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Demographic Components of Future Population Growth

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Kirill Andreev, Vladimíra Kantorová and John Bongaarts

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NOTE

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The term “country” as used in this paper also refers, as appropriate, to territories or areas.

This publication has been issued without formal editing.

PREFACE

The Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat is responsible for providing the international community with up-to-date and scientifically objective information on population and development. The Population Division provides guidance on population and development issues to the United Nations General Assembly, the Economic and Social Council and the Commission on Population and Development and undertakes regular studies on population estimates and projections, fertility, mortality, migration, reproductive health, population policies and population and development interrelationships.

The purpose of the *Technical Paper* series is to publish substantive and methodological research on population issues carried out by experts within and outside the United Nations system. The series promotes scientific understanding of population issues among Governments, national and international organizations, research institutions and individuals engaged in social and economic planning, research and training.

This paper presents the contributions of each demographic component—the current age structure of population, fertility, mortality and migration—to future population growth. Quantifying the roles of the demographic drivers of future population trends is important for developing policies and programmes aimed at balancing impending demographic changes and social, economic and environmental objectives.

Contributions of demographic components have been estimated by constructing a series of appropriate cohort-component population projections: *Standard, Natural, Replacement* and *Momentum*. The analysis is based on the 2012 Revision of World Population Prospects. Results are presented for 201 countries or areas with total population of more than 90,000 inhabitants as of July 1, 2013 and for the world, major areas and regions.

The authors are grateful to Ann Biddlecom for many stimulating discussions about the subject, for her assiduous work in revising the report, help and encouragement in development of this project. The authors also thank François Pelletier for reviewing the report and for overall supervision of the project. Gerhard Heilig, François Pelletier, Patrick Gerland, Kirill Andreev, Danan Gu, Nan Li and Thomas Spoorenberg, of the Population Division, produced the 2012 Revision of the World Population Prospects, on which all analyses in this technical report are based. Chandrasekhar Yamarthy, Igor Ribeiro, and Neena Koshy, of the Population Division, provided technical support for the production of the 2012 Revision. The authors also thank Kyaw-Kyaw Lay for preparing the annex tables and Neena Koshy for preparing the final document.

The *Technical Paper* series as well as other population information may be accessed on the Population Division's website at www.unpopulation.org. For further information concerning this publication, please contact the office of the Director, Population Division, Department of Economic and Social Affairs, United Nations, New York, 10017, USA, telephone (212) 963-3179, fax (212) 963-2147, email: population@un.org

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DEMOGRAPHIC COMPONENTS OF FUTURE POPULATION GROWTH

Kirill Andreev[*]*, Vladimíra Kantorová*[**] *and John Bongaarts*[***]

INTRODUCTION

The world population is growing. By the end of the century, it is expected to increase by 3.7 billion people, rising from 7.2 billion in mid-2013 to 10.9 billion by 2100 (United Nations, 2013a). The distribution of future population growth by countries, regions and major areas is readily available from population projections prepared by the Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat (United Nations, 2013a). This report identifies and estimates the major demographic components of future growth—fertility, mortality, migration and the current age structure of population. This decomposition is useful for understanding the relative weight of key factors that drive population growth and can inform policies and programmes aimed at balancing impending demographic changes and social, economic, health and environmental objectives (Bongaarts, 1994; Bongaarts and Bulatao, 1999).

The projections prepared by the United Nations Population Division are based on a theoretical framework known as demographic transition. Over the course of the demographic transition, populations move from a regime of high mortality and high fertility to a regime of low mortality and low fertility. Over time rapid population growth takes place because mortality decline typically begins before fertility decline: as death rates fall but birth rates remain high, the number of births exceeds the number of deaths and population therefore grows. The countries that are still in the beginning or in the middle of the demographic transition are expected to complete their transitions over the next several decades. Both fertility and mortality levels in these countries are assumed to decline. For the countries that have already completed their demographic transitions, mortality is still assumed to be declining but fertility is expected to fluctuate around or below a level of about two children per woman. For the countries with natural growth close to zero (i.e., when the number of deaths is close to equal to the number of births), future population trajectories are to a greater extent influenced by assumptions about future migration in or out of the countries. Future population trajectories therefore depend on assumptions about future trends in fertility, mortality and migration. In addition, the current population age structure influences future growth by actually affecting the overall number of births, deaths and migrations that are implied by fertility, mortality and migration rates. All four demographic components can have a significant impact, positive or negative, on future population growth.

Fertility provides a positive contribution to population growth if fertility is above replacement and a negative contribution to population growth if fertility is below replacement. The concept of replacement fertility is important in population projections because maintaining fertility at replacement level in the long run leads to a stationary population and stabilization of population growth (Preston et. al., 2000). If fertility is above replacement with constant mortality and zero migration, population will grow indefinitely. Similarly, if fertility stays below replacement, population will eventually decline to zero. To achieve replacement level fertility, women, on average, need to have one surviving daughter. In a population in which all females survive through the reproductive years and the probability of having a daughter at each pregnancy is 50 per cent, total fertility at replacement will be 2.0 children per woman. In reality, replacement-level fertility is slightly higher than 2.0 children per woman because the chances of

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survival from birth to the reproductive ages are less than 100 per cent and there are more boys born than girls (i.e., the sex ratio at birth is greater than 100).

The contribution of mortality to population growth will be positive if mortality is declining and negative if mortality is increasing. In population projections, a positive outlook for the future is usually adopted: life expectancy at birth is expected to continue to increase and death rates are expected to decline over all age groups. Under this assumption, the contribution of mortality to population growth will be positive. In more complex cases, death rates are not declining uniformly over all age groups but rather are increasing for some age groups and declining for others, as in countries that have been severely affected by HIV/AIDS epidemics. In these complex cases, the contribution of mortality to population growth is less clear. The contribution of mortality may also be related to the interplay between age-specific mortality rates and population age structure.

Assumptions about future migration are incorporated in the UN population projections by specifying net international migration levels and migration distributions by age and sex. Projected levels of net migration are kept constant in the near-term. After 2050, net migration is assumed to decline gradually and reach zero by 2100. The contribution of migration to population growth is determined by net migration: positive net migration will contribute to population increase and negative net migration will reduce population.

The population age structure at the starting point of the projection also influences the future growth trajectory. Even with assumptions of fertility at replacement level, constant mortality, and no migration, the total population will not necessarily remain constant. Total population could either increase or decrease before reaching a stationary population size. This phenomenon is called momentum of population growth and its value is defined by the ratio of ultimate population size to current population size (Keyfitz, 1971). In the countries in the midst of demographic transition and with young age structures, the total population will continue to grow because births produced by a large number of females of reproductive age will exceed deaths, even if total fertility is at replacement level. In this case, population momentum has a positive effect on population growth. In the countries that completed the demographic transition and with relatively old age structures due to long periods of low fertility and population ageing, the total population will actually decline before reaching ultimate population size. In this case, population momentum has a negative effect on population growth. The population growth brought about by the population momentum can be attributed exclusively to the initial age structure of population.

This report assesses the contributions of each demographic component—fertility, mortality, migration and the current age structure of population—to future population growth. The analysis is based on the 2012 Revision of *World Population Prospects* (United Nations, 2013b). Results are presented for 201 countries or areas with total population of more than 90,000 inhabitants as of July 1, 2013 and for the world, major areas and regions.

METHODOLOGY AND ILLUSTRATIVE CASES

The analysis presented in this report quantifies the contribution of the current age structure of a population, fertility, mortality, and migration to future population growth. To measure the contribution of a single demographic component, this report relies on a procedure proposed by Bongaarts and Bulatao (1999). It consists of constructing a series of appropriate cohort-component population projections.

The series of projections starts with a *Standard* population projection, which incorporates effects of all four demographic components. For our analysis the *Standard* population projection is set equal to the *Medium* variant from the 2012 Revision of *World Population Prospects* (United Nations, 2013b). This

projection starts with population by age and sex in 2010 and projects future population trajectories up to 2100 based on expected trends in fertility, mortality and net international migration, computed according to the methodology used in the 2012 Revision of *World Population Prospects* (United Nations, 2013b).

The effect of migration is estimated by constructing a *Natural* population projection variant, which is derived from the *Standard* variant by setting net migration to zero. Population growth in this case is driven only by natural increase based on assumptions about future fertility and mortality and by the initial age distribution. The difference in total population between the *Standard* and *Natural* variants shows the effect of net migration on future population growth.

The effect of fertility is estimated by a *Replacement* projection variant, which is derived from the *Natural* variant by setting total fertility at the replacement level for each five-year projection periods. The difference between the *Natural* and *Replacement* projection variants shows the effect of total fertility, above or below replacement level, on the overall population growth. Note that the *Replacement* projection variant is different from the instant-replacement variant published in the 2012 Revision of *World Population Prospects* (United Nations, 2013b), because the latter includes the effect of migration while the former does not.

The last projection variant, *Momentum*, is constructed by using as of 2010 constant mortality rates, constant fertility at the replacement level and by setting net migration at zero. Computing the difference in total population between the *Replacement* and *Momentum* variants shows the effect of anticipated mortality decline on future population size. It is important to note that trends in mortality between birth and the reproductive ages are taken into account by the changes that occur in the replacement levels of fertility. The difference between the *Replacement* and *Momentum* projections therefore measures only adult mortality above the average age at childbearing.

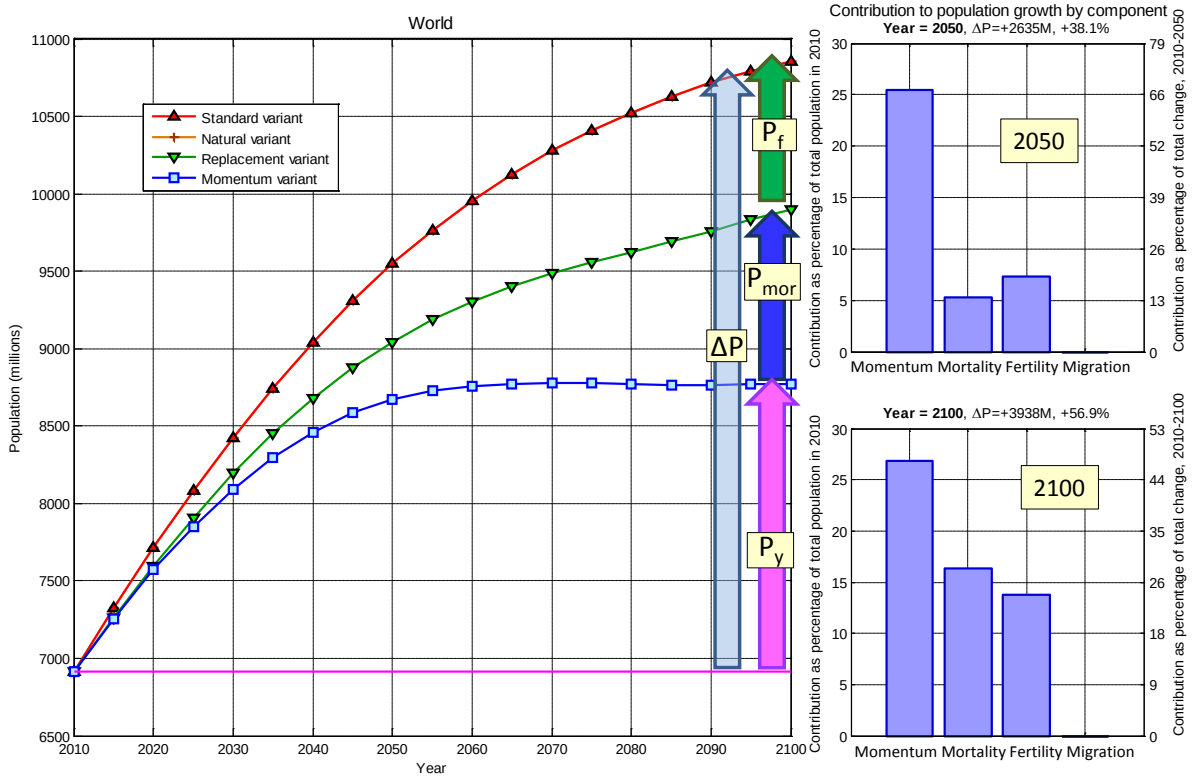
Lastly, the difference between the starting total population in 2010 and the *Momentum* variant is attributable to the initial age structure of a population. If fertility declines immediately to the replacement level as in the *Momentum* variant, population does not immediately stabilize; instead, population may still continue to increase or decrease for a few decades before it eventually tapers off and reaches the ultimate stationary level. This series of cohort-component projections is calculated for individual countries to estimate the contributions of each of the demographic components to future population growth. Standard aggregates for the world, major areas and regions published in the 2012 Revision of *World Population Prospects* (United Nations, 2013b) can be computed in two different ways. In the first approach, an aggregate (e.g., total population of the world) can be treated as a single "country", and the contributions of demographic components can be estimated by running a series of cohort-component projections as described above. For the *Momentum* projection variant, for example, this approach implies that world fertility falls immediately to the replacement level. In the second approach, the projections for an aggregate can be computed by summing up corresponding projections for individual countries. The *Momentum* projection for the world in this case is the sum of *Momentum* projections for all countries. The two approaches do not necessarily generate the same results. Computations show that the ultimate population size of the *Momentum* projection for the world is 174 million higher if the first approach is used (treating the world as a country) than if the second approach is used (summing the *Momentum* projections for all countries). The difference is due to compositional changes of world population over the projection period. However, the estimated contributions of the four demographic components are quite close regardless of the method used for aggregation. For consistency with aggregation procedures used in the 2012 Revision of *World Population Prospects*, the second approach was adopted in this analysis for producing projections of aggregated populations.

Figure 1 shows the components of population growth for the world population. Total population of the world is estimated at 6.9 billion people as of July 1, 2010. By 2100, total population is expected to

increase by 3.9 billion (light blue arrow labeled "ΔP") in the *Standard* variant reaching 10.9 billion people (the numbers may not sum up exactly due to rounding). With no migration at the world level, the *Natural* projection variant is the same as the *Standard* variant and, obviously, the effect of migration on population growth at the world level is zero (i.e., the world is a closed system). If total fertility is maintained at replacement level and mortality is declining, total population will reach 9.9 billion people in 2100 (*Replacement* variant). The difference between the *Natural* and *Replacement* variants, 0.95 billion people, is the contribution of fertility above replacement to future population growth (green arrow labeled "P_f"). In the *Momentum* variant, total population continues to grow for approximately five decades before it stabilizes at an ultimate population size of 8.8 billion people. The difference between the *Replacement* and *Momentum* variants, 1.13 billion people in 2100, is due to reductions in adult mortality over the projection period (blue arrow labeled "P_{mor}"). Lastly, the difference of 1.86 billion people between the starting population in 2010 and the ultimate population size of the *Momentum* variant, is due to the young age structure of world population in 2010 (magenta arrow labeled "P_y").

In sum, out of the total growth in world population of 3.94 billion people between 2010 and 2100, 1.86 billion is due to a young age structure in 2010, 1.13 billion is due to further reductions in mortality, and 0.95 billion is due to fertility that is above replacement level. Expressed as a proportion of the total population increase, the contributions are 47 per cent from population momentum, 29 per cent from mortality reductions and 24 per cent from above-replacement fertility levels (figure 1, the bar chart in the bottom right corner, the right-hand axis).

Figure 1. Population projection variants and contribution of demographic components to future population growth, the world, 2010-2100



NOTE: ΔP – total population change, 2010-2100 ; P_y – increase due to younger age structure in 2010; P_{mor} – increase due to mortality reductions; P_f – increase due to fertility above replacement.

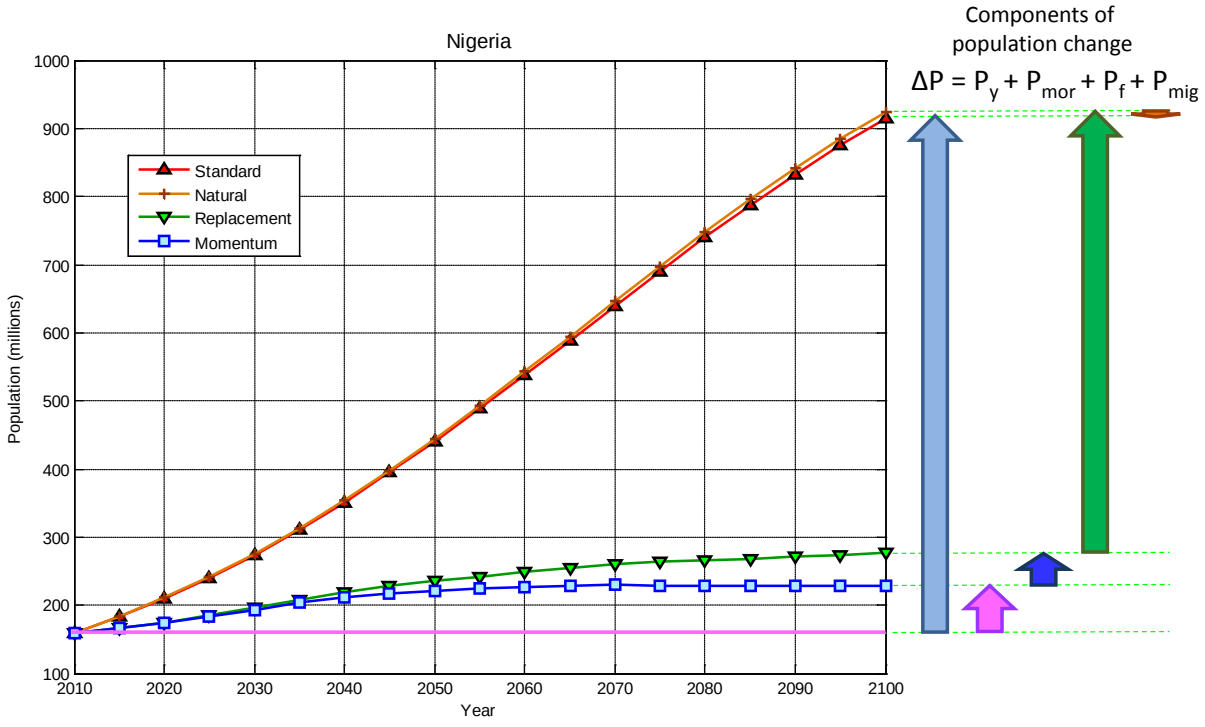
Expressed as a proportion of the total population in 2010, the contributions of each demographic components to population growth from 2010 to 2100 period are 27 per cent from population momentum, 16 per cent from mortality reductions and 14 per cent from above-replacement fertility (figure 1, the bar chart in the bottom right corner, the left-hand axis). The components of population growth for the period 2010-2050 are presented in the bar chart in the top right corner (figure 1).

In the annex, similar figures are presented the world, major areas and regions and for 201 countries or areas with total population of more than 90,000 inhabitants as of July 1, 2013 and for (annex figure 1).

Nigeria (figure 2) provides an example typical of countries where future population growth is mainly driven by high fertility. The total population of Nigeria is expected to increase from 160 million in 2010 to 914 million in 2100, or by 754 million people. This increase is designated by the light blue arrow in the chart (labeled "ΔP"). The total increase is a sum of four components: a) increase due to a young age structure (magenta arrow labeled "P_y" for population momentum); b) increase due to mortality reductions (blue arrow labeled "P_{mor}"); c) increase due to fertility above replacement level (green arrow labeled "P_f"); and d) small decline due to anticipated net emigration (brown arrow labeled "P_{mig}"):

$$\Delta P = P_y + P_{mor} + P_f + P_{mig}$$

Figure 2. Population projection variants and contribution of demographic components to future population growth, Nigeria, 2010-2100



NOTE: ΔP – total population change, 2010-2100; P_y – increase due to younger age structure in 2010; P_{mor} – increase due to mortality reductions; P_f – increase due to fertility above replacement; P_{mig} – decrease due to negative net-migration.

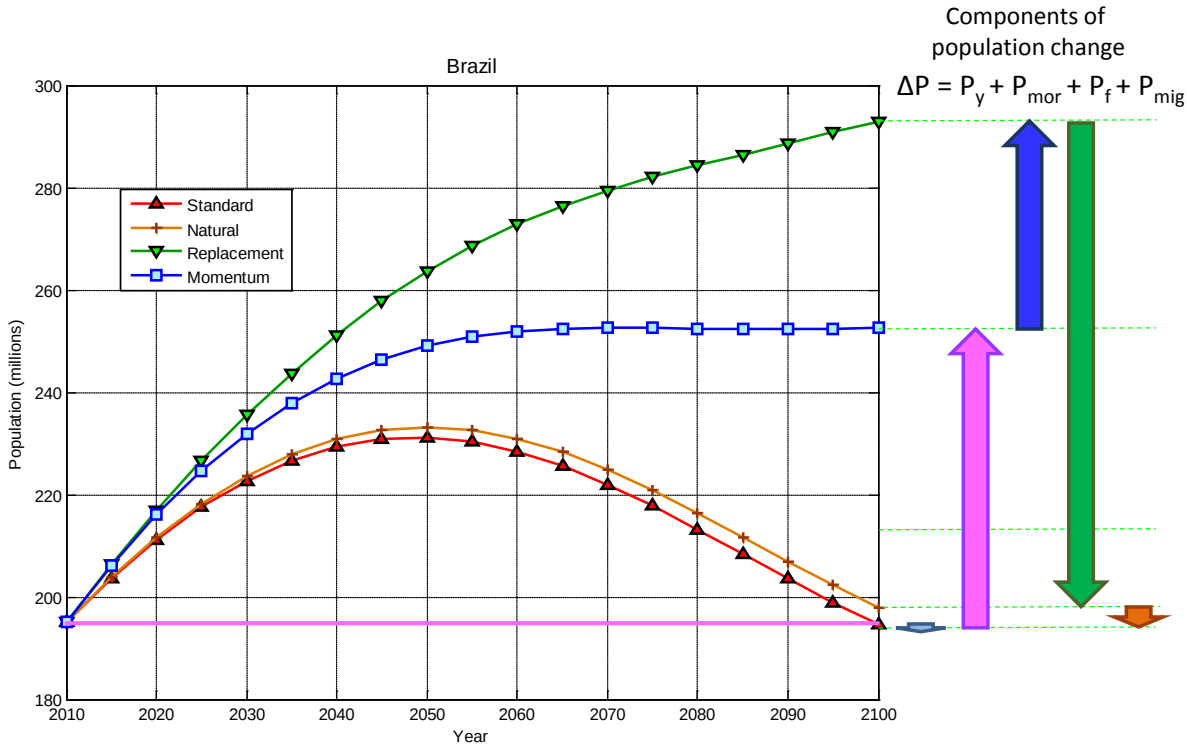
Mortality reductions account for only 6 per cent of the projected total population growth in Nigeria and a young age structure in 2010 accounts for about 9 per cent of projected growth. The overwhelming contribution to population growth in Nigeria—86 per cent or 647 million people—is accounted for by above-replacement fertility. In other words, population in Nigeria is expected to increase more than

fourfold by 2100 due to fertility levels that are above replacement level. Note also that figure 2 is similar to figure 1 except that the bar charts on the right have been removed for the sake of simplicity of the presentation and the arrows are moved to the right outside the plot area.

Countries with projected population growth that is near zero represent a complex interplay of demographic components. In Brazil, for example, nearly zero population growth is expected between 2010 and 2100. The nearly zero population growth is due to the compensation of a population increase because of a young population age structure and expected mortality reductions with total fertility below replacement (figure 3). Population momentum (figure 3, magenta arrow) adds 29 per cent to the total population size of 2010 and mortality reductions (figure 3, blue arrow) add a further 21 per cent. The combined increase of 50 per cent from both factors is offset by a decline in population caused by total fertility below replacement level, which amounts to -49 per cent (figure 3, green downwards arrow). An additional small decline of about -2 per cent is due to assumed net emigration from the country (figure 3, brown arrow).

Brazil is also an example of a country where close-to-zero population growth results in percentages of demographic components relative to the total increase in population from 2010 to 2100 that are not intuitive. In this and similar cases, the right-hand axis of the bar charts is excluded from the country profile plots (annex figure 1).

Figure 3. Population projection variants and contribution of demographic components to future population growth, Brazil, 2010-2100

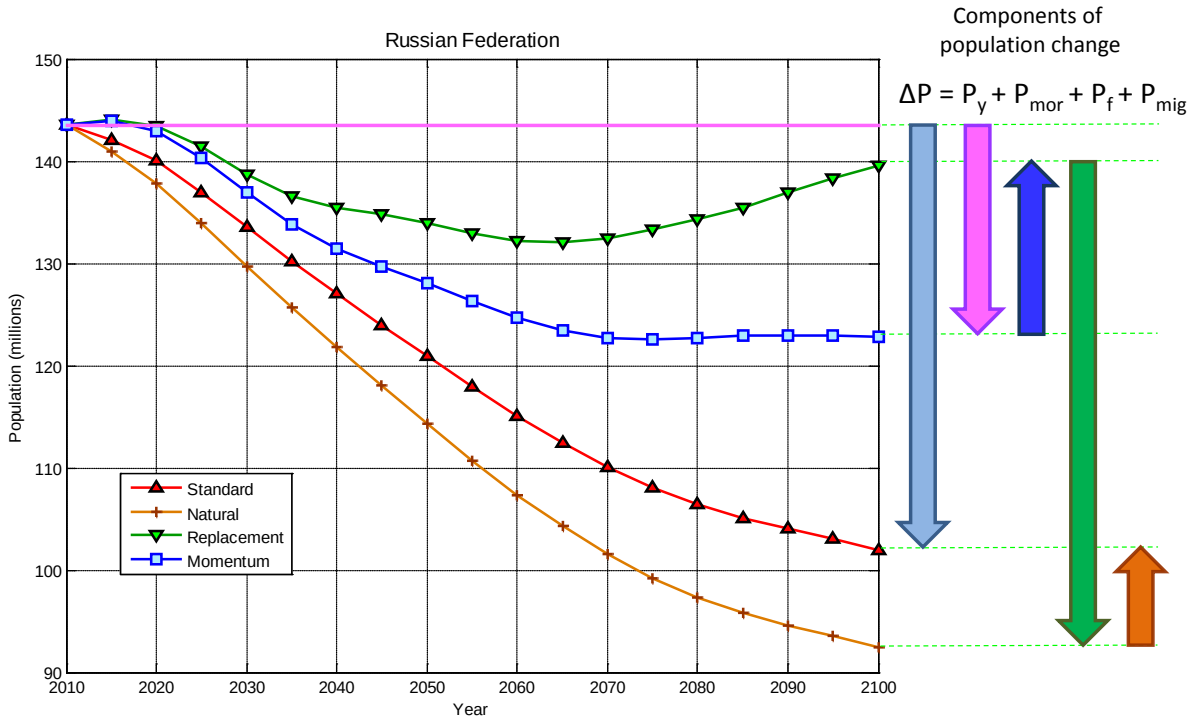


NOTE: ΔP – total population change, 2010-2100; P_y – increase due to younger age structure in 2010; P_{mor} – increase due to mortality reductions; P_f – decrease due to fertility below replacement; P_{mig} – decrease due to negative net-migration.

The Russian Federation illustrates another case where the effects of the four demographic components on projected total population are in positive and negative directions. In the Russian Federation, total population is expected to decline by -41.7 million people from 143.6 million in 2010 to 101.9 million in 2100 (figure 4, downwards light blue arrow). The largest contribution to the total decline in population (a decline of 47.2 million people) is due to fertility (figure 4, downwards green arrow) which is projected to stay at below-replacement level through 2100.

The Russian Federation also provides an example of negative population momentum, another contributor to the expected population decline. If mortality is kept constant at its level in 2010 and fertility is set to replacement level (which means an immediate increase in total fertility from the current below-replacement level), total population is still projected to decline to 122.8 million in 2100, a difference of -20.8 million people from 2010 (figure 4, downwards magenta arrow). Negative population momentum arises because the initial age structure is older than the age structure of the ultimate stationary population. The mortality and migration components, by contrast, are expected to provide positive contributions to population growth and thus offset the total population decline by 16.8 and 9.5 million people, respectively (figure 4, upwards blue and brown arrows). Expressed as proportions of the total population size in 2010, projected population change in the Russian Federation from 2010 to 2100 is accounted for by a decline of 33 per cent due to fertility, a decline of 14 per cent due to a relatively old age structure in 2010, an increase of 12 per cent due to further reductions in mortality, and an increase of 7 per cent due to positive net-migration (figure 4).

Figure 4. Population projection variants and contribution of demographic components to future population growth, the Russian Federation, 2010-2100



NOTE: ΔP – total population change, 2010-2100; P_y – decrease due to older age structure in 2010; P_{mor} – increase due to mortality reductions; P_f – decrease due to fertility below replacement; P_{mig} – increase due to positive net-migration.

RESULTS

World

A large part of the increase in the world population from 2010 to 2100 can be attributed to the population momentum that is a result of the young age structure of the world population today. The world population is projected to increase from 6.9 billion in 2010 to 10.9 billion in 2100, according to the medium projection variant (table 1). Nearly half of the projected population growth to 2100 will be due to population momentum, accounting for 1.9 billion people or 47 per cent of the total increase in the population (table 2). In other words, if total fertility is set to a replacement level and mortality remains unchanged from 2010 onwards in all countries of the world, the world population would still increase to 8.9 billion by 2100, or by 27 per cent compared to the 2010 population.

Continuing reductions in mortality rates and total fertility persisting above replacement level will each contribute to about a quarter of the world population increase from 2010 to 2100. Reductions in mortality will add 1.1 billion people by 2100 (or 29 per cent of the total increase) and total fertility above replacement at the world level will add 1.0 billion people (or 24 per cent of the total increase) (table 2).

TABLE 1. TOTAL POPULATION IN 2010 AND 2100, THE WORLD, MAJOR AREAS AND DEVELOPMENT GROUPS

	Total population (millions)		*Population change 2010-2100*	
Major area or development group	*2010*	*2100*	*Absolute (millions)*	*Relative to 2010 (per cent)*
World	6,916	10,854	3,938	57
More developed regions	1,241	1,284	43	3
Less developed regions	5,675	9,570	3,895	69
Least developed countries	839	2,928	2,089	249
Africa	1,031	4,185	3,153	306
Asia	4,165	4,712	546	13
Europe	740	639	-101	-14
Latin America and the Caribbean	596	736	140	23
Northern America	347	513	167	48
Oceania	37	70	33	90

Development groups and major areas

Most contemporary developed countries have already reached the end of the demographic transition, while most developing countries are still in transition. As a result the impact of demographic components on the future population growth differs sharply between developed and developing regions.

Developed regions will experience a small increase in the total population over the period 2010 to 2100, less than 4 per cent compared to the 2010 population. The demographic transition is in an advanced state and population age structures are ageing. Thus, in developed regions population momentum has a negative contribution to projected population growth. In the hypothetical situation of holding total fertility at the replacement level over the period 2010 to 2100, the population of developed regions would decline by 5 per cent compared to the population in 2010, in the absence of net migration and mortality reductions.

TABLE 2. CONTRIBUTION OF DEMOGRAPHIC COMPONENTS TO POPULATION GROWTH FROM 2010 TO 2100, THE WORLD, MAJOR AREAS AND DEVELOPMENT GROUPS

Major area or development group	*Contributions of demographic components*				
	Momentum	*Mortality*	*Fertility*	*Migration*	***Total***
	Relative to total population in 2010 (per cent)				
World	26.9	16.3	13.8	0.0	56.9
More developed regions	-5.2	11.5	-23.9	21.1	3.5
Less developed regions	33.9	17.4	21.7	-4.3	68.6
Least developed countries	54.8	26.4	177.0	-9.1	249.0
Africa	49.5	27.9	235.0	-6.6	305.8
Asia	27.7	14.1	-25.8	-2.9	13.1
Europe	-9.5	11.3	-28.8	13.2	-13.7
Latin America and the Caribbean	39.2	20.1	-27.3	-8.5	23.5
Northern America	6.8	12.1	-10.9	40.1	48.1
Oceania	20.8	13.4	4.9	50.9	90.0
	Relative to population change 2010-2100 (per cent)				
World	47.2	28.6	24.2	0.0	100.0
More developed regions	-149.5	329.8	-687.7	607.3	100.0
Less developed regions	49.3	25.3	31.6	-6.3	100.0
Least developed countries	22.0	10.6	71.1	-3.7	100.0
Africa	16.2	9.1	76.9	-2.2	100.0
Asia	211.0	107.9	-196.9	-21.9	100.0
Europe	69.0	-82.8	210.0	-96.2	100.0
Latin America and the Caribbean	166.8	85.7	-116.4	-36.1	100.0
Northern America	14.2	25.2	-22.8	83.4	100.0
Oceania	23.1	14.9	5.5	56.6	100.0
	Absolute (millions)				
World	1,857	1,128	953	0	3,938
More developed regions	-64	142	-296	262	43
Less developed regions	1,921	986	1,232	-245	3,895
Least developed countries	460	221	1,485	-76	2,089
Africa	510	288	2,423	-68	3,153
Asia	1,152	589	-1,075	-120	546
Europe	-70	84	-213	98	-101
Latin America and the Caribbean	234	120	-163	-51	140
Northern America	24	42	-38	139	167
Oceania	8	5	2	19	33

The total fertility projected for developed regions is, however, well below replacement level, and the contribution of total fertility towards population decline is estimated at 24 per cent of the 2010 population. Two components in developed regions that act in a different direction from fertility and population momentum are mortality reductions and positive net-migration trends. From 2010 to 2100, the mortality component would increase population in 2100 by 12 per cent compared to the 2010 population

size and the migration component would increase population in 2100 by 21 per cent compared to the 2010 population size.

In developing regions, the population is projected to increase by 69 per cent between 2010 and 2100. The demographic transition started later than in developed regions, and in most countries the population age structures are still young. Population momentum will have a positive impact on population growth in developing regions (about 34 per cent of the 2010 population). The fertility component contribution, although quite different across countries in the developing regions, accounts for an additional 22 per cent of the population size in 2010. The contribution of the mortality component in developing regions is larger than in the developed regions, accounting for 17 per cent of the population size in 2010. Only the migration component has a negative impact on projected growth (-4 per cent of the 2010 population).

In the least developed countries, the population is projected to increase by 249 per cent between 2010 and 2100, largely due to fertility levels above replacement (a 177 per cent increase compared to the 2010 population), followed by contribution of the population momentum (an additional 55 per cent of the 2010 population) and reductions in mortality (26 per cent of the 2010 population). As in developing regions as a whole, the migration component is negative (-9 per cent of the 2010 population).

Across the major areas, differences in the impact on population growth are largest for the fertility component. While in Africa the fertility component has a large impact on population increase, in other major areas the effect is small (e.g., Oceania) or negative (e.g., Asia). Due to future fertility trends alone, the populations of Asia, Europe, and Latin America and the Caribbean would all decline between 2010 and 2100 by at least 25 per cent.

Only in Europe has population ageing become so advanced that the contribution of population momentum in the period 2010 to 2100 will be negative (at -10 per cent of the 2010 population size). In contrast, the projected population to 2100 in Africa increases due to young age structures alone by an additional 50 per cent. The young population age structures in Asia and in Latin America and the Caribbean contribute to a population increase by 28 per cent and 40 per cent, respectively.

Mortality reductions to 2100 will have the largest impact on population projections in Africa (increasing the population size by 28 per cent compared to the 2010 population size). In other major areas, the impact is between 10 to 20 per cent. Future migration trends as projected for the period 2010-2100 will add 40 per cent of the population in Northern America and 51 per cent in Oceania.

Changes over time

The preceding analysis has used the year 2100 as the endpoint of the projections for estimating the contribution of each demographic component. The components, however, can gradually loose or gain in the impact they have on population growth during the projection period.

In general, the contribution of the population momentum component to population growth, expressed as a proportion of the 2010 population, is largest during the early decades and then stabilizes around the year 2060 (figure 5). The population momentum component has a positive impact on population growth in all major areas over the projection period with the exception of Europe. In Europe, population momentum has a small, positive contribution towards population growth up to 2025, followed by a negative contribution from 2030 onwards, though never more than 10 per cent relative to the 2010 population. After 2030, because of the relatively older population age structure of Europe, the population would decline even with the total fertility at replacement (assuming mortality is constant and net migration is zero).

The contribution of the fertility component to population growth rapidly increases over time in Africa, where the fertility component alone will add one billion people by 2055 and another billion by 2090. In Oceania, which is a very diverse group of countries, the contribution of the fertility component from 2010 to 2100 is positive but small (below 10 per cent) and declines towards 2100. In Latin America and the Caribbean, the fertility contribution to population growth is positive only until 2020 (though less than 1 per cent relative to the 2010 population), followed by a rapid negative impact on population. By 2100, the contribution of the fertility component towards population decline is more than 25 per cent relative to the 2010 population size in Asia, Europe and Latin America and the Caribbean.

Figure 5. Change in demographic components over time, as proportion of the total population in 2010, by major areas, 2010-2100

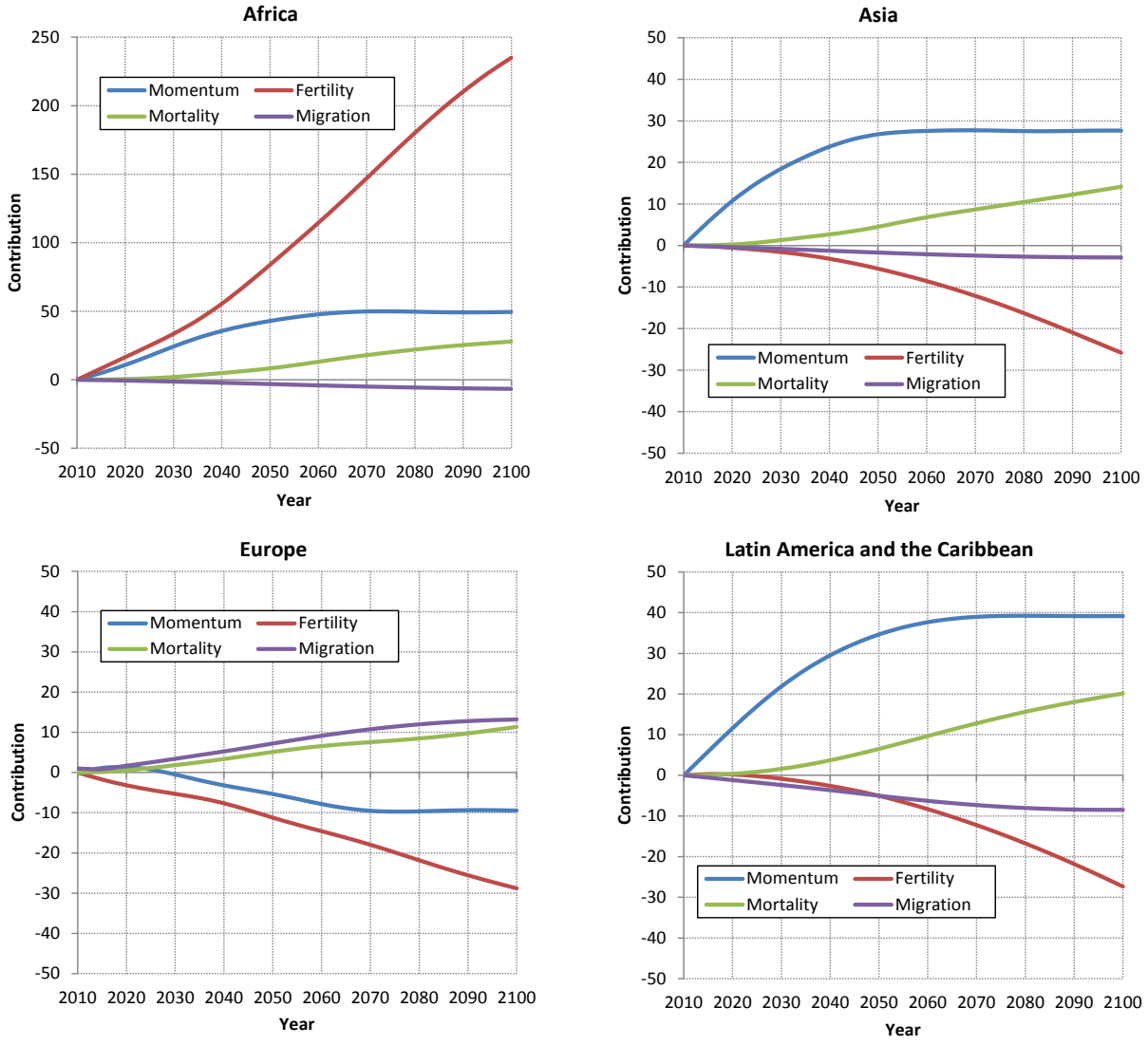
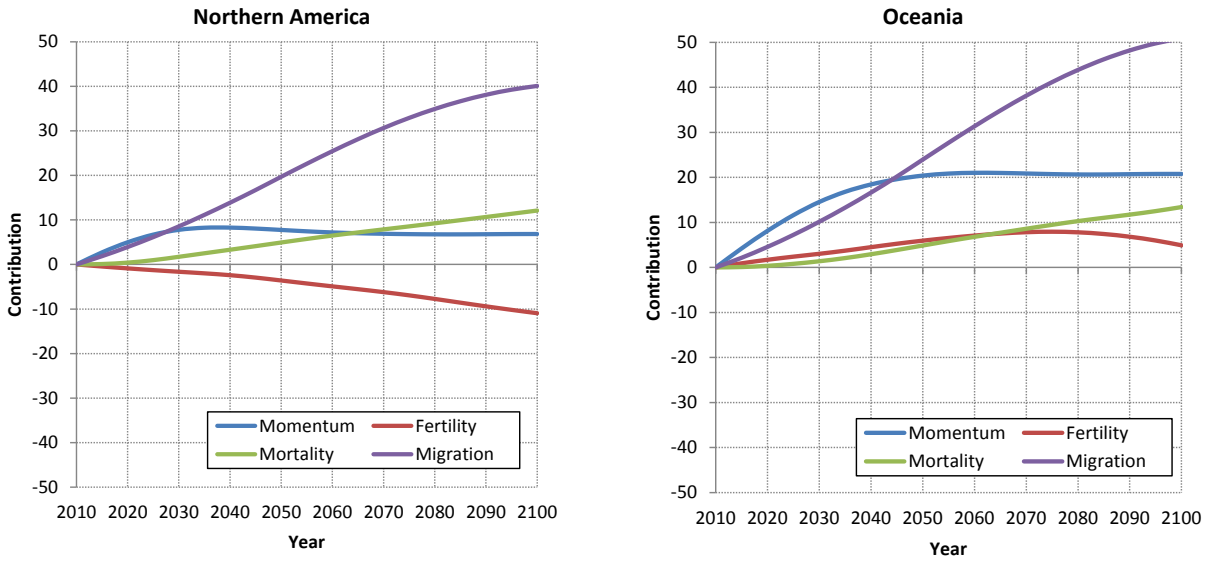


Figure 5 (*continued***)**



Countries

The diversity of experiences among countries is noteworthy. Among 201 countries or areas with total population of more than 90,000 inhabitants as of July 1, 2013, 55 countries are expected to have fewer inhabitants in 2100 than in 2010. These countries are in Asia, Europe and Latin America and the Caribbean. Variation in the fertility component is by far the largest cause of variation in population growth at the country level. On the one hand, there are strong positive impacts in many sub-Saharan African countries (figure 6) resulting from above-replacement fertility projected for the future. On the other hand, there are negative impacts of below-replacement fertility in many countries among all major areas.

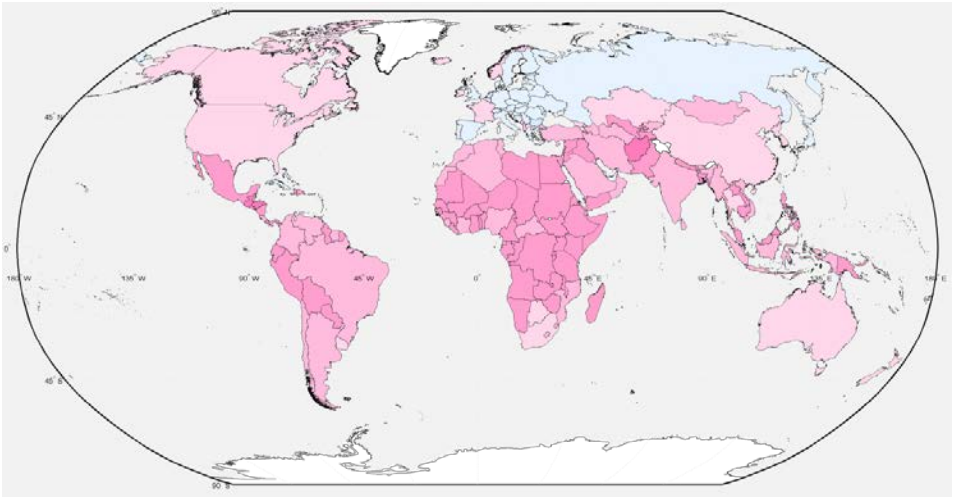
In projections to 2100 the fertility component has the largest absolute contribution of all components in 115 countries (or 57 per cent of all countries) (table 3). In 69 countries the fertility component makes a positive contribution to population growth. Momentum has the largest impact of all components in 49 countries (or 24 per cent of all countries). Mortality reductions are predominant in five countries. A net migration contribution to population growth has the largest weight in 32 countries (or 16 per cent of all countries). For projections to the year 2050, the momentum component is dominant in more countries (87 countries) and the fertility component is dominant in fewer countries (75 countries) compared to projection to 2100.

TABLE 3. NUMBER OF COUNTRIES WITH LARGEST ABSOLUTE CONTRIBUTIONS BY DEMOGRAPHIC COMPONENTS, 2050 AND 2100

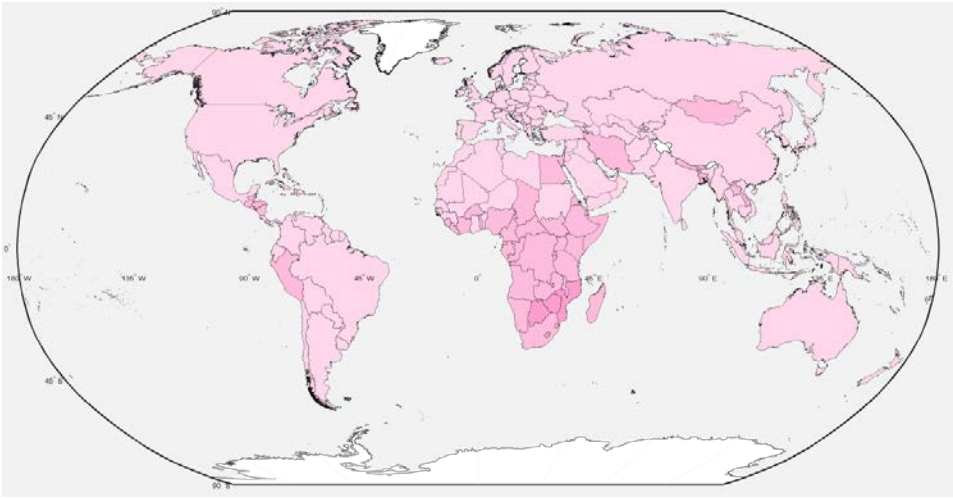
	The largest component:							
	Fertility		*Momentum*		*Mortality*		*Migration*	
Year of projection	*Number*	*Proportion of all countries (per cent)*	*Number*	*Proportion of all countries (per cent)*	*Number*	*Proportion of all countries (per cent)*	*Number*	*Proportion of all countries (per cent)*
2050	75	37.3	87	43.3	1	0.5	38	18.9
2100	115	57.2	49	24.4	5	2.5	32	15.9

Figure 6. Contributions of demographic components as proportion of total population in 2010, 2010-2100 (per cent)

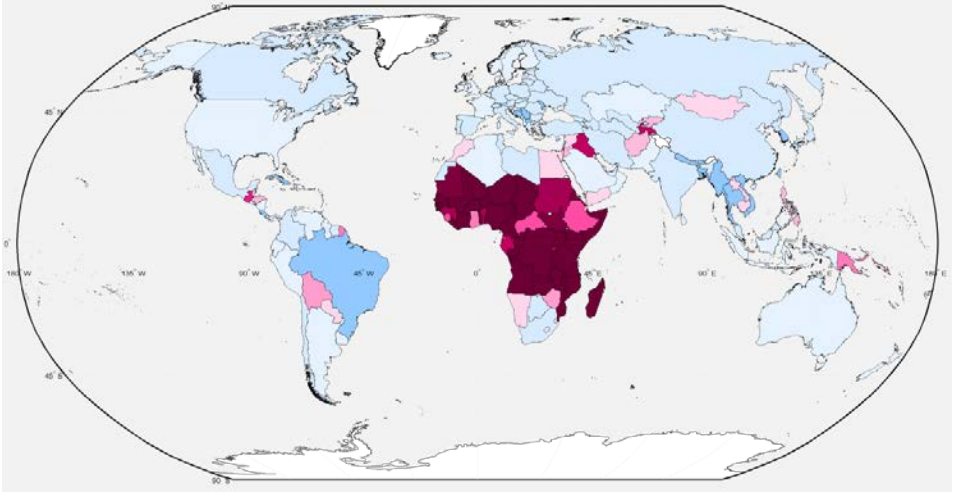
Momentum



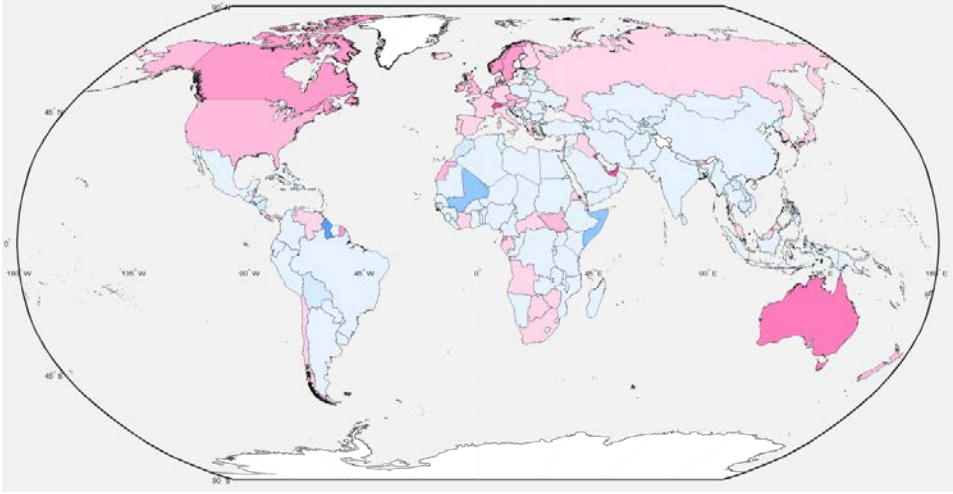
Mortality



Fertility



Migration



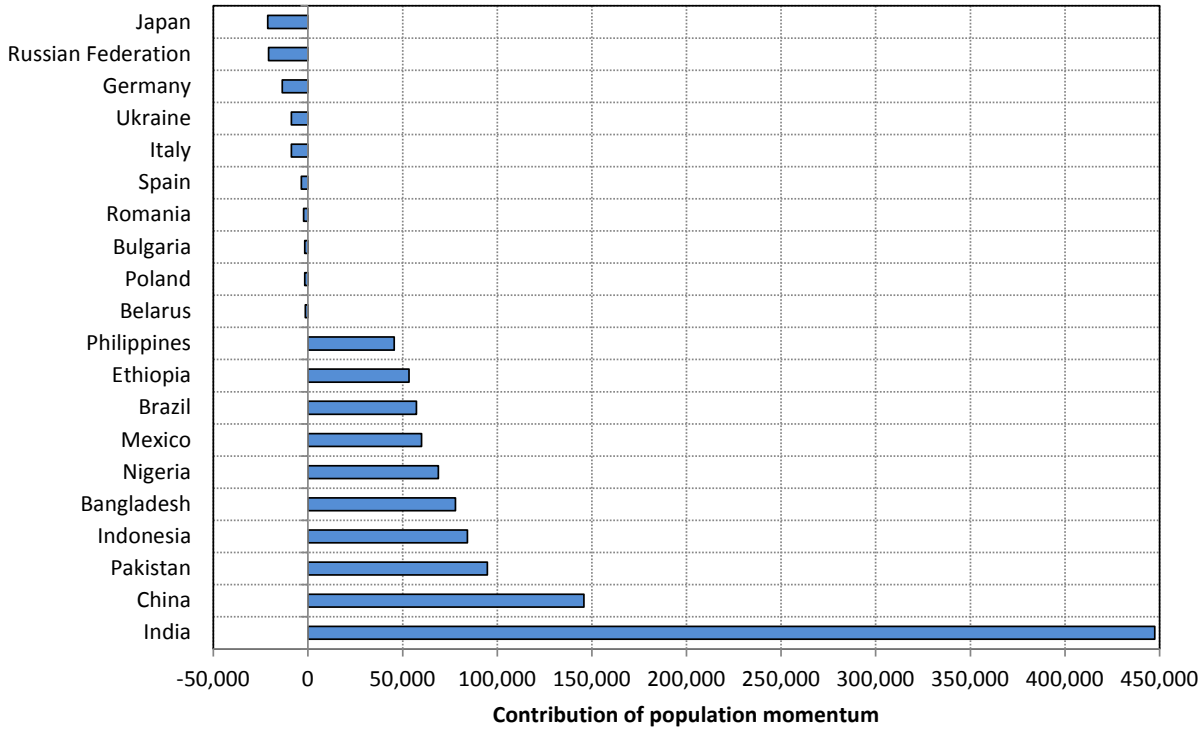
Largest contributions of population momentum

Countries with populations that are young have relatively large cohorts of young people which will in the near future contribute towards further increases in projected population size, even if the total fertility was set at replacement level. In contrast, a number of countries have already experienced population ageing due to long periods of low fertility. The older age structures in these countries will contribute towards further decreases in projected population size, even if the total fertility was at replacement level.

In absolute terms, the youthful age structure alone in India would increase its population by 447 million people by 2100 (or by 37 per cent relative to the 2010 population). In China, the contribution of population momentum is 146 million people (or 11 per cent relative to the 2010 population). The absolute contribution of population momentum will be between 50 million and 100 million in Bangladesh, Brazil, Ethiopia, Indonesia, Mexico, Nigeria and Pakistan (figure 7). In a further 10 countries (Afghanistan, Guatemala, Honduras, Mayotte, Nicaragua, Niger, Sao Tome and Principe, State of Palestine, Timor-Leste and Uganda), momentum would increase projected population in 2100 by more than two-thirds of the population size in 2010.

In the opposite direction, the largest absolute contribution of age structure to population decline, by 21 million people, will be in Japan and the Russian Federation (relative to the 2010 population, a decline of 17 per cent in Japan and 14 per cent in the Russian Federation). Population momentum is negative in 38 countries (figure 7), including most European countries, four countries in Asia (Japan, Hong Kong, SAR of China, Qatar, United Arab Emirates) and Cuba. In Qatar and Bulgaria, the ageing population would contribute to a decline of more than 20 per cent of the 2010 population in each country.

Figure 7. Countries with largest absolute contributions of population momentum to population growth from 2010 to 2100 (thousands)

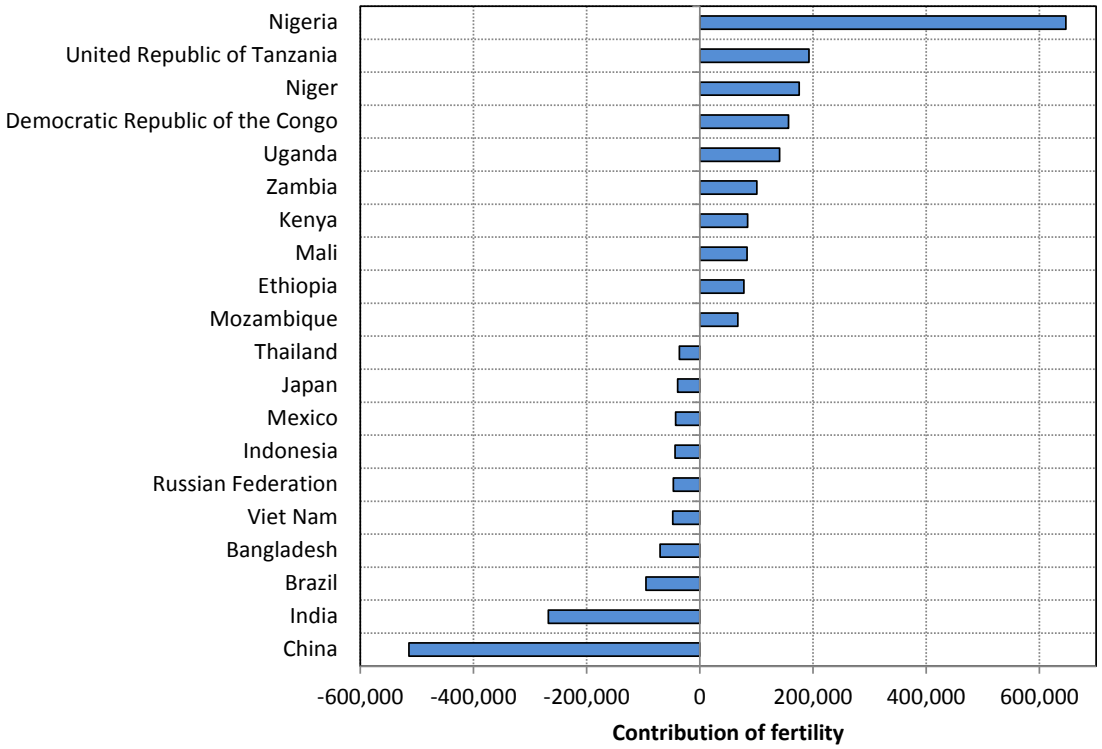


Largest contributions of fertility above or below replacement

Future trends in total fertility have a large impact on projected population growth in many countries. Nigeria's future fertility trends will have the highest absolute contribution to population growth of any country and any demographic component: the fertility component alone is estimated to account for 647 million people by 2100 (or four times Nigeria's population in 2010). In other populous African countries with high total fertility in 2010, such as the Democratic Republic of the Congo, Niger, Uganda, United Republic of Tanzania and Zambia, the fertility component accounts for population growth of more than 100 million people by 2100 (figure 8). In 77 countries continuing trends in total fertility above replacement level will make positive contributions to population growth, including 44 countries where the size of the fertility component's contribution to projected population growth is larger than the country's total population size in 2010. For the period 2010 to 2100, the fertility component alone would multiply the population of Niger 11 times compared to the 2010 population size. Large relative effects of the fertility component are also projected for Mali (5.9 times its 2010 population) and Zambia (7.6 times its 2010 population).

For 124 countries with projected total fertility below replacement, the fertility component will have a negative impact on population size over the period 2010-2100. The largest contribution in absolute terms will be in China with a decline of 425 million people to 2100 (or 38 per cent of China's 2010 population). Other countries with the fertility component accounting for a population decline of 50 million or more people are Bangladesh, Brazil and India (figure 8). In terms of the largest impact relative to population size, Lebanon and Singapore would see their populations decline by 63 per cent by 2100 due to the total fertility below replacement level.

Figure 8. Countries with largest absolute contributions of fertility levels above and below replacement level to population growth from 2010 to 2100 (thousands)

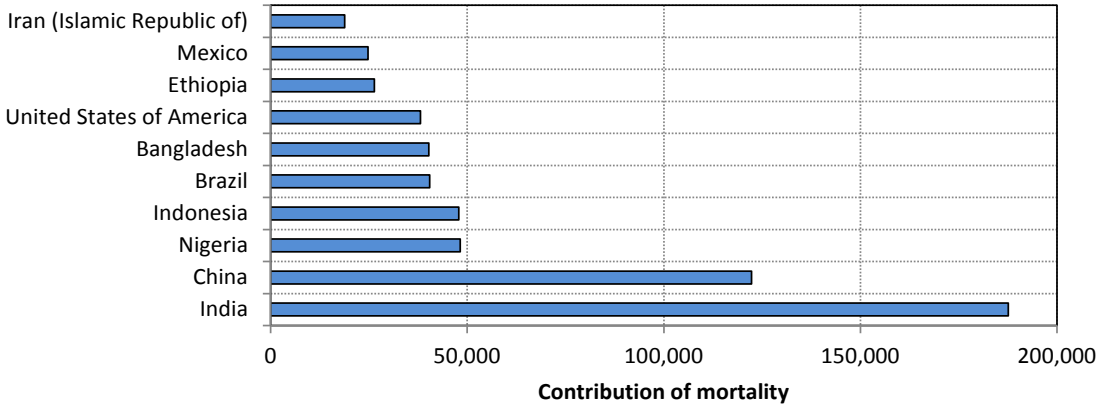


Largest contribution of mortality reductions

As reductions in mortality are projected to continue in all countries, the mortality component always makes a positive contribution to projected population. Countries with large populations and relatively low life expectancies have the largest contributions from the mortality component in absolute terms: the largest contribution is in India at 188 million people by 2100 (figure 9).

Countries that have experienced high mortality rates due to the HIV/AIDS epidemic in the recent past also have rapid reductions in mortality rates projected for the future. As a consequence, the largest contributions of the mortality component to population growth in relative terms are projected for these countries. In Botswana, Central African Republic, Lesotho, Mozambique, Swaziland and Zimbabwe, the mortality component is projected to contribute to an increase in the population to 2100 by more than 40 per cent relative to the population size in 2010 (annex table 1).

Figure 9. Countries with largest absolute contributions of reductions in mortality to population growth from 2010 to 2100 (thousands)



Largest contribution of migration

The contribution of migration can be substantial, especially for countries where natural population growth is close to zero. The extent of the contribution is determined by the assumptions made regarding the future migration trends. For example, in the United States of America, the migration component accounts for more than 117 million people by 2100, followed by Canada (22 million people) and Australia and the United Kingdom (18 million people each). In Australia and Canada, positive net migration would add 82 per cent and 64 per cent, respectively, of the 2010 population size of each country (annex table 1).

Comparison of fertility and momentum components

In most countries the largest contributions to future population growth will come from the fertility and momentum components. How these two components relate to each other and whether both components act in the same direction or compensate for each other depends on country-specific past and future population trends. Four groups of countries can be distinguished depending on the size and sign of the fertility and momentum components:

- Positive fertility and momentum. In many countries with projected fast population growth, total fertility above replacement is a major contributor to population growth. In 44 countries, (32 in the least developed world and 36 in Africa), the contribution of the fertility component is larger than the 2010 population size. Thus, projected total fertility above replacement will lead to more than a doubling of the population between 2010 and 2100. In an additional 33 countries the fertility component is positive but less than 100 per cent of the 2010 population. Population momentum contributes a further 37 per cent to 89 per cent to the population increase (as compared to population size in 2010) in this group of countries.

- Negative fertility offset by larger momentum. In countries with recent fertility declines towards or below replacement, the contribution of the fertility component to future population growth is negative. However, this effect is more than compensated by the impact of population momentum, since these countries have young age structures. Thirty-nine countries belong to this group, including countries in all major areas except Northern America. Some of the most populous countries (2010 population greater than 100 million) are in this group, including Bangladesh, India, Indonesia, Mexico and Pakistan.

- Negative fertility effect with smaller momentum. In this third group of countries young age structures contribute towards population increase, but the projected total fertility below replacement has a larger impact thus producing an overall population decline. In total, 47 countries from all major areas belong to this group. Among the most populous countries, these include Brazil, China and the United States of America.

- Negative fertility and negative momentum. Both population momentum and total fertility below replacement contribute towards a projected decline in population size in 38 countries, including 33 countries in Europe, four countries in Asia (Hong Kong, SAR of China; Japan, Qatar, United Arab Emirates) and Cuba.

CONCLUSIONS

The demographic conditions of countries around the world today are more diverse than at any previous point in history. At one end of the spectrum are countries that are still relatively early in their demographic transition and have rapid population growth, high fertility and young age structures; at the other end of the spectrum are countries that may be regarded as post transitional, where growth rates are negative, fertility has dropped well below the replacement level and populations are aging rapidly.

The main objectives of this technical report are to quantify the roles of the demographic drivers of future population trends for regions and countries and to identify the demographic causes of differences in their growth trajectories. Conventional demographic theory has established that population growth is related to fertility, life expectancy, migration and momentum, but it does not provide estimates of their contributions. This issue is addressed here by making a series of hypothetical cohort component projections which allow the quantification of the four demographic drivers of future population change. For example, the population of the world is expected to grow by 3.9 billion between 2010 and 2100 an increase of 57.9 per cent. This increase can be decomposed into contributions of high fertility (13.8 per cent), declining mortality (16.3 per cent) and momentum (26.9 per cent).

The analysis of regional and country estimates demonstrates that the fertility is the most influential component in causing differences in growth trajectories between populations. The contribution of fertility to future growth ranges from 235 per cent (of the 2010 population) in Africa to -28.8 per cent in Europe.

The regional contributions of the other factors have a much smaller range, in particular for mortality (27.9 per cent in Africa compared to 11.3 per cent in Europe). The range for momentum is from 49.5 per cent for Africa to -9.5 per cent for Europe (table 2).

The decompositions results are derived from the medium variant projection of the United Nations Population Division (United Nations, 2013b). These projections involve assumptions about the future trajectory of fertility, mortality and migration which are uncertain. As a result, the estimates of the demographic components for fertility, mortality and migration are also uncertain. In contrast, estimates of momentum do not rely on assumptions about the future and depend only on the current age structure of the population and mortality which are relatively well known. Estimates of the size of momentum are therefore subject to very little uncertainty. Overall, UN projections made in the past have turned out to be remarkably accurate at the regional and global levels for periods up to a few decades (NRC, 2000; Lee, 2011). The fact that momentum now accounts for half of world population growth and that it can be projected with confidence makes large errors unlikely at least for the next two or three decades.

These quantitative assessments of the demographic factors that drive population growth should be of interest to policy makers concerned about the adverse effects of population change for human welfare. In theory each of the components of growth can be affected by appropriate policies:

- Fertility. A range of policies are available to affect fertility. In many high fertility countries family planning programs have been implemented. These programs provide access to information about contraceptives with the goal of reducing unplanned pregnancies and to assist women in having the family size they desire (Bongaarts and Sinding, 2011). In countries with very low fertility many governments have implemented policies to help women combine childbearing with participation in the labor force (e.g. through child care subsidies or favorable taxes for families with children). The goal is to raise fertility to a level closer to the one wanted by women, because in these societies women often do not achieve their desired family size (Thévenon, 2011).

- Mortality. Better health and a longer life are universally desired and governments therefore make every effort to reduce mortality. This is therefore not a population policy variable.

- Migration. Most governments have laws regulating the level of immigration. In theory, countries with declining populations could raise immigration, but this option may be unattractive for social, economic or cultural reasons.

- Momentum. The age structure of a population cannot be changed, but momentum can be offset by raising the age at first birth and by wider spacing between births. These changes reduce the number of births occurring in future years, independent of the number of births women have over their lifetimes. Delays in early marriage and early first birth have a range of beneficial effects on the welfare of girls and women independent of the demographic effects (Bongaarts, 1994).

Governments have a variety policies at their disposal to address adverse demographic trends. The debate about which of these to implement in a particular country at a given point in time should partly be informed by the magnitude of the components of population growth as documented in this report.

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