low fertility assumptions) in addition to the medium variant. These three variants produce some range (which is often called a "plausible range") which, however, does not have any explicit probabilistic rationale. It is not clear whether the given range is supposed to cover 50 percent, 67 percent, 90 percent or 99 percent of all possible future paths. This information which is important for any user can only be provided by fully probabilistic population projections.

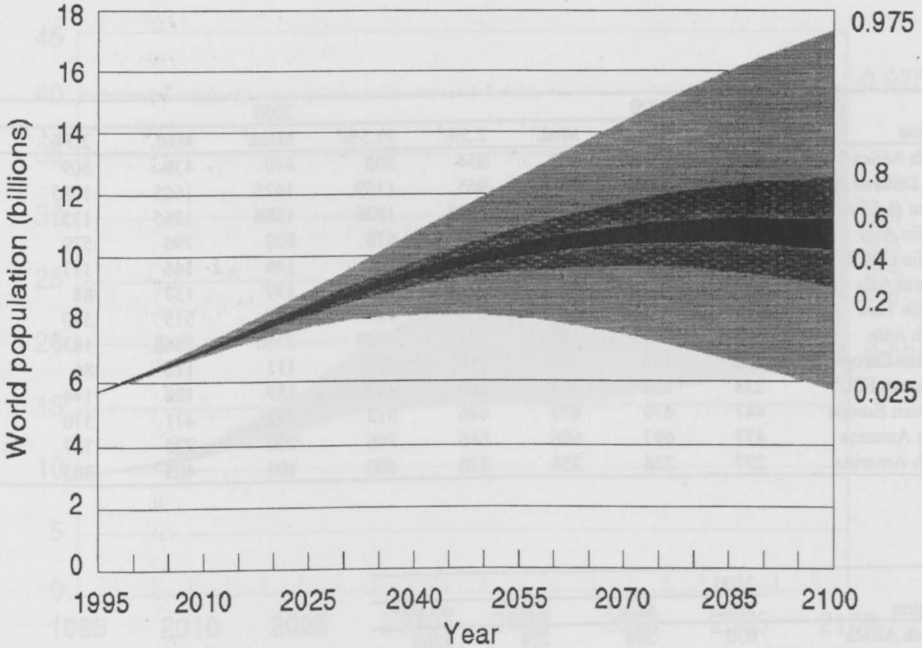
There is no one simple way of applying probabilistic methods to population projections (Lutz et al. 1999; Lee 1999). Assumptions about the future variance of the distributions of the three components have traditionally been based on time series analysis or ex-post analysis of projection errors. Both approaches have methodological problems, but the most important flaw for a global projection is the lack of appropriate time series data for large parts of the world population. For this reason the IIASA projections (which are summarized here; see Lutz 1996) chose an approach that is more intensively based on expert judgement. The procedure fits a normal distribution to the three values (high, central and low) that resulted from expert discussions, with 90 percent of the cases lying between the high and low values.[1] Results were derived through a set of 4,000 simulations that randomly combined fertility, mortality and migration paths from the three normal distributions for the 13 world regions. These simulations also considered the possibility that fertility and mortality trends may be correlated within regions (e.g. high fertility in sub-Saharan Africa is more likely to go hand in hand with high mortality than low mortality) and that regional trends may be either independent of each other (e.g. fertility in sub-Saharan Africa uncorrelated with fertility in Latin America) or correlated.

Figure 1 shows the distribution of future population sizes derived from the full set of 4,000 projections at five-year intervals to the year 2100. The high and low boundaries give the range into which 95 percent of all cases fall. The upper line indicates that there is an unlikely possibility of almost linear population growth between 1995 and 2100. The lower line shows that there is also an equally unlikely possibility that the world's population would peak in the middle of the 21st century and fall thereafter to below 6 billion by 2100. The much more probable range of future paths (between the 0.2 and 0.8 fractiles, covering 60 percent of all cases) is remarkably small. By 2050 this uncertainty range is less than 1.5 billion people, and by 2100 it doubles to about 3 billion people.

The figure also shows that in more than 60 percent of all cases the growth of the total world population levels off during the second half of the next century, or even starts to decline. Given that the world population in mid-1996 was estimated at 5.8 billion, Lutz et al. (1996, 1997) find that the probability of a doubling – that is, reaching or surpassing the 11.6 billion mark at any point during the next century – is only 33 percent. In other words, there is a two-thirds probability that world population will not double during the 21st century.

[1] Sensitivity analyses assuming that the high and low values covered 85% and 95% instead of 90% of all cases showed that the results are relatively insensitive to this parameter. Thus the high-low range may be thought to cover 85-95% of all cases.

Figure 1. Merged distribution of the size of the world's population (in billions): 1995-2100



Source: Lutz et al. 1996.

Regional results for the case of uncorrelated fertility and mortality trends are summarized in Table 1. (page 34). Sub-Saharan Africa displays the largest range of uncertainty in future population size, with a 95 percent confidence interval in 2100 ranging from 578 million to 4.345 billion around a mean of 1.9 billion. This large range results from the unusually large uncertainty surrounding trends in fertility and mortality in the region, in addition to the assumption that the two trends will be uncorrelated. On the other hand, it can be shown that if fertility and mortality are assumed to be positively correlated within the region, the range of uncertainty becomes significantly smaller.

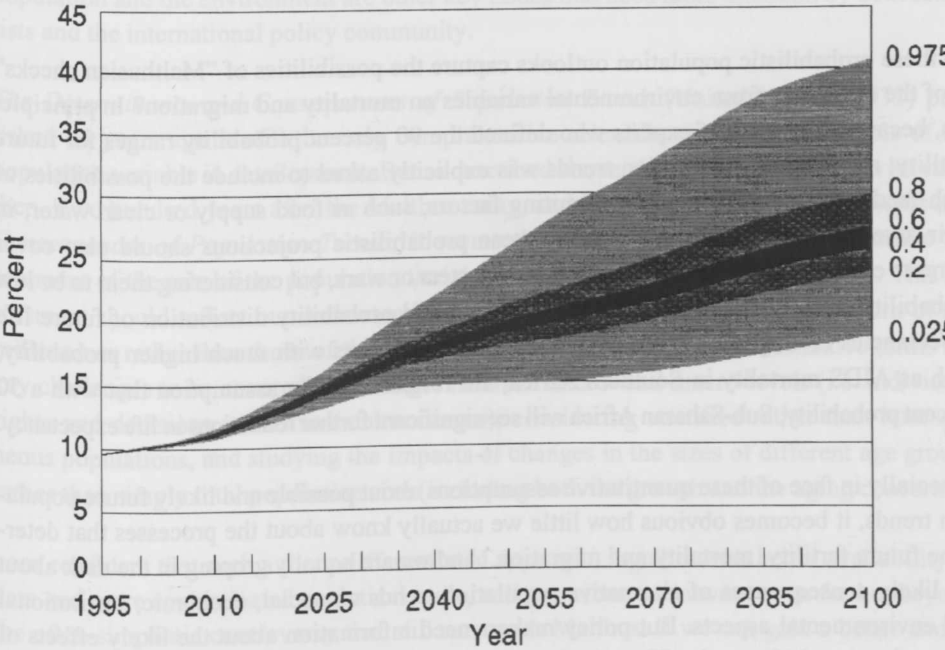
The distribution of the percentage of the global population above age 60 is shown in Figure 2. All the lines are rising, indicating confidence that the percentage of older people in the population will rise over time. In 2050, the mean percentage is 20 compared with 9.5 in 1995, with a 95 percent uncertainty interval between 15 percent and 26 percent. By 2100, the mean increases to 27 percent, with a 95 percent uncertainty interval between 19 percent and 41 percent. In other words, there is a 95 percent chance that the proportion of elderly will at least double over the next century. In the most likely case it will almost triple, and it may even more than quadruple. The uncertainty in the percentage above age 60 grows significantly during the second half of the 21st century due mainly to the uncertainty in future old-age mortality when combined with uncertainty in fertility.

Table 1. Population (in millions) by region for probabilistic projections assuming uncorrelated fertility and mortality. Mean, median, and 95 percent confidence intervals for 2020, 2050, and 2100. Source: Lutz 1996.

		2020				2050				2100			
Region	1995	Mean[b]	Med.[c]	2.5%[d]	97.5%[d]	Mean[b]	Med.[c]	2.5%[d]	97.5%[d]	Mean[b]	Med.[c]	2.5%[d]	97.5%[d]
North Africa	162	277	277	254	300	440	439	309	583	630	598	228	1202
Sub-Saharan Africa	558	1059	1058	965	1159	1625	1605	1085	2316	1909	1738	578	4345
China & CPA	1362	1670	1670	1526	1826	1888	1865	1351	2574	2051	1873	709	4428
Pacific Asia	447	629	629	576	678	802	796	579	1047	876	829	322	1696
Pacific OECD	147	155	155	145	167	146	146	117	182	125	120	59	221
Central Asia	54	87	87	76	100	139	137	88	206	212	194	65	477
Middle East	151	300	300	279	324	520	515	380	692	786	738	320	1516
South Asia	1240	1845	1845	1737	1949	2380	2368	1833	2970	2365	2246	1014	4327
Eastern Europe	122	124	124	116	133	111	110	86	141	83	78	31	168
European FSU[a]	238	224	224	209	240	189	188	144	241	147	138	53	290
Western Europe	447	479	479	446	512	472	471	370	584	430	416	196	769
Latin America	477	697	696	646	746	930	925	707	1177	1163	1106	489	2142
North America	297	356	356	320	400	405	403	303	534	482	467	229	865

[a] European part of the former Soviet Union.
[b] Data on the mean population size.
[c] Data on the median population size.
[d] Columns labeled 2.5% and 97.5% provide data on the lower and upper bounds, respectively, of the 95 percent confidence interval; 2.5% of all observations lie below the lower bound and 97.5% of all observations lie below the upper bound. All figures are based on 1,000 simulations and were produced using DIALOG, the multistate population projection model. Fertility and mortality are assumed to be uncorrelated within regions.

Figure 2. Merged distribution of the population of the world in the 60+ age group (in percent).



Source: Lutz et al. 1996.

Summarizing all the different global and regional results of the IIASA probabilistic population projection and alternative scenario analyses, it can be said that there are three near certainties:

(i) World population will increase substantially from its current level. Even in the lowest growth extreme scenario, population increases by close to 2 billion before commencing its decline. However a further doubling of world population has become unlikely.

(ii) The distribution of world population will continue to shift towards Least Developed Countries (LDCs). Even assuming rapid fertility decline and little improvement in mortality, LDCs still account for a rising share of world population.

(iii) The world population will continue to age. Probabilistic projections show that a doubling of the proportion above age 60 is a near certainty.

The need to reassess the role of the population variable in sustainable human development

Do these probabilistic population outlooks capture the possibilities of "Malthusian checks" or of the feedbacks from environmental variables on mortality and migration? In principle, yes, because the group of experts who defined the 90 percent probability ranges for future fertility, mortality and migration trends was explicitly asked to include the possibilities of such feedbacks and other possible limiting factors, such as food supply or clean water, in their assessments. Hence theoretically, these probabilistic projections should also cover extreme events, such as devastating natural disasters or wars, but considering them to be low probability events far out in the tails of the assumed probability distribution of future life expectancies or migration intensities. Some other disasters with much higher probability, such as AIDS mortality in Southern Africa, are reflected in the assumption that with a 50 percent probability, Sub-Saharan Africa will see significant further reductions in life expectancy.

Especially in face of these quantitative assumptions about possible and likely future population trends, it becomes obvious how little we actually know about the processes that determine future fertility, mortality and migration. And we are equally groping in the dark about the likely consequences of alternative population trends on social, economic, institutional and environmental aspects. But policy makers need information about the likely effects of alternative population paths. They need a scientific basis for their policies in order to make a decision between the alternative policy options. Such scientific analysis needs to be informed by plausible theory and by empirical data. Most importantly it needs to be oriented towards the future. Since policies are made to influence the future course of things and not the past (that cannot be changed), the scientific basis for such policies also needs to refer to the future. In this context it does not help much to know what has happened during the 1970s or 1980s when policies are to be made for the first decade of the new millennium, unless we assume that conditions over the next decade will be identical to those during the period studied. In some cases this assumption may be justified; in others it is clearly wrong. But who can make such judgements? It is only the experts, including demographers, that study these phenomena in much detail who should be in the position to tell the planners whether the trends and causal mechanisms they identified for the past are likely to hold for the future, or in what way they are expected to be different. Unfortunately most of the demographers seem to shy away from this task. It is conspicuous to see what small proportion of the demographic literature is being devoted to explicit statements about future trends, although this seems to be what the public expects most from demographers.

In the context of the international process of World Population Conferences, and particularly in the process of reviewing the progress made since the Cairo '94 conference, the international demographic community as represented by the IUSSP (International Union for the Scientific Study of Population) has stressed the need for a major new assessment of the role of the population variable in the context of the massive demographic changes recently observed. These changes are not yet sufficiently well reflected in the agenda of international agencies in the field. As discussed above, rapid population aging will not be limited to industrialized countries. It is expected to cause even more significant problems in the developing countries because of the absence of established social security schemes. The devastating consequences of AIDS in Southern Africa, persistent poverty and the interactions between population and the environment are other key issues that need more attention by both scientists and the international policy community.

The Determinants and Consequences of Population Trends (United Nations 1973) published 25 years ago is still the only comprehensive scientific summary of the role of the population variable in development. But as described above, the world has changed a lot since then. Two hundred years after the Malthus essay, and 25 years after *The Determinants and Consequences of Population Trends,* it seems to be time for another comprehensive assessment of the role of the population variable in sustainable human development. This assessment should reflect our understanding of these complex interactions at the turn of the millennium rather than those of the late 18th century or the 1970s. In substantive terms the key challenges to be covered are linkages between micro- and macro-levels (i.e. individual rights and decisions versus societal concerns), considering stratified rather than homogeneous populations, and studying the impacts of changes in the sizes of different age groups rather than simply total population size (including both the growth and the aging concerns).

I am confident that such a more differentiated approach, together with better availability of data and more sophisticated analytical tools, will contribute to moving even further beyond the often simplistic controversy that still surrounds Malthus. If we can gain a better understanding of these complex processes, it will be worth the effort, and will provide a useful basis for the formulation of future population related policies.

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