Economic & Social Affairs

World Population Prospects
The 2008 Revision

Executive Summary

United Nations

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Department of Economic and Social Affairs
Population Division

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DESA

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PREFACE

The present report highlights the results of the *2008 Revision* of the official world population estimates and projections prepared by the Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat. The *2008 Revision* is the outcome of the twenty-first round of global demographic estimates and projections undertaken by the Population Division since 1951.

The full results of the *2008 Revision* will be presented in three volumes. The first volume[1] will contain the comprehensive tables presenting the major demographic indicators for each development group, major area, region and country for 1950-2050; the second volume[2] will contain the distributions by age and sex of the population of each country for the period 1950-2050; and the third volume[3] will be devoted to an analysis of the results obtained.

Data are also available in digital form and can be consulted at the Population Division website www.unpopulation.org. Users requiring the complete results of the *2008 Revision* can purchase them on CD-ROM. A description of the data contained in the different CD-ROMs available and an order form are posted on the Division website.

Responsibility for the *2008 Revision* rests with the Population Division. Preparation of the *2008 Revision* was facilitated by the Division's collaboration with the regional commissions, especially the Economic Commission for Latin America and the Caribbean, and with the Joint United Nations Programme on HIV/AIDS (UNAIDS), the specialized agencies and other relevant bodies of the United Nations system.

A major source of official national population statistics used in the preparation of these estimates and projections has been the *Demographic Yearbook* of the United Nations and its accompanying databases, produced and maintained by the United Nations Statistics Division of the Department of Economic and Social Affairs of the United Nations Secretariat. The Population Division is grateful to the Statistics Division for its continuing cooperation.

For further information about the *2008 Revision,* please contact Ms. Hania Zlotnik, Director, Population Division, United Nations, New York, NY 10017, USA (fax: 1 212 963 2147).

[1] *World Population Prospects: The 2008 Revision,* vol. I, *Comprehensive Tables* (United Nations publication, forthcoming).

[2] *World Population Prospects: The 2008 Revision,* vol. II, *Sex and Age Distribution of the World Population* (United Nations publication, forthcoming).

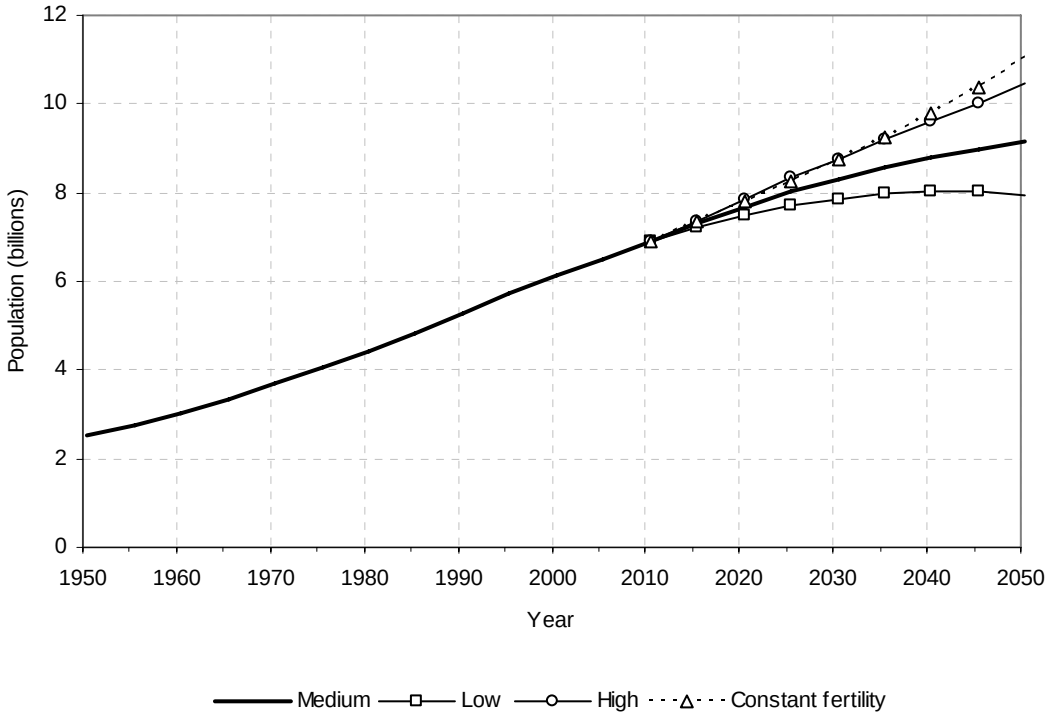
[3] *World Population Prospects: The 2008 Revision,* vol. III, *Analytical Report* (United Nations publication, forthcoming).

EXECUTIVE SUMMARY

The *2008 Revision* is outcome of the twenty-first round of official United Nations population estimates and projections prepared by the Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat. Those estimates and projections are used throughout the United Nations system as the basis for activities requiring information on population. The *2008 Revision* builds on the *2006 Revision*[4], and incorporates the results of both the 2000 round of national population censuses and the recent specialized surveys carried around the world. Those sources provide both the demographic and other information needed to assess the progress made in achieving the internationally agreed development goals, including the Millennium Development Goals. The comprehensive review of past worldwide demographic trends and future prospects presented in the *2008 Revision* provides the population-related basis for the assessment of those goals.

According to the *2008 Revision* of the official United Nations population estimates and projections, the world population is projected to reach 7 billion in late 2011, up from the current 6.8 billion, and surpass 9 billion people by 2050 (see figure).

Population of the world, 1950-2050, according to different projections and variants



Source: World Population Prospects: *The 2008 Revision* (United Nations publication, forthcoming).

[4] *World Population Prospects: The 2006 Revision*, vol. 1, *Comprehensive Tables*; vol. II, *Sex and Age Distribution of the World Population*; and vol. III, *Analytical Report* (United Nations publication, Sales Nos. E.07.XIII.2 and E.07.XIII.3 and forthcoming).

Most of those additional 2.3 billion people will enlarge the population of developing countries, which is projected to rise from 5.6 billion in 2009 to 7.9 billion in 2050 and to be distributed among the populations aged 15-59 (1.2 billion) and 60 years or over (1.1 billion) since the number of children under age 15 in developing countries will decrease.

In contrast, the population of the more developed regions is expected to change minimally, passing from 1.23 billion to 1.28 billion, and would have declined to 1.15 billion were it not for the projected net migration from developing to developed countries, which is projected to average 2.4 million persons annually from 2009 to 2050.

As noted, the results of the *2008 Revision* incorporate the findings of the most recent national population censuses and of numerous specialized population surveys carried out around the world. *The 2008 Revision* also provides the demographic data and indicators needed to assess trends at the global, regional and national levels and to calculate many other key indicators commonly used by the United Nations system.

The population of developing countries is still young

Currently, the population of the less developed regions is still young, with children under age 15 accounting for 30 per cent of the population and young persons aged 15-24 accounting for a further 19 per cent. In fact, in the less developed regions the number of children (at 1.6 billion) and the number of young people (at 1.0 billion) are both at all time highs, posing a major challenge to their countries, which are faced with the necessity of providing education and employment to large cohorts of children and youth even as the current economic and financial crisis unfolds. The situation in the least developed countries is even more pressing because children under age 15 constitute 40 per cent of their population and young people account for a further 20 per cent.

In the more developed regions, children and youth account for just 17 per cent and 13 per cent of the population, respectively, and whereas the number of children is expected to change little in the future, remaining close to 200 million, the number of young people is projected to decrease from 163 million currently to 134 million in 2050.

In both the more and the less developed regions, the number of people in the main working ages, 25 to 59, is at an all time high: 603 million and 2.4 billion, respectively. Yet, whereas in the more developed regions that figure is expected to peak over the next decade and decline thereafter, reaching 528 millions in 2050, in the less developed regions it will continue to rise, reaching 3.6 billion in 2050 and increasing by nearly half a billion over the next decade. These population trends justify the urgency of supporting employment creation in developing countries which should be part of any strategy created to address the global economic crisis being experienced worldwide.

Globally, the population aged 60 years or over is the fastest growing

Furthermore, the implications of population ageing cannot be dismissed. In the more developed regions, the population aged 60 years or over is increasing at the fastest pace ever (growing at 2.0 per cent annually) and is expected to increase by more than 50 per cent over the next four decades, rising from 264 million in 2009 to 416 million in 2050. Compared with the population of the more developed world, that of the less developed regions is ageing more rapidly. Over the next two decades, the population aged 60 years or over in the developing

world is projected to increase at rates far exceeding 3 per cent per year with an expected rise from 473 million in 2009 to 1.6 billion in 2050.

Projected trends are contingent on fertility declines in developing countries

Population ageing results mainly from declining fertility. According to the *2008 Revision*, fertility in the less developed regions as a whole is expected to drop from 2.73 children per woman in 2005-2010 to 2.05 children per woman in 2045-2050. The reduction projected for the group of 49 least developed countries is even steeper: from 4.39 to 2.41 children per woman. To achieve such reductions, it is essential that access to family planning expand, particularly in the least developed countries, where around 2005, the proportion using modern contraceptive methods among women of reproductive age who were married or in union was low at 24 per cent; a further 23 per cent of those women had an unmet need for family planning. The urgency of realizing the projected reductions of fertility is brought into focus by considering that, if fertility were to remain constant at the levels estimated for 2005-2010, the population of the less developed regions would increase to 9.8 billion in 2050 instead of the 7.9 billion projected by assuming that fertility will decline. In other words, without further reductions of fertility, the world population could increase by nearly twice as much as currently expected.

Projected growth is linked to sustained progress in the prevention and treatment of HIV/AIDS

The projected population trends also depend on achieving a major increase in the proportion of AIDS patients who are treated using antiretroviral therapy and on the success of efforts to control the further spread of HIV.

In the *2008 Revision*, the impact of the epidemic was modelled in 58 countries where adult HIV prevalence reached 1 per cent or higher at some point during 1980-2007 or where the number of people living with HIV/AIDS was at least half a million in 2007. Among those 58 countries, 38 were in Africa and 15 had an adult HIV prevalence of at least 5 per cent in 2007.

The *2006 Revision* had modelled the impact of HIV/AIDS in 62 affected countries; 5 of those countries were dropped from the list of affected countries in the *2008 Revision* because their HIV prevalence had been revised downward (the Gambia, Madagascar, Myanmar, the Niger and the Republic of Moldova) and 1 (Mauritius) was added. In projecting the effect of the disease, it has been assumed that, by 2015, 26 of the affected countries will manage to provide antiretroviral treatment to 70 per cent or more of the persons suffering from AIDS and that another 11 will reach treatment levels ranging from 50 to 70 per cent. In the remaining affected countries, treatment levels are expected to be lower, reaching 40-50 per cent by 2015. It is further assumed that persons receiving treatment will survive, on average, 27.8 years compared with the 11.7 years expected in the absence of treatment.

These assumptions together with the generally lower prevalence levels estimated for recent years have resulted in the projection of a lower number of deaths due to HIV/AIDS—26 million out of a total of 583 million deaths—in the period from 2005 to 2020 for the 58 countries concerned. In the *2006 Revision,* the corresponding figures were 43 million and 610 million, respectively.

However, the realization of these new projections depends on sustained funding for HIV/AIDS prevention and treatment programmes in the affected countries, funding that will be highly dependent on the commitment of donor countries and will need to be maintained despite the global economic downturn.

The complete results of the *2008 Revision* will be issued in three volumes. A wallchart[5] has already been published. Data on particular countries can also be accessed online at the Population Division website (www.unpopulation.org).

The 2008 Revision* of *World Population Prospects
Key findings

1. In July 2009, the world population will reach 6.8 billion, representing 317 million more than in 2005, or a gain of 79 million persons annually. Assuming that fertility levels continue to decline, the world population is expected to reach 9.1 billion in 2050 and to be increasing by about 31 million persons annually at that time, according to the medium variant.

2. Future population growth is highly dependent on the path that future fertility takes. In the medium variant, fertility declines from 2.56 children per woman in 2005-2010 to 2.02 children per woman in 2045-2050. If fertility were to remain about half a child above the levels projected in the medium variant, world population would reach 10.5 billion by 2050. A fertility path half a child below the medium would lead to a population of 8 billion by midcentury. Consequently, population growth until 2050 is inevitable even if the decline of fertility accelerates.

3. In the more developed regions, fertility has increased slightly in recent years; its estimated level in 2005-2010 (1.64 children per woman, according to the *2008 Revision)* is therefore higher than the level reported in the *2006 Revision* (1.60 children per woman). As a result of the slightly higher projected fertility and a sustained net in-migration averaging 2.4 million annually, the population of the more developed regions is expected to increase slightly from 1.23 billion in 2009 to 1.28 billion in 2050.

4. The population of the 49 least developed countries is still the fastest growing in the world, at 2.3 per cent per year. Although its rate of increase is expected to moderate significantly over the next decades, the population of the least developed countries is projected to double, passing from 0.84 billion in 2009 to 1.7 billion in 2050. Growth in the rest of the developing world is also projected to be robust, though less rapid, with its population rising from 4.8 billion to 6.2 billion between 2009 and 2050, according to the medium variant.

5. Slow population growth brought about by reductions in fertility leads to population ageing, that is to say, it produces populations where the proportion of older persons increases while that of younger persons decreases. In the more developed regions, 21 per cent of the population is already aged 60 years or over and that proportion is projected to reach 33 per cent in 2050. In developed countries as a whole, the number of older persons has already surpassed the number of children (persons under age 15) and by

[5] United Nations, Department of Economic and Social Affairs, Population Division. *World Population 2008.* (United Nations publication, Sales No. E.09.XIII.2), wallchart.

2050 the number of older persons in developed countries will be more than twice the number of children.

6. Population ageing is less advanced in developing countries. Nevertheless, the populations of a majority of them are poised to enter a period of rapid population ageing. In developing countries as a whole, although just 8 per cent of the population is today aged 60 years or over, that proportion will more than double by 2050, reaching 20 per cent in that year.

7. Globally, the number of persons aged 60 years or over is expected to almost triple, increasing from 737 million in 2009 to 2 billion by 2050. Furthermore, already 64 per cent of the world's older persons live in the less developed regions; by 2050, that proportion will be 79 per cent.

8. In ageing populations, the higher the age range considered, the faster the growth of the numbers of persons in older ages. Thus, whereas the number of persons aged 60 years or over is expected to almost triple by 2050, the number of persons aged 80 years or over (the oldest old) is projected to increase almost fourfold, so as to reach 395 million in that year. Today, just about half of the oldest old live in developing countries; however, that share is expected to reach 69 per cent in 2050.

9. Although the populations of all countries are expected to age over the foreseeable future, the population will remain relatively young in countries where fertility is still high, many of which are experiencing very rapid population growth. High population growth rates prevail in many developing countries, most of which are least developed. Between 2010 and 2050, the populations of 30 countries, the majority of which are least developed, will increase by a factor of 2 or more. Among those countries, Afghanistan, Burkina Faso, the Niger, Somalia, Timor–Leste and Uganda have population that are projected to increase by 150 per cent or more.

10. In sharp contrast, the populations of 45 countries or areas are expected to decrease between 2010 and 2050. These countries and areas include Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Cuba, Georgia, Germany, Greenland, Guyana, Hungary, Japan, Latvia, Lithuania, Niue, Poland, the Republic of Moldova, Romania, the Russian Federation, Ukraine and the United States Virgin Islands, all of which are expected to see their populations decline by at least 10 per cent by 2050.

11. Population growth remains concentrated in the populous countries. During 2010-2050, the following nine countries, listed according to the size of their contribution to global population growth, are expected to account for half of the world's projected population increase: India, Pakistan, Nigeria, Ethiopia, the United States of America, the Democratic Republic of Congo, the United Republic of Tanzania, China and Bangladesh.

12. Fertility has continued to fall in the vast majority of countries in the less developed regions. The number of developing countries with high fertility (5 children or more per woman) declined from 59 in 1990-1995 to 27 in 2005-2010 and their share of the world population dropped from 13 to 9 per cent. Over the same period, the number of developing countries with fertility levels that do not ensure the replacement of the population increased from 15 to 38.

13. Most developed countries have had below-replacement fertility (below 2.1 children per woman) for two or three decades. Among the 45 developed countries with at least 100,000 inhabitants in 2009, 42 had below-replacement fertility in 1990-1995 and all of them had below-replacement fertility in 2005-2010. However, between 2000-2005 and 2005-2010, 34 developed countries experienced slight increases in fertility. For the more developed regions as a whole, total fertility increased from 1.58 to 1.64 children per woman between those two periods. Yet, in 2005-2010, 25 developed countries, including Japan and most of the countries in Southern and Eastern Europe, still had fertility levels below 1.5 children per woman.

14. In 2005-2010, the 76 countries with below-replacement fertility accounted for 47 per cent of the world population. The most populous developing countries with below-replacement fertility are, in order of population size, China, Brazil, Viet Nam, the Islamic Republic of Iran, Thailand and the Republic of Korea.

15. Globally, total fertility is expected to fall from 2.56 children per woman in 2005-2010 to 2.02 in 2045-2050, according to the medium variant. However, in the more developed regions, total fertility is projected to increase from 1.64 children per woman currently to 1.80 in 2045-2050. A major reduction of fertility is projected for the group of least developed countries (from 4.39 to 2.41 children per woman) and the fertility of the rest of the developing world is expected to drop from 2.46 children per woman currently to 1.93 children per women in 2045-2050, thus nearly converging to the fertility levels by then typical of the developed world.

16. The median age, that is to say, the age that divides the population in two halves of equal size, is an indicator of population ageing. Globally, the median age is projected to increase from 29 to 38 years between 2009 and 2050. Today, Europe has the oldest population, with a median age of nearly 40 years; that median age is expected to reach 47 years in 2050.

17. The median age is higher in countries that have been experiencing low fertility for a long time. In 2010, 19 developed countries or areas are expected to have a median age of 40 years or higher, up from 11 developed countries in 2005. In addition, among developing countries or areas, median ages above 40 years were reached in Hong Kong Special Administrative Region of China and Singapore. The pervasiveness of population ageing will have increased by 2050, when all 45 developed countries are projected to have median ages higher than 40 years, and 43 developing countries will also have similarly high median ages. Whereas today about 7 per cent of the world population lives in countries where median ages are 40 years or higher, in 2050 the corresponding proportion is projected to be 43 per cent.

18. Countries where fertility remains high and has declined only moderately will experience the slowest population ageing. By 2050, 37 countries (slightly fewer than 1 in 5) are projected to have a median age under 30 years The youngest populations will be found among the least developed countries, nine of which are projected to have median ages below 25 years in 2050, including Afghanistan, Chad, Guinea-Bissau, the Niger, Somalia, Timor-Leste, Uganda, the United Republic of Tanzania and Zambia.

19. Increasing longevity also contributes to population ageing. Globally, life expectancy at birth is projected to rise from 68 years in 2005-2010 to 76 years in 2045-2050. In the more developed regions, the projected increase is from 77 years in 2005-2010 to 83

years in 2045-2050, while in the less developed regions, the increase is expected to be from 66 years currently to 74 years by midcentury.

20. Life expectancy remains low in the least developed countries, at just 56 years in 2005-2010; although it is projected to reach 69 years in 2045-2050, realizing such an increase is contingent on reducing the spread of HIV and combating successfully other infectious diseases. Similar challenges must be confronted if the projected increase of life expectancy in the rest of the developing countries, from under 68 years today to 76 years by midcentury, is to be achieved.

21. A major concern is that most developing countries are unlikely to meet the goal of reducing under-five mortality by two thirds between 1990 and 2015, as called for by the Millennium Development Goals. According to the *2008 Revision*, 133 of the 151 developing countries with more than 100,000 inhabitants in 2009 will not reach that goal. Furthermore, 60 developing countries, located mainly in sub-Saharan Africa or belonging to the group of least developed countries, are projected to have an under-five mortality higher than 45 deaths per 1,000 in 2015, thereby failing to meet, the less demanding target set by the Programme of Action of the International Conference on Population and Development.[6]

22. Among the more developed regions, Eastern Europe has the lowest life expectancy and has experienced reductions in life expectancy at birth since the late 1980s. In 2005-2010, life expectancy in the region increased somewhat but at 69.2 years, it was lower than it had been in 1965-1970 (69.6 years). Despite their having recorded some recovery since the late 1990s, currently the Republic of Moldova, the Russian Federation and Ukraine have the lowest life expectancies among developed countries (below 70 years).

23. Although the HIV/AIDS epidemic continues to be a major issue of concern in the global health agenda, adult HIV prevalence reached a peak over the past decade or so in at least two thirds of the 58 countries considered to be most affected by the epidemic, and a growing number of them are reaching and maintaining lower prevalence levels. Nevertheless, in countries where prevalence has been high, the impact of the epidemic in terms of morbidity, mortality and slower population growth continues to be evident. Thus, in Southern Africa, the region with the highest prevalence of the disease, life expectancy has fallen from 61 years in 1990-1995 to 52 years in 2005-2010. (It has only recently begun to increase and is not expected to recover before 2045 its level in the early 1990s). As a consequence, the growth rate of the population in the region has plummeted, passing from 2.4 per cent annually in 1990-1995 to 1.0 per cent annually in 2005-2010, and is expected to continue to decline for the foreseeable future.

24. Given the low fertility prevailing in developed countries, deaths are expected to exceed births over the foreseeable future. Consequently, the population of the more developed regions would be decreasing if the excess of deaths over births was not counterbalanced by a net migration gain. During 2010-2050, the net number of international migrants to more developed regions is projected to be 96 million, whereas the excess of deaths over births is projected to be 58 million, implying an overall growth of 38 million.

[6] *Report of the International Conference on Population and Development, Cairo, 5-13 September 1994* (United Nations publication, Sales No. E.95.XIII.18), chap. I, resolution 1, annex, para. 8.16.

25. In 2005-2010, net migration in nine countries or areas—Belgium, Macao Special Administrative Region of China, Luxembourg, Malta, Qatar, Singapore, Slovakia, Slovenia and Spain—more than doubled the contribution of natural increase (birth minus deaths) to population growth. In addition, in a further 11 countries or areas—Austria, the Channel Islands, Croatia, the Czech Republic, Germany, Greece, Hungary, Italy, Japan, Portugal and the Russian Federation—net migration counterbalanced totally or in part the excess of deaths over births.

26. In terms of annual averages, the major net receivers of international migrants during 2010-2050 are projected to be the United States of America (1.1 million), Canada (214,000), the United Kingdom of Great Britain and Northern Ireland (174,000), Spain (170,000), Italy (159,000), Germany (110,000), Australia (100,000) and France (100,000). The major countries of net emigration are projected to be Mexico (-334,000), China (-309,000), India (-253,000), the Philippines (-175,000), Pakistan (-161,000), Indonesia (-156,000) and Bangladesh (-148,000). Although in the current economic crisis migration flows may be reduced from the levels registered over the recent past, the major economic and demographic asymmetries that persist in future are likely to remain powerful generators of international migration over the medium term.

ASSUMPTIONS UNDERLYING THE *2008 REVISION*

The preparation of each new revision of the official population estimates and projections of the United Nations involves two distinct processes: (a) the incorporation of all new and relevant information regarding the past demographic dynamics of the population of each country or area of the world; and (b) the formulation of detailed assumptions about the future paths of fertility, mortality and international migration. The data sources used and the methods applied in revising past estimates of demographic indicators (that is, those referring to 1950-2010) are presented online see (http://esa.un.org/wpp/sources/country.aspx) and in *World Population Prospects: The 2008 Revision;* volume III, *Analytical Report* (forthcoming).

The future population of each country is projected starting with an estimated population for 1 July 2010. Because population data are not necessarily available for that date, the 2010 estimate is derived from the most recent population data available for each country, usually obtained from a population census or a population register, projected to 2010 using all available data on fertility, mortality and international migration trends between the reference date of the population data available and 1 July 2010. In cases where data on the components of population change relative to the past 5 or 10 years are not available, estimations of demographic trends are projections based on the most recent available data. Population data from all sources are evaluated for completeness, accuracy and consistency, and adjusted as necessary[7].

To project the population until 2050, the United Nations Population Division uses assumptions regarding future trends in fertility, mortality and international migration. Because future trends cannot be known with certainty, a number of projection variants are produced. Summarized below are the main assumptions underlying the derivation of demographic indicators for the period starting in 2010 and ending in 2050. A more detailed description of the different assumptions will be available in volume III of the *2008 Revision.*

A. FERTILITY ASSUMPTIONS: CONVERGENCE TOWARDS TOTAL FERTILITY BELOW REPLACEMENT LEVEL

The fertility assumptions are described in terms of the following groups of countries:

- *High-fertility countries*: Countries that until 2007 had no fertility reduction or only an incipient decline

- *Medium-fertility countries*: Countries where fertility has been declining but whose estimated level was still above 2.1 children per woman in 2005-2010

- *Low-fertility countries*: Countries with total fertility at or below 2.1 children per woman in 2005-2010

[7] For a general description of the procedures used in revising estimates of population dynamics, see the chapter on the methodology of the United Nations population estimates and projections in *World Population Prospects: The 2008 Revision,* vol. III.

1. Medium-fertility assumption

Total fertility in all countries is assumed to converge eventually towards a level of 1.85 children per woman. However, not all countries reach this level during the projection period, that is, by 2045-2050. Projection procedures differ slightly depending on whether a country had a total fertility above or below 1.85 children per woman in 2005-2010.

Fertility in high- and medium-fertility countries is assumed to follow a path derived from models of fertility decline established by the Population Division of the United Nations Secretariat on the basis of the past experience of all countries with declining fertility during 1950-2000. The models relate the level of total fertility during a period to the average expected decline in total fertility during the next period. If the total fertility projected by a model for a country falls to 1.85 children per woman before 2050, total fertility is held constant at that level for the remainder of the projection period (that is, until 2050). Therefore, the level of 1.85 children per woman represents a floor value below which the total fertility of high- and medium-fertility countries is not allowed to drop before 2050. However, it is not necessary for all countries to reach the floor value by 2050. If the model of fertility change produces a total fertility above 1.85 children per woman for 2045-2050, that value is used in projecting the population.

In all cases, the projected fertility paths yielded by the models are checked against recent trends in fertility for each country. When a country's recent fertility trends deviate considerably from those consistent with the models, fertility is projected over an initial period of 5 or 10 years in such a way as to ensure that it follows recent experience. The model projection takes over after that transition period. For instance, in countries where fertility has been declining very slowly or where it has stalled, fertility is projected to fall more slowly over the first 5 or 10 years of the projection period than it would have fallen according to the model. After that transition period, the model pattern of change is used.

Fertility in low-fertility countries is generally assumed to remain below 2.1 children per woman during most of the projection period and reach 1.85 children per woman by 2045-2050. For countries where total fertility was below 1.85 children per woman in 2005-2010, it is assumed that, over the first 5 or 10 years of the projection period, fertility will follow the recently observed trends in each country. After that transition period, fertility is assumed to increase linearly at a rate of 0.05 children per woman per quinquennium. Thus, countries whose fertility is currently very low need not reach a level of 1.85 children per woman by 2050.

2. High-fertility assumption

Under the high variant, fertility is projected to remain 0.5 children above the fertility in the medium variant over most of the projection period. By 2045-2050, fertility in the high variant is therefore half a child higher than that of the medium variant: that is to say, countries reaching a total fertility of 1.85 children per woman in the medium variant have a total fertility of 2.35 children per woman in the high variant at the end of the projection period.

3. Low-fertility assumption

Under the low variant, fertility is projected to remain 0.5 children below the fertility in the medium variant over most of the projection period. By 2045-2050, fertility in the low variant is therefore half a child lower than that of the medium variant. That is to say, countries reaching a total fertility of 1.85 children per woman in the medium variant have a total fertility of 1.35 children per woman in the low variant at the end of the projection period.

4. Constant-fertility assumption

For each country, fertility remains constant at the level estimated for 2005-2010.

5. Instant-replacement assumption

For each country, fertility is set to the level necessary to ensure a net reproduction rate of 1 starting in 2010-2015. Fertility varies over the rest of the projection period in such a way as to ensure that the net reproduction rate always remains equal to unity, thus ensuring the replacement of the population over the long run.

B. MORTALITY ASSUMPTIONS: INCREASING LIFE EXPECTANCY EXCEPT WHEN AFFECTED BY HIV/AIDS

1. Normal-mortality assumption

Mortality is projected on the basis of models of change of life expectancy produced by the Population Division of the United Nations Secretariat. The higher the life expectancy already reached, the smaller the gains produced by those models. The selection of a model for each country is based on recent trends in life expectancy by sex. For countries highly affected by the HIV/AIDS epidemic, the model incorporating a slow pace of mortality decline has generally been used to project a certain slowdown in the reduction of general mortality risks not related to HIV/AIDS.

2. The impact of HIV/AIDS on mortality

In the *2008 Revision*, countries where HIV prevalence among persons aged 15-49 was ever equal to or greater than 1 per cent during 1980-2007 are considered to be affected by the HIV/AIDS epidemic and their mortality is projected by modelling explicitly the course of the epidemic and projecting the yearly incidence of HIV infection. Also considered among the affected countries are those where HIV prevalence has always been lower than 1 per cent but whose population is so large that the number of people living with HIV in 2007 surpassed 500,000, namely, Brazil, China, India, the Russian Federation and the United States of America. In total, 58 countries are considered to be affected by the HIV/AIDS epidemic in the *2008 Revision*.

The model developed by the Joint United Nations Programme on HIV/AIDS (UNAIDS) Reference Group on Estimates, Modelling and Projections[8,9] is used to fit past estimates of HIV prevalence provided by UNAIDS for each of the affected countries[10] so as to derive the parameters determining the past dynamics of the epidemic in each of them. For most countries, the

[8] See P. D. Ghys and others (2008). "Improved data, methods and tools for the 2007 HIV and AIDS estimates and projections", *Sexually Transmitted Infections*, vol. 84, Supplement No. 1 (August 2008), pp. i1-i4. Available from http://sti.bmj.com/cgi/content/full/84/Suppl_1/i1.

[9] See T. Brown and others. "Progress and challenges in modelling country-level HIV/AIDS epidemics: the UNAIDS Estimation and Projection Package 2007", *Sexually Transmitted Infections*, vol. 84, Supplement No. 1 (August 2008), pp. i5–i10. Available from http://sti.bmj.com/cgi/content/full/84/Suppl_1/i5.

[10] See Joint United Nations Programme on HIV/AIDS (UNAIDS*), 2008 Report on the Global AIDS Epidemic* (Geneva, 2008). Available from http://www.unaids.org/en/KnowledgeCentre/HIVData/GlobalReport/2008/2008_Global_report.asp. See also online table entitled "Adult (15-49) HIV prevalence percent by country, 1990-2007 (with 95% confidence intervals)", available from http://data.unaids.org/pub/GlobalReport/2008/080813_gr08_prev1549_1990_2007_en.xls.

model is fitted assuming that the relevant parameters have remained constant in the past. Beginning in 2007, the parameter PHI, which reflects the rate of recruitment of new individuals into the high-risk or susceptible group, is projected to decline by half every 20 years. The parameter R, which represents the force of infection, is projected to decline by half every 30 years. The reduction in R reflects the assumption that changes in behaviour among those subject to the risk of infection, along with increases in access to treatment for those infected, will reduce the chances of HIV transmission.

In the *2008 Revision*, interventions to prevent the mother-to-child transmission of HIV are modelled on the basis of estimated country-specific coverage levels that, in 2007, averaged 36 per cent among the 58 affected countries, but varied from 0 to 99 per cent among them (with 22 countries having less than 20 per cent coverage of pregnant women in 2007 and only 8 countries having more than 75 per cent coverage). These coverage levels are projected to reach 60 per cent on average by 2015, varying between 40 and 99 per cent among the affected countries.[11] After 2015, the coverage of interventions to prevent mother-to-child transmission of HIV is assumed to remain constant until 2050 at the level reached in each of the affected countries in 2015. Among women receiving treatment, the probability of transmission from mother to child is assumed to vary between 2 and 19 per cent, depending on the particular combination of breastfeeding practices (mixed breastfeeding, replacement feeding and exclusive breastfeeding), its duration in the population, and the type of treatment available (single-dose nevirapine, dual-prevention or triple-prevention antiretroviral treatment). These assumptions produce a reduction in the incidence of HIV infection among children born to HIV-positive women; however, the size of the reductions varies from country to country depending on the level of coverage reached by treatment in each country.[12]

The survivorship of infected children[9] takes account of varying access to paediatric treatment.[13] In the 2008 Revision, HIV-infected children are divided into two groups: (a) those infected in utero, among whom the disease progresses rapidly and whose average survival is set at 1.3 years and (b) those infected through breastfeeding after birth, among whom the disease progresses slowly and whose average survival is set at 15.2 years without treatment.[13] Explicit inclusion of paediatric treatment is effected through use of country-specific coverage levels which averaged 34 per cent in 2007 but varied between 0 and 99 per cent among the 58 affected countries (with 15 countries having less than 10 per cent coverage in 2007 and only 12 countries having a coverage level above 75 per cent). By 2015, the projected coverage is expected to reach 60 per cent on average in the 58 affected countries, varying from 40 to 100 per cent.[15] Coverage levels are assumed to remain constant from 2015 to 2050 at the level reached in each country by 2015. The annual survival of children receiving treatment is 80 per cent during the first year, 90 per cent the second year and 95 per cent thereafter, so that their mean survival time is 31.1 years and the median survival time is 20.5 years, in the absence of other causes of death.[13]

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[11] United Nations Children's Fund, UNAIDS Secretariat, World Health Organization and United Nations Population Fund. *Children and AIDS: Third Stocktaking Report 2008,* with statistical annexes (December 2008), tables 1 ("Preventing mother-to-child transmission of HIV") (pp. 33-35) and 2 ("Providing paediatric treatment) (pp. 36-38). Available from http://www.uniteforchildren.org/uniteforchildren/knowmore/files/StocktakingReport08_Full_110708.pdf.

[12] See J. Stover and others. "The Spectrum projection package: improvements in estimating mortality, ART needs, PMTCT impact and uncertainty bounds", *Sexually Transmitted Infections*, vol. 84, Supplement No. 1 (August 2008), pp. i24-i30. Available from http://sti.bmj.com/cgi/content/full/84/Suppl_1/i24.

[13] M. Marston and others. "Estimating the net effect of HIV on child mortality in African populations affected by generalized HIV epidemics", *JAIDS Journal of Acquired Immune Deficiency Syndromes*. vol. 38, No. 2, 1 February 2005, pp. 219–227; `and M. L. Newell and others, Mortality of infected and uninfected infants born to HIV-infected mothers in Africa: a pooled analysis, *Lancet*. vol. 364 (2 October 2004), pp. 1236–1243.

The *2008 Revision* incorporates a longer survival for persons receiving treatment with highly active antiretroviral therapy (ART).[9,13] The proportion of the HIV-positive population receiving treatment in each country is consistent with estimates prepared by the World Health Organization,[14] which averaged 36 per cent in 2007 among the 58 affected countries, but varied between 8 and 99 per cent. Coverage is projected to reach between 40 and 100 per cent by 2015, averaging 60 per cent for the affected countries. Between 2015 and 2050, coverage levels are assumed to remain constant at the level reached in each country by 2015. It is assumed that adults receiving treatment have, on average, an 85 per cent chance of surviving on the first year of treatment, and a 95 per cent chance of surviving each year thereafter in the absence of other causes of death. Under this assumption, mean survival time after the initiation of therapy is 19.3 years and the median survival time is 10.9 years, in the absence of other causes of death. Therapy is assumed to start at the time full-blown AIDS develops. Without treatment, infected adults have a mean survival time of 3.2 years (and a median survival time of 3.0 years) after the onset of full-blown AIDS.[9,13]

3. Constant-mortality assumption

Under this assumption, mortality over the projection period is maintained constant for each country at the level estimated for 2005-2010.

C. INTERNATIONAL MIGRATION ASSUMPTIONS

1. Normal migration assumption

Under the normal migration assumption, the future path of international migration is set on the basis of past international migration estimates and consideration of the policy stance of each country with regard to future international migration flows. Projected levels of net migration are generally kept constant over most of the projection period.

2. Zero-migration assumption

Under this assumption, for each country, international migration is set to zero starting in 2010-2015.

D. EIGHT PROJECTION VARIANTS

The *2008 Revision* includes eight different projection variants (see table). Five of those variants differ among themselves only with respect to the level of fertility in each, that is to say, they share the assumptions made with respect to mortality and international migration. The five fertility variants are: low, medium, high, constant-fertility and instant-replacement fertility. A comparison of their results allows an assessment of the effects that different fertility paths have on other demographic parameters.

In addition to the five fertility variants, a constant-mortality variant, a zero-migration variant and a constant variant have been prepared. The constant-mortality variant and the zero-migration variant both have the same fertility assumption (namely, medium fertility). Furthermore, the

[14] World Health Organization, Joint United Nations Programme on HIV/AIDS (UNAIDS) and United Nations Children's Fund, T*owards Universal Access: Scaling Up Priority HIV/AIDS Interventions in the Health Sector, Progress Report 2008* (Geneva, WHO, June 2008). Available from http://www.who.int/entity/hiv/pub/towards_universal_access_report_2008.pdf.

constant−mortality variant has the same international migration assumption as the medium variant. Consequently, the results of the constant-mortality variant can be compared with those of the medium variant in order to assess the effect that changing mortality has on other demographic parameters. Similarly, the zero-migration variant differs from the medium variant only with respect to the underlying assumption regarding international migration. Therefore, the zero-migration variant allows an assessment of the effect that non-zero net migration has on other demographic parameters. Lastly, the constant variant has the same international migration as the medium variant but differs from the latter in having constant fertility and mortality. Consequently, the results of the constant variant when compared with those of the medium variant shed light on the effects that changing fertility and mortality have on the results obtained.

PROJECTION VARIANTS IN TERMS OF ASSUMPTIONS FOR FERTILITY, MORTALITY AND INTERNATIONAL MIGRATION

	Assumptions		
Projection variant	*Fertility*	*Mortality*	*International migration*
Low-fertility	Low	Normal	Normal
Medium-fertility	Medium	Normal	Normal
High-fertility	High	Normal	Normal
Constant-fertility	Constant as of 2005-2010	Normal	Normal
Instant replacement-fertility	Instant-replacement as of 2010-2015	Normal	Normal
Constant-mortality	Medium	Constant as of 2005-2010	Normal
No change	Constant as of 2005-2010	Constant as of 2005-2010	Normal
Zero-migration	Medium	Normal	Zero as of 2010-2015

E. METHODOLOGICAL CHANGES INTRODUCED IN THE *2008 REVISION*

The following changes and adjustments were made in the *2008 Revision* in relation to procedures followed in the *2006 Revision*.

- The base year, that is to say, the year in which the projections start changed from 2005 to 2010
- In the *2008 Revision*, the impact of HIV/AIDS on mortality is modelled explicitly for all countries where HIV prevalence among persons aged 15-49 was ever equal to or greater than 1 per cent during 1980-2007
- The models of the incidence of HIV infection by age have been revised to take into account newly available data from nationally representative population surveys. Three new regional models, one each for Africa, Asia and the Caribbean, have been the basis for estimations by the Population Division for each sex using adult HIV prevalence rates by age and sex from 24 Demographic and Health Surveys (DHS) (covering 21 countries between 2001 and 2007).[15] In the new models, mean age at infection is lower than in the models used in previous revisions, particularly for males. The mean age of infection for females varies between 25.0 years (Asia) and 26.9 years (Africa) while for males it varies between 27.9 years (Asia) and 31.9 years (Africa)

[15] The approach is based on methodology presented at the UNAIDS Reference Group on Estimates, Modelling and Projections January 2008 meeting (London) by Ray W. Shiraishi and others, on "Using Population-based HIV surveys to estimate HIV incidence in Kenya, Malawi and Uganda".

- The survival of HIV-positive children receiving treatment increased with respect to the model used in the *2006 Revision*
- The survival time of HIV-positive adults after they developed full-blown AIDS increased with respect to that in models used previously, both for those receiving treatment and for HIV-positive persons not receiving treatment

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