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WORLD POPULATION IN 2300

Highlights

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Population Division

WORLD POPULATION IN 2300

Highlights

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UNITED NATIONS
DEPARTMENT OF ECONOMIC AND SOCIAL AFFAIRS
POPULATION DIVISION

WORLD POPULATION IN 2300
EXECUTIVE SUMMARY

The Population Division of the Department of Economic and Social Affairs of the United Nations has prepared for the first time a set of population projections to the year 2300 for each country of the world. All projection scenarios share the same assumptions about the steady decline of mortality after 2050 and the consequent increase of life expectancy. In addition, in all scenarios, international migration is assumed to be zero after 2050. All scenarios take off in 2050 from the results of the different projections variants of the *2002 Revision* of *World Population Prospects* (United Nations, 2003a and 2003b).

In terms of fertility, the *medium scenario* assumes that the total fertility of each country will reach below replacement levels and remain at those levels for about 100 years, after which it will return to replacement level and remain there until 2300. In the *high scenario* total fertility after 2050 is assumed to be a quarter of a child higher than in the medium scenario and to remain constant at 2.35 children per woman when the medium scenario stabilizes at replacement level. Similarly, in the *low scenario* total fertility is assumed to be 0.25 of a child lower than in the medium scenario and to remain constant at 1.85 children per woman when the medium scenario settles at replacement level. The *zero-growth scenario* maintains the same fertility levels as the medium scenario until about 50 years after the latter reaches replacement level and from there on the zero-growth scenario has fertility levels that ensure that the number of births matches the number of deaths in each population, thus ensuring zero-growth. Lastly, the *constant-fertility scenario* maintains fertility constant during 2000-2300 at the level estimated for 1995-2000.

The main findings yielded by a comparison of these scenarios are summarized below.

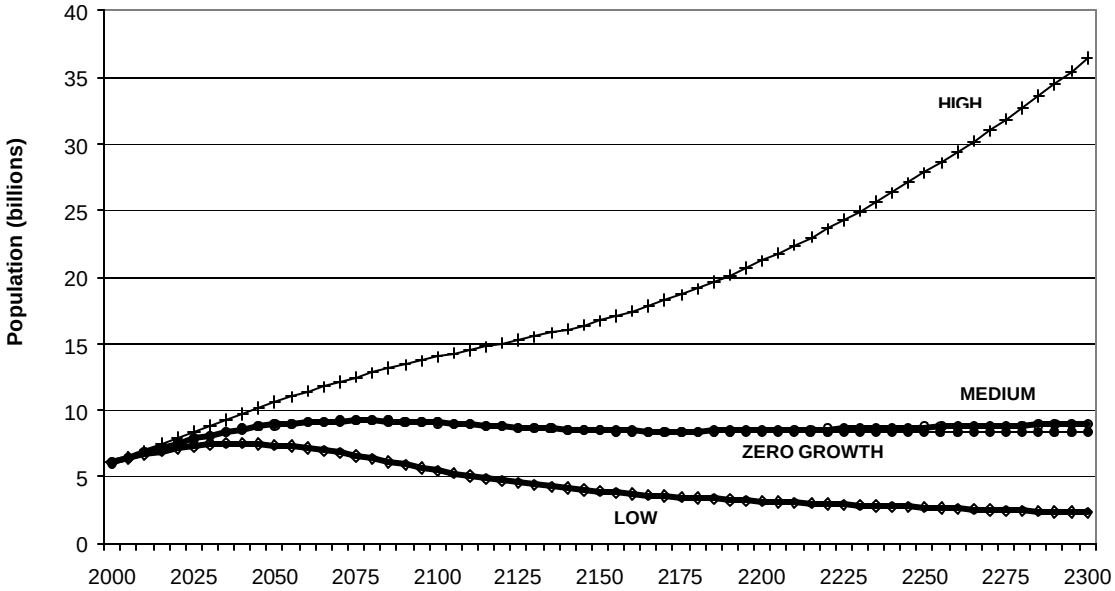
1. According to the medium scenario, world population rises from 6.1 billion persons in 2000 to a maximum of 9.2 billion persons in 2075 and declines thereafter to reach 8.3 billion in 2175. The return to replacement level fertility coupled with increasing longevity in the medium scenario produces a steadily increasing population after 2175 that reaches 9 billion by 2300. If the effects of increasing longevity are counterbalanced by fertility, population size remains constant at 8.3 billion from 2175 to 2300 as in the zero-growth scenario (figure 1).

2. Future population size is highly sensitive to small but sustained deviations of fertility from replacement level. Thus, the low scenario results in a declining population that reaches 2.3 billion in 2300 and the high scenario leads to a growing population that rises to 36.4 billion by 2300 (table 1).

3. In the medium scenario, most of the expected population increase between 2000 and 2300 occurs in the less developed regions, whose population rises form 4.9 billion in 2000 to 7.7 billion in 2300. Although the population of more developed regions also increases, the change is considerably less (from 1.2 billion in 2000 to 1.3 billion in 2300).

Source: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, *The World Population in 2300* (ESA/P/WP.187), forthcoming.

Figure 1. World population according to different scenarios, 2000-2300



4. If, for the sake of illustration, the fertility of countries is kept constant at 1995-2000 levels, the world population soars to 244 billion by 2150 and 134 trillion in 2300, a definitely impossible outcome. All of this increase occurs in the less developed regions, whose population rises from 4.9 billion today to 134 trillion in 2300. In sharp contrast, the population of the more developed regions declines from 1.2 billion in 2000 to 0.6 billion in 2300 were its fertility to remain constant at current levels. Among the less developed regions, Africa, with its very high current fertility levels, grows most rapidly, passing from 0.8 billion in 2000 to 115 trillion in 2300 in the illustrative constant-fertility scenario.

5. All scenarios result in significant shifts in the geographical distribution of the world population (tables 2 and 3). According to the medium scenario, the share of Africa doubles (passing from 13 per cent of the world population in 2000 to 24 per cent in 2300), whereas that of Asia is reduced by about ten per cent (from 61 per cent in 2000 to 55 per cent in 2300) and that of Europe by about half (from 12 per cent in 2000 to 7 per cent in 2300).

6. According to the medium scenario, China, India and the United States are and will continue to be the most populous countries of the world until 2300. By 2050, India is expected to have surpassed China in population size and will remain as the most populous country in the world thereafter. However, between 2000 and 2100, the three most populous countries are expected to account for a declining share of the world population, passing from 43 per cent in 2000 to 34 per cent in 2100. Their share is then expected to rise slightly and remain at about 35 per cent until 2300.

7. In the medium scenario, the number of countries accounting for 75 per cent of the world population is expected to increase from 24 in 2000 to 29 in 2100 and to remain unchanged thereafter. This relative stability in terms of total population belies the major changes projected in terms of the contribution of different countries to population increase or decrease. In the medium scenario, the annual change of world population is projected to decrease steadily from 77 million in 2003 to -14 million in 2010-2015 and then to rise steadily until it becomes positive again in 2175-2180 (figure 2). Consequently,

TABLE 1. EVOLUTION OF THE POPULATION OF THE WORLD AND THE MAJOR DEVELOPMENT GROUPS ACCORDING TO THE DIFFERENT SCENARIOS, 2000-2300

	Population (billions)				
Year	*Low*	*Medium*	*Zero-growth*	*High*	*Constant*
World					
2000	6.1	6.1	6.1	6.1	6.1
2050	7.4	8.9	8.9	10.6	12.8
2100	5.5	9.1	9.1	14.0	43.6
2150	3.9	8.5	8.5	16.7	244.4
2200	3.2	8.5	8.3	21.2	1 775.3
2250	2.7	8.8	8.3	27.8	14 783.0
2300	2.3	9.0	8.3	36.4	133 592.0
More developed regions					
2000	1.2	1.2	1.2	1.2	1.2
2050	1.1	1.2	1.2	1.4	1.2
2100	0.8	1.1	1.1	1.7	0.9
2150	0.6	1.2	1.1	2.2	0.8
2200	0.6	1.2	1.1	2.8	0.7
2250	0.5	1.2	1.1	3.6	0.7
2300	0.4	1.3	1.1	4.7	0.6
Less developed regions					
2000	4.9	4.9	4.9	4.9	4.9
2050	6.3	7.7	7.7	9.3	11.6
2100	4.7	7.9	7.9	12.4	42.7
2150	3.3	7.3	7.3	14.6	243.6
2200	2.6	7.3	7.2	18.4	1 774.6
2250	2.2	7.5	7.2	24.2	14 782.3
2300	1.9	7.7	7.2	31.8	133 591.4
Least developed countries					
2000	0.7	0.7	0.7	0.7	0.7
2050	1.4	1.7	1.7	2.0	3.0
2100	1.5	2.2	2.2	3.1	19.9
2150	1.1	2.0	2.0	3.5	156.1
2200	0.8	1.9	1.9	4.3	1 352.3
2250	0.7	1.9	1.9	5.6	12 451.7
2300	0.6	2.0	1.9	7.4	119 748.5

whereas in 2000 the majority of the countries of the world have an increasing population, by 2100 the majority will have a decreasing population according to the medium scenario, and just three—Niger, Uganda and Yemen—are expected to account for over half of the positive contribution to population growth at that time. Concomitantly, China and India alone are projected to account for nearly 48 per cent of the population losses projected to occur in 2100. Net population losses are still projected to occur in some countries around 2200 but by 2300, all countries will be experiencing population increases in the medium scenario.

TABLE 2. POPULATION OF THE MAJOR AREAS ACCORDING TO THE DIFFERENT SCENARIOS, 2000-2300

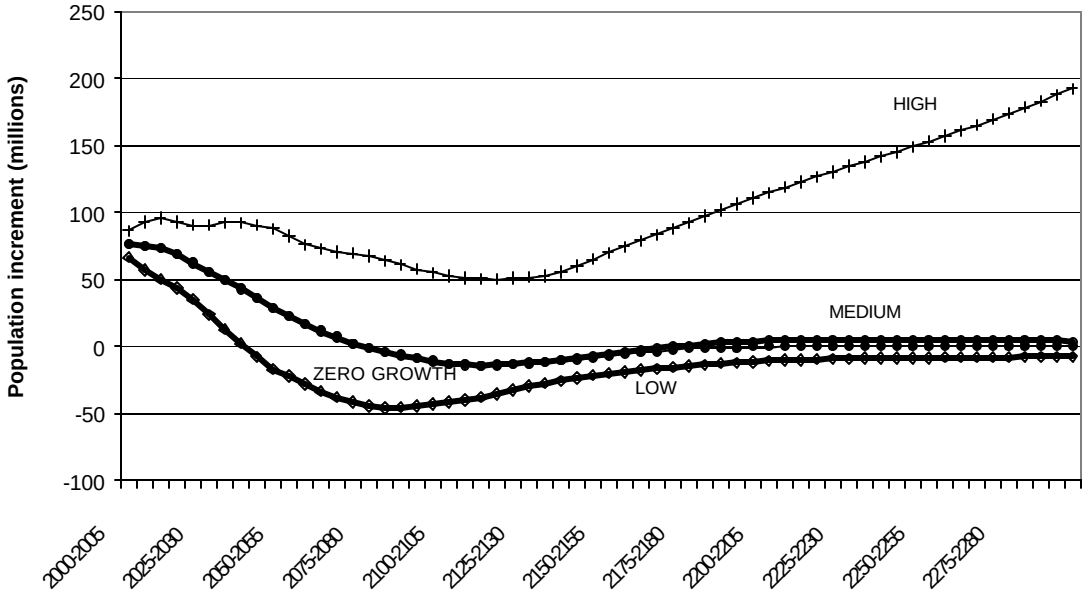
	Population (millions)						
Major area and scenario	*2000*	*2050*	*2100*	*2150*	*2200*	*2250*	*2300*
Africa							
Low	796	1 516	1 508	1 084	832	714	620
Medium	796	1 803	2 254	2 083	2 008	2 060	2 113
Zero-Growth	796	1 803	2 254	2 083	2 014	2 013	2 013
High	796	2 122	3 235	3 725	4 565	6 016	7 962
Constant	796	3 279	20 731	159 289	1 347 036	12 133 531	114 847 325
Asia							
Low	3 680	4 274	2 864	1 973	1 595	1 353	1 143
Medium	3 680	5 222	5 019	4 651	4 682	4 824	4 943
Zero-Growth	3 680	5 222	5 019	4 645	4 583	4 583	4 583
High	3 680	6 318	8 060	9 583	12 254	16 066	20 994
Constant	3 680	7 333	19 813	78 634	409 438	2 580 643	18 461 775
Latin America and the Caribbean							
Low	520	623	407	276	224	192	163
Medium	520	768	733	675	681	703	723
Zero-Growth	520	768	733	675	669	669	669
High	520	924	1 171	1 393	1 792	2 366	3 114
Constant	520	1 032	2 096	5 249	16 374	60 759	251 354
Northern America							
Low	316	391	318	264	229	197	168
Medium	316	448	474	490	509	523	534
Zero-Growth	316	448	475	477	477	477	477
High	316	512	695	914	1 193	1 547	1 998
Constant	316	453	488	500	510	519	528
Europe							
Low	728	565	362	300	263	230	200
Medium	728	632	538	550	574	594	611
Zero-Growth	728	632	540	538	538	538	538
High	728	705	790	1 025	1 328	1 714	2 204
Constant	728	597	365	228	154	113	90
Oceania							
Low	31	40	31	25	21	19	16
Medium	31	46	46	45	45	47	48
Zero-Growth	31	46	46	45	44	44	44
High	31	52	67	83	104	134	172
Constant	31	58	133	451	1 788	7 394	30 921

TABLE 3. POPULATION OF THE MAJOR AREAS AS A PERCENTAGE OF THE WORLD POPULATION ACCORDING TO THE DIFFERENT SCENARIOS, 2000-2300

	Percentage of the world population						
Major area and scenario	*2000*	*2050*	*2100*	*2150*	*2200*	*2250*	*2300*
Africa							
Low	13.1	20.5	27.5	27.7	26.3	26.4	26.8
Medium	13.1	20.2	24.9	24.5	23.6	23.5	23.5
Zero-Growth	13.1	20.2	24.9	24.6	24.2	24.2	24.2
High	13.1	20.0	23.1	22.3	21.5	21.6	21.8
Constant	13.1	25.7	47.5	65.2	75.9	82.1	86.0
Asia							
Low	60.6	57.7	52.1	50.3	50.4	50.0	49.5
Medium	60.6	58.6	55.4	54.8	55.1	55.1	55.1
Zero-Growth	60.6	58.6	55.4	54.9	55.1	55.1	55.1
High	60.6	59.4	57.5	57.3	57.7	57.7	57.6
Constant	60.6	57.5	45.4	32.2	23.1	17.5	13.8
Latin America and the Caribbean							
Low	8.6	8.4	7.4	7.0	7.1	7.1	7.1
Medium	8.6	8.6	8.1	7.9	8.0	8.0	8.1
Zero-Growth	8.6	8.6	8.1	8.0	8.0	8.0	8.0
High	8.6	8.7	8.4	8.3	8.4	8.5	8.5
Constant	8.6	8.1	4.8	2.1	0.9	0.4	0.2
Northern America							
Low	5.2	5.3	5.8	6.7	7.2	7.3	7.3
Medium	5.2	5.0	5.2	5.8	6.0	6.0	6.0
Zero-Growth	5.2	5.0	5.2	5.6	5.7	5.7	5.7
High	5.2	4.8	5.0	5.5	5.6	5.6	5.5
Constant	5.2	3.6	1.1	0.2	0.0	0.0	0.0
Europe							
Low	12.0	7.6	6.6	7.6	8.3	8.5	8.7
Medium	12.0	7.1	5.9	6.5	6.8	6.8	6.8
Zero-Growth	12.0	7.1	6.0	6.4	6.5	6.5	6.5
High	12.0	6.6	5.6	6.1	6.3	6.2	6.0
Constant	12.0	4.7	0.8	0.1	0.0	0.0	0.0
Oceania							
Low	0.5	0.5	0.6	0.6	0.7	0.7	0.7
Medium	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Zero-Growth	0.5	0.5	0.5	0.5	0.5	0.5	0.5
High	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Constant	0.5	0.5	0.3	0.2	0.1	0.1	0.0

8. Life expectancy is projected to increase steadily in all countries after 2050. No limit is set on the increase of life expectancy. As a result some countries reach very high levels of survivorship by 2300. At that time, females in Japan are projected to have a life expectancy of 108 years, with males having 104 years. These are the highest projected life expectancies in the world. The lowest are projected for

Figure 2. World population annual increment according to different scenarios, 2000-2300



Liberia and Mali at 88 years for females and 87 for males, levels similar to those attained today by Japan, the country with the lowest current mortality levels.

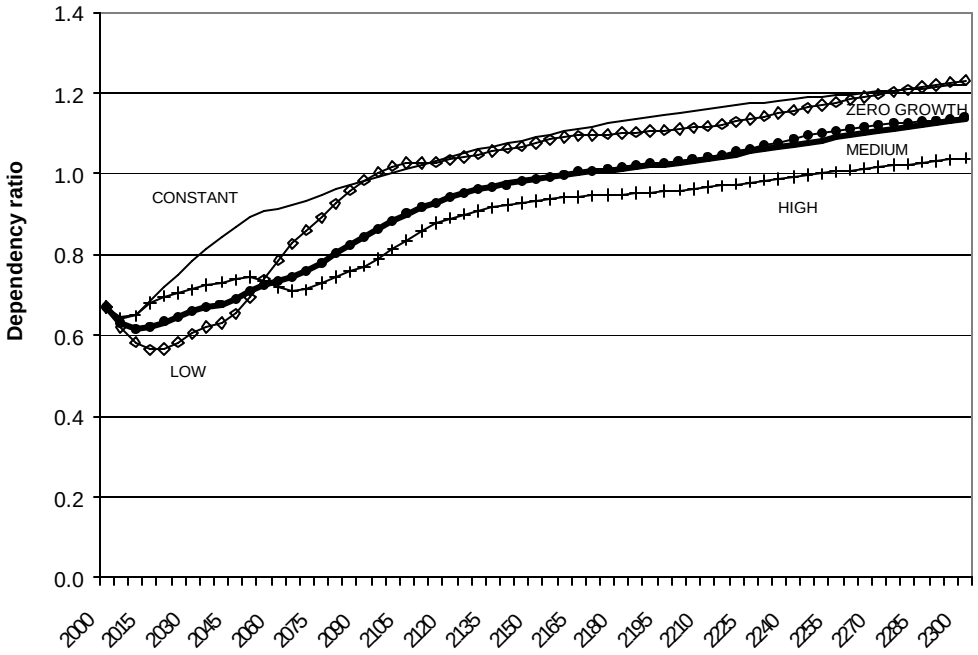
9. The low, medium and high scenarios all result in significant shifts of the age distribution toward older ages. According to the medium scenario, the share of persons aged 0-14 declines from 30 per cent in 2000 to 16 per cent in 2300, whereas the share of persons aged 60 years or over rises from 10 per cent to 38 per cent over the same period. Because the ageing process is more advanced in the more developed regions, the relative increase in the proportion of the population aged 60 years or over is less that in the less developed regions: from 19 per cent in 2000 to 41 per cent in 2300 in the more developed regions as compared to a rise from just under 8 per cent in 2000 to 37 per cent in 2300 in the less developed regions.

10. All scenarios result in a significant increase of the ratio of dependents (persons under age 15 and persons aged 60 year or over) to the population of working age (persons aged 15 to 59). In the medium scenario, the world's dependency ratio rises from 0.7 in 2000 to 1.1 in 2300, implying that by that time there will be more than one "dependent" per person of working age. But as figure 3 indicates, even in the high scenario, where higher fertility leads to a population of 36 billion, the projected dependency ratio in 2300 is above one. That is, especially if longevity continued to rise, the working ages will have to be extended well beyond age 60.

11. With increasing longevity and continued low fertility, there is expected to be a continued rise in the proportion of the population aged 80 years or over and in that surpassing the 100 years of age. The proportion of those aged 80 or over, which was just 1.1 per cent in 2000, is projected to reach 17 per cent in the medium scenario by 2300. This number includes those persons aged 100 year or more, who are projected to account for nearly 2 per cent of the world population in 2300. Even in the high scenario, where population ageing is slower, the proportion of the population aged 80 or over is projected to rise to over 13 per cent by 2300 and the proportion of centenarians increases to more than 1 per cent.

12. Population ageing can also be gauged from the increase in the median age of the population, that is, the age that divides the population in half (half of the people are younger and half older than the median age). At the world level, the median age is projected to rise from 26 years in 2000 to 42 years in the high scenario, 48 years in the medium, and 52 years in the low scenario, The change in the median age will be more marked in the less developed regions, where the medium scenario projects it to rise from 24 years in 2000 to 48 years in 2300. In the more developed regions the equivalent change is projected to be from 37 to 50 years. By 2300, countries with the most aged population will likely include Belgium, France, Germany, Japan, Malta, Spain and Sweden, all with median ages of 52 years or higher according to the medium scenario.

Figure 3. Evolution of the dependency ratio for the world according to different scenarios, 2000-2300



INTRODUCTION

The Population Division of the Department of Economic and Social Affairs of the United Nations has prepared for the first time a set of population projections to the year 2300 for each country of the world. These projections extend the projection results published in *World Population Prospects: The 2002 Revision*, Volumes I and II (United Nations, 2003a and 2003b) which cover the period 2000-2050. Because of the uncertainty inherent in projecting population trends over very long periods, the results presented here should be treated as scenarios representing just a few of the many possible future paths of world population.

The value of the scenarios presented here is that they illustrate, often dramatically, the implications of small differences in future fertility levels. The scenarios selected also demonstrate that it is possible to attain over the next 300 years a world population that will be growing very slowly if at all and whose overall size might not differ markedly from that expected for the middle of this century. Attainment of such a population depends crucially on the continued reduction of fertility in developing countries, so that they may emulate developed countries in attaining and maintaining below-replacement fertility for lengthy periods. However, if the world population is to avoid a sustained decline in the long run, most populations need to return eventually to fertility levels that ensure population replacement. In the medium scenario, each country is assumed to experience below-replacement fertility levels for an average of 100 years before returning to levels that ensure replacement.

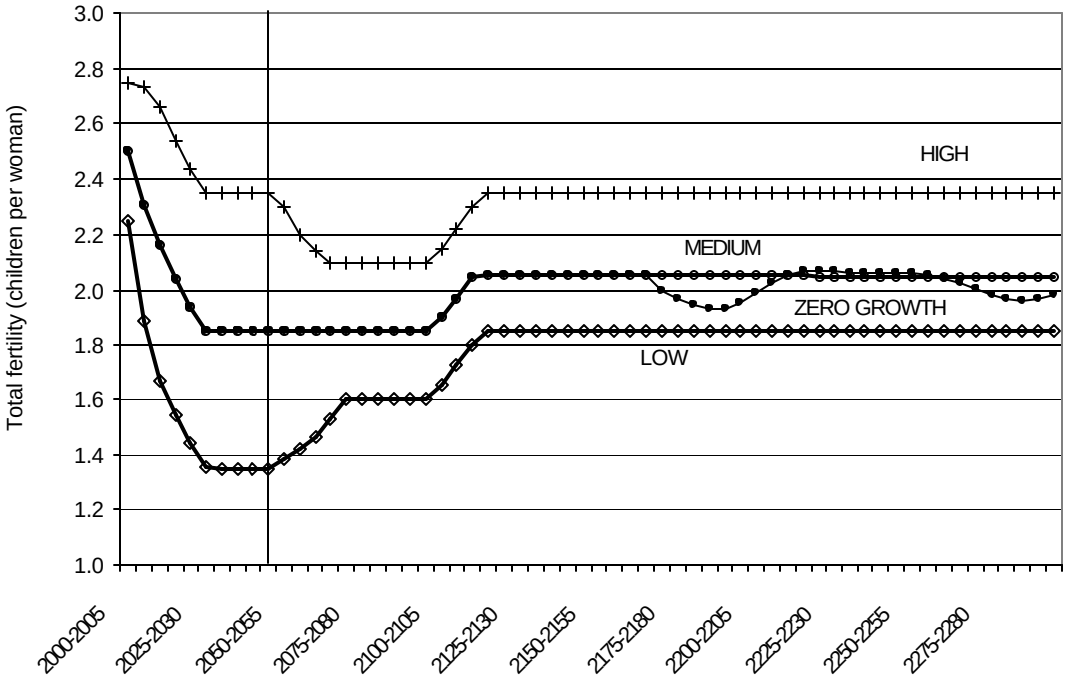
In addition to the medium scenario, four other scenarios have been prepared, varying among themselves only on the assumptions made about future fertility trends. In all scenarios, the expectation of life at birth is assumed to increase steadily over time. Because no limit has been put on the increase of life expectancy, some countries attain very high levels of life expectancy by 2300. Such steady increases in survivorship imply that the population continues to grow even when fertility reaches and maintains a level ensuring the replacement of generations. Another feature that all scenarios have in common is that international migration is assumed to be zero for every country from 2050 onwards. A scenario incorporating non-zero international migration assumptions at the country level is in preparation.

The five scenarios that permit an assessment of the effects that different fertility paths have on population dynamics are described below. Figure 4 illustrates the fertility paths according to the first four scenarios for a typical developing country.

(*a*) *Medium scenario*: This scenario takes off in 2050 from the medium variant of the *2002 Revision.* It assumes that the total fertility of each country remains at below-replacement level for about 100 years over the span 1950-2175 and that it then rises to reach and maintain replacement level (a net reproduction rate of one female child per woman) until 2300. The onset of below-replacement fertility varies considerably among countries depending on the timing and speed of their transition to low fertility. Most developing countries, which in 2000 still had fertility levels considerably above replacement, are projected to reach a minimum total fertility of 1.85 children per woman, maintain it for a lengthy period and then rise to replacement level which, at the high life expectancies projected beyond 2100 is close to 2.05 children per woman (the value needed to produce a net reproduction rate of one).

(*b*) *Low scenario:* This scenario takes off in 2050 from the low variant of the *2002 Revision.* In the low scenario the total fertility of each country remains below-replacement level during most of the 2050-2300 period, maintaining generally a level that is 0.25 children below that of total fertility in the medium

Figure 4. Projected total fertility according to the low, medium, zero-growth and high scenarios, 2000-2300 (example of a developing country)



scenario until the latter reaches replacement level. At that point, the total fertility level in the low scenario is set at 1.85 children per woman and is maintained constant until 2300 implying that it is, on average, 0.2 children below the replacement-level fertility in the medium scenario, which tends to be about 2.05 children per woman.

(*c*) *High scenario:* This scenario takes off in 2050 from the high variant of the *2002 Revision.* In the high scenario, the total fertility of each country generally remains at or above replacement level during 2050-2300, being 0.25 children higher than that in the medium scenario until the latter reaches replacement level fertility. From that point on, the high scenario has a constant total fertility of 2.35 children per woman, a value that is approximately 0.3 children above replacement-level fertility in the medium scenario, which is close to 2.05 children per woman.

(*d*) *Zero-growth scenario*: This scenario takes off in 2050 from the medium variant of the *2002 Revision* and its fertility path coincides with that of the medium scenario until about 50 years after the latter reaches a stable replacement level (the time needed for population momentum to subside, that is, for the population to stop decreasing because of that momentum). At that point, fertility in the zero-growth scenario is calculated so that the number of births balances the number of deaths in each period, thus effectively maintaining zero population growth despite the steady reduction of mortality.

(*e*) *Constant-fertility scenario:* This scenario takes off in 2050 from the constant-fertility scenario of the *2002 Revision.* In it fertility is maintained constant at the level it had in each country as of 1995-2000. This scenario is prepared merely for illustrative purposes since its results show that the population dynamics it embodies are unsustainable.

This set of scenarios of long-range population dynamics has several features that make them distinct from previous sets of long-range projections prepared by the Population Division. First, the

scenarios cover the period 2000-2300, twice as long as the period 2000-2150 covered by previous sets of long-range projections. Second, whereas only the populations of major areas and very populous countries were projected separately in previous sets, the scenarios to 2300 have been prepared for each country. These changes were necessary to permit a better reflection of the increasing heterogeneity in fertility trends that has been observed recently and that has already been projected to continue during 2000-2050 in the *2002 Revision*.

More specifically, whereas in the late 1980s and early 1990s the prevalence of below-replacement fertility among countries that had experienced an early transition to low fertility was still considered transitory, it is now clear that populations can and probably will experience lengthy periods of below-replacement fertility. In addition, an increasing number of developing countries, whose transition to low fertility started much later, are attaining below-replacement fertility levels and are likely to maintain them for some time. However, many countries are still far from experiencing low fertility and in some there are as yet no signs of significant reductions in fertility. In some of these countries, fertility may not even decrease sufficiently to reach replacement level by 2050. Given this variability in the timing of the transition to low fertility and the prospect that fertility reductions may lead, more often than not, to levels of fertility below replacement that are maintained over lengthy periods, it was necessary to model the implications of those trends with some detail. The scenarios to 2300 are the result of such modelling.

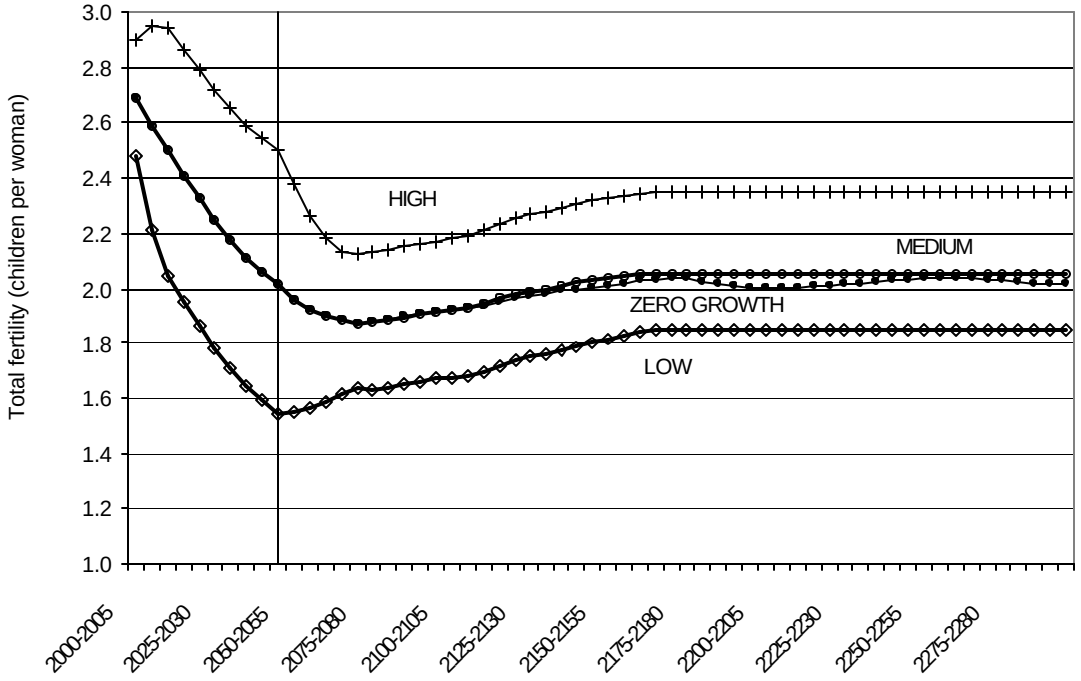
The scenarios produced permit to answer a few critical questions about the future of world population: can the population recover from sustained and long-term levels of below-replacement fertility? What effect would small deviations in fertility levels sustained over time have on population growth and size? To what extent can increasing longevity counterbalance low fertility? Which populations are most likely to face demographic strains because of population growth or decline? The insights provided by an analysis of the scenarios produced will help answer some of these questions.

I. THE EFFECT OF FERTILITY ON POPULATION SIZE AND GROWTH

It is well known that, because of the exponential nature of population growth, any non-zero rate of population growth maintained constant over the long term leads to significant increases or decreases of population. The size of the increases or reductions will be higher the larger the starting point. Because world population increased to unprecedented levels over the course of the 20th century, any future trends in population growth will build on an already large population.

The low, medium and high scenarios illustrate the population changes that may be expected if fertility continues to decline in all countries with current fertility levels above 2.35 and if, eventually, their fertility levels remain within an interval of half a child around replacement level. As table 1 indicates, in the high scenario, whose fertility remains at or above replacement level until 2300 (figure 5), the world population, which reaches 10.6 billion in 2050, is projected to keep on rising steadily to attain 36.4 billion in 2300. In contrast, the low scenario, where fertility remains below replacement level until 2300, projects a population of 7.4 billion in 2050 and 2.3 billion in 2300. The wide difference between 2.3 billion and 36.4 billion is largely the result of half a child difference in fertility levels roughly centered on replacement level and maintained for approximately 250 years. World population has the potential to attain any size in between (or even higher or lower sizes for that matter). However, the medium scenario illustrates a path that is consistent with our understanding of current trends and that leads to less marked changes in population size. Thus, by assuming that national populations will reach and maintain below-replacement fertility levels for lengthy periods but not forever, the medium scenario projects that world population will reach a maximum of 9.2 billion in 2075 and then decline to 8.3 billion in 2175. Under the further assumption that fertility will eventually return to replacement level in all countries, world

Figure 5. Total fertility for the world according to different scenarios, 2000-2300

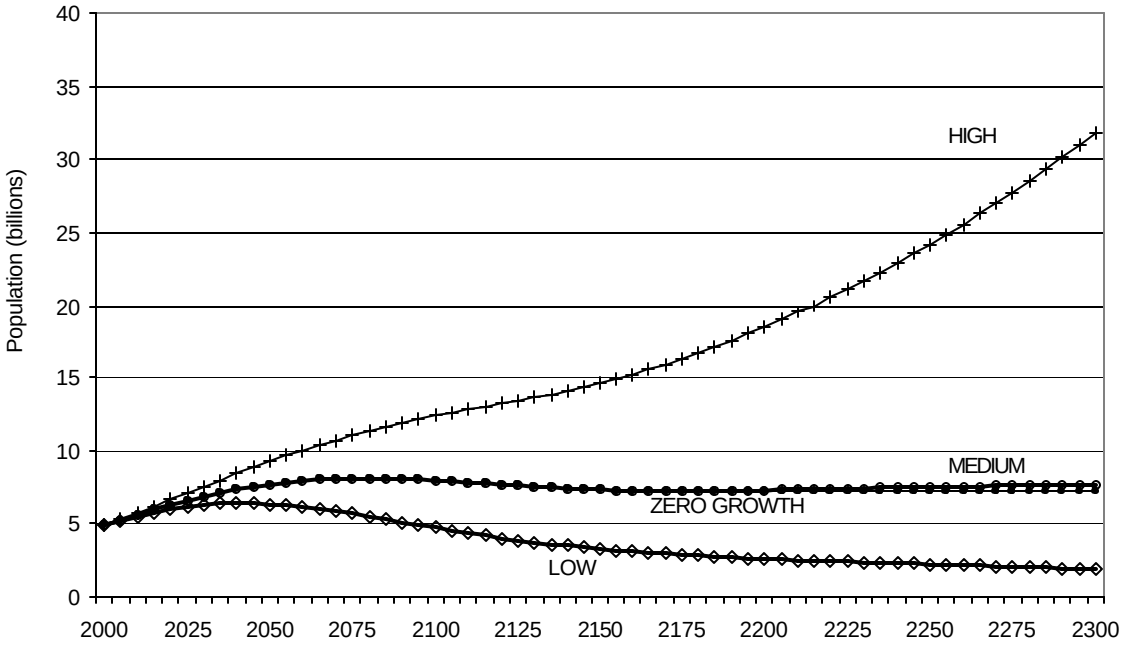


population rises slowly after 2175, partly as a result of increasing longevity, so that it reaches 9 billion by 2300. Even if the effects of rising longevity were counterbalanced by changes in fertility, as in the zero-growth scenario, world population would remain in the range of 8 billion to 9 billion (8.3 billion in 2300 is the figure produced by the zero-growth scenario). That is, the medium scenario produces a path for world population growth that is more likely to be sustainable than the path resulting from the high scenario. In addition, the medium scenario also produces a population that, although nearly four times as large as that in the low scenario, is not as concentrated in older ages as the latter, an outcome that would seem preferable given the challenges posed by rapid population ageing.

In all scenarios, population growth or decline is more concentrated in the less developed regions of today. According to the medium scenario, the population of the less developed regions increases from 4.9 billion in 2000 to 8.1 billion in 2080 and then starts a steady decline to reach 7.2 billion in 2175 (figure 6). From there on, as fertility reaches and remains at replacement level and life expectancy continues to increase, the population of the less developed regions rises slowly to reach 7.7 billion in 2300.

It is important to underscore that according to the medium scenario the major population increase projected for the less developed regions occurs during the 21st century as a result of the still relatively high levels of fertility that are expected to prevail in most developing countries during the next 20 to 30 years and the effects of population momentum after replacement or below-replacement fertility is attained. Thus, by 2050 the medium scenario already projects a population of 7.7 billion in the less developed regions. Even with the considerably lower fertility levels projected in the low scenario, the population of the less developed regions would increase from 4.9 billion in 2000 to 6.3 billion in 2050, but population reductions would start after 2040. That is, in the low scenario the population of the less developed regions peaks in 2040 at 6.4 billion whereas in the medium scenario it peaks in 2080 at 8.1

Figure 6. Population in less developed regions according to different scenarios, 2000-2300

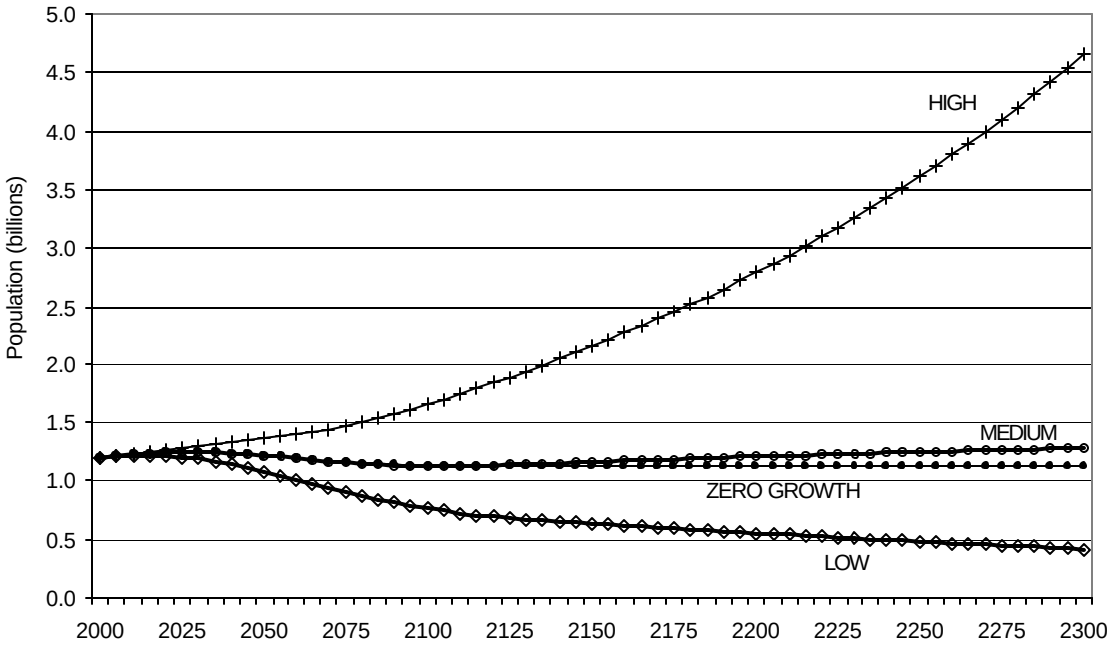


billion. Only in the high scenario is a steady increase in the population of the less developed regions projected for the 21st century as a whole, leading to a population of 9.3 billion in 2050 and 12.4 billion in 2100. Given current fertility trends in the majority of developing countries, it is not expected that they would follow the high scenario over the long-run but, if fertility levels fail to decline as fast as projected in the medium scenario, the onset of population reductions in the less developed regions as a whole may occur after 2080.

Overall, the high scenario shows that maintaining fertility levels above replacement level, even if not far from it, for lengthy periods can lead to very substantial and eventually unsustainable population growth. Thus, according to the high scenario the population of the least developed countries more than quadruples over the course of the 21st century, passing from 0.7 billion in 2000 to 3.1 billion in 2100, despite the major reductions of fertility that even the high scenario incorporates for that group of countries (from just above 5 children per woman in 2000 to 2.1 children per woman in 2100). Furthermore, were the least developed countries to maintain over the long run a fertility level of 2.35 children per woman, their population would rise to 7.4 billion by 2300, a figure higher than the total of the world population today and similar to that expected under the medium scenario for all developing countries in 2050.

Whereas there is still uncertainty about how fast and how low the fertility of developing countries will fall, there is no question about the possibility of reaching and maintaining low fertility in developed countries. In the case of the more developed regions the issue is whether fertility will rise sufficiently to ensure the replacement of generations. The medium scenario assumes that such an increase will take place but not before a lengthy period of below-replacement fertility. Under that assumption, the population of the more developed regions declines from 1.2 billion in 2000 to reach a minimum of 1.1 billion in 2105 and then rises steadily to reach 1.3 billion in 2300, largely as a result of increasing longevity (figure 7). If fertility levels were to vary in such a way as to counterbalance the population gains due to increasing

Figure 7. Population of the more developed regions according to different scenarios, 2000-2300



longevity, the population of the more developed regions would remain at 1.1 billion until 2300 as projected in the zero-growth scenario. In that scenario, periods of below-replacement fertility alternate with periods where fertility is near or just above replacement level but at the regional level total fertility never drops below 1.9 children per woman.

If the fertility of the more developed regions fails to return to replacement level, their population may experience trends such as those embodied by the low scenario, whose fertility levels over the long run remain at 1.85 children per woman. Such sustained low fertility leads to a very substantial reduction of the population: from 1.1 billion in 2000 to 0.4 billion in 2300. According to the low scenario, 28 of the 44 countries in the more developed regions would see their populations drop to between one-tenth and one third of their size in 2000. Italy, Japan, Poland, Spain, the Russian Federation and the Ukraine are in that group. In comparison, in the medium scenario only four countries, Bulgaria, Estonia, Latvia and the Ukraine would see their populations decrease to less that 60 per cent of their size in 2000 (the largest decline would be experienced by Estonia whose population in 2300 would be 43 per cent as large as in 2000). Furthermore, whereas all countries in the more developed regions would see their populations decrease by 2300 in the low scenario, in the medium, 19 countries in the more developed regions would have a higher population in 2300 than in 2000, including Australia, Canada, Denmark, Finland, France, Germany, Luxembourg, New Zealand, the Netherlands, Norway, Sweden, the United Kingdom and the United States of America.

It seems less likely today that the countries of the more developed regions might follow the fertility path of the high scenario which would result in a moderate increase of their population during the 21st century: from 1.2 billion in 2000 to 1.7 billion in 2100. From there on the high scenario projects an acceleration of population growth that would result in a population doubling every 140 years or so and would produce by 2300 a total of 4.7 billion inhabitants in the more developed regions, roughly the same

population size as that of today's developing world. Just as in the case of the less developed regions, this outcome would likely strain sustainability.

To conclude, let us consider the results of the constant-fertility scenario, which assumes that fertility in each country remains constant at 1995-2000 levels from 2000 to 2300. This scenario makes plain the impossibility of sustaining current fertility levels over the long run. The results of the constant-fertility scenario also help to magnify the heterogeneity of current fertility levels among countries. Thus, whereas the low-fertility countries of today see their populations decline, sometimes sharply, under the constant-fertility scenario, those with moderate to high recent fertility levels are projected to see their populations rise to incredible sizes by 2300.

Among the 44 low-fertility countries that constitute the more developed regions, 24 are projected to see their populations drop by 2300 to less than one-tenth of their respective population sizes in 2000. The population of the more developed regions as a whole is projected to decreased by half in the constant-fertility scenario, passing from 1.2 billion in 2000 to 0.6 billion in 2300. In sharp contrast, extremely rapid population growth is projected for the less developed regions, whose population rises from 4.9 billion in 2000 to 134 trillion in 2300, 115 trillion of which are projected to live in Africa. Indeed, a country such a Niger, whose total fertility in 2000 was estimated at 8 children per woman, is projected to see its population increase by a factor of more than 2 million over the next 300 years under the constant-fertility scenario. The populations of countries such as Angola, Guinea-Bissau, Liberia, Mali, Somalia, Uganda or Yemen are also multiplied by hundreds of thousands under that scenario. Clearly, such growth is not sustainable and will not occur over the long run. However, it might materialize over shorter periods. Thus, without reductions of fertility, the population of the 49 least developed countries of the world could double by 2025 and more than quadruple by 2050. For some of the countries that have not yet begun the transition to low fertility, the short-term outcomes of the constant-fertility scenario are not as yet beyond the realm of possibility.

II. PROJECTED MORTALITY

Population growth is also affected by changes in mortality. Under constant fertility conditions, reductions in the risks of dying contribute to increase population growth. When fertility is falling, the effects of declining mortality counterbalance those of declining fertility on population growth. The main long-range projection scenarios prepared by the Population Division assume that mortality declines steadily after 2050. Thus, the expectation of life at birth for women at the world level increases from 77 years in 2045-2050 to 97 years in 2300. For men the increase is from 72 years to 95 years over the same period.

Before 2050 the projections of mortality for the 53 countries that are highly affected by the HIV/AIDS epidemic take into account explicitly the impact of the disease with the result that increases in mortality levels are projected for several of those countries over portions of the period 2000-2050. In preparing the long-range projections it was assumed that by 2050 HIV/AIDS would be largely controlled, becoming an endemic disease and a chronic illness for those infected by the virus. Over the long-run the age-specific effects of AIDS mortality were assumed to diminish. Those assumptions were implicit in the method used to project mortality schedules. Starting from the mortality schedules projected for 2045-2050, which showed clearly the effects of AIDS, convergence to a "normal" mortality pattern (for a population not affected by AIDS) was used.

As described in the paper accompanying the Proceedings of the United Nations Technical Working Group on Long-range Population Projections (Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, 2003), the Lee-Carter method was used to

project age-specific mortality. The time series model proposed by Carter and Lee was fit to the mortality schedules already projected for each population from 2000 to 2050 in the *2002 Revision*. In the case of AIDS affected countries, the extrapolation of mortality was based on the No-AIDS mortality schedules prepared for each country.

To ensure the non-divergence of projected life expectancies for males and females, the Lee-Carter model was fit to mortality schedules for both sexes combined to estimate the rate of mortality change during 2000-2050. That rate was then used to extrapolate mortality trends from 2050 to 2300 for each sex separately. This approach produced reasonable sex differentials by sex over the long run and even ensured that in the AIDS-affected countries where female mortality had become higher than male mortality, a reversal of the differential would occur after 2050.

Because no limit was set on the life expectancy that countries could reach, it was necessary to extend the age range of life tables to ensure plausible probabilities of death at very advanced ages (up to age 130), an age range for which current empirical evidence does not exist. The extension was made by using models to close the life tables at those advanced ages.

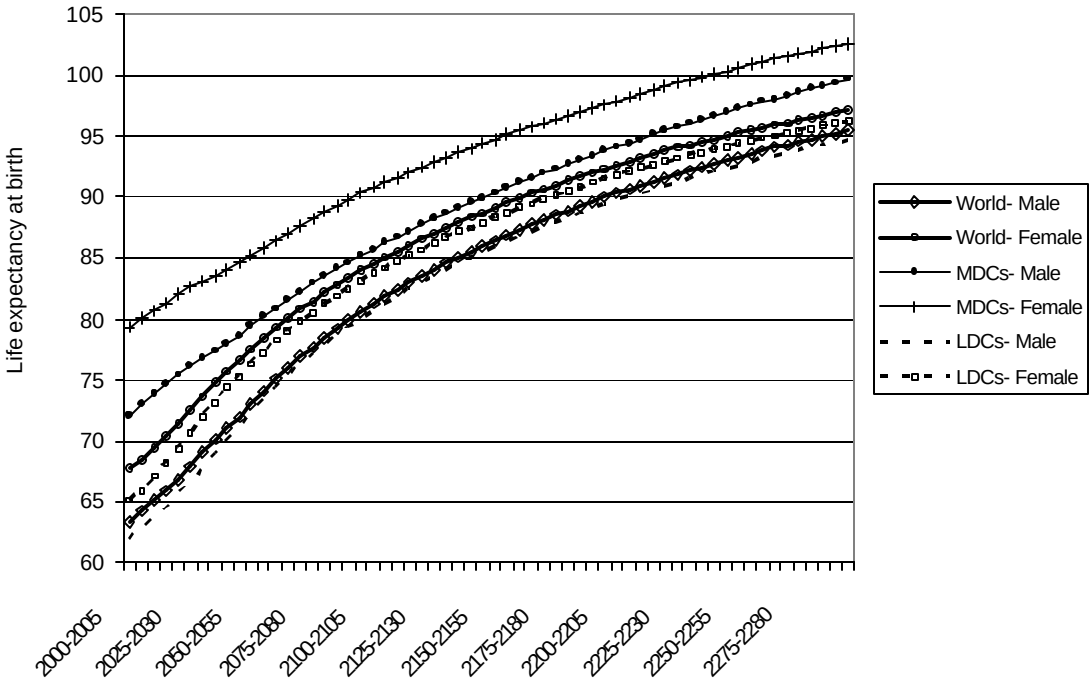
The trends in life expectancy resulting from the application of the Lee-Carter method were generally acceptable. However, extrapolation of the 2000-2050 trends resulted in very fast rises in life expectancy for some countries, particularly those with low life expectancies in 1995-2000 that were projected to catch up with lower-mortality countries between 2000 and 2050. Consequently, it was necessary to modify somewhat the rates of mortality change for those countries over the long term. Even before adjustment, the projected values of life expectancy by 2300 tend to be higher the higher the life expectancy a country had 1995-2000, the main exceptions being the countries highly affected by HIV/AIDS.

Projected life expectancy at the world level rises more among males than among females during 2000-2100, with males gaining 19 years (rising from 62 year in 2000 to 81 years in 2100) and females gaining 17 years (from 67 years in 2000 to 84 in 2100). By 2100, females in the more developed regions as a whole are expected to have an expectation of life of 90 years and males of 85 years. In the less developed regions the equivalent values are 83 years for females and 80 years for males (figure 8). Life expectancy is projected to increase more in the less developed regions than in the more developed regions during the 21st century, gaining 19 years among both males and females in the less developed regions, and 14 years among males and 11 among females in the more developed regions (see annex tables A.22 and A23).

Life expectancy increases slow down in future centuries as ever higher expectations of life at birth are reached. The world's females gain 8 years of life expectancy between 2100 and 2200 to reach 92 years in 2200, but just 5 during 2200-2300 to reach 97 years by the end of the twenty-third century. For males the gains are larger: 9 years during 2100-2200 and 5 during 2200-2300, leading to life expectancies of 90 years in 2200 and 95 in 2300. That is, the differences in survivorship between males and females are projected to decline markedly over the next 300 years.

Differences in the male and female life expectancies are expected to remain higher in the more developed regions than in the less developed regions. By 2300, female life expectancy in the more developed regions is projected to be 103 years, but that of males is projected at 100. In the less developed regions, the male and female life expectancies are projected to differ by just one year: 96 years for females and 95 years for males.

Figure 8. Life expectancy at birth by development group and sex, 2000-2300



Projected levels of life expectancy for the major areas indicate that their ranking remains mostly unchanged from 2000 onwards (see annex tables A.22 and A.23). By 2300, Africa has the lowest life expectancy of all major areas (92 years), followed by Asia (96 years), and Latin America and the Caribbean (98 years). Europe, Northern America and Oceania have higher life expectancies than the other major areas over the whole projection period, but their relative position varies somewhat over time, especially in terms of female life expectancy. Within Europe, Eastern Europe maintains the lowest life expectancy throughout and Western Europe the highest. By 2300, females in Western Europe reach a life expectancy of 106 years and males of 103. Among the developed regions, only Eastern Europe does not reach a life expectancy of 100 years or more by 2300.

Japan is the country with the highest life expectancy during the whole projection period. By 2300, females in Japan have a life expectancy of 108 years and males of 104.5 years. Female life expectancies of 100 years or higher are projected for 51 countries, including 22 countries in Europe plus Australia, Canada, New Zealand and the United States, and several countries in Asia and Latin America and the Caribbean. The latter include China, with a projected female life expectancy of 101 years in 2300. Male life expectancy more rarely reaches 100 or over. In 2300, just 17 countries are projected to have a male life expectancy of 100 years or higher, 10 of which are in Europe. Male life expectancy in China, at 98 years, remains well below the 100 year mark.

III. THE CHANGING GEOGRAPHICAL DISTRIBUTION OF THE POPULATION

Because the different major areas find themselves today at different stages of the transition from high to low mortality and fertility, their growth paths differ considerably over the next century. According to all scenarios, Africa experiences the highest rates of population growth during 2000-2100 and Europe

experiences the lowest over the same period. Different rates of growth result in a redistribution of the population by major area. In all projection scenarios the fastest growing area, Africa, increases its share of the world population, whereas Europe sees its share reduced (see table 3). According to the medium scenario, the number of Africa's inhabitants increases from 796 million in 2000 to 2.3 billion in 2100, and their share of the world population nearly doubles, passing from 13 per cent to 25 per cent. For Europe, the population declines from 728 million in 2000 to 538 million in 2100 and its share of the world population falls from 12 per cent to 6 per cent. Among the other major areas, only Asia experiences a marked reduction in its share of the world's population, from 61 per cent in 2000 to 55 per cent in 2100, as its population rises from 3.7 billion to 5 billion (see annex table A.1). The shares of other major areas experience less marked changes during 2000-2100.

During 2100-2150, the growth rates of all major areas become either very low (in Europe and Northern America) or negative in the medium scenario (see annex table A.6). Beyond 2150, the growth rates of all major areas except that for Africa during 2150-2000 become positive but very low, not surpassing 0.1 per cent per year. Because of their low magnitude and the similarity of the growth rates for the different major areas, they do not lead to major changes in the geographic distribution of the population. Thus, between 2100 and 2300, the major changes in the distribution of the world's population occur between Africa on the one hand and Europe and Northern America on the other, with the former reducing its share from 25 per cent to 23 per cent, and the latter two gaining one percentage point each, to represent 6 per cent and 7 per cent of the world population, respectively, in 2300.

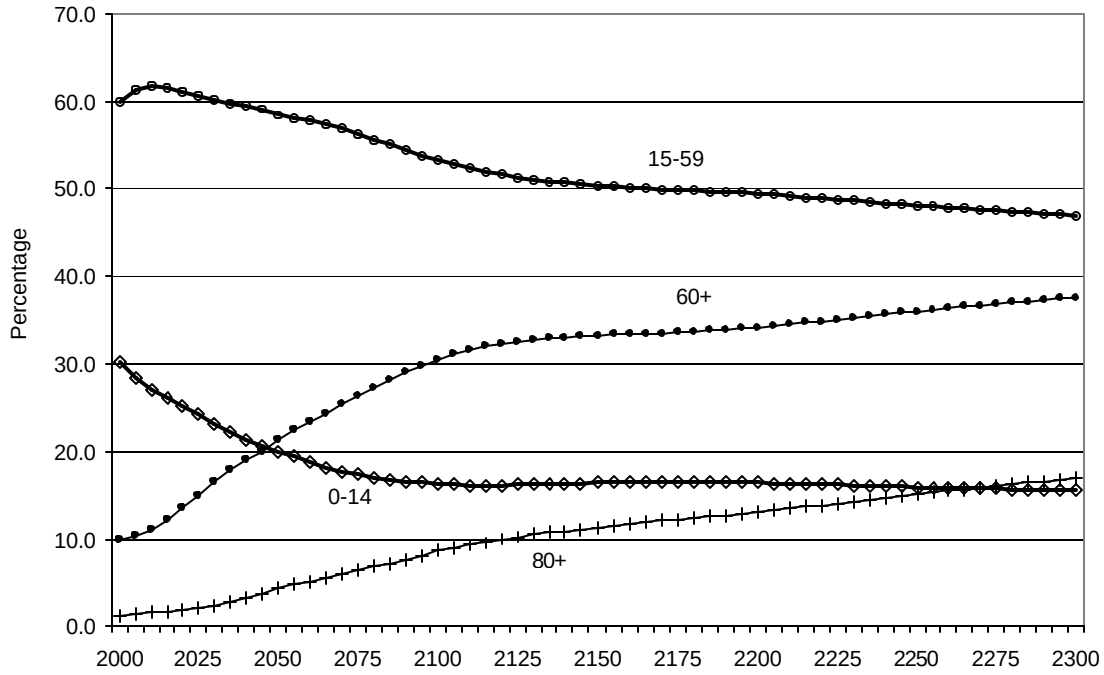
In terms of the distribution of the world population among countries, annex table B.1 lists the number of countries accounting for 75 per cent of the world population at the start of every century from 2000 onwards. In 2000, 24 countries accounted for three-quarters of the world population. By 2100 that number had increased to 29 countries and is projected to remain invariant until 2300. Three countries head the list in all periods: China, India and the United States of America. China, which is currently the most populous country in the world, is expected to be surpassed by India during the first half of the 21st century. Beyond 2150, India remains the most populous country in the world according to the medium scenario but, as its population decreases between 2050 and 2200, its share of the world population also drops, from 17 per cent in 2000 to 15 per cent in 2200. After 2200, India's share of the world population remains virtually unchanged.

China also experiences a reduction of its share of the world population, mainly between 2000 and 2100, when it drops from 21 per cent to 13 per cent. Thereafter, it recuperates slightly, growing to 14 per cent by 2300. The share of the United States remains fairly stable between 2000 and 2100, at about 5 per cent, and then rises slightly to 5.5 per cent by 2300. In all, the share of the world's population accounted for by China, India and the United States combined is projected to decline, from 43 per cent in 2000 to 34 per cent in 2100, rising to 35 per cent by 2200 and then remaining virtually unchanged until 2300.

IV. THE UNAVOIDABLE AGEING OF THE POPULATION

In a growing population, children outnumber their parents and younger age groups comprise rising proportions of the population. When fertility declines, the number of children starts to fall and, if fertility reductions are sustained, younger age groups account for a decreasing proportion of population over time. The declining proportion of children is counterbalanced by a rising proportion of adults, at first concentrated largely in the middle age range and later impacting mostly the upper age range (see figure 9). Consequently, reductions in fertility result in population ageing, a process whereby the proportions of children and younger persons decline and those of middle-aged and older adults rise. Given that, with the exception of the constant scenario, all other scenarios assume a decline of fertility for most areas during 2000-2050 at least, they all result in a considerable ageing of the population (figure 3).

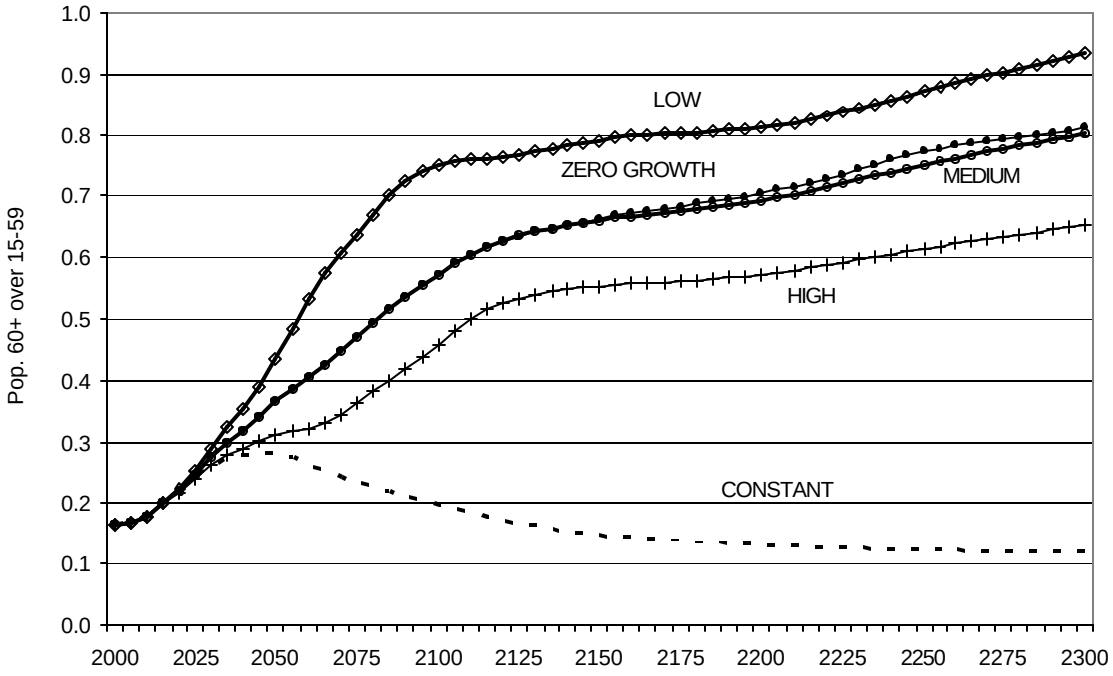
Figure 9. Changes in the age distribution of the world, medium scenario, 2000-2300



To gauge the extent of population ageing over the projection period note that, according to the medium scenario, world population increases by 3 billion persons between 2000 and 2100, yet the number of children (0 to 14 years of age) declines slightly (from 1.8 billion in 2000 to 1.5 billion in 2100), whereas that of persons aged 15 to 59 years rises by 1.2 billion (from 3.6 billion to 4.8 billion) and that of persons aged 60 years or more increases by 2.2 billion (from 0.6 billion in 2000 to 2.8 billion in 2100). In terms of the distribution by age, these changes imply that the proportion of children declines from 30 per cent in 2000 to 16 per cent in 2100, whereas the proportion of persons aged 60 or over triples, passing from 10 per cent in 2000 to 30 per cent in 2100 (see table 3). The proportion of the population aged 15 to 59 changes moderately, passing from 60 per cent in 2000 to 53 per cent in 2100, but the nature of the economically dependent population changes drastically: by 2150, instead of involving mostly children who depend on their support on parents, it will involve mostly elderly persons whose support may have to depend either directly or indirectly on younger generations unless the period of economically productive life is effectively extended and provisions are taken to ensure that sound mechanisms for the funding of old-age pensions are in place.

As already mentioned, population ageing occurs in all the scenarios except the one with constant fertility. Furthermore, in all of them, the ratio of dependents, defined as children 0 to 14 years of age and the elderly (those aged 60 or over) to the population of working age (15-59) increases steadily (see figure 3), mainly as a result of the rise in the number and proportion of elderly persons. Figure 10 displays the projected increase in the ratio of elderly persons to those of working age in all the scenarios. With the exception of the constant-fertility scenario, that ratio rises in all the others, particularly before 2100 and more markedly in the low scenario than in the others. Between 2000 and 2300, the elderly ratio is projected to rise from 0.17 elderly persons per person of working age to 0.8 elderly persons per person of

Figure 10. Ratio of population aged 60 or over to the population 15-59 for the world according to different scenarios, 2000-2300



working age in the medium scenario. The equivalent figures in the high and low scenarios are 0.65 and 0.93, indicating clearly that in the long run population ageing is inevitable.

Another major change brought about by the long-term ageing of the population is a very marked increase in the number and proportion of the population of the very old (those aged 80 years or over). According to the medium scenario, by 2100 there will be 773 million persons in that age group, eleven times the number in 2000, and by 2300 the number of persons aged 80 or over is projected to be above 1.5 billion in the medium scenario.. As a proportion of the population, those aged 80 or over will also become prominent, comprising 17 per cent of the population in 2300 instead of one per cent as they do today. These changes suggest that the society of the future will have to value more the contributions of its older members so as to ensure that they remain active and engaged for most of their lengthy life spans. If the world population evolves as projected in the medium scenario, society has some time to adapt to the expected changes, especially as savings can be accrued because of the slow growth and eventual reduction of the number of children. However, in historical terms, the time available is short and successful adaptation requires that we embark early in the path of societal change.

With increasing longevity there is also a projected increase in the number and proportion of persons reaching age 100 and above. By 2300 their number is projected to be 162 million and will account for nearly 2 per cent of the world population. Even in the high scenario, where population ageing is slower, the proportion of the population the proportion of centenarians is projected to reach more than 1 per cent in 2300 when there would be nearly half a billion centenarians in the world.

Population ageing can also be gauged from the increase in the median age of the population, that is, the age that divides the population in half (half of the people are younger and half older than the median age). At the world level, the median age is projected to rise from 26 years in 2000 to 42 years in the high scenario, 48 years in the medium, and 52 years in the low scenario (see annex tables A.24 to A28). The change in the

median age will be more marked in the less developed regions, where the medium scenario projects it to rise from 24 years in 2000 to 48 years in 2300. In the more developed regions the equivalent change is projected to be from 37 to 50 years. By 2300, countries with the most aged population will likely include Belgium, France, Germany, Japan, Malta, Spain and Sweden, all with median ages of 52 years or higher according to the medium scenario.

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