Working Paper

World Population Prospects:
Analyzing the 1996
UN Population Projections

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WP-96-146
December, 1996
http://www.iiasa.ac.at/Research/LUC

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Abstract

This working paper (which is also available as an electronic document on the INTERNET at http://www.iiasa.ac.at/Research/LUC/Papers/gkh1/) analyzes the most recent population assessments and projections (the 1996 edition), conducted by the United Nations Population Division, New York. Its main objective is to cut through the maze of available data and identify ten demographic trends, which are most relevant for studying global (land-use) change.

The paper also discusses possibilities for improving the accuracy of population projections by applying probabilistic methods or a scenario approach. Finally, the paper analyzes factors that might affect future trends in world population growth, such as global food constraints or a widespread health crisis due to AIDS.

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World Population Prospects
Analyzing the 1996 UN Population Projections

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INTRODUCTION

- ***What is this paper about?***

This paper, which is also available as an electronic document (http://www.iiasa.ac.at/ Research/LUC/ - WP-96-146), analyzes the most recent UN population assessments and projections (the 1996 edition), conducted by the United Nations Population Division, New York. Its main objective is to cut through the maze of available data and identify ten demographic trends which are most relevant for studying global (land-use) change.

The future number of people on the globe, evidently, is an important anthropogenic factor of global change. However, even more important, will be their spatial distribution. This paper will emphasize the projected massive shift in population from the developed countries of Europe and Northern America to the future population giants of Asia and Africa. It will identify those countries that will add the largest number of people to the globe between now and 2050. We will also identify countries and regions that had the highest growth rates in the past. In a second chapter some methodological issues will be discussed - such as the question, whether probabilistic projections or scenario methods could improve the predictive capability of population projections. The final chapter of the document deals with issues that are often considered limiting factors of global population growth: food and epidemic disease (especially AIDS).

- ***Which data sources were used?***

The main data source are preliminary tables from the 1996 edition of the "World Population Prospects" (Annex I and II) to be published by the United Nations Population Division in early 1997 (United Nations, 1997). These tables were available to the author in draft form. We have also used the most recent "World Population Profile: 1996" which is prepared in the International Programs Center of the United States Bureau of the Census Population Division (US Bureau of the Census, 1996). The third data source are the "IIASA Population Scenarios" and the "IIASA Probabilistic Population Projections Based On Expert Opinions" prepared by the IIASA Population Project (Lutz, 1996).

- ***Electronic version***

This paper is a hard copy of the IIASA Web document: http://www.iiasa.ac.at/ Research/LUC/gkh1 (version 1.4) on the Internet. Please check this page for updates of the paper.

CHAPTER 1

World Population: Major Trends

- ***World population will grow significantly - despite falling fertility.***

There is a most striking paradox in global population trends: on one hand we have had a rapid decline in fertility for over two decades in many developing countries - not to mention the already very low fertility in most of the highly developed nations; on the other hand we will almost certainly experience a further massive increase in the world's population. In their most recent projection ("World Population Assessment and Projection. The 1996 edition") the United Nations Population Division projects a global population of 8.04 billion for the year 2025 and 9.37 billion for 2050 (see Figure C1.1 and Table C1.1). According to this medium variant, an increase of some 2.35 billion people can be expected worldwide between 1995 and 2025; and an additional 1.3 billion between 2025 and 2050.

These numbers are a little smaller than previous UN estimates, leading some mass media to jump to the conclusion that world population growth will be over soon. This rash judgment might be premature. This UN medium variant projection is based on the assumption that almost all countries worldwide will have a Total Fertility Rate (TFR) of only 2.1 in 2050 at the latest (only for 10, mostly European countries, the UN assumes a TFR in 2050 that is a little less - between 1.84 and 2.1). This assumption would require a further steep fertility decline in many developing nations - especially in Pakistan, Nigeria, Iran or India, where the Total Fertility Rates are still far above the reproductive level of 2.1 children per woman. According to the most recent UN estimates, Pakistan for instance, currently has a TFR of about 5 children per woman - the medium variant projection assumes that it will drop to 2.1 during the next 25 years. In other words, we will only have a world population of about 9.4 billion by 2050, if the Total Fertility Rate, measured as a global average, declines from about 3.0 in 1990-95 to the reproductive level of 2.1 children per woman in 2035-40.

Obviously, there is no guarantee that this will happen. There could be a much higher increase in world population, as indicated by the "high" variant UN projection: If worldwide fertility would drop to only about 2.6 children per woman (instead of 2.1 as assumed in the medium variant), we would have a global population of some 8.6 billion by 2025 and 11.2 billion by 2050. This would be equivalent to a 2.89 billion increase between 1995 and 2025 and a 2.58 billion increase between 2025 and 2050. In other words, we cannot exclude another doubling of the world population between now and the middle of the next century as being projected by the UN high variant projection.

Is it possible to completely stop world population growth during the next few decades? Yes, it is - if fertility, worldwide, would decline to 1.57 children per woman, the global population could stabilize at about 7.5 billion by 2025. This is the result of the 1996 UN low variant projections. Please note that this variant assumes a drastic drop of average fertility to a level of some 24% below replacement - in all countries worldwide. While such a steep decline, in fact, already happened in many European countries, it is rather unlikely that populous developing nations such as Pakistan, India, Indonesia or Nigeria - which greatly determine world population growth - would quickly follow this trend.

- ***The current annual population increase of about 80 million will remain constant until 2015.***

Currently world population is growing by about 80 million people per year (see Figure C1.2). This is a little less than in the early 1990s when the growth was more than 85 million per year. According to the most recent UN medium variant projection this will change very little during

the next decades. Only after 2015 will we observe a gradual decline of the annual population increase - reaching about 50 million by 2050. Thus, by the middle of the next century, world population growth (in absolute numbers) will have declined to the level of the early 1950s. However, this is only possible, if fertility - in all developing countries - falls to the "reproductive level" of 2.1 children per woman by 2050. For countries like India, Pakistan or Nigeria this is a long way to go.

- ***Between now and 2050 world population growth will be generated exclusively in developing countries.***

Between now and the middle of the next century world population will most likely increase by some 3.68 billion people - all of these increases will be contributed by the developing countries (see Table C1.2). In fact, the population of the developed nations as a group will most likely decline by almost 10 million people between now and the year 2050 - according to the UN medium variant projections. Most of this population growth in the developing world will occur during the next 30 years: between 1995 and 2025 the population in developing countries will increase by 2.3 billion; between 2025 and 2050 it will "only" grow by 1.39 billion.

Comparing the centennial growth of developed and developing countries reveals a dramatic divergence: The population of the developed countries as a group will have increased by less than 350 million between 1950 and 2050. The developing countries, on the other hand, will have an estimated 6.8 billion people more - thus almost quintupling their 1950 population.

This modern "population explosion" in the Third World is not comparable to the demographic transition of Europe in the 18th and 19th century. It is a historically unique phenomenon. Both the absolute numbers of population increase and the growth rates are without historical precedence. No country in Europe has experienced annual population growth rates of more than 0.5 to 1 percent during its "high growth" period.

- ***World population increase is concentrated in Asia.***

From the 3.68 billion people that will be added to the world's population between 1995 and 2050, Asia will contribute some 2 billion (see Figure C1.3 and Table C1.2). This enormous increase is due to the already massive size of the population. Most of this growth will occur in the next three decades. Between 1995 and 2025 Asia's population will grow by 1.35 billion - between 2025 and 2050 the increase is projected to be just 658 million (see Table C1.2).

Despite a projected increase in mortality due to AIDS, we cannot expect a significant slowing down of population growth in Africa. This continent will contribute 1.3 billion people to the world's population between 1995 and the middle of the next century - almost twice as much as its current total population. Fertility is still so high in Sub-Saharan Africa that it can offset the effect of rising mortality. With an increase of 734 million over the next 30 years Africa's population will more than double.

Latin America and the Caribbean, on the other hand, will have only a very moderate population increase of some 334 million between 1995 and 2050 - almost two-thirds (213 million) during the next three decades. This is due to both the smaller initial size of the population and the already relatively low level of fertility.

Europe's population will almost certainly decline - by 27 million over the next 30 years and by another 64 million between 2025 and 2050. Hence, the UN medium variant projection assumes a shrinking of Europe's population by some 91 million between 1995 and the middle of the next century.

The ten countries which will contribute most to world population growth over the next 30 years are India, China, Pakistan, Nigeria, Ethiopia, Indonesia, United States of America, Bangladesh, Zaire, and Iran - in that order!

According to the most recent (medium variant) UN population projection, India's population will increase by an additional 401 million between 1995 and 2025 - China will grow by "only" 260 million (see Table C1.3). The next largest contributor to world population growth - surprisingly - is not Indonesia which has the third largest population among developing countries, but Pakistan. This country's population will grow by about 133 million between 1995 and 2025. An almost equal contribution to world population growth will probably come from Nigeria - 127 million. Perhaps unexpectedly, the next largest contributor to world population growth will be Ethiopia, which will have an additional 80 million people over the next three decades. Indonesia, on the other hand, will grow by "only" 78 million people - which is just sixth place in the "hit list" of contributors to world population growth. The United States of America will probably grow by 65 and Bangladesh by 62 million. Few development experts would have put Zaire on a watchlist for population growth. But this Central African country is projected to have an increase in population of almost 61 million between 1995 and 2025. The tenth largest contributor to world population growth will be Iran - with a population increase of almost 60 million during the next three decades (see Table C1.3).

Which countries, worldwide, will have the highest increase in population during the 100-year period between 1950 and 2050? If the 1996 UN medium variant population assessments and projections are accurate (and there is no reason to believe otherwise) India will lead the group with an increase of 1.18 billion people - significantly larger than that of China, which will have a population increase of "only" 962 million (see Table C1.3). The third largest contributor to world population growth between 1950 and 2050 will be Pakistan with an increase of 318 million people. The ranking of the other 7 countries is as follows: Nigeria (+306 million); Indonesia (+ 239 million); Ethiopia (+ 194 million); United States of America (+ 190 million); Brazil (+ 189 million); Bangladesh (+ 176 million) and Iran (+ 153 million).

Please note again that these data are all based on the most recent medium variant UN population projection, which assumes that all countries, worldwide, will reduce their average TFR to 2.1 children per woman by 2050. It is certainly possible, if not likely, that some of these countries, such as Pakistan or Iran, will not be able (or willing) to reduce average fertility to that level. In this case these countries would have an even higher increase in population than reported above.

- ***By far the highest rates of population growth can be found in Western Asia and Africa, south of the Sahara.***

On a country-by-country basis it was mainly the oil-exporting nations of Western Asia that had the highest population growth rates over the past 45 years. According to the most recent UN assessment, the United Arab Emirates, for instance, had a mean annual growth rate of 7.7% between 1950 and 1995 (which was equivalent to a continuous exponential growth rate of 1.4% over four and a half decades). This exceptionally rapid population growth was fueled by both very high rates of fertility and immigration. Extremely high growth rates were also estimated for Qatar, Western Sahara, Kuwait, Djibouti and Saudi Arabia (see Table C1.4).

Between 1995 and 2025 more and more countries in Sub-Saharan Africa will be among those with the most rapidly growing population. Between 1995 and 2025 the fastest growing populations will that of the Gaza Strip, Liberia, Oman and Yemen. However, there will be also extremely high rates of population growth in Rwanda, Somalia, Niger, Ethiopia, and Angola.

Which country will have the highest rate of population growth considering the whole century from 1950 to 2050? According to the UN medium variant population projection it will be the United Arab Emirates, with a spectacular mean annual population growth of 4%. If that projection is accurate, then the United Arab Emirates will have a continuous exponential population increase of 0.7% over a 100 year period. Most of the other "top ten" countries with high rates of centennial population growth are also oil-exporting nations of Western Asia.

- ***India will out-grow China.***

India has one of the oldest family planning programs. It started way back in the 1950s. The country's average fertility, however, declined only slowly. In the early 1950s both China and India had a Total Fertility Rate (TFR) of about 6 children per woman. But while China's TFR sharply fell to about 2.4 in 1990, it declined only slowly in India and was still above 4 children per woman in 1990. This relatively slow decline of fertility has built up a huge population momentum in India. The country's population structure is much "younger" than that of China (see Figure C1.5). This "broad base" of children and young adults - born during the high growth period in the 1960s, 1970s and early 1980s - will enter reproductive age in the near future. Even if fertility continues to decline to reproductive level by 2020 (as being assumed by the UN projections) the Indian population will probably increase to almost 1.6 billion by 2050 - slightly more than that of China (UN medium variant) (see Figure C1.4).

However, India's population might become even much larger. If the average Total Fertility Rate would only decline to 2.6 (instead of 2.1) children per woman in 2020, the population would increase to about 1.9 billion by 2050 (see high UN variant in Figure C1.4).

According to the UN low variant projection India's population would increase to 1.2 billion by 2050. This would require an average TFR decline to 1.6 children per woman by 2010-15 (from currently around 2.9). For those who know India this does not seems a very likely scenario.

- ***Nigeria and Pakistan: emerging population giants***

There are not many countries in the world where population projections are more difficult to believe than in Nigeria. If the latest UN projections are correct then our children (and the younger among us) will watch the emergence of an African population giant, well comparable to the most populous Asian nations. In 1950 the West-African country had a population of about 33 million; since then the population has more than tripled. The UN Population Division estimates that Nigeria's population in 1995 was about 112 million (please note that the UN does not revise their estimate according to the most recent Nigerian census, which was significantly lower. Obviously, the UN Population and Statistical Divisions do not consider this census accurate enough). Between 1995 and the year 2050 the country's population will probably triple again and reach almost 339 million (see Figure C1.6). If this does occur, we will have a tenfold increase of a 33 million population within one century. This would have no historical precedence. And this is just the medium variant UN projection. Based on the demographic parameters it would be not impossible that Nigeria's population will grow even faster.

There are several overwhelmingly Muslim populations with very high population growth rates, such as those of Saudi Arabia, Kuwait or the United Arab Emirates. But none of them is projected to have such a massive absolute increase of the population as Pakistan. In 1950 Pakistan had a population of about 40 million people. Since then it has more than tripled and stood at 136 million in 1995. But the real population explosion in Pakistan will only come over the next few decades, because the country not only has a very young population, but also still an extremely high fertility - much higher, for instance, than in Bangladesh or Thailand.

These large numbers of children and young adults will soon come into reproductive age and will produce a large number of offspring even if we assume, as in the UN medium variant, a rapid decline in average fertility to reproductive level (of 2.1 children per woman) by 2020. Pakistan's population will be about 357 million by 2050 (according to the UN medium variant projection) (see Figure C1.6).

High fertility in the early 1950s was not the only reason for the exceptional population growth in Nigeria and Pakistan. There were other countries which initially had a similar or even higher level of fertility. Consider the case of Bangladesh and Thailand. The Total Fertility Rate of Bangladesh during the early 1970s was as high as in Nigeria or Pakistan and the initial population size was quite comparable. Yet Bangladesh is projected to have a population of "only" 220 million by 2050 (as compared to 339 in Nigeria). Even more impressive are the demographic trends in Thailand, which reflect one of Asia's success stories in population control. The country's average TFR was comparable to that in Nigeria, but declined sharply in the early 1970s. This "saved" Thailand from building up this massive population momentum which characterizes the situation in Nigeria or Pakistan. Consequently Thailand will have only a very moderate population increase of 14.7 million between 1995 and 2050 (see Figure C1.6).

- ***The global balance of population has shifted significantly between 1950 and 1995. It will change even more dramatically between now and 2050.***

Europe's share of the world population has sharply declined from 21.7 to 12.8 percent - Africa's share, on the other hand, has increased from 8.9 to 12.7 %. Today, both Europe and Africa are each home to about one eighth of the world population. This will change significantly in the future. Europe's share of the global population will shrink to about 6.8 percent in 2050. Africa's share will grow to 21.8 percent. Hence, one century of population growth will completely reverse Europe's and Africa's position: Europe's share of the global population in 2050 will be the same as that of Africa in 1950 - and vice versa. If the UN medium variant projections turn out to be correct (and there is no sign that they may be wrong) we have to expect a dramatic change in the global balance of population: A much bigger share of the world's population will live in Africa South of the Sahara. In only some 50 years Western Africa, for instance, will have the same population as all of Europe. Eastern Africa will have many more people than all the countries of South America, the Caribbean and Oceania combined.

- ***Worldwide, the population will age.***

Over the next decades the world population will inevitably age. This is an unavoidable consequence of large birth cohorts during the 1950s and 1960s and the rapid fertility decline since the 1970s. In 2025 the "baby boomers" of the 1950s and 60s will be between 65 and 75 years of age. These large aging cohorts are followed by the relatively small "baby bust" generations of the worldwide fertility decline.

In 1950 there were only 131 million people aged 65 and older; in 1995 their number had almost tripled and was estimated at 371 million. Between now and 2025 the number will more than double again; and by 2050 we will probably have more than 1.4 billion elderly worldwide (see Figure C1.7). The percentage of elderly increased from 5.2 in 1950 to 6.2 in 1995. By 2050 one out of ten people worldwide will be 65 years of age or more.

While currently population aging is most serious in Europe and Japan, China will experience a dramatic increase in the proportion of elder people by the middle of the next century. This is largely due to the country's success in family planning, which rapidly reduced the relative size of birth cohorts since the 1970s.

CHAPTER 2

Methodology

- ***The Population Momentum***

There is little doubt that the world's population will grow for quite some time, as being projected by the most recent UN World Population Assessment. Of course we can imagine massive natural catastrophes such as the world being hit by a huge meteor; we can also speculate about the emergence of a highly contagious lethal virus for which no cure or immunization can be found (Garrett, 1994); or we might fear a worldwide nuclear war that would result in sudden, irreversible climate change - but short of these highly unlikely events (see: Budiansky, 1995) nothing could stop the global population from increasing another few billion people. Why are we so sure about this?

First, there is a driving force concealed in the "young" age structure of the world population that just cannot be switched off (see Figure C2.1). Due to high fertility in the 1950s, 1960s and 1970s in many developing countries large numbers of women (and men) are currently entering reproductive age. The world is full of young adults that will have children. Even if each couple has a smaller number of children than their parents the total number of offspring will be substantial. This "echo effect" of a high-fertility period in the past creates a "population momentum" which works against changes in reproductive behavior that favor smaller families.

Second, it is highly unlikely that large populations will change their reproductive behavior instantly. Certain sections of a population, such as highly educated middle-class couples in urban areas, might adopt radical behavioral change almost overnight, but many developing countries still have large rural populations where fertility is linked to deep-rooted cultural values or social conditions and can decline only gradually over two or three generations. We must also take into account that the average fertility of a population is a composite measure which results from the reproductive behavior of several parent cohorts: these include couples which already have a certain number of children and can only reduce the number of additional offspring. Even in a country like China, where we have the most rigorous family planning program and a highly controlled society, it took 20 years to reduce average fertility from about 6 to 2.4 children. In India - according to UN projections - this process might take 60 years or more.

These two basic facts, which are well known among demographers, tend to slow-down demographic change. They can produce a considerable time-lag between the first signs of a fertility decline and a slow-down of population growth. In fact, it is quite typical for developing countries that the total number of birth increases for one or even two decades, while the fertility (that is the average number of children per women) already declines.

The divergent trends of population growth and fertility decline become apparent when we plot indices of the Total Fertility Rate, the average annual increase of the population and the annual population growth rates. For the five-year period of 1950-55 the indices are set to 100 (see Figure C2.2). While the index of annual population growth increased to 180 between 1950 and 1990, the index of the annual growth rate - after initially increasing to about 115 in the early 1970s - slightly fell to below 100 in 1990. The index of the Total Fertility Rate, however, significantly declined to 67 in 1990 as compared to 100 in 1950 - a worldwide drop in fertility by about 33%.

This "paradox" of population growth during a time of fertility decline is simply a consequence of the fact that the increase in the number of parents outpaced the decline in fertility. In fact,

this situation will continue for some time to come. According to the most recent UN projections we will have a stable annual increase of about 80 million people until 2015 - only then will this increase gradually decline to about 47 million in 2050. By the middle of the next century the world's population will still grow by about the same number of people as in 1950 - only the total number of people on the planet will be more than three times larger.

- ***How accurate are population projections?***

There is general agreement among demographers that population projections - properly done - are fairly accurate for some 5 to 10 years. In the short run not much can go wrong with population predictions because of the two factors discussed above: the demographic momentum and the relative stability of reproductive behavior and mortality. In fact, it was shown that even simple trend extrapolations are usually fairly accurate in the short run.

Projections for more than two or three decades, however, are much more problematic. They increasingly depend on the reproductive behavior of generations not yet born. There is also the possibility of an unforeseeable breakthrough in medical science that would affect life expectancy. And finally, one cannot predict economic and political revolutions such as the breakup of the Soviet Union and the radical change in Eastern Europe which all have significantly affected fertility and mortality.

The core problem of population projections are rapid and fundamental changes in the demographic components (fertility, migration and mortality) that "come out of the blue". We do not have a causal theory or model which would be robust enough to predict non-continuous changes in human (reproductive) behavior. There are numerous examples where projections have failed miserably due to a certain rapid change in fertility. For instance, most projections for developed countries in the early 1960s where much too high, because with the experience of a "baby boom" no one had expected the massive drop in fertility during the early 1970s and the continuation of below-replacement fertility in the 1980s, and 1990s.

Projections have also failed because of the principal unpredictability of migration. The number of immigrants largely depends on political decisions. It is a - more or less - planned process that can be switches on and off voluntarily.

Even with mortality sudden, completely unpredictable, changes can occur. The emergence and rapid spread of AIDS and other transmittable diseases should remind us that there is no natural law which guides the smooth increase of life expectancy worldwide. Russia is the most dramatic example that a country sometimes can significantly divert from general demographic trends. While in recent years mortality further declined in all industrialized countries it sharply increased in Russia due to economic and social crises (Eberstadt, 1993; Mesle, Shkolnikov and Vallin, 1994; Ryan, 1995; Shkolnikov, Mesle and Vallin, 1996 a and b).

- ***Comparison of various projections***

In Table C2.1 (a and b) I have compiled results from various world population projections, including the most recent IIASA World Population Scenarios and the 1996 edition of the UN Population Estimates and Projections. There are several remarkable results:

The "medium" or "central" variants of all projections for the year 2000 are very close - no matter whether these projections were prepared in the early 1960s or mid-1990s. For instance, the UN projection from 1993 projected the world population for the year 2000 at 6.13 billion. In 1996 the US Bureau of the Census (International Programmes Center) published its "World Population Profile" with an estimate of 6.09 for the year 2000. In 1981 Frejka projected a 6.2

billion world population for the year 2000 and in 1983 Keyfitz projected a 6.08 billion population.

For the year 2025 we can compare two UN projections, one from 1980 and the most recent from 1996: the first has projected the 2025 population at 8.2 billion, the second at 8.04 billion.

There is also remarkable little variation in the selected "medium" variant projections for the year 2050: In 1981 Frejka projected the world population for the year 2050 at 9.89 billion; the most recent UN projection in 1996 was 9.37 billion. Only Keyfitz had a more "optimistic" estimate for the year 2050 world population, 8.68 billion.

Table C2.1 also shows the extremely wide range of "variants" or "scenarios" in some of the projections. The most recent IIASA World Population Scenarios, for instance, include scenarios that range from a projected population of 7.1 billion to 13.3 billion for the year 2050. The most recent UN projections, on the other hand, have a much lower range of output: the low variant projection for 2050 is 7.26; the high variant is 8.08 billion.

As already mentioned, the United Nations Population Division has a tradition of fine-adjusting their assessments with each new round of world population projections. This should be seen as a strength rather than a weakness in their approach. In their most recent edition of the World Population Trends the UN has somewhat reduced their projections. It is interesting to see in which countries the UN thought it necessary to make the biggest adjustments. Table C2.2 presents only the differences in population estimates and projections (both as an increase or decline in the number of people and as a percentage of the 1994 assessment). The biggest adjustment was made for India: the 1996 edition has a projection for 2025 population which is almost 62 million smaller than in the 1994 edition. This is a 4.4% lower projection than in the 1994 edition. Obviously the UN is a little more "optimistic" that India will be able to reduce population growth than in the 1994 assessment.

As one can see in Table C2.2 the UN not only adjusts its projections according to new trends in fertility, but also revises the historical population estimates. The population of Russia in 1950 was estimated more than 1 million lower in the 1996 edition, as compared to the 1994 edition.

Finally, it is interesting that most of the differences between the 1994 and 1996 edition of the UN World Population Trends is due to adjustments in only 12 countries. The world population in 2050 is projected to be some 466 million less in the 1996 edition than in the 1994 edition. Almost 400 million (of this 466 million difference) is due to adjustments in the 12 countries listed in Table C2.2.

- ***What can be done to improve the methodology of population projections?***

Demographers have developed various measures to improve the predictive power of population projections, or - at least - to specify their uncertainty. There is, however, no consensus which of these methods and techniques should be applied or even, whether it is at all possible to increase the validity of population projections (important contributions to this debate are from: Keyfitz, 1981, 1985, 1989; Lee, 1974, 1992; Alho, 1990; Demeny, 1984; Frejka, 1981; Keilman, 1990). There are - at least - three approaches to this problem:

- Replace population projections by population scenarios.
- Develop more sophisticated projection techniques - including probabilistic projections.
- Live with the problem, but regularly revise projections.

- *Scenario Approach*

Scenarios are defined as "if-then" relationships. A certain set of assumptions - concerning fertility, mortality and migration - is made and the researcher then strictly applies numerical methods (such as a cohort-component projection) to calculate the demographic consequences. It is important to understand that these sets of assumptions do not have to be realistic. For instance, one could assume that all vital rates remain constant for the projection period - even if it is very likely that they will change. This "constant rates" scenario would then result in a "status quo" projection. It would tell us, what would happen - demographically - if the current conditions in fertility, mortality or migration remain unchanged. This exercise can be very instructive, because the long-range consequences of certain demographic conditions are often not obvious.

Typically, however, one would not only define one "status quo" scenario, but several sets of assumptions. These scenarios could be based, for instance, on hypothetical "extremes" in the demographic components - such as a "very high fertility - very low mortality" or a "very low fertility - very high mortality" scenario. In this case the scenarios would be used to estimate upper or lower boundaries for population growth. The IIASA population scenarios have taken this approach one step further by systematically combining high and low possibilities in the demographic components (Lutz, Sanderson, Scherbov and Goujon, 1996). This resulted in a 9 different scenarios.

While the scenario approach is certainly useful for better understanding the consequences of certain demographic assumptions, it also has its shortcomings:

In its most rigorous form the scenario approach does not help the user to choose between the different scenarios. They are just presented as "possible alternative futures". The user of the projection has to decide which set of assumptions (scenario) is more likely. This is particularly frustrating when a large number of scenarios is presented - resulting in extremely divergent demographic trends. In essence, a strict scenario approach is an attempt to transfer responsibility for the critical decisions from the demographic expert to the user, who is usually a non-demographer.

Knowing about the difficulties of users to choose between a broad range of alternative scenarios, some demographers have tried to define "most likely" or "medium variant scenarios. This, actually, is in no way different from the traditional approach of population projection. In practice, everyone will use the "most likely" scenario results as if they were some kind of "old-style" medium variant population projection.

In essence, the scenario approach in population projections is a "didactic tool" for educating the (often non-demographic) audience about the non-obvious consequences of certain demographic assumptions. However, it does not solve the basic problem of predicting human (reproductive or migration) behavior - namely the possibility of radical changes in human (reproductive) behavior and (migration) policy.

- ***Probability Projections***

The second approach to improve population projections is to use probabilities. Two major approaches are discussed in the literature:

One can use information from past changes in fertility, mortality and migration to estimate the probability of certain changes in the future. For instance, one could use the distribution of inter-annual changes in fertility during the last 20 years to estimate the probability that the fertility rate will increase or decline by a certain margin in the future. If, for example, the (age specific) fertility rates only dropped by a small margin from year to year it is unlikely -

according to this approach - that it will jump up by a huge margin in the future. There are several highly sophisticated variants in using time-series data to calculate probabilities for future changes in the demographic components (Lee, 1974 and 1992), but none of these methods does anything to solve the basic problem that the past does not necessarily give us hints about the future. Moreover there are numerous technical problems, such as where to begin the time-series for the calculation of the probability estimates: Should they go back before the "baby boom"? Should they be only for the most recent few years? If we take into account fertility data from the "baby boom" and "baby bust" years we automatically end up with a much broader probability distribution for our estimates of future fertility.

The second approach in probabilistic population projections is a variation of the scenario method. A panel of demographic experts is asked to estimate the probability of certain changes or levels in fertility, mortality or migration (Lutz, Sanderson and Scherbov, 1996). These probability estimates are then used to calculate a population projection with (various) confidence intervals. Unfortunately, it is by no means easier to estimate the probability of a certain future fertility range (or level) than just to predict a specific, most likely, level of these demographic components. How can one say, for instance, that with 95% probability Germany's TFR will be in the range between 1.1 and 1.9 in 2030? This "point-based" probability estimates completely depend on the ability of demographic experts to translate their intuitive "best guess" estimate of future fertility, mortality or migration levels into (quantitative) probabilities. Cognitive research tells us that humans are particularly bad in estimating the probability of certain events. For instance, many people are frightened to fly because they believe crashes are quite frequent - not realizing that driving their car to the airport is the real risk.

Probability projections use - sometimes excessively - methodological sophistication in order to solve the principal problems of predicting human behavior. Unfortunately, they either depend on information extracted from historical time-series data or they must rely on the cognitive capacity of experts to estimate the probability of future events. While they are certainly more complicated than conventional projections, it is rather questionable whether they are more accurate.

- ***Simple Method - but Frequent Revisions***

The third - pragmatic - approach, in my view, is the most realistic. Rather than aiming for a more sophisticated projection techniques it tries to continuously fine-adjust a simple population projection based on the most recent empirical evidence. The projection is usually based on a traditional cohort-component model with a low, medium and high "variant". These variants are the results of relatively mechanical, straight-forward assumptions on future trends in fertility, mortality and migration.

This approach is used by the United Nations Population Division in their World Population Estimates and Projections. For instance, they simply assume that fertility will converge to a level of 2.1 by 2050 at the latest for (almost) all countries worldwide in the medium variant, and somewhat higher or lower in the high and low variants (only for 10, mostly European countries, the UN assumes that the TFR will be a little lower than 2.1).The UN assumptions on mortality and migration are also very simple. While this is certainly not the ultimate methodological sophistication in population projection, the approach has proved to be rather useful and surprisingly accurate. The UN medium variant is widely used as a best-guess projection of future demographic trends. The fertility, mortality and migration assumptions are simple, but open for debate. While everyone can question the UN assumption that the TFR will be 2.1 in 2050 it is impossible to disagree with an intuitive probability estimates generated by a panel of experts.

CHAPTER 3

Problems Related to World Population Growth

- ***Is there a fertility decline in the Third World?***

People in developed countries sometimes believe that world population growth could be stopped rather quickly, if only the couples in the developing world would reduce their fertility. This misconception, unfortunately, is by no means restricted to laymen. It is based on the believe that people in the Third World so far have not - or only moderately - reduced the number of children. The opposite is the case. As we have demonstrated in Chapter 1 there was already a massive decline of fertility in many developing countries since the middle of the 1970s. And the projections assume a further significant drop. In fact, a world population of 9.4 billion people by the middle of the next century is only possible, if fertility - on a worldwide average - declines to about 2.1 children per woman.

Figure C3.1 is an attempt to visualize this past and projected fertility transition on a global level. It presents the cumulated number of people that lived (or are projected to live) in countries below a certain average level of fertility in 1950, 1995 and 2025. In 1950 there were no countries that had a Total Fertility Rate of less than 2.1. But some 1.5 billion of the 2.5 billion world population lived in countries with a Total Fertility Rate of more than 4.7. As can be seen from the lower blue line in the chart, only about 500 million people lived in countries where the TFR was less than 2.7.

That had changed significantly by 1995 (see the violet line in Figure C2.1). Now some 2.5 billion people lived in countries with a TFR of 2.1 or less. And - due to the rapid fertility decline in China - some 4.2 billion people lived in countries where the average number of children was 3.4 or less.

A world population of "only" 9.3 billion people by 2050 would require that roughly 6 billion people would have to follow a "low fertility" regime - that is, the average TFR in their countries would have to be only 2.1 children per women or less.

We can see some interesting patterns if we study this global fertility decline on a country-by-country basis. In Table C2.1 we have sorted all countries according to their changes in average Total Fertility Rates between the five-year periods of 1950/55 and 1990/95. The largest (absolute) decline in fertility - according to the 1996 UN estimates - was recorded in Thailand: the average number of children per woman dropped from 6.6 to 1.9 children. Today, the average Thai family has almost 5 children less than in the early 1950s.

Singapore is a small country, but in its effort to reduce average family size it is great. In the past four decades the average number of children per women dropped by 4.6 - from 6.4 to 1.8. Both Thailand and Singapore now have below-replacement level fertility. In the long run this would lead to a natural population decline.

Spectacular declines of fertility in the Third World are not restricted to Asia. A good example is the Dominican Republic. Here the average number of children per women fell from 7.4 in 1950/55 to 3.1 in 1990/95. The population in Turkey, which had a very high Total Fertility Rate of 6.9 in the early 1950s, reduced the average number of children to 2.7 in 1990/95. There are even African countries with a very significant fertility decline in the past four decades: in Mauritius the TFR dropped from 6.3 to 2.4 in 1990/95 (today it is even lower).

The most significant fertility decline, however, has occurred in China. While the population increased from 555 million in 1950 to 1.2 billion in 1995, the average fertility dropped from 6.2 to 1.9 children per women. This UN-estimate of below-replacement fertility for China is

confirmed by independent demographic research (see for instance: Feeney, 1996). The government's strictly executed "one-child" family planning program and the social environment of this highly controlled society certainly helped to achieve this widespread change in reproductive behavior. But especially in recent years of rapid economic development young couples in cities are increasingly favoring postponement of birth and small families from their own choice. Due to the size of its population China's fertility decline is a crucial factor of world population growth. We have to realize that more couples are restricting the number of children in the still very poor developing country of China than in all highly developed nations of Europe and Northern America combined.

To answer the question stated above we can conclude that billions of couples in the Third World have already a much lower fertility than their parents. All UN projections (even the high fertility variants) assume a further rapid decline of average fertility in the Third World. Only then will we observe the projected slow-down of population growth and a leveling off at about 10 billion people.

- ***Will world population growth be stopped by food shortages?***

The race between population and food is one of the oldest themes of (demographic) research - and probably one of the most controversial. Since Malthus' essay, 200 years ago, numerous books and papers - both scientific and popular - have been written on the issue (see for instance: Malthus, 1798; Vogt, 1948; Osborn, 1948; Fremlin, 1964; Ehrlich, 1968; Daily and Ehrlich, 1992; Waggoner, 1994; Cohen, 1995). Just summarizing the main arguments of this debate would go far beyond the scope of this paper. Elsewhere I have published a more detailed analysis (Heilig, 1996). Here, I will only mention a few arguments and facts which are essential for understanding the problem.

- ***We must distinguish food crises from the problem of a population outgrowing the carrying capacity of its land.***

There is a long record of severe famines that have affected populations in various places. The Irish Famine, the food crisis under Stalin's terror regime, the "Great Leap Forward" in China (an euphemism that covered up one of the most massive famines in recorded history), the Bengali famine and numerous famines in African countries, such as in Ethiopia and Somalia, have all caused the death of millions (Boyle, 1994; Conquest, 1991; Nove, 1990). These tragic losses of human life have left deep marks in the age structures of the populations affected - some of them still visible today. But they have certainly not slowed down world population growth. In fact, many very large famines had only a surprisingly minor impact on the long-term population trends - even in the countries where they occurred. One major consequence of an acute famine is the increase in infant and child mortality. But parents often replace "lost" children some time later, when the food situation has improved again.

Just consider the case of the two most populous nations on earth: India and China. They both have a long history of exceptionally severe famines, before the "Green Revolution" and economic reforms improved the food supply for most people in the 1980s and 1990s. Especially for India, where floods and monsoons frequently destroyed the harvests, historians have documented numerous famines of apocalyptic dimensions, such as the great famine of 1630-31 which affected all of India or the food crises between 1555 and 1596 in the northwestern part of the country (Braudel, 1990). Yet none of these disasters decimated India's population in the long run.

We can identify many obvious reasons for the great famines in history - natural catastrophes, such as hurricanes, floods, droughts, crop pests or volcano eruptions; or man-made conditions, such as civil wars, trade restrictions, political terror, or forced deportation of peasants as in

Stalin's terror regime. But to my knowledge there is no clear evidence that any of these famines was caused by a population suddenly outgrowing the carrying capacity of their land. When the natural disaster was over and the economic or political constraints removed, the food situation usually normalized - and very often the population began to grow again.

A lot has been published on the ecological collapse of past civilizations (Lowe, 1985; Culbert, 1973; Diamond, 1994). It is, for instance, quite likely that chronic food shortages - triggered by a dry period around AD 800 - did contributed to the decline of the Maya civilization (Hodell, Curtis and Brenner, 1995; Sabloff, 1990, 1995). But that was certainly only one element in a multi-factorial process of socio-economic decline - they didn't just perish all of a sudden in a famine. If food constraints really have contributed to the collapse of the Maya culture, then it was not an absolute limitation of bio-physical resources which caused the decline, but an inability to adapt the technology and the economic, social and political organization to the environmental constraints. The correlation between paleoclimatic records and the decline of the Classic Maya civilization is not necessarily a causal explanation of the collapse. For instance, it does not explain why the Mayas moved from the most seriously drought-affected southern lowlands to the northern lowlands (to Chichen Itza, Uxmal, Kabah or Sayil) which are not very suitable for agriculture. Why did they not move to the highlands where agro-climatic conditions are much better? (see also: Pohl, 1990; Sharer, 1994).

- ***Famines are a thing of the past for most of the world's people.***

Famines and food shortages were very common throughout human history. In fact, bad harvests with subsequent food crises were so frequent in pre-industrial Europe that they became a part of everyday life. They shaped traditions and religious practices and affected the rise and fall of empires. The ups and downs in food supply (and the repeated spread of epidemics) is mirrored in early birth and death records of Parish registers. They show a recurrent pattern of excess deaths over births every few years. In Asia, the food situation was even worse. Much of the recorded history in China deals with food shortages and famines and the political disruptions they triggered. We also have historical documents from early European travelers to Russia, India and China who reported famines of apocalyptic dimension. (For a more detailed discussion of historical trends in food supply see: Walter and Schofield, 1989; Watkins and Menken, 1985).

A high variability in the supply of food was typical for all traditional agriculture - especially in tropical regions where climatic hazards are abundant. They lacked the technology and economic arrangements to stabilize the food supply that have been invented over the past few decades, such as satellite-based early warning systems, emergency food aid or a strategic international cereal reserve. These modern measures of food crisis intervention have saved the lives of hundreds of millions. But there is a second, even more important, improvement in modern agriculture, that gives hope for the future: the enormous increase in productivity that could be achieved through artificial fertilizers, pesticides, efficient methods of irrigation and high yield varieties of major food and feed crops. Modern agricultural technology and new methods of farm management, combined with free access to (international) markets, have boosted the production of food during the past few decades - not only in Northern America and Europe, but also in Asia and Latin America.

- ***Today, more people can be fed than ever before.***

Despite gloomy predictions of biologists in the 1960s the global food situation is much better today than three or four decades ago. We have not only "survived" a doubling of the human population since 1950, but we are able to provide more and better nutrition to a much larger section of the world's population. The agricultural productivity gain in industrialized countries

- further stimulated by production subsidies - was so great that most of them ran into problems of over-production. They not only had to reduce subsidies, but also decided to remove arable land from cultivation. The modern agricultural revolution, however, had its greatest impact in Asia. Consider the case of China: In the 1950s and 1960s, when the population was just between 555 and 657 million, the food situation was very critical; in fact in 1959-61 China had one of the largest famines in history. Today, with a population of 1.2 billion, China can feed itself. It is estimated that China's economic reforms since 1978 have lifted some 200 million people out of poverty - a major step to increase food security. Cereal prices on international markets have fallen significantly - giving poor food-deficit countries the chance to import larger amounts of food.

Worldwide, the average per capita food calorie supply increased from 2274 to 2709 calories per person per day between the three-year interval of 1961/63 and 1992/94. We eat more fat, vitamins and better and more protein than thirty years ago (see Table C3.2). The average per capita protein supply increased from 62.6 to 71.6 g per person per day. In Asia the increase was most spectacular: the average calorie supply grew from 1865 to 2577 calories per person per day; the average protein supply increased from 47.2 to 63.9 g per person per day. In the "Least Developed Countries" (which include some 50 poor developing countries) the average food situation, unfortunately, improved only marginally from 2012 calories per person in 1961/93 to 2032 calories per capita in 1992/94. This worldwide increase in food supply has certainly contributed to the fact that life expectancy has increased almost everywhere. The infant mortality of now is a small fraction of what it was when the world's population was only half as large as today.

- ***Hunger and under-nutrition have remained the fate of millions.***

Of course, there is still much hunger and under-nutrition in our world. Numbers are quite controversial, but the general trend is clear: In the early 1990s the FAO published a detailed study which analyzed chronic under-nutrition in 93 developing countries. According to these estimates, the number of undernourished people worldwide declined from 941 million in 1969/71 to 781 million in 1988/90 while the population increased from 2.6 to 3.9 billion. Hence, the percentage of people with insufficient diet significantly declined from 36% of the world population in 1969/71 to 20% in 1988/90. And in the 1990s the situation further improved. Especially Asia could reduce the number of malnourished people. New estimates for the second half of the 1990s are not available, but taking into account China's increase in per capita food production since 1980, an estimate of some 500 million undernourished people is not unreasonable.

This chronic under-nutrition is a tragedy, but it is overwhelmingly not caused by bio-physical limitations of agriculture, but by economic, social and political deficiencies in certain countries, such as extreme poverty or inefficient and unfair systems of food distribution. For instance, it is not the soil conditions or the climate or population growth which have caused the near collapse of agriculture in Russia and the Ukraine in the early 1990s. Corruption, bureaucratic inefficiency, and the rigidity of a centralized command agriculture were the core problems of Russia's deficient food supply. Poverty plays a major role in India's food problems. While the country has experienced rapid economic development with a major increase in living standards among a growing (urban) middle class, a large section of the rural population still lives in absolute poverty. The scandal of under-nutrition in the face of abundance in India is the inability or unwillingness of the ruling classes (and casts) to share some of their wealth with the poor. However, nowhere is the link between under-nutrition and policy failure more obvious than in Africa. Civil war, corruption, economic mismanagement,

the lack of agricultural infrastructure investment, failure to promote agricultural training, or radical economic experiments have played major roles in all recent African food crises.

- ***The battle to feed all of humanity is not over yet.***

In 1968 Paul Ehrlich wrote: "The battle to feed all of humanity is over" because he believed that world population growth would soon hit biophysical limits of sustenance (Ehrlich, 1968). He was wrong. We are still fighting. But our chances to win are not bad. We can be optimistic, because we have seen the remarkable effects of agricultural modernization and policy reform in Asia - especially in China. We are now much more aware of what is causing chronical under-nutrition and triggering acute famine than 30 years ago. Usually, it is not bio-physical limitation, but policy failure and lack of socio-cultural change. Depending on model assumptions, only some 25 to 35 percent of the world's *potential* arable land is now under cultivation and current crop yields are well below their theoretical maxima in many parts of the developing world - especially in Latin America and Africa. In a study of developing countries (excluding China) the FAO has estimated that from an area of 2570 million hectares with rainfed crops production potential only 760 million hectares (or 30%) are currently used in crop production.

The challenge of the world food problem is to bring the high-productivity agriculture - that was so successful in Europe, Northern America and parts of Asia to those developing countries where agricultural productivity is still very low - and utilize the advantages of food trade in our global economic system.. This will require major social, economic and political reforms in these countries.

- ***There is no indication that the world population is approaching physical limits of food production in the foreseeable future.***

Those who continue to predict population growth running into agricultural resource constraints hold on to a serious misconception of how human sustenance is generated in the 20th and 21st century. They believe - as Ehrlich wrote - that "human carrying capacity is the long-term ability of an area to support human beings" (Ehrlich, 1968). The critical phrase here is "area". It suggests that human sustenance is primarily based on the bio-physical characteristics of a certain territory. This was certainly correct for neolithical tribes, but it is simply wrong for at least 200 years. The well-being of a modern, industrial society depends on its ability to promote and efficiently organize economic activities outside the agricultural sector, often even outside their own country - in research and development, in industry, in international trade, in banking, in tourism and other service sectors. Those, who succeed in these economic activities can buy food on the world market if their own territory is unsuited for food production - or even grow wheat in the desert, as do some of the oil-exporting nations in Western Asia and Northern Africa. If the price is right, farmers in resource-rich countries, such as Canada, the United States of America or Brazil would be more than willing and able to supply international markets with additional amounts of food and feed grain. Even Russia could produce for the international market if they would cultivate their land with "western" productivity. Were they properly managed, the large arable land of the Ukraine could feed many more people than actually live there (before World War II the Ukraine was a major food exporter to Western Europe). Even parts of Africa, such as Sudan, have huge resources of arable land, sufficient water and adequate climate conditions. As a well-known FAO-IIASA study has shown, Sudan has a population supporting capacity of up to a billion people - twice the actual population of Africa (FAO/IIASA/UNFPA, 1982).

In its landmark study on World Agricultural: Towards 2010, the FAO has concluded that "there appear to be no insurmountable resources and technology constraints at the global level

that would stand in the way of increasing world food supplies by as much as required by the growth of effective demand. And, on balance, there is scope for such growth in production to be achieved while taking measures to shift agriculture on to a more sustainable production path."(Alexandratos, 1995).

- ***Would a smaller world population be more "sustainable"?***

Those, who entertain the public with "doomsday scenarios" of looming global food or health crises often argue that small populations separated by undisturbed natural environment would be more healthy and "sustainable" (whatever that means). So let's go back in history to the "golden ages", when the world was an almost empty place. From paleo-demographic research we know that for most of human history the world population consisted of small tribes - each of a few dozen people - isolated from each other through vast areas of natural land. However, these ancient people lived short lives - often on the brink of starvation. Their remains frequently show signs of multiple chronically diseases, poor nutritional status and injuries related to violent conflicts. Most of their children died in the first few years. If they survived childhood they rarely became older than 35 years. We know of several (ancient) civilizations that vanished from earth despite (or maybe because) they lived thinly scattered over vast areas of almost natural, undisturbed land.

Even in more recent history the mighty Greek or Roman empires only had a tiny population as compared with today's populous countries in Asia or Africa. During the time of the "Peloponnesian War" in the middle of the 5th century B.C. (it was the peak period of ancient Greece) the city of Athens had a total population of just 133 to 173 thousand (Ploetz, 1986). In the eleventh century Europe's large cities typically had less than 10,000 inhabitants - but even places with more than 500 inhabitants were considered a town. The city of Rome, "center of the world" for hundreds of years, never had a population of more than 200,000 people before the 18th century. Compared to the mega-cities of today with 10, 20 or even 30 million inhabitants these historical settlements were idyllic places. Yet, their population incredibly suffered from poor sanitation, lethal epidemics and frequent devastation due to war or fire.

At the beginning of the 14th century European populations typically were smaller than that of average Asian cities today. Most people lived in small rural settlements which were separated by huge areas of virgin land. It was estimated that in 1340 Italy's population was about 10 million; the British islands had a population of only some 5 million; France and the Netherlands had a total population of 19 million and Germany some 11.5 million (Ploetz, 1986). Living in an almost undisturbed natural environment this small and dispersed populations, however, suffered the greatest public health crises in recorded history: the bubonic plague. Within a century one third (or more) of the European population was killed. By the middle of the 15th century Italy's population had declined by 2.5 million (25%); on the British islands the population decline was in the order of 2 million (40%); the population in France and the Netherlands shrank by 7 million (or 37%); and Germany's population fell by 4 million (35%). But even this massive epidemic did not stop Europe's population growth in the long run. Only a century later the population had recovered.

- ***Is there a social upper limit to population density?***

Some people have argued that increasing population density will trigger a process of social erosion and disintegration. Experiments with rats and other animals have shown that stress related to population density can affect the social structure and individual health of the animals. However, this cultural and social doomsday scenario is by no means more likely than the dire food crisis predictions. There are few urban places in the world where crime rates are

lower and average (healthy) life expectancy is higher than - for instance - in the extremely densely populated urban agglomerate of Tokyo-Yokohama, Japan. Even the densely populated "urban jungle" of New York or Washington is a rather healthy and kind environment for people - if compared to the sparsely populated villages of Zaire, Sudan or the Ukraine (to select just three of the many rural crises regions). Recently, New York City has demonstrated that it is possible to lower crime rates even in places of extreme concentration of population and social problems. One might argue that it is unfair to compare highly developed urban areas with villages in poor countries. But it is easy to find other examples: China's very poor rural population has one of the highest densities in the world - yet their life expectancy and infant mortality is lower, and their nutritional and health status, better than in most parts of sparsely populated Africa, Latin America or Russia. High population density as such has little influence on human well-being. And it is certainly not a limiting factor of further population growth.

Of course, we have serious public health crises or events of social disintegration in certain countries or regions which have even increased national mortality rates, such as in certain African countries or Russia (Shkolnikov, Mesle and Vallin, 1996; Ryan, 1995). But they are man-made. They are caused by inadequate political, social and economic structures, which could be (and have been in other countries) changed by a competent political administration and/or by individual behavioral change. Human populations do not act like rats in a cage. Other than these rodents, they can intentionally modify their social conditions and individual behavior in order to adapt to a more densely populated world. This socio-economic adaptability to population growth is frequently ignored in Global Change research which is focused on the bio-geophysical aspects.

In my view, the successful adaptation of billions of people worldwide to an urban-industrial environment is one of the most interesting characteristics of global change. Only a few generations ago the majority of the world's population lived from agriculture and settled in small villages and towns - usually under quite harsh conditions with high (infant) mortality and fertility, frequent famines and poverty. Today a large section of the (much larger) world population has not only changed (and improved) its mode of sustenance, but also adapted to the living environment of urban-industrial complexes with multi-million inhabitants and unprecedented population density. Many of us (including the author) might not like living in crowded cities - but we cannot ignore the fact that the concentration of people into an urban-industrial world was a highly successful organizational innovation in human evolution. In fact, with a projected 10 billion people on the globe, we will be able to reserve some space for nature only if the human population can be concentrated in compact, high-density urban agglomerates.

- ***Will AIDS stop world population growth?***

While there is no evidence that traditional health crises are able to limit world population growth new types of diseases might be more devastating. The obvious example is AIDS. For demographers dealing with population projections this is one of the most interesting questions and many studies have investigated the problem (see for instance: Bongaarts, 1996; US Bureau of Statistics, 1996). Of course, no one can be sure about the future spread of HIV, but from our current knowledge it seems to be unlikely that the AIDS epidemic will have a significant effect on world population growth. The reasons are the following:

First, there is not one large uniform HIV epidemic spreading across the world population, but many distinct epidemics. Each one has its own origin, its specific transmission patterns and social background. Each one involves a certain risk behavior and is open to different types of prevention measures. Homosexual men, drug addicts, sharing injection needles, prostitutes

and their clients, and heterosexual people who practice unprotected sex with multiple partners have a much higher probability of getting infected than those who avoid this practices. This is the reason while after more than 15 years of HIV spread in Europe still 76 percent of all AIDS cases diagnosed in 1996 were either homo/bi-sexual men or injecting drug users. Only 14% of the newly diagnosed AIDS cases were heterosexual men and women - many of these were partners of intravenous (IV) drug users. For instance, 31% of heterosexually infected female AIDS patients were partners of IV drug users (European Centre for the Epidemiological Monitoring of AIDS, 1996). In Europe, HIV so far has spread mainly among people with specific kinds of risky behavior that are not practiced by the great majority of the population. In fact, the available statistics indicate that in Europe - especially in Northern Europe - the AIDS incidence seems to have stabilized. The situation, obviously, is quite different in Africa, where a high prevalence of HIV infection is reported among the "general population". Several studies have demonstrated that HIV-related diseases are already the leading cause of death for young adults in many African cities (for instance in Abidjan). Rapid increases of HIV infections and AIDS cases were recently reported from India and Thailand. But these epidemics also seem to spread mainly among IV drug users, prostitutes and their customers and homosexual men with multiple, unprotected sex contacts. In any case, it is clear now that the AIDS disease is the result of a compartmented epidemic which is closely linked to behavioral and cultural patterns - not comparable, for instance, to the Black Death in the Middle Ages that swept more or less indiscriminately over Europe's population.

Second, while AIDS in Africa South of the Sahara has already increased infant and adult mortality rates by as much as 50%, the impact on fertility is much smaller. A large percentage of HIV-infected women will contract the virus only after they have already given birth to one or more children, because fertility is still very high and the average child-bearing age is very low. And even after having been infected with the AIDS virus pregnancies are likely - due to the 8 to 10 year asymptomatic incubation period of HIV. Some 30% of these babies born by HIV infected mothers will not carry the virus (in Europe and Northern America mother-to-child transmission does not occur in about 50 to 60 percent of the pregnancies of HIV infected mothers). In Africa, AIDS typically kills people in their early 30s - an age where much of the reproductive period is already completed. AIDS is undoubtedly a major public health crisis in Africa South of the Sahara - but its demographic effects are restricted to the increase of adult and infant mortality rates. Population growth rates will not be affected much due to the still high level of fertility and the massive demographic momentum built into the young age structure of African populations.

Third, the situation in Asia is unclear. Despite much higher HIV prevalence rates in Africa, AIDS could potentially have a greater impact on population growth in Asia due to the much lower initial fertility. On the other hand it seems unlikely that all of Asia would be affected in a similar way. China, for instance, has so far reported very few AIDS cases.

In conclusion, we can assume for the moment that AIDS has no great overall demographic effect in Europe and Northern America. It increases mortality patterns in certain geographical regions and age groups, but not to such an extent that it would affect overall population growth. Despite very high rates of HIV prevalence and increasing mortality AIDS will probably only moderately slow down Africa's population growth. And in Asia - so far - many countries show no sign of rapidly spreading HIV infections.

BIBLIOGRAPHY

Alexandratos, N. (Ed.) (1995): *World Agriculture: Towards 2010. An FAO Study.* Chichester et al. (FAO and John Wiley & Sons).

Alho, J. M. (1990): *Stochastic methods in population forecasting.* In: International Journal of Forecasting, Vol. 6, 521-530.

Bongaarts, J. (1988): *Modeling the spread of HIV and the demographic impact of AIDS in Africa.* The Population Council, Working Paper No. 140.

Bos, E., Vu, My T., Massiah, E. and Bulatao, R.A. (1994): *World population projections, 1994-95 edition: estimates and projections with related demographic statistics.* Washington, D.C. , Baltimore, London (World Bank, Johns Hopkins University Press).

Boyle, P.P. and O'Grady, C. (1986): *Fertility Trends, Excess Mortality, and the Great Irish Famine.* In: Demography, Vol. 23, 543-562.

Braudel, F. (1990): *Sozialgeschichte des 15.-18. Jahrhunderts. Der Alltag.* München (Kindler Verlag). Original: Civilisation matérielle et capitalisme, XV-XVIII siécle. Le structures do quotidien: Le possible et l'impossible. Paris, 1979.

Budiansky, S. (1995): *Plague fiction.* In: New Scientist, Vol. 2, 28-31.

Cohen, J.E. (1995): *How many people can the earth support.* New York (W.W. Norton).

Conquest, R. (1991): *Excess deaths and camp numbers: some comments.* In: Soviet Studies, Vol. 43, No. 5, 949-952.

Culbert, T. (1973): *The Classic Maya Collapse.* Albuquerque (University of New Mexico Press).

Daily, G. and Ehrlich, P. (1992): *Population, sustainability and the Earth's carrying capacity.* In: BioScience, Vol. 42, 761-771.

Demeny, P. (1984): *A perspective on long-term population growth.* In: Population and Development Review, Vol. 10, 103-126 .

Diamond, J. (1994): *Ecological collapses of past civilizations.* In: Proceedings of the American Philosophical Society, Vol. 138, No. 3, 363-370.

Ehrlich, P. (1968): *The Population Bomb.* New York (Ballantine).

Eberstadt, N. (1993): *Mortality and the fate of communist states.* In: Communist Economies and Economic Transformation, Vol. 5, No. 4, 499-517.

European Centre for the Epidemiological Monitoring of AIDS (1996): *HIV / AIDS surveillance in Europe.* Quarterly Report, No. 51 (WHO-EC Collaborating Center on AIDS, Saint-Maurice, France).

FAO (1996): *FAOSTAT Electronic Data Base.* Rome (Food and Agricultural Organization).

FAO/IIASA/UNFPA (1982): *Potential population supporting capacity of lands in the developing world.* Technical Report on Project INT/513. Rome (Food and Agricultural Organization).

Feeney, G. and Yuan, Jianhua (1994): *Below Replacement Fertility in China? A Close Look at Recent Evidence.* In: Population Studies, Vol. 48, No. 3, 381-394.

Frejka, T. (1981): *World population projections: A concise history.* In: International Population Conference, Vol. 3, IUSSP, Manila, Philippines.

Frejka, T. (1981): *Long-term prospects for world population growth.* In: Population and Development Review, Vol. 7, No. 3, 489-511.

Fremlin, J. (1964): *How many people can the world support?* In: New Scientist, Vol. 29, 285-287.

Garrett, L. (1994): *The Coming Plague: Newly Emerging Diseases in a World Out of Balance.* New York (Farrar, Straus, and Giroux).

Harper, L. (1992): *Census Bureau lifts population forecast, citing fertility, immigration, longevity.* In: The Wall Street Journal, December 4, 1992, B1.

Heilig, G.K. (1996): *How Many People Can Be Fed On Earth?* In: Lutz, W. (Ed.): The Future Population of the World. What can we assume today? Revised and Updated Edition. London (Earthscan), 196-249.

Heilig, G.K. (1996): *Who is Changing the Land? Lifestyles, Population, and Global Land-Use Change.* In: Ramphal, S. and Sinding, S.W. (Eds.): Population Growth and Environmental Issues. Westport, London (Praeger, Environmental Literacy Series, The Rene Dubos Center for Human Environments).

Heilig, G.K. (1994): *Neglected Dimensions of Global Land-use Change: Reflections and Data.* In: Population and Development Review, Vol. 20, No. 4, 831-859, (December 1994).

Heilig, G.K. (1993): *Food, Lifestyles, and Energy.* In: van der Heij, D.G. (Ed.): Food and Nutrition Policy. Proceedings of the Second European Conference on Food and Nutrition Policy. The Hague, Netherlands, 21-24 April 1992, Wageningen, (Pydoc), 60-86.

Hodell, D., Curtis, J. and Brenner, M. (1995): *Possible role of climate in the collapse of classic Maya civilization.* In: Nature, Vol. 375, 391-394.

Johnson, P.D. (1995): *International Data Base.* Washington. (International Programmes Center of the US Bureau of the Census).

Keilman, N.W. (1990): *Uncertainty in National Population Forecasting:* Issues, Backgrounds, Analyses, Recommendations. Amsterdam (Swets & Zeitlinger).

Keyfitz, N. (1983): *Can knowledge improve forecasts?* Laxenburg, Austria (International Institute for Applied Systems Analysis, Research Report, RR-83-05).

Keyfitz, N. (1981): *The limits of population forecasting.* In: Population and Development Review, Vol. 7, No. 4, 579-593.

Keyfitz, N. (1972): *On future population.* In: Journal of the American Statistical Association, Vol. 67, No. 338, 347-363.

Keyfitz, N., Allen, E., Edmonds, R., Dougher, R. and Wiget, B. (1983): *Global Population (1975-2075) and Labor Force (1975-2050).* Institute for Energy Analysis, Oak Ridge Associated Universities, ORAU/IEA-83-6(M). Oak Ridge, Tennessee.

King, J. and Slesser, M. (1995): *Prospects for Sustainable Development: The Significance of Population Growth.* In: Population and Environment: A Journal of Interdisciplinary Studies, Vol. 16, No. 6, 487-505, p. 488.

Lee, R. D. (1992): *Stochastic demographic forecasting.* In: International Journal of Forecasting, Vol. 8, 315-328.

Lee, R. D. (1974): *Forecasting births in post-transitional populations: Stochastic renewal with serially correlated fertility.* In: Journal of the American Statistical Association, Vol. 69, No. 247, 607-617.

Lowe, J.W. (1985): *The Dynamics of Apocalypse.* Albuquerque (University of New Mexico Press).

Lutz, W. (Ed.) (1996): *The Future Population of the World. What Can We Assume Today?* Revised Edition. London. (Earthscan Publications Ltd.).

Lutz, W., Sanderson, W., Scherbov, S. and Goujon, A. (1996): *World Population Scenarios for the 21st Century.* In: Lutz, W. (Ed.) (1996): The Future Population of the World. What Can We Assume Today? Revised Edition. London. (Earthscan Publications Ltd.).

Lutz, W., Sanderson, W. and Scherbov, S. (1996): *Probabilistic Population Projections Based on Expert Opinion.* In: Lutz, W. (Ed.) (1996): The Future Population of the World. What Can We Assume Today? Revised Edition. London. (Earthscan Publications Ltd.).

Malthus, T. (1798): *An Essay on the Principles of Population.* Reprinted 1960. New York (Modern Library).

Mesle, F., Shkolnikov, V. and Vallin, J. (1994): *Brusque montee des morts violentes en Russie. [Rapid increase in mortality form violent causes in Russia.]* In: Population, Vol. 49, No. 3, 780-790.

Niu, Wen-Yuan and Harris, W.M. (1996): *China: The Forecast of its Environmental Situation in the 21st Century.* In: Journal of Environmental Management, Vol. 47, 101-114.

Nove, A. (1990): *How many victims in the 1930s?* In: Soviet Studies, Vol. 42, No. 2, 369-373.

Oeppen, Jim (1993): *Generalized inverse projection.* In: David S. Reher and Roger Schofield (Eds.) (1993): Old and new methods in historical demography. 29-39 (Clarendon Press: Oxford, England).

Osborn, F. (1948): *Our Plundered Planet.* Boston (Little, Brown).

Pimentel, David (1991): *Global warming, population growth, and natural resources for food production.* In: Society and Natural Resources, Vol. 4, No. 4, 347-363.

Ploetz (1986): Der Grosse Ploetz. *Auszug aus der Geschichte. 30. Aktualisierte Auflage.* Freiburg, Würzburg.

Pohl, M. D. (Ed.) (1990): *Ancient Maya Wetland Agriculture: Excavations on Albion Island, Northern Belize.* Boulder (Westview Press).

Poleman, T.T. (1995): *Population: Past Growth and Future Control.* In: Population and Environment: A Journal of Interdisciplinary Studies, Vol. 17, No. 19, 19-40, p.33.

Romaniuc, A. (1994): *Reflection on population forecasting: from prediction to prospective analysis.* In: Canadian Studies in Population, Vol. 21, No. 2, 1994. 165-80 pp. Edmonton, Canada.

Ryan, M. (1995): *Alcoholism and rising mortality in the Russian Federation.* In: British Medical Journal, Vol. 310, No. 6980, 646-648.

Sabloff, J.A. (1995): *Drought and decline.* In: Nature, Vol. 375, 357.

Sabloff, J.A. (1990): *The New Archeology and the Ancient Maya.* New York (Freeman).

Sharer, R.J. (1994): *The Ancient Maya.* 5th Edition. (Stanford University Press).

Shkolnikov, V., Mesle, F. and Vallin, J. (1996a): *Health crisis in Russia. I. Recent trends in life expectancy and causes of death from 1970 to 1993.* In: Population, An English Selection. Vol. 8, 123-154.

Shkolnikov, V., Mesle, F. and Vallin, J. (1996b): *Health crisis in Russia. II. Changes in causes of death: a comparison with France and England and Wales (1970 to 1993).* In: Population, An English Selection. Vol. 8, 123-154.

Tiffen, M. and Mortimore, M. (1993): *Population Growth and Natural Resource Use: Do We Need to Despair of Africa?* In: Outlook on Agriculture, Vol. 22, No. 4, 241-249.

United Nations (1997) (to be published): *World Population Prospects, 1950 - 2050.* The 1996 Revision. UN Population Division, New York.

United Nations (1995): *World Population Prospects, 1950 - 2050.* The 1994 Revision. UN Population Division, New York.

US Department of Agriculture (1996): *World Agricultural Supply and Demand Estimates.* Washington.

US Bureau of the Census (1996): *Trends and Patterns of HIV/AIDS Infection in Selected Developing Countries.* Country Profile, June 1996. Washington, D.C. (Health Studies Branch, International Programs Center, Population Division, US Bureau of the Census, Research Note No. 22.)

Vogt, W. (1948): *Road to Survival.* New York (William Sloan).

Waggoner, P.E. (1994): *How Much Land Can Ten Billion People Spare for Nature?* Ames, IA (Council for Agricultural Science and Technology, Task Force Report, No. 121. Published in cooperation with the Program for the Human Environment. The Rockefeller University, New York.)

Walter, J. and Schofield, R. (Eds.)(1989): *Famine, disease and the social order in early modern society.* Cambridge.

Watkins, S.C. and Menken, J. (1985): *Famines in historical perspective.* In: Population and Development Review, Vol. 11, No. 4, 647-675.

APPENDIX 1: ALL TABLES

Table C1.1: Regions: Total Population by Variant in 1950, 1995, 2025 and 2050 (in 1000) Low, Medium and High UN Projection Variant, 1996 Edition.

	Historical Estimates		UN Projections, 1996					
			Low Variant		Medium Variant		High Variant	
	1950	1995	2025	2050	2025	2050	2025	2050
World total	**2,523,878**	**5,687,113**	**7,474,059**	**7,662,248**	**8,039,130**	**9,366,724**	**8,580,509**	**11,156,318**
More devel. regions	812,687	1,171,384	1,149,984	959,159	1,220,250	1,161,741	1,286,133	1,351,681
Less devel. regions	1,711,191	4,515,729	6,324,075	6,703,089	6,818,880	8,204,983	7,294,375	9,804,637
Africa	**223,974**	**719,495**	**1,370,579**	**1,731,421**	**1,453,899**	**2,046,401**	**1,546,302**	**2,408,106**
Eastern Africa	65,624	221,315	453,249	593,984	480,182	698,596	506,719	812,974
Middle Africa	26,316	83,271	181,841	252,289	187,525	284,821	200,438	336,396
Northern Africa	53,302	158,077	236,621	258,834	256,716	317,267	276,175	381,781
Southern Africa	15,581	47,335	78,449	90,256	82,901	106,824	87,335	124,900
Western Africa	63,151	209,498	420,419	536,058	446,574	638,892	475,634	752,055
Latin Am. & Carib.	**166,337**	**476,637**	**631,598**	**649,866**	**689,618**	**810,433**	**752,670**	**1,000,555**
Caribbean	17,039	35,686	44,778	45,478	48,211	56,229	51,224	65,827
Central America	36,925	123,474	175,438	189,415	189,143	230,425	206,032	282,729
South America	112,372	317,477	411,382	414,973	452,265	523,778	495,414	651,999
Northern America	**171,617**	**296,645**	**336,398**	**301,140**	**369,016**	**384,054**	**393,598**	**451,503**
Asia	**1,402,021**	**3,437,787**	**4,428,376**	**4,405,219**	**4,784,833**	**5,442,567**	**5,108,307**	**6,500,750**
Eastern Asia	671,156	1,421,314	1,572,978	1,374,217	1,695,469	1,722,380	1,785,553	1,999,209
South-eastern Asia	182,035	481,920	634,064	651,846	691,911	811,891	749,613	994,046
South-central Asia	498,583	1,366,866	1,944,779	2,057,954	2,100,034	2,521,304	2,256,712	3,053,930
Western Asia	50,247	167,686	276,556	321,202	297,420	386,992	316,429	453,566
Europe	**547,318**	**728,244**	**669,468**	**537,521**	**701,077**	**637,585**	**736,585**	**742,331**
Eastern Europe	219,296	310,506	271,948	215,673	284,170	255,955	303,706	311,048
Northern Europe	78,094	93,372	89,039	75,785	95,593	94,194	98,776	105,667
Southern Europe	109,012	143,377	131,939	102,990	137,196	119,887	142,603	135,502
Western Europe	140,916	180,988	176,542	143,072	184,118	167,550	191,500	190,115
Oceania	**12,612**	**28,305**	**37,640**	**37,081**	**40,687**	**45,684**	**43,047**	**53,073**
Australia/New Zeal.	10,127	21,427	26,380	24,235	28,809	30,557	30,561	35,495
Melanesia	2,095	5,814	9,636	11,040	10,150	12,972	10,655	15,036
Micronesia	153	481	811	928	857	1,097	905	1,285
Polynesia	237	583	813	879	871	1,059	926	1,257
Least dev. countr.	**197,572**	**579,035**	**1,092,685**	**1,384,413**	**1,159,255**	**1,631,820**	**1,231,329**	**1,916,482**

***Source**: UN Population Division (1997): World Population Prospects, 1950-2050. The 1996 Edition. (Annex I and II).*

Table C1.2: Major Regions: Total Population, 1950, 1995, 2025 and 2050 (in 1000) and Population Change, 1950-1995, 1995-2025, 2025-2050 and 1950-2050 (in 1000 and in %) (Medium Variant UN Projection, 1996 Edition).

	Population Change & Annual Exponential Growth Rates							
	1950-1995		1995-2025		2025-2050		1950-2050	
	in 1000	in%	in 1000	in %	in 1000	in %	In 1000	in %
World Total	3,163,235	0.34	**2,352,017**	0.22	**1,327,594**	0.12	6,842,846	0.25
More Dev. Regions	358,697	0.15	48,866	0.03	-58,509	-0.04	349,054	0.07
Less Dev. Regions	2,804,538	0.41	**2,303,151**	0.26	**1,386,103**	0.14	**6,493,792**	0.30
Africa	495,521	**0.49**	734,404	**0.44**	592,502	0.26	1,822,427	0.42
Eastern Africa	155,691	0.51	258,867	0.49	218,414	0.28	632,972	0.45
Middle Africa	56,955	0.48	104,254	0.51	97,296	0.32	258,505	0.45
Northern Africa	104,775	0.46	98,639	0.30	60,551	0.16	263,965	0.34
Southern Africa	31,754	0.47	35,566	0.35	23,923	0.19	91,243	0.36
Western Africa	146,347	0.50	237,076	0.48	192,318	0.27	575,741	0.44
Latin Am. & Carib.	310,300	**0.44**	212,981	0.23	120,815	0.12	644,096	0.30
Caribbean	18,647	0.31	12,525	0.19	8,018	0.12	39,190	0.23
Central America	86,549	0.51	65,669	0.27	41,282	0.15	193,500	0.35
South America	205,105	0.44	134,788	0.22	71,513	0.11	411,406	0.29
Northern America	125,028	0.23	72,371	0.14	15,038	0.03	212,437	0.15
Asia	2,035,766	0.38	**1,347,046**	**0.21**	**657,734**	0.10	**4,040,546**	0.26
Eastern Asia	750,158	0.31	274,155	0.11	26,911	0.01	1,051,224	0.18
So.Eastern Asia	299,885	0.41	209,991	0.23	119,980	0.12	629,856	0.28
So.Central Asia	868,283	0.42	733,168	0.27	421,270	0.14	2,022,721	0.31
Western Asia	117,439	0.51	129,734	0.36	89,572	0.20	336,745	0.39
Europe	180,926	0.12	**-27,167**	-0.02	**-63,492**	-0.07	90,267	0.03
Eastern Europe	91,210	0.15	-26,336	-0.06	-28,215	-0.08	36,659	0.03
Northern Europe	15,278	0.07	2,221	0.01	-1,399	-0.01	16,100	0.04
Southern Europe	34,365	0.11	-6,181	-0.03	-17,309	-0.10	10,875	0.02
Western Europe	40,072	0.10	3,130	0.01	-16,568	-0.07	26,634	0.03
Oceania	15,693	0.34	12,382	0.23	4,997	0.09	33,072	0.24
Aust.-N. Zeal.	11,300	0.31	7,382	0.19	1,748	0.04	20,430	0.21
Melanesia	3,719	0.43	4,336	0.35	2,822	0.19	10,877	0.34
Micronesia	328	0.48	376	0.36	240	0.19	944	0.37
Polynesia	346	0.38	288	0.25	188	0.15	822	0.28
Least Dev. Count.	381,463	0.45	580,220	0.44	472,565	0.26	1,434,248	0.40

Source: *UN Population Division (1997): World Population Prospects, 1950-2050. The 1996 Edition. (Annex I and II).*

Table C1.3: The 10 countries with the highest population increase between 1950-1995, 1995-2025, 2025-2050 and 1950-2050. (All Data: UN Medium Variant Projection, 1996 Edition).

Past Population Increase, 1950-1995

	(in 1000)
China	665,464
India	571,444
Indonesia	117,922
United States of America	109,302
Brazil	105,040
Pakistan	96,744
Nigeria	78,786
Bangladesh	76,446
Mexico	63,408
Iran (Islamic Republic of)	51,452

Projected Population Increase, 1995-2025

	(in 1000)
India	401,196
China	260,206
Pakistan	132,647
Nigeria	126,676
Ethiopia	79,884
Indonesia	77,785
United States of America	65,366
Bangladesh	61,751
Zaire	60,472
Iran (Islamic Republic of)	59,886

Projected Population Increase, 2025-2050

	(in 1000)
India	173,982
Nigeria	80,945
Pakistan	72,642
Ethiopia	62,534
Zaire	47,987
China	40,372
Indonesia	36,802
Iran (Islamic Republic of)	34,993
Bangladesh	32,585
Brazil	23,143

Centennial Population Increase, 1950-2050

	(in 1000)
India	1,175,113
China	961,904
Pakistan	317,840
Nigeria	305,575
Indonesia	238,726
Ethiopia	194,298
United States of America	189,730
Brazil	189,284
Bangladesh	176,405
Iran (Islamic Republic of)	153,356

Source: UN Population Division (1996): World Population Prospects, 1950-2050. The 1996 Edition. (Annex I and II).

Table C1.4: Average Annual Population Growth Rates, 1950-1995, 1995-2025, 2025-2050 and 1950-2050 (All Data: Medium Variant UN Projection, 1996 Edition).

Past Population Growth, 1950-1995

Population Growth Rates (in %)		
	Exponential 1950-1995	Av. Annual 1950-1995
United Arab Emirates	1.4	7.7
Qatar	1.3	6.9
Western Sahara	1.2	6.4
Kuwait	1.0	5.4
Djibouti	1.0	5.0
Brunei Darussalam	0.8	4.0
Saudi Arabia	0.7	3.9
Libyan Arab Jamahiriya	0.7	3.7
Cote d'Ivoire	0.7	3.5
Oman	0.7	3.5

Projected Population Growth, 1995-2025

Population Growth Rates (in %)		
	Exponential 1995-2025	Av. Annual 1995-2025
Gaza Strip	0.7	3.8
Liberia	0.7	3.8
Oman	0.7	3.6
Yemen	0.6	3.2
Rwanda	0.6	3.1
Somalia	0.6	3.0
Niger	0.6	3.0
Ethiopia	0.6	2.9
Libyan Arab Jamahiriya	0.5	2.9
Angola	0.5	2.9

Projected Population Growth, 2025-2050

Population Growth Rates (in %)		
	Exponential 2025-2050	Av. Annual 2025-2050
Gaza Strip	0.4	2.3
Oman	0.4	2.1
Ethiopia	0.3	1.8
Zaire	0.3	1.8
Yemen	0.3	1.7
Niger	0.3	1.7
Somalia	0.3	1.7
Angola	0.3	1.7
Congo	0.3	1.7
Liberia	0.3	1.7

Centennial Population Growth, 1950-2050

Population Growth Rates (in %)		
	Exponential 1950-2050	Av. Annual 1950-2050
United Arab Emirates	0.7	4.0
Western Sahara	0.7	3.7
Qatar	0.7	3.5
Djibouti	0.6	3.2
Oman	0.6	3.2
Kuwait	0.6	3.1
Saudi Arabia	0.6	2.9
Libyan Arab Jamahiriya	0.6	2.9
Gaza Strip	0.5	2.9
Niger	0.5	2.7

Source: UN Population Division (1997): World Population Prospects, 1950-2050. 1996 Edition. (Annex I and II). Note: The exponential growth rate was calculated with the formula: r = (log(Pn / Po)) / n log e. The average annual growth rate is the mean of the reported five-year annual averages.

Table C1.5: Total Population (in 1000) and Proportion of Global Population by Region (in %), 1950, 1995, 2025 and 2050. (All Data: Medium Variant UN Projection, 1996 Edition).

	Total Population (in 1000)				Percentage of World Pop.			
	1950	1995	2025	2050	1950	1995	2025	2050
World Total	2,523,878	5,687,113	8,039,130	9,366,724	100.0	100.0	100.0	100.0
More Dev. Regions	812,687	1,171,384	1,220,250	1,161,741	32.2	20.6	15.2	12.4
Less Dev. Regions	1,711,191	4,515,729	6,818,880	8,204,983	67.8	79.4	84.8	87.6
Africa	223,974	719,495	1,453,899	2,046,401	**8.9**	12.7	18.1	**21.8**
Eastern Africa	65,624	221,315	480,182	698,596	2.6	3.9	6.0	**7.5**
Middle Africa	26,316	83,271	187,525	284,821	1.0	1.5	2.3	3.0
Northern Africa	53,302	158,077	256,716	317,267	2.1	2.8	3.2	3.4
Southern Africa	15,581	47,335	82,901	106,824	0.6	0.8	1.0	1.1
Western Africa	63,151	209,498	446,574	638,892	2.5	3.7	5.6	**6.8**
Latin Am. & Carib.	166,337	476,637	689,618	810,433	6.6	8.4	8.6	8.7
Caribbean	17,039	35,686	48,211	56,229	0.7	0.6	0.6	0.6
Central America	36,925	123,474	189,143	230,425	1.5	2.2	2.4	2.5
South America	112,372	317,477	452,265	523,778	4.5	5.6	5.6	5.6
Northern America	171,617	296,645	369,016	384,054	6.8	5.2	4.6	4.1
Asia	1,402,021	3,437,787	4,784,833	5,442,567	55.6	60.4	59.5	58.1
Eastern Asia	671,156	1,421,314	1,695,469	1,722,380	26.6	25.0	21.1	18.4
So.Eastern Asia	182,035	481,920	691,911	811,891	7.2	8.5	8.6	8.7
So.Central Asia	498,583	1,366,866	2,100,034	2,521,304	19.8	24.0	26.1	26.9
Western Asia	50,247	167,686	297,420	386,992	2.0	2.9	3.7	4.1
Europe	547,318	728,244	701,077	637,585	**21.7**	12.8	8.7	**6.8**
Eastern Europe	219,296	310,506	284,170	255,955	8.7	5.5	3.5	2.7
Northern Europe	78,094	93,372	95,593	94,194	3.1	1.6	1.2	1.0
Southern Europe	109,012	143,377	137,196	119,887	4.3	2.5	1.7	1.3
Western Europe	140,916	180,988	184,118	167,550	5.6	3.2	2.3	1.8
Oceania	12,612	28,305	40,687	45,684	0.5	0.5	0.5	0.5
Aust.-N. Zeal.	10,127	21,427	28,809	30,557	0.4	0.4	0.4	0.3
Melanesia	2,095	5,814	10,150	12,972	0.1	0.1	0.1	0.1
Micronesia	153	481	857	1,097	0.0	0.0	0.0	0.0
Polynesia	237	583	871	1,059	0.0	0.0	0.0	0.0
Least Dev. Count.	197,572	579,035	1,159,255	1,631,820	7.8	10.2	14.4	17.4

Source: UN Population Division (1997): World Population Prospects, 1950-2050. The 1996 Edition. (Annex I and II).

Table C2.1: Comparison of Various Population Projections.

	1950	1995	2000	2020	2025	2050	2100
Frejka, 1981							
Low			6,046			8,762	9,208
Medium			6,200			9,889	10,778
High			6,353			11,015	12,348
Difference: Highest-Lowest			**307**			**2,253**	**3,140**
Keyfitz, 1983							
Low			5,892			8,198	
Medium			6,079			8,676	
High			6,466			10,677	
Difference: Highest-Lowest			**574**			**2,479**	
UN, 1963 Edition							
Low	2,515	5109	5449				
Medium	2,515	5648	6130				
High	2,515	6326	6994				
Difference: Highest-Lowest	**0**	**1,217**	**1,545**				
UN, 1980 Edition							
Low	2,525	5,496	5,837	6,949	7,168		
Medium	2,525	5,677	6,119	8,553	8,195		
High	2,525	5,823	6,337	7,813	9,135		
Difference: Highest-Lowest	**0**	**327**	**500**	**864**	**1,967**		
UN, 1994 Edition							
Low	2,520	5,689	6,081	7,372	7,603	7,918	
Medium	2,520	5,716	6,158	7,888	8,294	9,833	
High	2,520	5,742	6,235	8,392	8,979	11,912	
Difference: Highest-Lowest	**0**	**53**	**154**	**1,020**	**1,376**	**3,994**	
UN, 1996 Edition							
Low	2,524	5,687	6,062	7,264	7,474	7,662	
Medium	2,524	5,687	6,091	7,672	8,039	9,367	
High	2,524	5,687	6,123	8,062	8,581	11,156	
Difference: Highest-Lowest	**0**	**0**	**61**	**798**	**1,106**	**3,494**	
US Bureau of the Census: World Population Profile							
1994 **Edition**	2,555	5,642	6,165 /1	7,924			
1996 **Edition**	2,556	5,772	6,091 /2	7,600			
IIASA, 1996 Scenarios:							
CCC		5,702		7,879		9,874	10,350
LHC		5,702		7,261		**7,103**	**3,937**
CHC		5,702		7,723		9,021	8,120
HHC		5,702		8,191		11,300	15,070
LCC		5,702		7,408		7,802	5,134
HCC		5,702		8,356		12,330	18,950
LLC		5,702		7,547		8,488	6,507
CLC		5,702		8,026		10,690	12,680
HLC		5,702		8,510		**13,300**	**22,740**
Difference: Highest-Lowest		**0**		**1,249**		**6,197**	**18,803**
IIASA, 1996 Probabilistic Projections: Merged							
Mean		5,702		7,893		9,984	10,909
2.5% Confidence Interv.		5,702		7,474		8,108	5,715
97.5% Conficence Interv.		5,702		8,290		11,950	17,330
Difference: Highest-Lowest		**0**		**816**		**3,842**	**11,615**

Notes: /1 For 1994 /2 For 1996

Sources: see following page

Table C2.1: Comparison of Various Population Projections.

Sources:

(i) Frejka, T. (1981): *Long-term prospects for world population growth.* In: Population and Development Review, Vol. 7, No. 3, 489-511.
(ii) Keyfitz, N., Allen, E., Edmonds, R., Dougher, R. and Wiget, B. (1983): *Global Population (1975-2075) and Labor Force (1975-2050).*
(iii) Institute for Energy Analysis, Oak Ridge Associated Universities, ORAU/IEA-83-6(M). Oak Ridge, Tennessee.
(iv) United Nations (1966): *World Population Prospects as Assessed in 1963.* Department of Economic and Social Affairs. UN Population Division. Population Studies No. 41.
(v) United Nations (1981): *World Population Prospects as Assessed in 1980.* New York. UN Population Division.
(vi) United Nations (1995): *World Population Prospects. The 1994 Revision.* New York. UN Population Division.
(vii) United Nations (to be published in 1997): *World Population Prospects. The 1996 Revision.* Annexes I and II. New York. UN Population Division.
(viii) US Bureau of the Census (1994): *World Population Profile: 1994.* With a Special Chapter Focusing on HIV/AIDS prepared by Peter O. Way and Karen A. Stanecki. Washington, D.C. (Report prepared by Ellen Jamison and Frank Hobbs of the International Programs Center (IPC), Population Division, US Bureau of the Census, Report WP/94).
(ix) US Bureau of the Census (1996): *World Population Profile: 1966.* With a Special Chapter Focusing on Adolescent Fertility in the Developing World. Washington, D.C. (Report prepared by Thomas M. McDevitt of the International Programs Center (IPC), Population Division, US Bureau of the Census, Report WP/96).
(x) Lutz, W. (Ed.) (1996): *The Future Population of the World. What Can We Assume Today?* Revised Edition. London. (Earthscan Publications Ltd.).

Table C2.2: Comparison of the 1994 and 1996 UN Medium Variant Population Assessments and Projections.

	Differences between the 1994 and 1996 Edition of the World Population Assessments and Projections							
	(in thousands)				(in percent)			
	1950	*1995*	*2025*	*2050*	*1950*	*1995*	*2025*	*2050*
India	0	-6,739	-61,885	-107,189	0.0	-0.7	-4.4	-6.5
China	0	-1,238	-45,676	-89,327	0.0	-0.1	-3.0	-5.6
Cote d'Ivoire	0	-559	-12,420	-29,735	0.0	-3.9	-33.7	-48.4
Kenya	0	-1,111	-13,158	-26,140	0.0	-3.9	-20.8	-28.4
Sudan	0	-1,391	-11,538	-24,882	0.0	-5.0	-19.8	-29.3
Pakistan	0	-4,240	-15,923	-24,135	0.0	-3.0	-5.6	-6.3
Brazil	531	-2,775	-13,654	-21,090	1.0	-1.7	-5.9	-8.0
Bangladesh	0	-2,204	-16,148	-20,324	0.0	-1.8	-8.2	-8.5
Russian Federation	-1,091	1,460	-7,153	-15,513	-1.1	1.0	-5.2	-11.9
Viet Nam	0	-752	-8,044	-13,857	0.0	-1.0	-6.8	-9.6
Myanmar	0	-1,421	-7,921	-13,673	0.0	-3.1	-10.5	-14.5
Syrian Arab Republic	0	-458	-7,202	-12,749	0.0	-3.1	-21.5	-27.0
Sum of 12 countries	**-560**	**-21,428**	**-220,722**	**-398,614**				
World	**4,130**	**-29,313**	**-255,211**	**-466,484**	**0.2**	**-0.5**	**-3.1**	**-4.7**

Sources:

United Nations (1995): *World Population Prospects.* The 1994 Revision. New York, UN Population Division.

United Nations (to be published in 1997): *World Population Prospects:* The 1996 Revision. Annexes I and II. New York, UN Population Division.

Table C3.1: Countries with highest / lowest Fertility Decline between 1950/55 and 1990/95 (Based on UN Estimates and Medium Variant Projection, 1996 Edition).

Countries with the highest decline in the Total Fertility Rate between 1950/55 and 1990/95

	Total Fertility Rate (TFR)				Change of Total Fertility Rate			
	1990/95	1990/95	2020/25	2045/50	1950/55 - 1990/95 *sorted*	1990/95 - 2020/25	2020/25 - 2045/50	1950/55 - 2045/50
Thailand	**6.6**	**1.9**	2.0	2.1	-4.7	0.1	0.1	-4.5
Singapore	6.4	1.8	2.1	2.1	-4.6	0.3	0.0	-4.3
Dominican Republic	7.4	3.1	2.1	2.1	-4.3	-1.0	0.0	-5.3
China	**6.2**	**1.9**	2.1	2.1	-4.3	0.2	0.0	-4.1
Turkey	6.9	2.7	2.1	2.1	-4.2	-0.6	0.0	-4.8
Guyana	6.7	2.6	2.1	2.1	-4.1	-0.5	0.0	-4.6
Kuwait	7.2	3.1	2.1	2.1	-4.1	-1.0	0.0	-5.1
Brunei Darussalam	7.0	3.0	2.1	2.1	-4.0	-0.9	0.0	-4.9
Mauritius	6.3	2.4	2.1	2.1	-3.9	-0.3	0.0	-4.2
New Caledonia	6.7	2.7	2.1	2.1	-3.9	-0.6	0.0	-4.6
Suriname	6.6	2.7	2.1	2.1	-3.9	-0.6	0.0	-4.5
Colombia	6.8	2.9	2.1	2.1	-3.8	-0.8	0.0	-4.7
Samoa	8.0	4.2	2.1	2.1	-3.8	-2.1	0.0	-5.9
Republic of Korea	**5.4**	**1.7**	1.9	2.1	-3.8	0.3	0.2	-3.3
Mexico	**6.9**	**3.1**	2.1	2.1	-3.8	-1.0	0.0	-4.8
Brazil	**6.2**	**2.4**	2.1	2.1	-3.7	-0.3	0.0	-4.1
Martinique	5.7	2.1	2.1	2.1	-3.7	0.1	0.0	-3.6
Tunisia	6.9	3.3	2.1	2.1	-3.7	-1.2	0.0	-4.8
Fiji	6.6	3.0	2.1	2.1	-3.6	-0.9	0.0	-4.5
Costa Rica	6.7	3.1	2.3	2.1	-3.6	-0.8	-0.2	-4.6

Countries with the lowest decline or even increase in the TFR between 1950/55 and 1990/95

	Total Fertility Rate (TFR)				Change of Total Fertility Rate			
	1950-55	1990-95	2020-25	1990/95	1950/55 - 1990/95 *sorted*	1990/95 - 2020/25	2020/25 - 2045/50	1950/55 - 2045/50
Mali	7.1	7.1	4.1	2.1	0.0	-3.0	-2.0	-5.0
Oman	7.2	7.2	4.4	2.1	0.0	-2.8	-2.3	-5.1
Cameroon	5.7	5.7	3.3	2.1	0.0	-2.4	-1.2	-3.6
Chad	5.8	5.9	3.6	2.1	0.1	-2.3	-1.5	-3.7
Uganda	6.9	7.1	4.0	2.1	0.2	-3.1	-1.9	-4.8
Afghanistan	6.7	6.9	3.9	2.1	0.2	-3.0	-1.8	-4.6
Niger	7.1	7.4	4.3	2.1	0.3	-3.1	-2.2	-5.0
Mozambique	6.2	6.5	3.9	2.1	0.3	-2.6	-1.8	-4.1
Equatorial Guinea	5.5	5.9	3.6	2.1	0.4	-2.3	-1.5	-3.4
Sierra Leone	6.1	6.5	3.9	2.1	0.4	-2.6	-1.8	-4.0
Malawi	6.8	7.2	4.1	2.1	0.4	-3.1	-2.0	-4.7
Liberia	6.3	6.8	4.0	2.1	0.5	-2.8	-1.9	-4.2
Lao People's D. R.	6.2	6.7	2.9	2.1	0.5	-3.8	-0.8	-4.1
Congo	5.7	6.3	3.8	2.1	0.6	-2.5	-1.7	-3.6
Zaire	6.0	6.7	3.9	2.1	0.7	-2.8	-1.8	-3.9
Guinea-Bissau	5.1	5.8	3.6	2.1	0.7	-2.2	-1.5	-3.0
Burkina Faso	6.3	7.1	3.9	2.1	0.8	-3.2	-1.8	-4.2
Angola	6.4	7.2	4.1	2.1	0.8	-3.1	-2.0	-4.3
Gabon	4.1	5.0	3.3	2.1	0.9	-1.7	-1.2	-2.0
Gaza Strip	**7.4**	**8.8**	5.1	2.1	1.4	-3.8	-3.0	-5.3

Source: UN Population Division (1997): World Population Prospects, 1950-2050. The 1996 Edition. (Annex I and II) Chart: G.K. Heilig, 1996, IIASA-LUC

Table C3.2: Average Per Capita Supply of Calories, Fat and Protein.

		Calories per person per day		
		1961/63	1992/94	Change: 1961/63-1992/94
World	Calories	2,274	2,709	435
	Fat	48.7	68.3	19.6
	Protein	62.6	71.6	9.0
Africa	Calories	2,061	2,333	272
	Fat	38.7	47.2	8.5
	Protein	53.3	57.9	4.6
Asia	Calories	1,865	2,577	**712**
	Fat	24.6	51.8	27.1
	Protein	47.2	63.9	16.7
Least Developed	Calories	2,012	2,032	21
	Fat	29.0	32.8	3.8
	Protein	50.6	50.0	-0.6
Latin America	Calories	2,345	2,722	377
	Fat	50.4	76.3	25.9
	Protein	62.2	69.7	7.5

Source: FAO (1996): FAOSTAT Data Base. Rome

Table C3.3: Estimates of Under-nutrition in 93 Developing Countries.

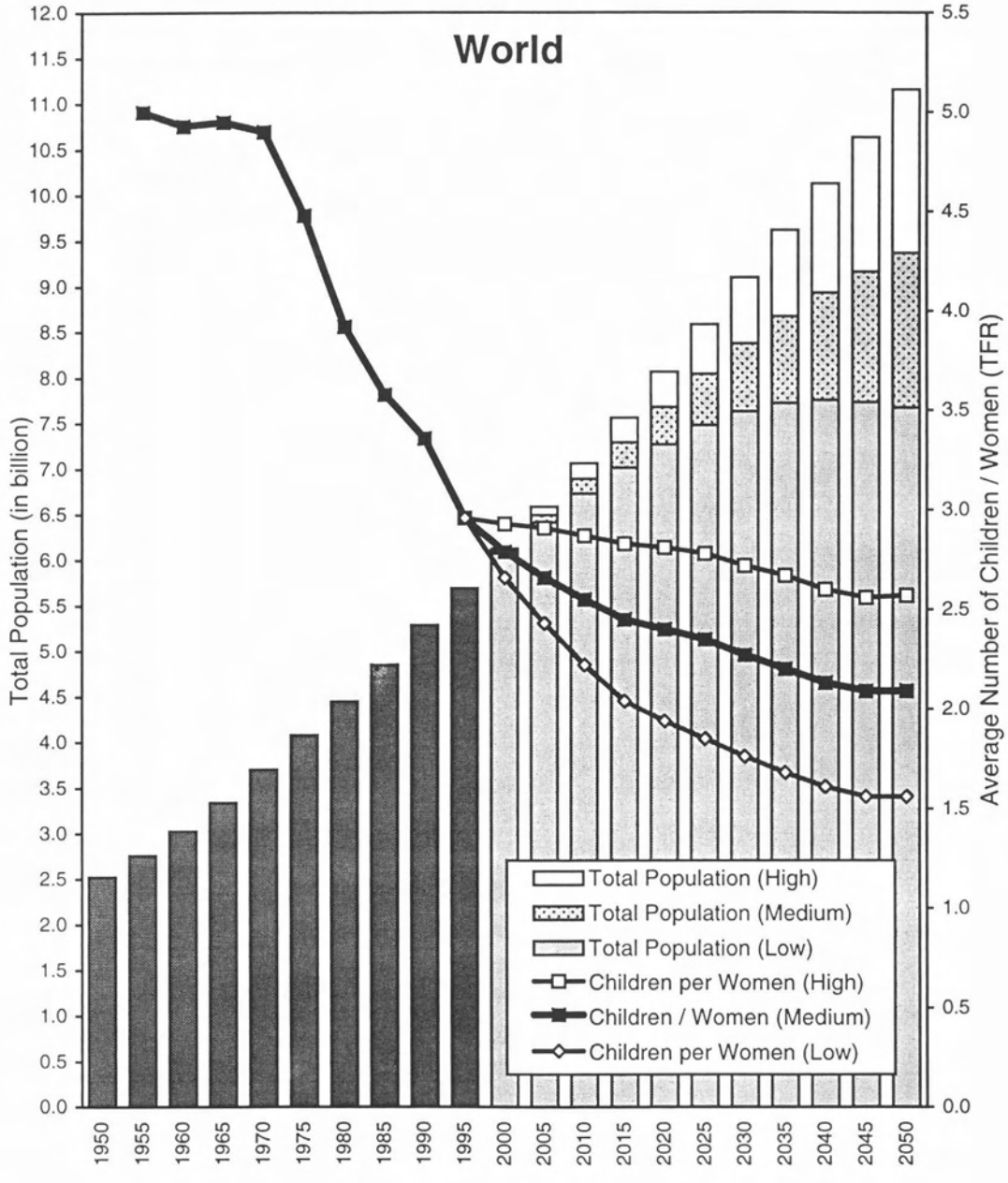
	Total Population (millions)			Undernourished * (millions)			Undernourished * (% of Total Pop.)		
	1969/71	1979/81	1988/90	1969/71	1979/81	1988/90	1969/71	1979/81	1988/90
Africa (sub-Sahara)	268	358	473	94	129	175	35	36	37
Near East / North Africa	178	233	297	42	23	24	24	10	8
East Asia	1147	1392	1598	506	366	258	44	26	16
South Asia	711	892	1103	245	278	265	34	31	24
Latin America & Carribean	281	357	433	54	47	59	19	13	14
Total	2585	3232	3905	941	843	781	36	26	20

Note:
* Persons who, on average during the course of a year, are estimated to have food consumption levels below those required to maintain body weight and support light activity. This threshold level (ranging from an average of 1760 cal/person/day for Asia to 1985 for Latin America) is set equal to 1.54 times the basal metabolic rate.

Source: Alexandratos, N. (Ed.) (1995): *World Agriculture Towards 2010. An FAO Study.* Rome (FAO, John Wiley & Sons).

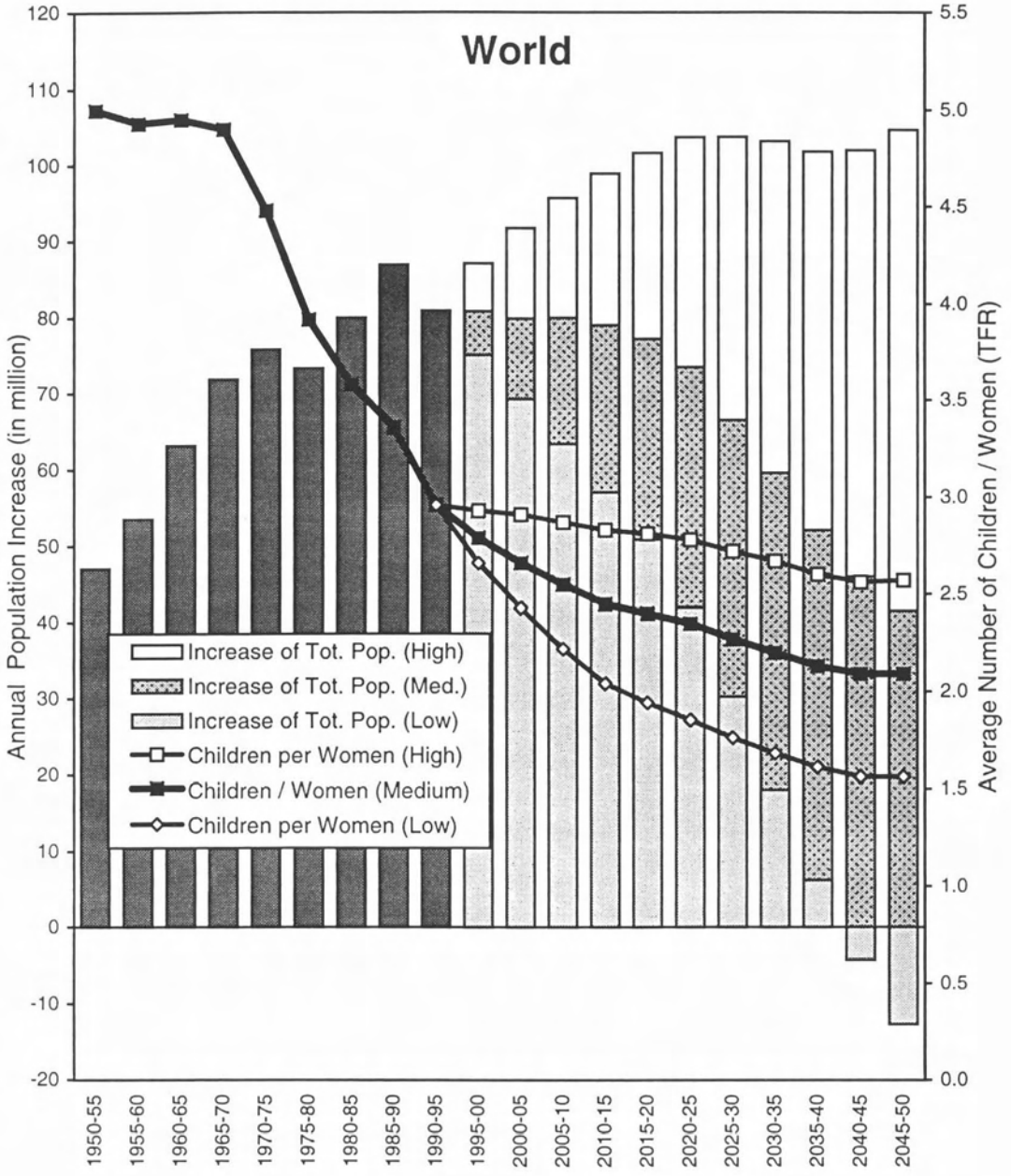
APPENDIX 2: ALL FIGURES

Figure C1.1: World, 1950 - 1995: Total Population (in billion) and Average Number of Children (Total Fertility Rate, TFR) High, Medium and Low Variants.



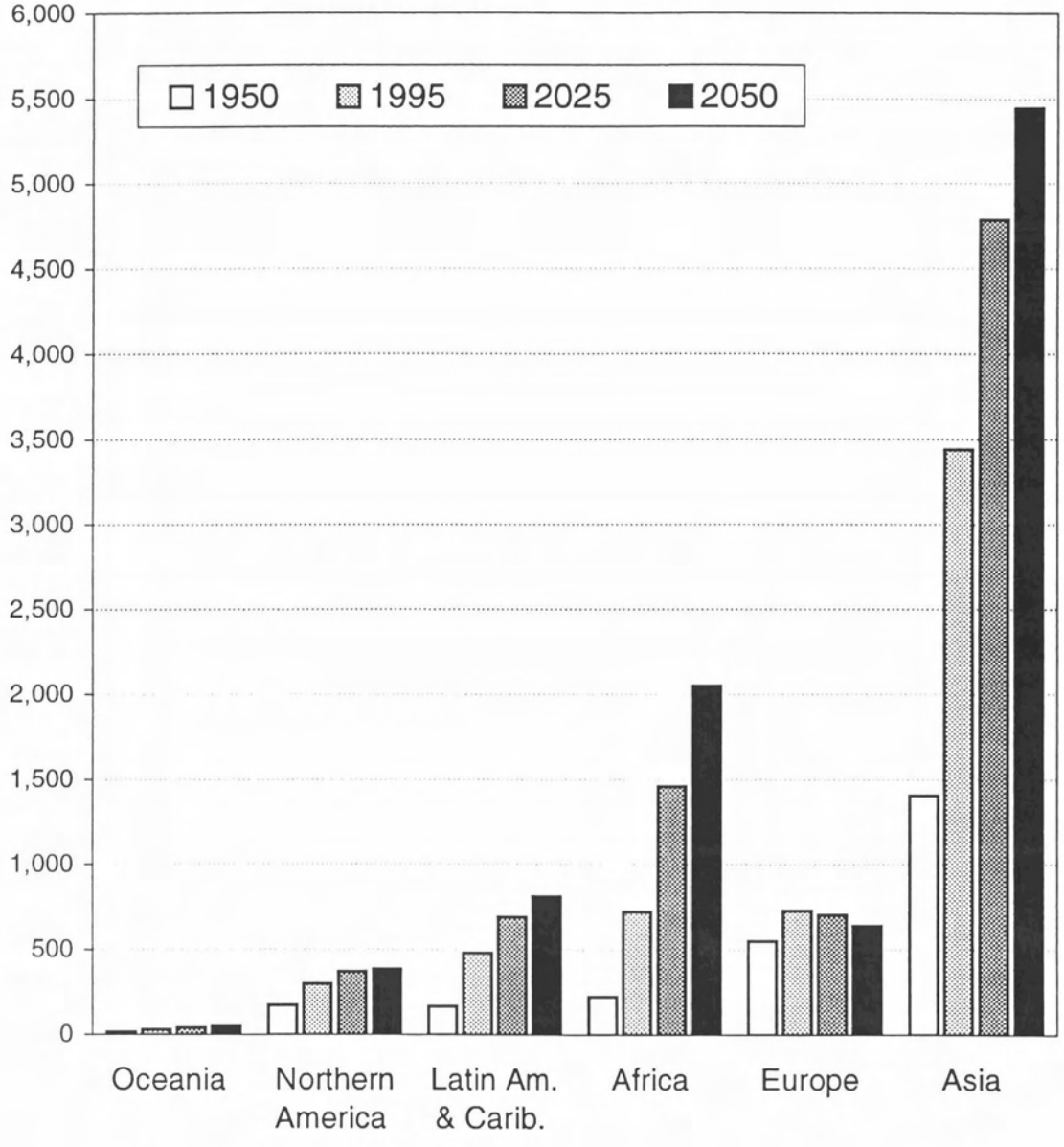
Source: UN Population Division (1997): *World Population Prospects, 1950-2050.* The 1996 Edition. (Annex I and II).

Figure C1.2: World, 1950 - 2050: Annual Population Increase (in million) and Average Number of Children per Woman (TFR) UN Low, Medium and High Variants, 1996 Edition.



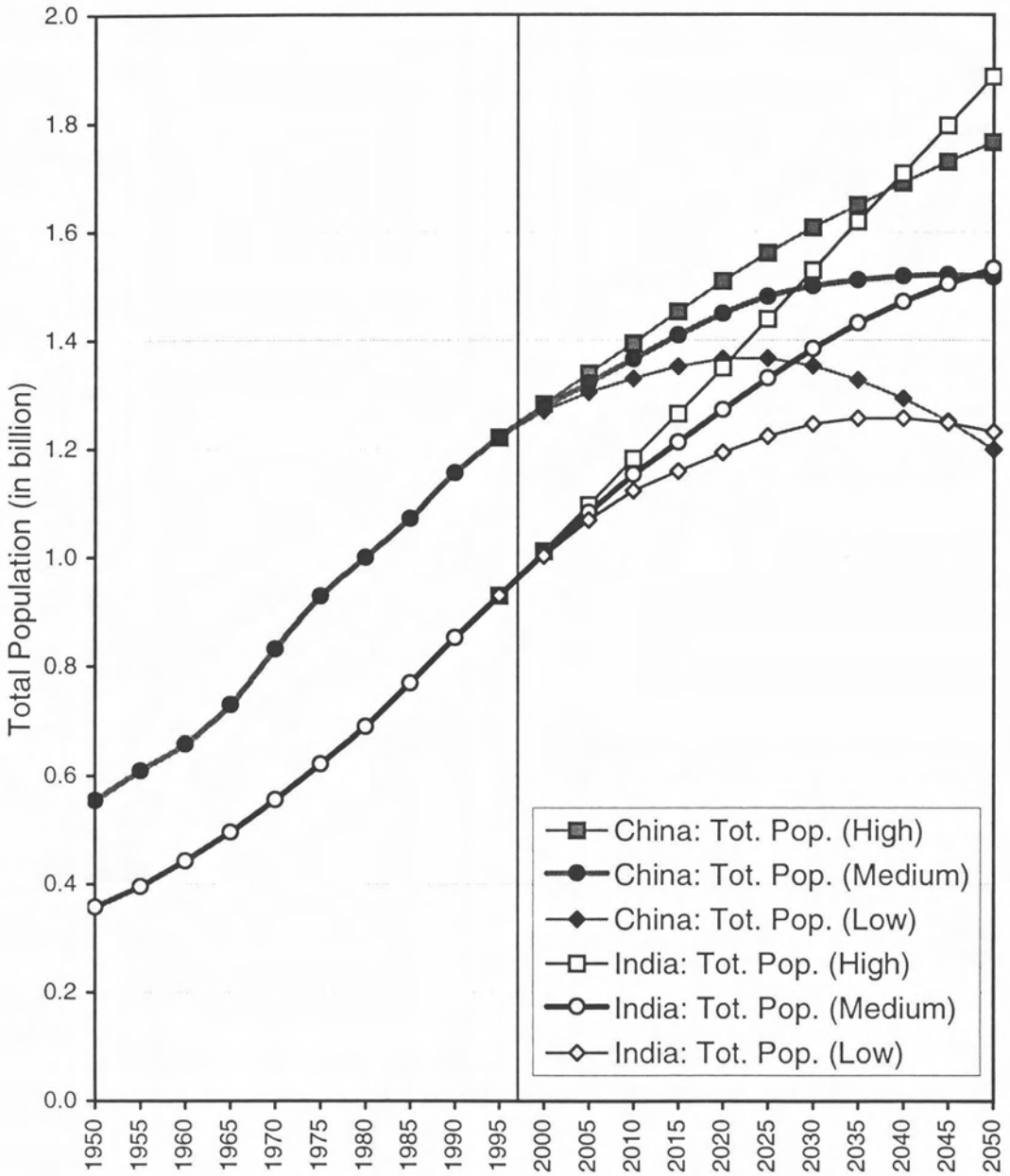
Source: UN Population Division (1997): *World Population Prospects, 1950-2050.* The 1996 Edition (Annex I and II).

Figure C1.3: Total Population by Region, 1950, 1995, 2025, and 2050 (in million) UN Medium Variant.



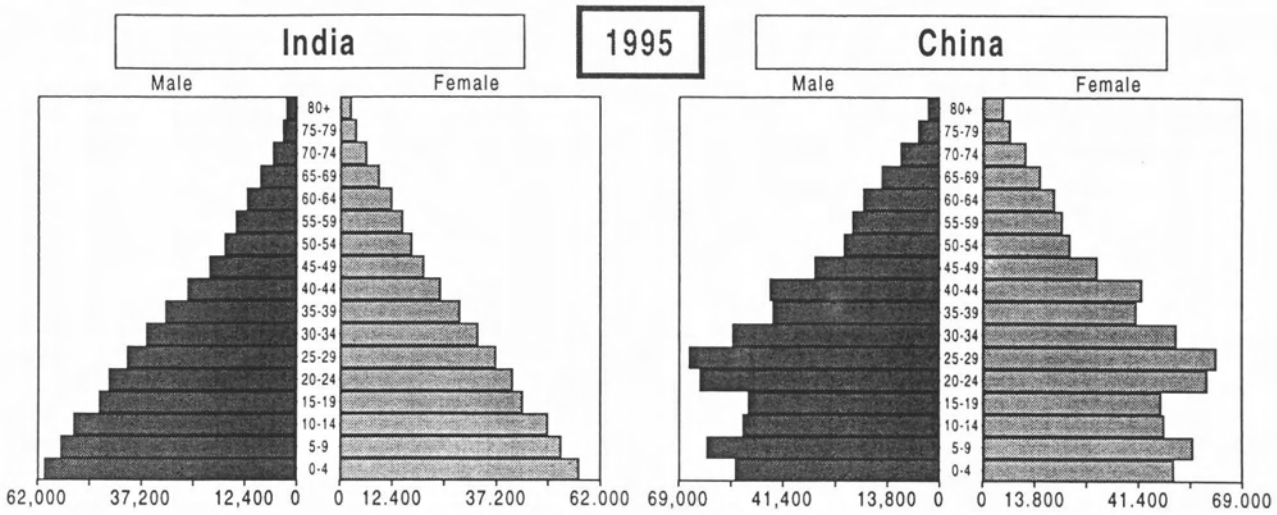
Source: UN Population Division (1997): *World Population Prospects, 1950-2050.* The 1996 Edition. (Annex I and II).

Figure C1.4: China & India, 1950 - 2050: Total Population (in billion) High, Medium and Low Variants.



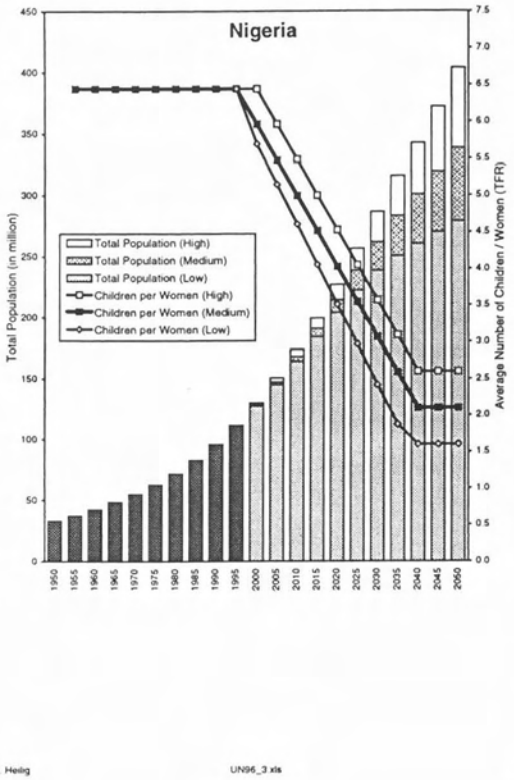
Source: UN Population Division (1997): *World Population Prospects, 1950-2050.* The 1996 Edition. (Annex I and II).

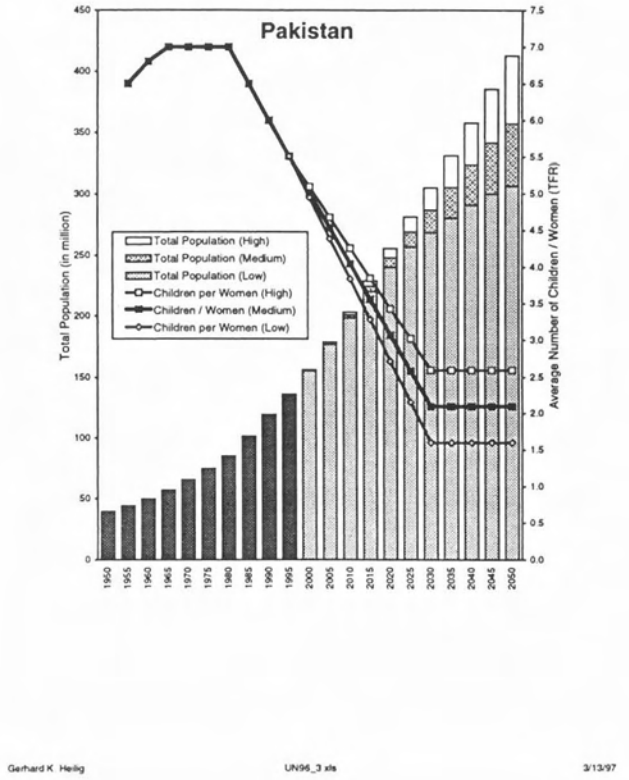
Figure C1.5: China & India, 1995: Total Population by Age and Sex. UN Medium Variant.

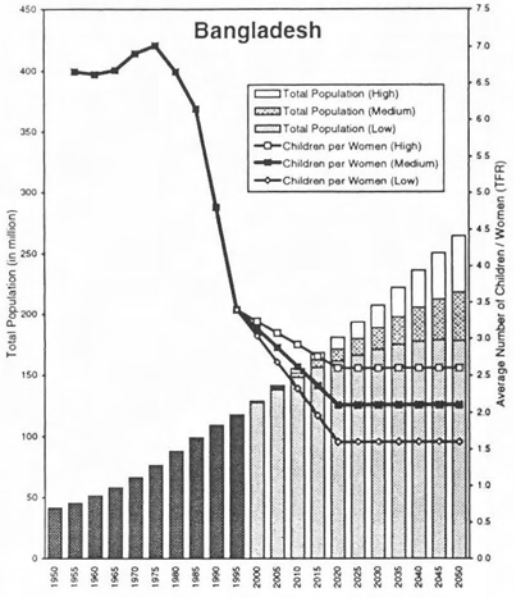


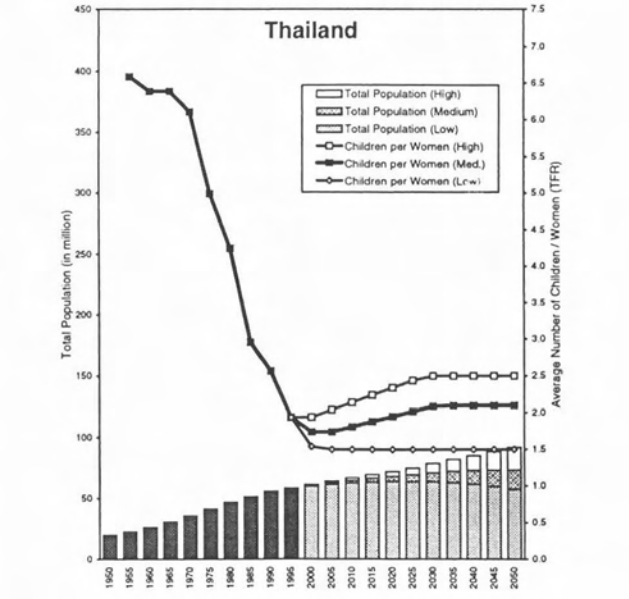
Source: UN Population Division (1995): *World Population Prospects, 1950-2050.* The 1994 Edition. (Electronic Data Base on Diskettes).

Figure C1.6: Nigeria and Pakistan, 1950 - 2050: Total Population (in million) and Average Number of Children per Women (TFR) High, Medium and Low Variants.



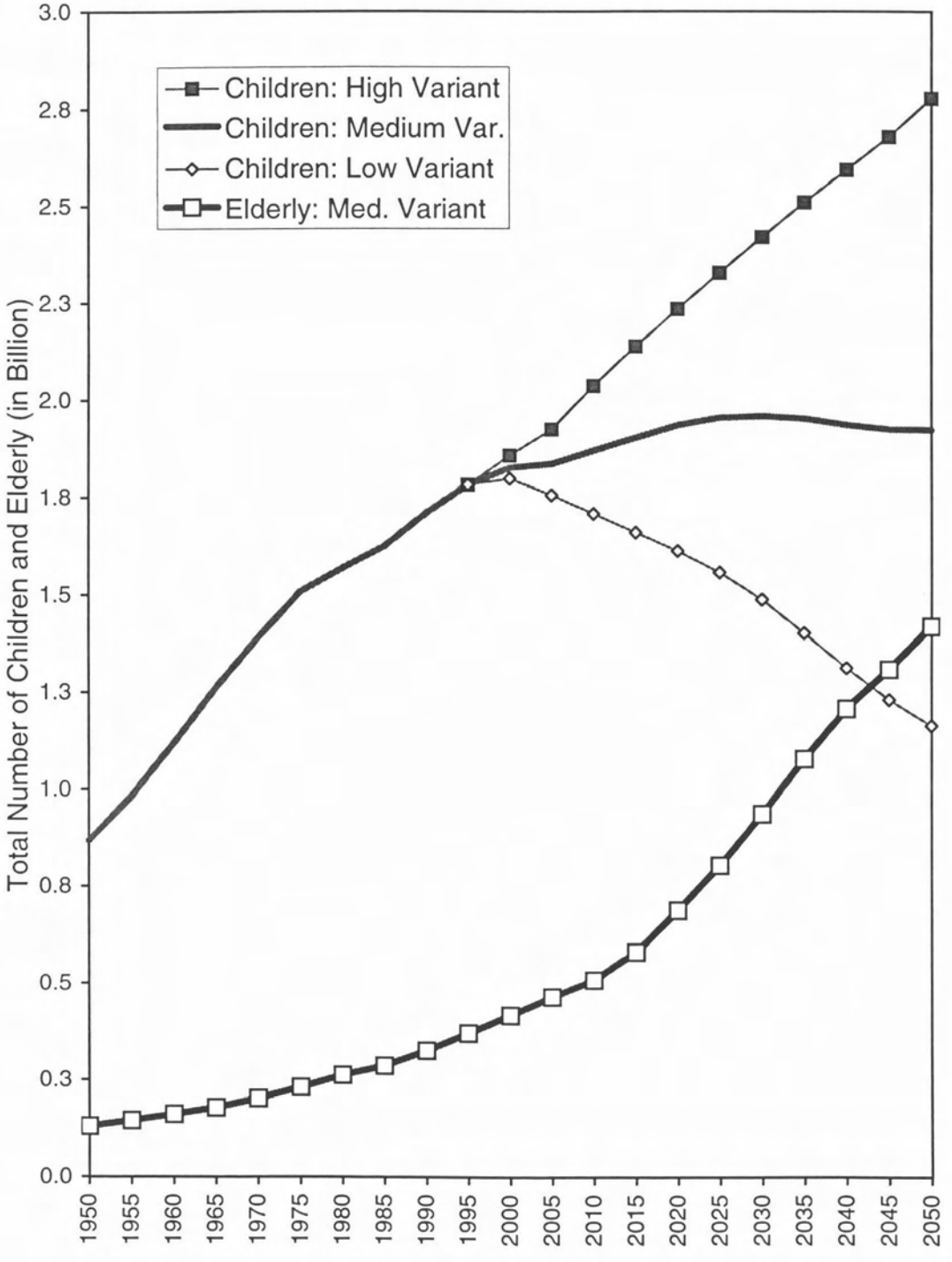






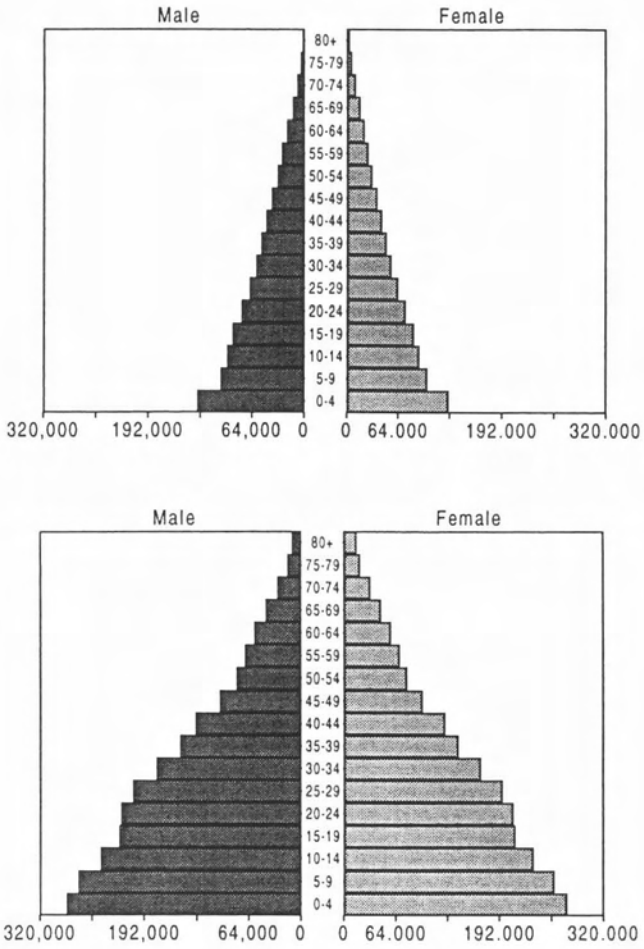
Source: UN Population Division (1997): *World Population Prospects, 1950-2050.* The 1996 Edition. (Annexes I and II).

Figure C1.7: Total Number of Children (< 15 years of age) and Elderly (65+). Medium Variant UN Projection, 1996.



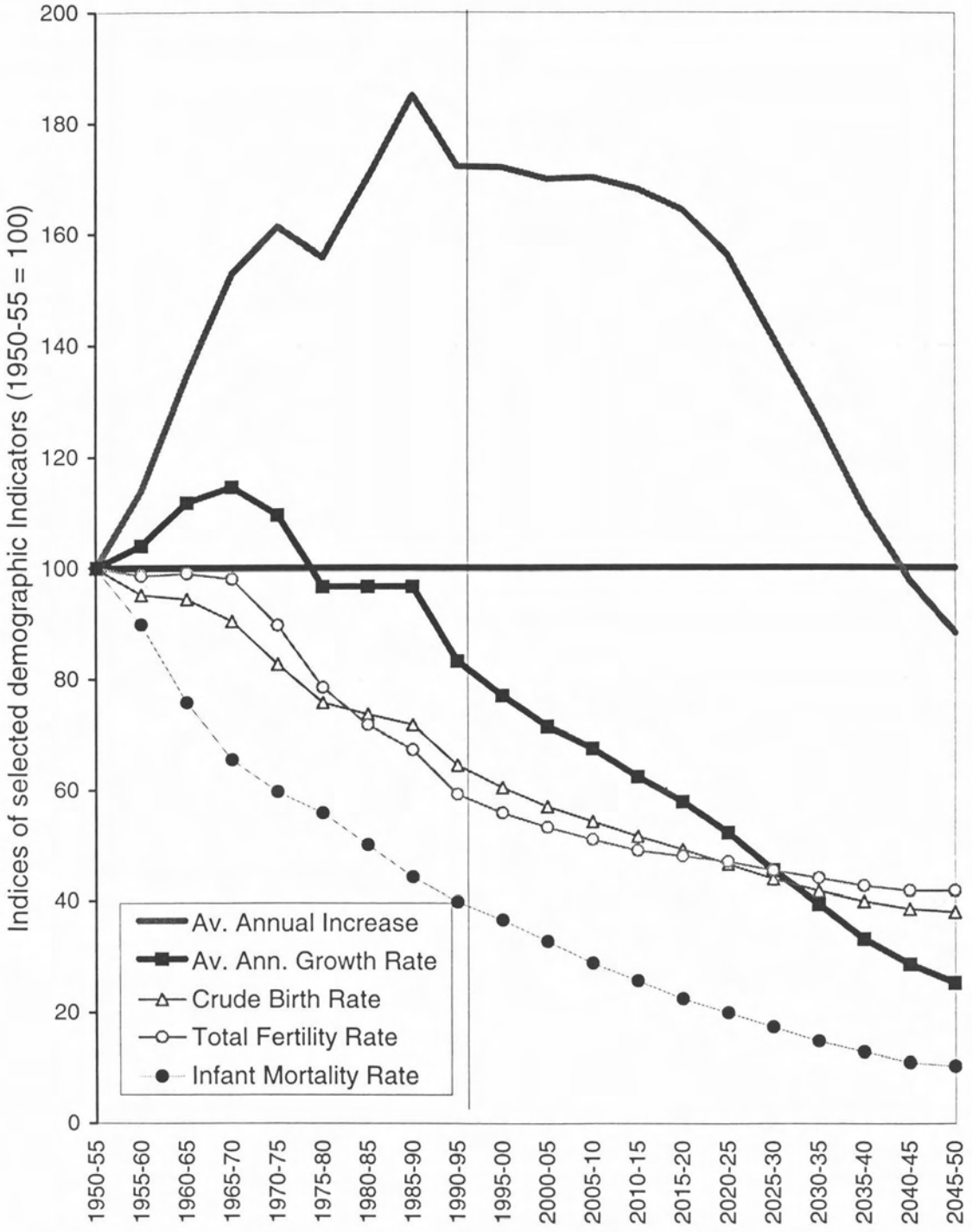
Source: UN Population Division (1997): *World Population Prospects, 1950-2050.* The 1996 Edition (Annexes I and II).

Figure C2.1: Less Developed Countries: Age Structure, 1950 and 1995.



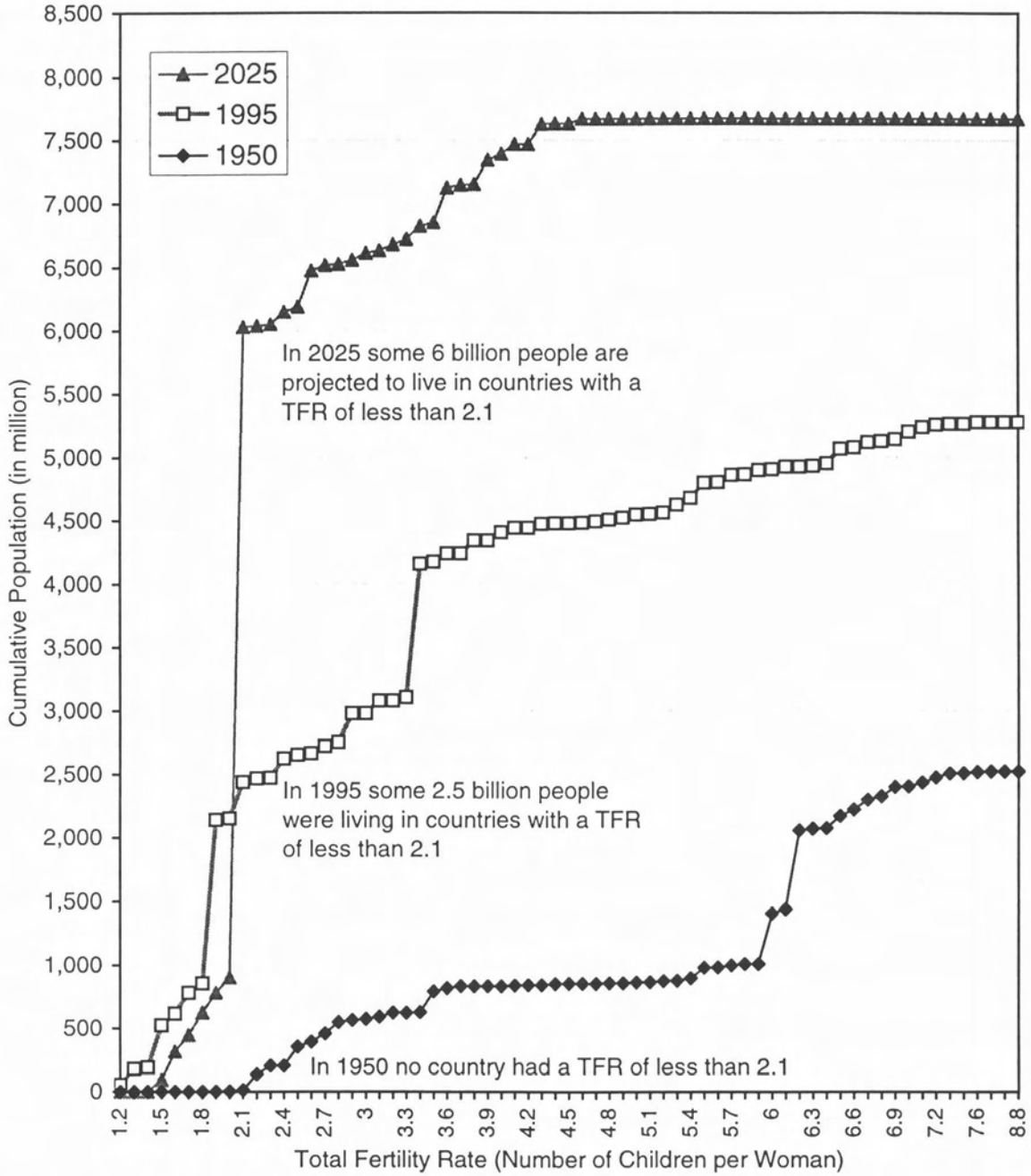
Source: UN Population Division (1997): *World Population Prospects, 1950-2050.* The 1996 Edition. (Annex I and II).

Figure C2.2: Indices of Av. Annual Population Increase, Growth Rate of the Population, Total Fertility Rate, Crude Birth Rate, and Infant Mortality Rate, 1950-55 = 100. (UN Medium Variant Projection, 1996 Edition).



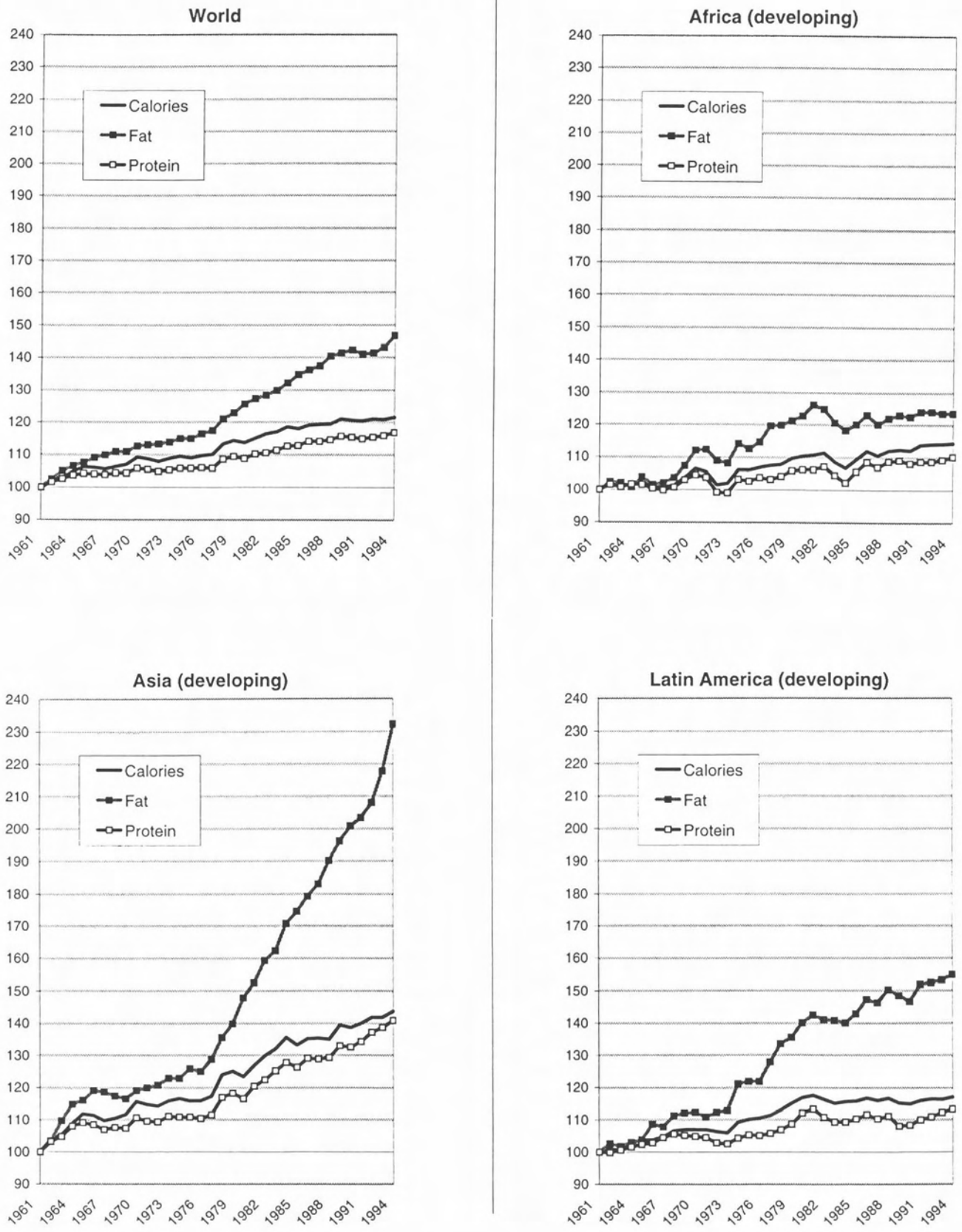
Source: UN Population Division (1976): *World Population Prospects, 1950-2050.* The 1996 Edition. (Annexes I and II).

Figure C3.1: World: Cumulative Number of People Living in Countries of the Specified Average Total Fertility Rate (Number of Children per Woman) (Based on UN Estimates and Medium Variant Projection, 1996 Edition).



Source: UN Population Division (1997): *World Population Prospects, 1950-2050.* The 1996 Edition. (Annex I and II).

Figure C3.2: Indices of Per Capita Average Calorie, Fat, and Protein Supply: World, Africa, Asia and Latin America (Index is based on 1961 = 100).



Source: FAO (1996): FAOSTAT Electronic Data Base. Rome.