

## POPULATION PROJECTIONS AND WORLD POPULATION TRENDS

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### Summary

The Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat has been producing population projections for the world and the countries that constitute it since the 1950s. This chapter focuses on the work of the Population Division in producing estimates and projections of the world population and on the implications of such work for our understanding of the relevance of population dynamics for development. It presents a history of the population projections prepared by the United Nations and the rationale for the assumptions that underpin them. It discusses the methodology used to project fertility, mortality and international migration in the most recent set of projections (the *2006 Revision*).

On the basis of the results of the *2006 Revision*, this chapter discusses population trends and prospects until 2050 in terms of the expected changes in fertility and mortality; the resulting changes in population growth and size, and trends in population ageing. The focus is on trends and prospects at the world level, the major development groups and the major areas of the world. (Note: The temporally relative statements in this chapter with such terms as ‘the past/last’, ‘the next’, have to be understood with reference to the date of this writing, that is, the year 2008)

## 1. Introduction

Population projections constitute the basic demographic tool to understand population dynamics in a holistic way. Populations change over time as a result of births, deaths and migration. Births and the arrival of migrants add individuals to a population, whereas deaths and the departure of migrants subtract individuals from a population. Newly born children have age 0 and are added to the population of children. Deaths occur to people of different ages and should be subtracted from the population in the appropriate age groups. For the purposes of population accounting, the arrival of migrants of a given age and the departure of emigrants of that same age will cancel each other out if the numbers of immigrants and emigrants coincide, but result in a net addition to the population of that age if immigrants are more numerous than emigrants or a net reduction if the reverse is true. These simple rules underpin the calculation of population projections.

Thus, in order to project a population, it is necessary to know the initial distribution of the population by age and sex and then have a way of finding the number of births, the number of deaths by age and sex, and the net number of migrants by age and sex that the population will experience over a period following the initial observation of the population. Population specialists have developed models and techniques that allow the projection of populations, often over lengthy periods. In the United Nations, the Population Division of the Department of Economic and Social Affairs has been producing population projections for the world and the countries that constitute it since the 1950s. This chapter focuses on the work of the Population Division in producing estimates and projections of the world population and on the implications of such work for our understanding of the relevance of population dynamics for development.

At present, in addition to the United Nations Population Division, the main institution producing, on a regular basis, population projections for each country in the world is the US Census Bureau. In 1985, the US Census Bureau released its first comprehensive set of estimates and projections, covering more than 200 countries and areas. Since then, the US Census Bureau has routinely updated the estimates and projections for particular countries as new data become available. The population estimates and projections prepared by the US Census Bureau are based on methodology similar to that used by the United Nations Population Division. A full description of the US Census Bureau methodology can be found at ([www.census.gov/ipc/www/idb/estandproj.html](http://www.census.gov/ipc/www/idb/estandproj.html)).

The World Bank disseminates population projection data and produces country projections as needed by its country programs. The site where the data can be accessed (<http://go.worldbank.org/H4UN4D5KI0>) provides minimal documentation on data sources and virtually no explanation of the methodology or assumptions underlying the projections.

This paper focuses on the population projections produced by the United Nations Population Division because, as the paper argues, they have been influential in shaping government views on population dynamics and in guiding action to modify those dynamics. For a full assessment of the United Nations population projections in comparison to those produced by the other institutions see Bongaarts and Bulatao

(2000). A succinct description of the approaches used by different institutions to make population projections can be found in O'Neill et al. (2001).

## **2. The United Nations Population Projections: History and Relevance**

The most recent set of population estimates and projections for the world, its major areas and regions, and all countries or areas is the *2006 Revision of World Population Prospects* (United Nations, 2007). The *2006 Revision* is the twentieth set of population estimates and projections prepared by the Population Division since it was established in 1946.

The first set of United Nations projections was published in 1951 and it provided a “long-term view” of future population growth by projecting the population for eleven groups of countries from 1950 to 1980. The second set appeared in the proceedings of the first conference on population held under the auspices of the United Nations, the 1954 World Population Conference held in Rome, Italy. In preparing both sets of population projections, analysts at the Population Division were guided by the view that: “Under the conditions which exist at present in regions like the Near East, mortality can be reduced greatly without any radical social changes; certain relatively simple measures of economic development and sanitary reform can lead to a stable death rate much below the present level.” (United Nations, 1951, p. 4). Consequently, both the *1951* and *1954 Revisions* projected an increase in the population growth rates of Asia and Latin America and the Caribbean, consistent with a reduction of death rates in those regions, though they were not equally optimistic about Africa.

The next revision, completed in 1957 (United Nations, 1958), was the first to present population projections based on the component method, that is, prepared by making independent assumptions about the future path of fertility (which determines the number of births) and mortality (which determines the number of deaths). Overall, the results of the *1957 Revision* turned out to be closer to actual trends than those of previous *Revisions*. Thus, its medium variant projected a world population of 4.2 billion in 1980, fairly close to the 4.5 billion estimated today. In addition, the results of the *1957 Revision* made plain that the projected reductions in mortality would produce an acceleration of population growth in developing regions: it projected a population increase of 1.5 billion in developing countries as a whole between 1950 and 1980, compared to a gain of just 0.2 billion in developed countries.

In the 1960s, the *1963* and the *1968 Revisions* extended the projection period to 2000 and projected reductions in fertility based on the view that “a [...] calamity would eventually ensue, at least in the remote future, if fertility decline were to be postponed indefinitely while mortality decline continued” (United Nations, 1966, p. 4). The report of the *1963 Revision* noted that the high growth rates caused by declining mortality could not be sustained forever and, consequently, fertility would have to decline. Therefore, both *Revisions* projected declining fertility in most developing regions even if the onset of fertility reductions were projected to occur relatively late in some regions (mainly in sub-Saharan Africa) and the projected pace of decline was, in retrospect, modest for some countries. Nevertheless, the medium variant of the *1963 Revision* projected with considerable accuracy that the 2000 world population would be 6.1

billion, while that of the *1968 Revision* overshot the mark by projecting a population of 6.5 billion in 2000. Both *Revisions* noted that, were fertility to remain constant at 1960s levels, the 2000 population would surpass 7 billion persons.

The results of these early *Revisions* were influential in raising awareness about the implications of the demographic transition, the process whereby a population passes from a regime of high mortality and high fertility to one of low mortality and low fertility, with mortality declining first and fertility decline following. The acceleration of population growth that the population projections documented set the stage for major developments in the policy arena. In December 1967, at the United Nations, the Secretary-General received the World Leaders Declaration on Population, a document that signaled the political acceptability of governmental policies to influence population growth. The Declaration, signed by 30 heads of State or Government, noted that the world population had taken all of recorded time to reach a billion at about 1850 but that the second billion had been added in just 100 years and it had taken only thirty years to add the third. It stated that “At today’s rate of increase, there will be four billion people by 1975 and nearly seven billion by the year 2000.” Convinced that rapid population growth seriously hampered efforts to raise living standards, to further education, to improve health and sanitation, and to provide better housing and transportation, the signatories expressed the belief that the “population problem must be recognized as a principal element of long-range national planning if governments are to achieve their economic goals and fulfill the aspirations of their people”.

This Declaration and the report on “World Population: A Challenge to the United Nations and its System of Agencies” (Berelson, 1978), were important elements leading to the decision of the Secretary-General to transfer in 1969 the recently established trust fund on population to the United Nations Development Programme where it grew into the United Nations Fund for Population Activities (UNFPA), a key institution supporting the family planning programs that would underpin the reduction of fertility in many developing countries.

The United Nations population projections also served to set the stage for the first inter-governmental conference on population held at the global level, namely, the United Nations World Population Conference, held in Bucharest, Romania, in 1974 (United Nations, 1975). The World Population Plan of Action adopted by the Conference used the results of the *1973 Revision* to present recent trends and prospects in regard to population goals and policies, providing guidance on how best to achieve moderate or low population growth and setting goals for the reduction of mortality. During the general debate at the Conference, participants referred to the accelerating population growth that developing countries were experiencing. Expecting that mortality would continue to decline, many speakers believed that fertility was also bound to decrease but considered that the timing and tempo of this reduction would be contingent on advances in social and economic development. The representatives of some developing countries spoke about initiatives to develop policies and programs having a direct bearing on fertility and many stated that the age distributions of their populations were not beneficial for development, displaying high dependency ratios that would not decline significantly in the medium-term. Representatives of developed countries noted that their populations were beginning to age, that the number of old people was increasing

and that their populations were highly concentrated in urban areas with deleterious effects on the environment (United Nations, 1975).

After the World Population Conference, the need to monitor the implementation of the Plan of Action that emerged from it added relevance to the task of preparing comprehensive and comparable estimates and projections of population. As the Group of Experts on Population Projections convened by the Population Division in 1977 noted, the United Nations projections were useful because: (1) they were made for every country and territory of the world; (2) they were internationally comparable; (3) they filled the gap left by the fact that over two thirds of countries, having about three quarters of the world population, had never prepared official population projections of their own, and (4) the reports accompanying the projections presented the methods, assumptions and the resulting demographic parameters in a comparable fashion (United Nations, 1979).

In response to increased demand for timely population estimates and projections, revisions of World Population Prospects began to be issued biennially starting with the *1978 Revision*. Furthermore, the projection horizon was expanded to 2025 starting with the *1980 Revision* and ending with the *1992 Revision*, after which it was extended to 2050. In extending the projection horizon to 2025, fertility in developing countries was assumed to decline until it eventually reached replacement level and stabilized at that level if it was reached before 2020. High-fertility countries, however, did not reach replacement level by 2025. The start of the decline in fertility was established from existing evidence or projected on the basis of socio-economic and policy information for the countries concerned. Starting with the *1984 Revision*, the fertility of countries with below-replacement levels, most of which were in the developed world, was maintained below replacement level for a short period and was then assumed to increase slowly so as to reach replacement level by 2025. Since fertility in developed low-fertility countries actually continued to drop, the medium variants of the revisions prepared in the 1980s tended to overestimate fertility in the more developed regions.

The *1992 Revision* marked a turning point in the projection of mortality because it made for the first time explicit allowance for the effect of the HIV/AIDS epidemic in the most affected countries (15 at the time). Furthermore, its results set the stage for the consideration of population issues at the International Conference on Population and Development (ICPD) held in Cairo, Egypt, in 1994. Thus, the Programme of Action resulting from the Conference cited the results of the *1992 Revision* and used it as a guideline to set goals regarding the reduction of mortality.

As the HIV/AIDS epidemic continued to expand, successive revisions introduced further innovations in modeling the effects of the epidemic. Furthermore, as evidence emerged that mortality in several countries with economies in transition had been stagnating if not increasing, expectations that future mortality reductions would occur everywhere had to be abandoned. With respect to AIDS, the number of highly affected countries increased steadily from one revision to the next, rising from 15 in the *1992 Revision*, to 34 in the *1998 Revision* and to 62 in the *2006 Revision*. In the *1992 Revision*, all highly affected countries were in sub-Saharan Africa. By the *2006 Revision*, the most affected countries included 40 in sub-Saharan Africa, 12 in the

Americas (including Brazil and the United States), five in Asia (including China and India), four in Europe (including the Russian Federation), and one in Oceania. In these countries the epidemic was expected at best to dampen potential reductions in mortality or, at worst, produce outright increases in mortality. Overall, the results of the revisions modeling the impact of the HIV/AIDS epidemic have contributed to raise awareness of the devastating impact of the disease. After the establishment of the Joint United Nations Programme on HIV/AIDS (UNAIDS) in 1996, close collaboration between UNAIDS and the Population Division has ensured that the methodology used to derive estimates of previous trends in the epidemic is consistent with that used to project its future path. Furthermore, as efforts to control the epidemic and provide effective treatment for those infected bear fruit, the models used make allowance for the effect of anti-retroviral treatment in prolonging life.

Given that longevity continues to increase in most countries of the world, it has been necessary to expand existing mortality models so that they can be used in projecting all populations over several decades. To that end, existing families of model life tables have been extended to cover ever wider ranges of life expectancies. For the revisions issued after 1980 and before 1998, the highest life expectancy at birth in the model life tables used for projection purposes was 75 years for males and 80 years for females. In the *1998 Revision*, the highest life expectancy was raised to 82.5 years for males and 87.5 years for females, and in the *2002 Revision*, it was raised again to 92.5 years for each sex. Although the highest life expectancy at birth is not reached by any country during the projection period, it acts as the mathematical limit toward which the life expectancy of each country tends. However, the highest life expectancy used for projection purposes is not meant to represent an actual limit for human longevity.

With respect to the projection of fertility, the *2002 Revision* marked an important turning point because it was the first to drop the assumption that fertility would stabilize at replacement level (that is, at 2.1 children per woman) over the medium-term future. Instead, it was assumed that fertility would converge to a level of 1.85 children per woman, a value close to the average fertility of countries that had below replacement fertility during 1990-2000. When a country's recent fertility was above 1.85 children per woman, fertility was projected to decline until it reached that level, either within the projection period, if the starting fertility level was moderate, or beyond the projection period if the starting fertility level was high. When a country's recent fertility was below 1.85 children per woman, it was projected to increase slowly until it reached 1.85 children per woman and it then remained constant until the end of the projection period. This change in the limit to which fertility tended was prompted by the fact that, for many populations, the transition to low fertility had led to prolonged periods of below replacement fertility. However, there is considerable uncertainty about how long that period will last, especially in countries where fertility has not yet reached very low levels. The revised fertility assumptions underpinning recent *Revisions* are contributing to raise awareness about the consequences of sustained low fertility in terms of population ageing and reductions in population size.

### **3. Methods and Assumptions used to project National Populations**

The United Nations population projections are prepared by making assumptions about

future trends in fertility, mortality and international migration. In all cases, a method is used to establish future levels of the relevant variable and another is used to obtain a distribution of its effects by age. The previous section has described the major changes made over time in key characteristics of the models used and has set those changes in a historical perspective. This section will focus on the methods underlying the most recent set of projections (the *2006 Revision*). Population trends and prospects will be discussed in the next section on the basis of the results of this most recent *Revision*.

### 3.1. The Projection of Fertility

Assumptions about future fertility are set differently for two major categories of countries: high-fertility and medium-fertility countries, on the one hand, and low-fertility countries on the other. All countries in the first group had a total fertility in 2000-2005 above replacement level (that is, higher than 2.1 children per woman). Low-fertility countries are those with total fertility at or below replacement level in 2000-2005. In the medium variant, fertility is assumed to converge eventually to 1.85 children per woman, although some high-fertility countries do not reach that level before 2050. Fertility in high-fertility and medium-fertility countries is assumed to follow a path derived from models of fertility decline established on the basis of the past experience of all countries whose fertility decreased during 1950-2000. The models relate total fertility during a period to its expected decline during the next period. Once total fertility reaches 1.85 children per woman it remains at that level until 2050.

In low-fertility countries, fertility in the medium variant generally remains below replacement level during the projection period and moves towards 1.85 children per woman by 2045-2050. In countries with total fertility below 1.85 children per woman in 2000-2005, fertility is assumed to increase linearly at about 0.1 children per woman per decade after a transition period of 5 or 10 years and it may not reach 1.85 children per woman by 2050. Once the future path of total fertility is established for the medium variant, that of the low variant is produced by letting total fertility be approximately half a child below that of the medium variant and that of the high variant is produced by making its total fertility be half a child above the fertility of the medium variant.

To project the age pattern of fertility, interpolation is used to move from the most recently observed or estimated proportionate age pattern of fertility to a model proportionate age pattern of fertility at a future period. The model pattern is attained at the end of the projection period or when the lowest level of total fertility is first reached and, in this latter case, is kept constant thereafter. Model patterns were derived from the experience of low-fertility countries and reflect the variety of patterns observed today in those populations.

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### **Biographical Sketch**

**Hania Zlotnik** is Director of the Population Division of the United Nations. Having joined the Population

Division in 1982, she directed its Mortality and Migration Section from 1993 to 1999 and its Population Estimates and Projections Section from 1999 to 2003 when she became Assistant Director. She holds a Ph.D. from Princeton University and is a graduate of the Universidad Nacional Autónoma de México (UNAM). Her work has spanned the field of demography, covering the analysis of fertility, mortality, international migration and urbanization with especial emphasis on their quantitative aspects. She has prepared manuals on demographic estimation techniques and on the collection of international migration statistics. She drafted the United Nations Recommendations on International Migration Statistics. She has edited or written numerous reports published by the United Nations, including studies of female migration, population distribution and migration, population estimates and projections, and levels and trends of urbanization. She has published over 35 articles in books or refereed journals and has collaborated in editing books on international migration and international migration statistics. She has been an active member of several professional associations, having served as Board Member for the Population Association of America and as Vice-President of the International Union for the Study of Population (IUSSP) from 2001 to 2005.

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