

NEW UNITED NATIONS WORLD POPULATION PROJECTIONS

■ Tom Wilson

New United Nations World population projections have just been released. This article describes and comments on the main features of these projections, including those for Australia. Comparisons with previous sets of projections are made, and the issue of projection uncertainty is briefly addressed.

INTRODUCTION

The United Nations Population Division released its latest set of World and national population projections on 24th February. According to the medium series projections reported in World Population Prospects: The 2004 Revision Highlights¹ the World's population will increase from just under 6.5 billion today to 9.1 billion by 2050. Although this represents a huge increase, roughly equivalent to the current populations of China and India, both the World population growth rate and absolute annual increase are declining.

This article describes and comments on the main features of these new projections, and thus updates an earlier commentary in this journal by Graeme Hugo on a previous set of UN projections.² Comparisons are made with earlier sets of UN projections, and with recent projections prepared by the US Census Bureau and the International Institute for Applied Systems Analysis (IIASA). UN projections for Australia are also reported. A few remarks on projection uncertainty are made by way of conclusion.

PROJECTION METHOD AND ASSUMPTIONS

The UN uses the standard cohort-component model to prepare its projections. A jump-off date of 1st July 2005 is used in the latest revision (itself a short-term projection) and the projection horizon extends to 1st July 2050. Six

series have been prepared: medium, low, high, constant fertility, constant mortality and zero migration.

Fertility assumptions are formulated in terms of the Total Fertility Rate (TFR). For the medium series for all countries the TFR is assumed to reach 1.85 in the long-run, though not necessarily by 2050. For those countries with TFRs currently above 1.85 the UN assumes fertility decline will follow paths observed for other countries over the 1950 to 2000 period until 1.85 is reached. Fertility in countries currently below a TFR of 1.85 is assumed to continue recently observed trends for five to 10 years, after which it is set to increase by 0.07 every five years. Thus for those countries with the very highest (lowest) fertility the fall (rise) to 1.85 is not attained until after 2050. At a global scale this translates to the TFR falling from 2.65 in 2000 to 2.05 in 2045-50. In the high and low series TFRs are set 0.5 above and below the medium assumption for most of the projection horizon.

Mortality assumptions are prepared in terms of life expectancy at birth for each sex, and converted into the age-sex-specific survival probabilities required for the cohort component calculations via model life tables. Explicit consideration of HIV-AIDS has been made in the UN projections since the 1992 revision. At this time the effect of the disease was incorporated into the

mortality assumptions for those 16 countries which had adult prevalence rates of one per cent or more. In the 2004 revision the pandemic has been modelled for 60 countries, 56 of which had a prevalence rate of at least one per cent in 2003; four other populous countries were included because, although they had low prevalence rates, they have large numbers of people living with HIV. New for this set of projections are slightly lower estimates of current HIV prevalence for some countries and longer survival times for those receiving antiretroviral therapy. The result is marginally lower projected mortality from AIDS compared to the 2002 revision. Overall, world life expectancy is expected to rise from the 2000 to 2005 value of 62.5 years for males and 67.0 years for females to 72.4 and 77.0 years by 2045-50.

Migration assumptions for countries are made in terms of total net migration, and sum to zero at the global scale.³

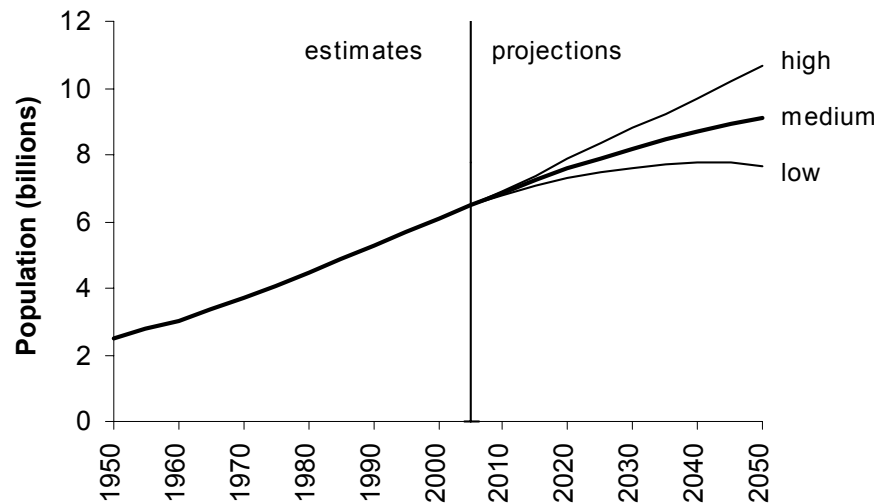
PROJECTION RESULTS

At the time of writing the United Nations had released a 2004 revision *Highlights report*⁴ which includes a summary commentary and selected tables, and a database which may be queried via the web page <http://esa.un.org/unpp/>. Three more detailed reports, *Comprehensive Tables*, *Sex and Age Distribution of the World Population* and an *Analytical Report* are forthcoming, as is a CD-ROM with more detailed data. Selected features of the world's demographic future, obtained from the online database, are discussed in this section. Where not explicitly stated, reference is made to the medium series projections.

The future population of the World

Figure 1 shows the estimated population of the world from 1950 to 2000 and the low, medium and high projections to 2050. By mid-century the population is projected to have reached 9.1 billion

Figure 1: United Nations world population estimates and projections, 1950 to 2050



Source: United Nations, for Figures 1, 2, 3 and 4

(medium series), 7.8 billion (low series) or 10.6 billion (high series). On the medium series trajectory the seven billion milestone is only seven years away and the eight billion mark is due to be passed in about 2027. The years of all the billion milestones up to nine billion are given in Table 1.

Table 1: World population billion milestones

Estimates	Medium series projections
1 billion in 1804	7 billion in 2012 (13 years later)
2 billion in 1927 (123 years later)	8 billion in 2027 (15 years later)
3 billion in 1960 (33 years later)	9 billion in 2048 (21 years later)
4 billion in 1974 (24 years later)	
5 billion in 1987 (13 years later)	
6 billion in 1999 (12 years later)	

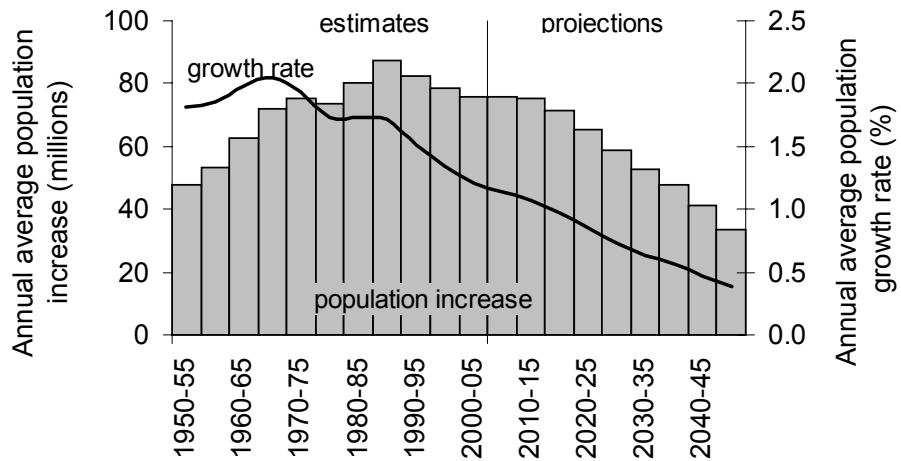
Source: United Nations

Another way of looking at this projected World population trajectory is to focus on change. Figure 2 plots estimated and projected growth rates and annual average population increments over each quinquennium from 1950 to 2050. In recent years the World's population has experienced an annual increase of about 76 million people, roughly equivalent to adding the current population of Egypt every year, or South Australia's population every week. By 2045-50 the growth rate is expected to have fallen to about 34 million per year. In terms of growth rates,

these figures correspond to a decline from an annual increase of 1.2 per cent at the moment to 0.38 per cent by 2045-50.

The current 9.1 billion projected for 2050 does not represent a major departure from earlier UN projections for mid-century, and in fact, is roughly the average of the last few projections, as shown in Table 2. Compared to the 2002 revision figures, the latest mid-century projection is 157 million higher. Marginally higher trajectories for both fertility and life expectancy have been assumed, as indicated by the assumptions for 2045-

Figure 2: Absolute and relative growth of the world's population, 1950 to 2005 and medium series projections to 2050



50 shown in the table. The change to life expectancy is partly due to the projected longer survival of AIDS patients through the expanded provision of antiretroviral treatments. Part of the earlier and larger difference between the 2000 and 2002 revision projections (404 millions) was also due to HIV-AIDS, in this case a more serious assumed impact.⁵ Table 2 also includes recent 2050 World projections published by the US Census Bureau⁶ and the International Institute for Applied Systems Analysis (IIASA).⁷ As can be seen, the differences with the latest UN projection are small, particularly for the US Census Bureau figure.

In relation to Figures 1 and 2 it is interesting to refer to a comment by Joel Cohen⁸ that never before the end of the 20th century had anyone lived through a tripling of the World's population (for example, those people who lived between 1927 and 1999 — see Table 1). These projections suggest that such an experience may occur to those born around or before 1960 if they live to their eighties and nineties, but probably not to those born after this date because the downward trajectory of the growth rate implies much less population increase after mid-century. In fact, a longer term outlook produced by the UN last year⁹ has World population peaking at under 10 billion about three quarters of the way through this century before starting to decline.

Age structure

The long-established trend of population ageing is projected to accelerate, with the percentage aged 65 and over increasing

Table 2: Selected World population projections for 2050

Projection series	Jump-off year	Billions	2045-50 TFR	2045-50 e_0 for persons (years)
UN, 2004 revision	2005	9.076	2.05	74.7
UN, 2002 revision	2000	8.919	2.02	74.3
UN, 2000 revision	2000	9.323	2.15	76.0
UN, 1998 revision	1995	8.909	2.0	76.3
UN, 1996 revision	1995	9.367	2.1	76.6
USCB ^a	2002	9.079	2.0 ^b	77.0 ^b
IIASA ^c	2000	8.979	n/a	n/a

^a United States Census Bureau

^b 2050

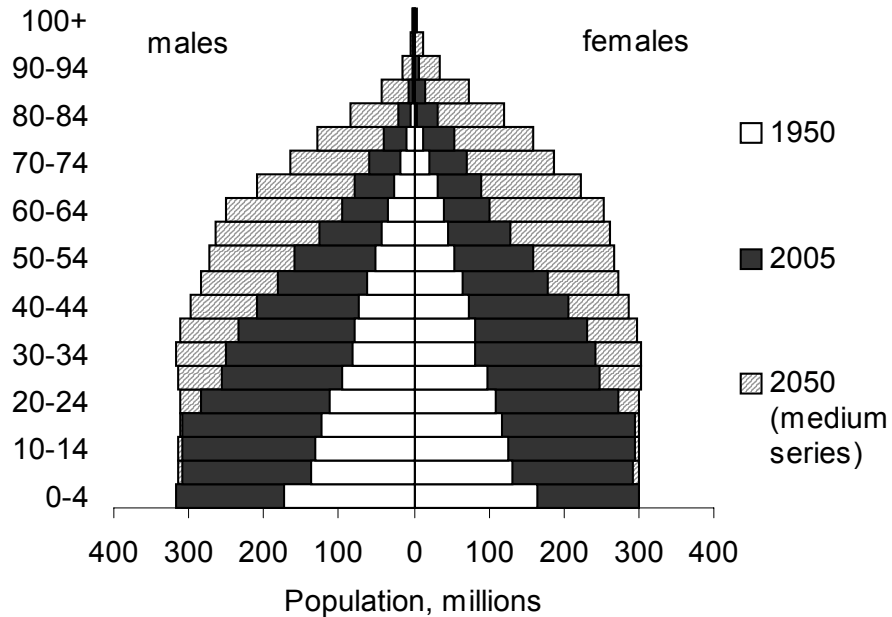
^c International Institute for Applied System Analysis projections, reported by Lutz et al.⁷

Source: United Nations

from the current seven per cent to 16 per cent by 2050. The shape of the world's population pyramid will change dramatically as larger birth cohorts, less depleted by mortality than their predecessors, progressively expand the middle and upper sections of the pyramid (Figure 3). The numbers in the very elderly ages look set to increase by the greatest amounts in percentage terms. The global 85+ population is projected to rise from 33 million today to about 188 million by 2050. The world's centenarians are projected to rise in number from ¼ million to 3.7 million over the same period!

As well as being a consequence of the World's fertility and mortality history over the last century, age structure also has considerable influence on future population growth. When there are relatively large numbers of people in the reproductive age groups there exists potential for further population growth even if fertility is low. This is termed population momentum, defined by Rowland¹⁰ as 'the potential for change in total population numbers, measured as the difference in size between the present population and the future stationary population, obtained from a projection

Figure 3: The age-sex structure of the world's population, 1950, 2005 and 2050 (medium series projection)



holding mortality constant at the present level and fertility constant at replacement level'. In fact it has been shown that out of the three contributors to World population growth — fertility above replacement, declining mortality, and momentum — the majority of World population growth over the next half century will be attributable to momentum.¹¹ And as the TFR falls over time the fertility contribution to population growth declines and momentum becomes even more important. Those commentators who fear a global population implosion in the coming decades due to low fertility are simply wrong. Population momentum will ensure continued population growth for many more years.

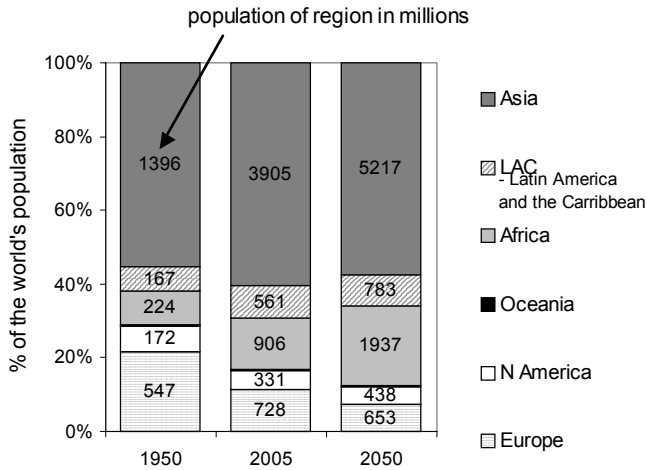
Shifting geographical distribution

Nearly all the projected population growth to 2050 is expected to take place in developing countries. As shown in

Figure 4, in terms of shifts in World population shares, Africa and Europe stand out whilst the shares for the other global regions — Asia, North America, Oceania, and Latin America and the Caribbean — are projected to change by relatively small amounts. As can be seen, Africa is expected to experience phenomenal growth, its population more than doubling from 0.9 to 1.9 billion and its global share of population rising to 21 per cent. Europe's demographic presence in the world looks set to decline in both relative and absolute terms. Negative momentum will play an important role in this decline. As Lutz and colleagues recently noted, sustained low fertility in Europe has resulted in an age structure with relatively small childbearing age populations, and this has just started generating negative momentum.¹²

Within the global regions there is considerable diversity in projected

Figure 4: The changing geographical distribution of the world's population by global region, 1950, 2005, 2050 (medium series projection)



population change. We look now at selected countries at both ends of the growth spectrum, starting with the high growth nations.

Substantial population growth in some countries

India, Pakistan, Nigeria, the Democratic Republic of the Congo, Bangladesh, Uganda, the USA, Ethiopia and China will account for half of the World's population increase to 2050. India is projected to increase from its current 1.1 billion to 1.6 billion by mid-century, overtaking China around 2030 to become the World's most populous country. And although growing at a much lower rate, China's population is still expected to be 1.4 billion by 2050. This huge expansion in human resources in Asia, coupled with economic development, clearly has enormous implications for shifts in global economic power, amongst

many other consequences. A recent Goldman Sachs study¹³ predicts that China's economy will overtake America's sometime in the first half of this century, so that by 2050 the largest economies will be China, the US and India.

Nigeria looks set to cement its position as Africa's demographic giant, increasing from 132 to 258 million between 2005 and 2050. In Latin America and the Caribbean this position will be taken by Brazil as its numbers rise from 186 to 253 million. Other demographic heavyweights include: the USA (increasing from 298 to 395 million over the 2005-50 period), Pakistan (158 to 305 million), Indonesia (223 to 285 million), and Bangladesh (142 to 243 million).

Rapid population growth measured as a percentage is arguably more important as it raises questions about countries' abilities to cope in terms of infrastructure and employment provision. Some com-

mentators have raised issues of security about growing numbers, particularly of young men, in politically unstable and poverty-stricken nations.¹⁴ For example, the Democratic Republic of the Congo is projected to grow by just over 200 per cent to a 2050 population of 177 million; Uganda is expected to undergo an incredible expansion from 29 to 127 million by mid-century — a 340 per cent increase in less than two generations. This is not to make the simplistic assertion that population growth equals problems, of course. RAND researchers have described how as countries move through the demographic transition their age structures become particularly favourable for economic development. 'If most of a nation's population falls within the working ages, the added productivity of this group can produce a 'demographic dividend' of economic growth'.¹⁵ For a while these countries have relatively few people in the dependent age groups and this allows resources to be concentrated on development. As these researchers stress, this dividend is far from automatic; rather it provides a window of opportunity for economic growth which may or may not be realised.

Population decline in some countries

Whilst much of the attention in population projections tends to be on growth, and the challenges this potentially creates, the fact that many countries are expected to shrink in population can sometimes be overlooked. Indeed, the populations of 51 countries or territories are projected to be smaller in 2050 than they were in 2005. Population decline itself may be no bad thing, but rapid decline caused by low fertility generates top-heavy age structures which provide serious challenges for public finances, amongst other things. Russia, Ukraine, Japan, Italy

and Poland are projected to decline, respectively, by 31.4, 19.6, 15.9, 7.2 and 6.6 million to 2050, with Ukraine undergoing the severest decline in percentage terms (-43 per cent). Russia, Ukraine and Poland were already declining in population over the 2000 to 2005 period, with Russia alone declining by about $\frac{2}{3}$ million each year.

Another country set to decline in population over the 2005 to 2050 period is Germany, the most populous in the European Union. This position may be relinquished to Turkey if the latter is successful in joining the Union. Germany's current population of 82.7 million is expected to have fallen to 78.8 million by mid-century. Turkey's is expected to equal Germany's at around 2015 and reach 101 million by 2050.

Whilst population decline is most commonly associated with Europe and the states of the former USSR and their sustained low fertility, a number of small populations in other continents will have fewer people in 2050 than in 2005 due to net emigration exceeding natural increase, such as Tonga, Samoa and the Federated States of Micronesia. In addition, a few countries are expected to decline in population from excess mortality caused by AIDS.

The impact of HIV-AIDS

The projected impact of HIV-AIDS has been measured by running projections for the 60 selected countries using no-AIDS mortality assumptions. The difference in population by 2015 for these countries totals 115 million; by 2050 it is 344 million. For the most infected countries the expected demographic impact is enormous. Botswana, where the adult HIV prevalence rate in 2003 was estimated to be the highest in the world at 36 per cent, will experience population

decline for most of the 2005 to 2050 projection horizon. Life expectancy at birth (for both sexes combined) has dropped from 64 years in 1990 to 1995 to an estimated 37 years for 2000 to 2005. Swaziland and Lesotho are the other two countries expected to decline in population as a result of the disease.

In terms of age structure, AIDS is creating in the most affected countries what the US Census Bureau has described as 'the population chimney'.¹⁶ These pyramids are fairly wide from infant ages up to age 30 or so, but then dramatically contract in the 40s due to AIDS deaths, and continue up to the elderly ages with almost vertical sides (the chimney). The childhood age populations are also smaller than would be the case without AIDS because of deaths to those who would otherwise have (more) children.

UN PROJECTIONS FOR AUSTRALIA

We now turn to the question 'What is the UN's view of Australia's demographic future?' It is assumed that the current TFR of 1.75 will gradually rise to 1.85 (because, as mentioned earlier, 1.85 is assumed to be the long-run level of fertility for all countries). This seems to be an optimistic, but entirely plausible, assumption. Life expectancy at birth will reach 82.7 years for males and 87.4 years for females by 2045-50, a rather pessimistic assumption in view of Australian life expectancy gains in recent decades. Annual net immigration has been set at 100,000. These assumptions result in the current population of just over 20 million rising to 24.3 million by 2025 and 27.9 million by mid-century.

How do these compare to other projections? In its series B projections ABS projects 24.0 million for 2025 and 26.4 million for 2050.¹⁷ Fertility is assumed to

be 1.6 in the long run whilst life expectancy at birth is assumed to be around 83.9 years for males in 2045-50 and 87.5 for females. Long term net immigration is set to 100,000 per year. Probabilistic projections prepared by Wilson and Bell¹⁸ give median figures of 24.2 million for 2025 and 27.9 million for 2050. Although these total populations are very similar to the UN's they are achieved with differing assumptions for fertility and mortality. The long-run TFR is set a little lower at 1.7 and life expectancy at birth is higher (averaging 87.1 years for males and 91.5 years for females over the 2045-50 period). The net immigration assumption is the same.

UNCERTAINTY

It is all too easy to be given the false impression that because the UN projections appear in official-looking reports they will all turn out to be fairly accurate, at least to the number of significant figures presented. Past studies have certainly shown that out to a decade from the jump-off year, and to a lesser extent 20 years ahead, World projections have proved reasonable reliable,¹⁹ but out to 2050 there is quite a lot of uncertainty. But just how much uncertainty? A number of researchers have attempted to answer this question. They have employed a variety of methods, including seeing how much error there has been in past projections, or by creating probabilistic simulations which use statistical models to project the TFR and life expectancy.²⁰ A few years ago the US National Research Council developed models based on errors of previous UN population projections. They used these to generate 95 per cent confidence intervals that could be applied to population projections of the total population.²¹ This enables the user to say that 'based on past projection errors we

assume that there is a 95 per cent chance the actual population will turn out to lie somewhere within this range'. For a projection over a 45 year horizon the 95 per cent interval ranges from 0.920 to 1.116 of the point projection.²² Applying these factors to the 2050 medium series projection gives a 95 per cent predictive interval ranging from about 8.3 to 10.1 billion.

Notwithstanding this uncertainty, several features of the World's demographic future are pretty much guaranteed: substantial population growth will continue over the next few decades, most of this will take place in developing countries, and the World's population will age considerably as it moves to complete its demographic transition to low rates of fertility and mortality.

References

- ¹ United Nations Population Division, *World Population Prospects: the 2004 Revision Highlights*, United Nations, New York, 2005.
- ² G. Hugo, 'Six billion and counting: global population trends at the turn of the century', *People and Place*, vol. 7, no. 2, 1999, pp. 11-18.
- ³ More details on the assumptions are provided at <http://esa.un.org/unpp/index.asp?panel=4>.
- ⁴ United Nations Population Division, op. cit., 2005.
- ⁵ United Nations Population Division, *World Population Prospects: the 2002 Revision Highlights*, United Nations, New York, 2003.
- ⁶ US Census Bureau, *Global Population Profile: 2002*, US Government Printing Office, Washington DC, 2004.
- ⁷ W. Lutz, W. Sanderson and S. Scherbov, 'The end of World population growth', *Nature*, vol. 412, 2001, pp. 543-545.
- ⁸ J.E. Cohen, 'Human population: the next half century', *Science*, vol. 302, 2003, pp. 1172-1175.
- ⁹ United Nations Population Division, *World Population in 2300*, United Nations, New York, 2004.
- ¹⁰ See D. Rowland, *Demographic Methods and Concepts*, Oxford University Press, Oxford, 2003, p. 327
- ¹¹ See Figure 7 on p. 19 of US Census Bureau, 2004, op. cit.; see also J. Bongaarts and R.A. Bulatao, 'Completing the demographic transition', *Population and Development Review*, vol. 25, no. 3, 1999, pp. 515-529.
- ¹² W. Lutz, B.C. O'Neill and S. Scherbov, 'Europe's population at a turning point', *Science*, vol. 299, 2003, pp. 1991-1992.
- ¹³ D. Wilson and R. Purushothaman, 'Dreaming with BRICs: the path to 2050', Goldman Sachs Global Economic Paper no. 99, 2003, <http://www.gs.com/insight/research/reports/99.pdf>.
- ¹⁴ See the publications listed at <http://www.rand.org/labor/popmatters/security.html>
- ¹⁵ D.E. Bloom, D. Canning and J. Sevilla, *The Demographic Dividend*, RAND, Santa Monica, 2002, p. ix.
- ¹⁶ US Census Bureau, 2004, op. cit. For an example of age structure see, United Nations Population Division, op. cit., 2005, Figure 9, p. 29.
- ¹⁷ Australian Bureau Statistics (ABS), *Population Projections Australia 2002-2101*, ABS, Canberra, 2003.
- ¹⁸ T. Wilson and M. Bell, 'Australia's uncertain demographic future', *Demographic Research*, vol. 11, article 8, 2004, <http://www.demographic-research.org>.
- ¹⁹ N. Keilman, 'How accurate are the United Nations World population projections?', in W. Lutz, J.W. Vaupel and D.A. Ahlburg (eds), *Frontiers of Population Forecasting*, Population Council, New York, 1999, pp. 15-41. Supplement to *Population and Development Review* vol. 24.
- ²⁰ N. Keilman, D.Q. Pham and A. Hetland, 'Norway's Uncertain Demographic Future', *Social and Economic Studies*, no. 105, Statistics Norway, Oslo, 2001.
- ²¹ National Research Council, *Beyond Six Billion: Forecasting the World's Population*, National Academy Press, Washington DC, 2000.
- ²² Estimated by interpolating values in Table F-7 in Appendix F of National Research Council, (panel on population projections), *Beyond Six Billion: Forecasting the World's Population*, National Academy Press, Washington DC, 2000.