United Nations | Department of Economic and Social Affairs

Global Population Growth and Sustainable Development

United Nations Department of Economic and Social Affairs, Population Division

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Global Population Growth and Sustainable Development

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Contents

Notes on regions, development groups, countries or areas

In this report, data for countries and areas are often aggregated in six continental regions: Africa, Asia, Europe, Latin America and the Caribbean, Northern America, and Oceania. Further information on continental regions is available from https://unstats.un.org/unsd/methodology/m49/. Countries and areas have also been grouped into geographic regions based on the classification being used to track progress towards the Sustainable Development Goals of the United Nations (see: https://unstats.un.org/sdgs/indicators/regional-groups/).

The designation of "more developed" and "less developed", or "developed" and "developing", is intended for statistical purposes and does not express a judgment about the stage in the development process reached by a particular country or area. More developed regions comprise all countries and areas of Europe and Northern America, plus Australia, New Zealand and Japan. Less developed regions comprise all countries and areas of Africa, Asia (excluding Japan), Latin America and the Caribbean, and Oceania (excluding Australia and New Zealand).

The group of least developed countries (LDCs) includes 47 countries, located in sub-Saharan Africa (32), Northern Africa and Western Asia (2), Central and Southern Asia (4), Eastern and South-Eastern Asia (4), Latin America and the Caribbean (1), and Oceania (4). Further information is available at http://unohrlls.org/about-ldcs/.

The group of Landlocked Developing Countries (LLDCs) includes 32 countries or territories, located in sub-Saharan Africa (16), Northern Africa and Western Asia (2), Central and Southern Asia (8), Eastern and South-Eastern Asia (2), Latin America and the Caribbean (2), and Europe and Northern America (2). Further information is available at http://unohrlls.org/about-lldcs/.

The group of Small Island Developing States (SIDS) includes 58 countries or territories, located in the Caribbean (29), the Pacific (20), and the Atlantic, Indian Ocean, Mediterranean and South China Sea (AIMS) (9). Further information is available at http://unohrlls.org/about-sids/.

The classification of countries and areas by income level is based on gross national income (GNI) per capita as reported by the World Bank (July 2021). These income groups are not available for all countries and areas.

Preface

The present report, *Global Population Growth and Sustainable Development*, examines the linkages between global population growth and the social, economic and environmental dimensions of sustainable development. It is organized in four sections.

As an introduction to the topic, Part A provides an overview of population growth as a demographic process, briefly analyses its connections to human development, explores the challenge that it presents for environmental sustainability and reviews its history in the context of international conferences and agreements. Part B, *Population growth and its drivers*, explains how the current rapid growth of the human population is a consequence of the demographic transition—the historic shift towards longer lives and smaller families that has been a universal feature of social and economic development in recent centuries. Using the 2019 United Nations population estimates and projections, it describes how the growth of the global population is shaped by trends in the three components of growth—fertility, mortality and international migration—which vary considerably across countries and regions and over time. Part B also discusses how population trends possess a momentum affecting future trends and making them relatively predictable and inflexible over the next few decades.

Part C, *Socioeconomic causes and consequences of population growth*, investigates the social and economic processes that interact in myriad ways with demographic change and population growth. The discussion focuses on several interrelated themes, including the challenge of leaving no one behind, a key promise of the 2030 Agenda for Sustainable Development,[1] in the face of a growing global population. The chapters of part C examine linkages between population growth and various aspects of social and economic development, including poverty and inequality, hunger, food security and nutrition, health and well-being, education, gender equality and women's empowerment, and sustained economic growth and decent work. Part D, *Impacts of population growth on the environment*, focuses on the relationship between population growth and environmental sustainability, including an analysis of the role of population increase in climate change alongside other influences, including energy efficiency, sustainable consumption and production, and sustainable food systems.

The report is part of a series on major demographic trends being prepared by the Population Division of the United Nations Department of Economic and Social Affairs. Reports in the series investigate the linkages between demographic processes, social and economic development, and environmental change. Following the analysis of global population growth presented here, subsequent reports will examine issues related to population ageing and international migration. The main purpose of the series is to provide basic information and informed analysis of population patterns and trends in a manner that is accessible to a general audience and that can help to guide the policymaking of Member States and the deliberations of the United Nations Commission on Population and Development.

[1] A/RES/70/1

Executive summary

Since the middle of the twentieth century, world population has more than tripled in size, rising from around 2.5 billion in 1950 to almost 7.9 billion in 2021. Projections by the United Nations suggest that the size of the global population could grow to almost 11 billion by the end of the twenty-first century, when it is expected to stabilize. A growth rate close to zero around 2100 would signal the end of the current era of rapid population growth, which began around 1800 in some regions and in the middle of the twentieth century on a global scale.

The unprecedented growth of the global population that has occurred since 1950 is the result of two trends: on the one hand, the gradual increase in average human longevity due to widespread improvements in public health, nutrition, personal hygiene and medicine, and on the other hand, the persistence of high levels of fertility in many countries. The pace of world population growth has slowed considerably since around 1970, as fertility levels have fallen in varying degrees throughout the world. Today, there is substantial variation in levels of mortality and fertility and in rates of population growth across countries and regions. Countries span a wide demographic continuum, from populations that are youthful and growing rapidly to those that are older and growing slowly if at all. Over time, as the latter group of countries has grown, it has come to include a growing number where fertility has remained at very low levels for several decades and where the size of the population has thus begun to decline.

The continuing high levels of fertility that drive the rapid growth of populations in many low-income and lower-middle-income countries are both a symptom and a cause of slow progress in development. The world's poorest countries have some of the fastest growing populations: the total population of low-income countries is projected to nearly double in size between 2020 and 2050. In this context, sustained rapid population growth adds to the challenges of achieving social and economic development and magnifies the scale of the investments and effort required to ensure that no one is left behind. Rapid population growth makes it more difficult for low-income and lower-middle-income countries to afford the increase in public expenditures on a per capita basis that is needed to eradicate poverty, end hunger and malnutrition, and ensure universal access to health care, education and other essential services.

High fertility and rapid population growth are often linked to a lack of autonomy and opportunity among women and girls. Achieving the Sustainable Development Goals (SDGs) of the 2030 Agenda for Sustainable Development, especially targets related to reproductive health, education and gender equality, requires empowering individuals to make choices that are likely to contribute to a reduction in the pace of global population growth. Today, millions of people around the globe, mostly in low-income and lower-middle-income countries, lack access to the information and services needed to determine whether and when to have children. In this situation, women and girls are often unable to exercise their full range of rights, including reproductive rights, resulting in high levels of childbearing over the life course and increasing the probability of poor outcomes for both mothers and their children.

In addition to driving rapid population growth, continuing high levels of fertility in some regions, combined with lower levels of mortality especially at younger ages, have helped to maintain a relatively youthful global age distribution. From a purely demographic perspective, a youthful age structure ensures that the global population will continue to grow even if average fertility drops immediately to the "replacement level", at which each generation bears the exact number of children needed to replace itself. Despite a drop to replacement-level fertility, the world's population would continue to grow in this situation because of a

continuing increase in the number of women of reproductive age over the next few decades. Indeed, fully two thirds of the anticipated increase in global population between 2020 and 2050 will be driven by the momentum of growth embedded in the relatively youthful age distribution of the world's population in 2020.

A youthful population presents an opportunity for accelerated economic growth on a per capita basis, if countries where the population is growing rapidly achieve a substantial and sustained decline in the fertility level, leading to an increased concentration of the population in the working-age range. However, reaping the maximum potential benefit of this "demographic dividend" also requires sufficient improvements in education, health and gender equality and in access to productive employment and decent work. Under these conditions, lower levels of fertility and smaller cohorts of dependent children and youth create a window of opportunity for accelerated economic and social development. Such changes can also contribute to a slower pace of world population growth and mitigate the increased environmental pressures associated with economic growth and magnified by population increase.

Environmental damage often arises from economic processes that lead to higher standards of living for the population, especially when the full social and environmental costs, such as damage from pollution, are not factored into economic decisions about production and consumption. Population growth amplifies such pressures by adding to total economic demand. However, the countries that have been contributing the most to unsustainable patterns of production and consumption are generally those where income per capita is high and the population is growing slowly if at all, not those where income per capita is low and the population is growing rapidly.

Moving the global economy towards greater sustainability will require a progressive decoupling of the growth in population and in economic activity from a further intensification of resource extraction, waste generation and environmental damage. Limiting climate change and global warming, for example, will require rapid progress in decoupling economic activity from the current over-reliance on fossil fuels.

Charting a path toward sustainability will depend critically on humanity's capacity and willingness to mitigate the deleterious impacts of human activities on the global environment. In the 2030 Agenda for Sustainable Development, Governments agreed on the importance of moving toward sustainable patterns of consumption and production, with the developed countries taking the lead and with all countries benefiting from the process. The greater emphasis on the responsibility of developed countries adheres to the principle of "common but differentiated responsibilities", an aspect of international environmental law affirming that all states are responsible for addressing global environmental destruction yet not equally responsible.[1]

Countries where the population is still growing rapidly tend also to have high levels of poverty and hunger and to face other serious challenges affecting their progress in development. Because of their delayed social and economic development, these countries are poorly equipped to mitigate or adapt to environmental threats.

To end poverty and hunger, achieve the SDGs related to health, education and access to decent work, and build the capacity to address environmental challenges, the economies of low-income and lower-middle-income countries need to grow much more rapidly than their populations, requiring greatly expanded investments in infrastructure as well as increased access to affordable energy and modern technology in all sectors. Wealthy countries and the international community can help to ensure that these countries receive the necessary technical and financial assistance so that their economies can grow using technologies that will minimize future greenhouse gas emissions.

[1] Rio Declaration on Environment and Development (Principle 7), 1992, and United Nations Framework Convention on Climate Change, 1994.

A path towards a more sustainable future requires demographic foresight, which involves anticipating the nature and consequences of major population shifts before and while they occur and adopting forward-looking and proactive planning guided by such analysis. In working to achieve sustainable patterns of consumption and production and to reduce the impacts of human activity on the environment, it is important to recognize that plausible future trajectories of world population lie within a relatively narrow range, especially in the short or medium term. Over the next 30 or 40 years, a slowdown in global population growth that is substantially faster than anticipated in the United Nations projections seems highly unlikely. Even though the pace of global population growth will continue to decline in the coming decades, world population is likely to be between 20 and 30 per cent larger in 2050 than in 2020.

Having accurate estimates of population trends and reliable forecasts of future changes, including for the size of populations and their distributions by age, sex and geographical location, is required for policy formulation and implementation and as a guide to assist countries in following a path towards sustainable development. However, there are still many gaps in the available data.

Demographic data are an essential public good and are most useful if freely available to all. Population estimates and projections, such as those published at the global level by the United Nations in the *World Population Prospects* series, provide essential data for monitoring progress towards achieving internationally agreed development goals. Improving data literacy and fostering the ability to interpret demographic information correctly are essential. Literacy in the case of demographic data should include an understanding of its inherent limitations and uncertainties, in particular for population projections.

Part A. Introduction

“Haitian Students Breathe New Life into Depleted Pine Forest”,
UN Photo/Logan Abassi

Chapter 1. The era of rapid population growth

The world's population, which numbered around 7.8 billion in 2020, has been growing rapidly and is expected to continue to grow in the coming decades, albeit at a progressively slower pace. Projections by the United Nations suggest that the size of the global population could rise to almost 11 billion by the end of the twenty-first century. The size of the global population is expected to stabilize around 2100, bringing an end to the current era of rapid growth that began around 1800 in some regions and in the middle of the twentieth century on a global scale. Plausible future trajectories of world population in the short or medium term lie within a relatively narrow range. Over the next 30 or 40 years, a slowdown in global growth that is substantially faster than anticipated in the United Nations projections is unlikely.

Since the middle of the twentieth century, the world's population has grown rapidly, rising from around 2.5 billion in 1950 and reaching an estimated 7.8 billion in 2020. The size of the global population is projected to climb to 8.5 billion in 2030, the target date for achievement of the Sustainable Development Goals (SDGs). From there, it is projected to continue rising to around 9.7 billion in 2050 and 10.9 billion in 2100. Such rapid growth was unprecedented in human history prior to the industrial era. It is a direct consequence of a process known as the "demographic transition", in which decreasing levels of mortality and fertility lead to longer lives and smaller families. The transition often unfolds in a series of stages, during which population growth first accelerates and then slows down (box 1.1).

Globally, population growth is shaped entirely by trends in fertility and mortality; at the national or regional level, international migration can also play an important part. Historical levels and trends in these three variables determine the demographic characteristics of the current population, including its distribution by age, which can be a source of momentum that helps to drive future trends.

Over the past 70 years, reductions in mortality levels, particularly at younger ages, have contributed significantly to population growth (chap. 5). Various social and economic changes have led to higher standards of living and a healthier life in general. These changes include the increased availability of safe and nutritious foods; improvements in public health, sanitation, housing, working conditions and educational attainment; and advances in the prevention and treatment of disease (Desai and Alva, 1998; Lleras-Muney, 2005; Santow, 2001). Despite these gains, significant disparities in life expectancy at birth remain across countries and regions. High levels of infant and child mortality persist in many regions even though such deaths are largely preventable (chaps. 5 and 12).

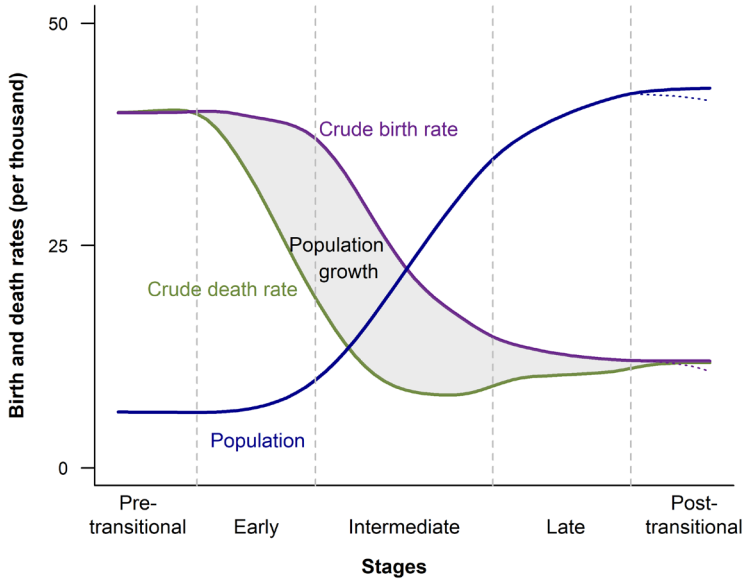
Box 1.1

Population growth and the demographic transition

Before the onset of the demographic transition, the size of a population is relatively stable, as high levels of fertility are offset by comparably high levels of mortality (figure 1.1). Accelerated growth begins early in the transition, after mortality rates have begun to decline, especially among infants and children, while the fertility level remains high. In an intermediate stage, mortality declines further, and fertility starts to decline as well (Bongaarts, 2009). During this stage, the population grows rapidly thanks to the large and sustained excess of births over deaths. As the transition moves forward, population growth decelerates as birth and death rates come back into balance at historically low levels. The death rate tends to rise in the later stages due to population ageing, as a larger proportion of the population becomes concentrated at older ages with higher mortality risks. Once the transition is complete, the population growth rate is typically quite close to zero and may even become negative if fertility falls to low levels. In that case, the number of deaths may come to exceed the number of births resulting in a decline of population size (dashed trend lines, figure 1.1).

Figure 1.1

Schematic representation of the demographic transition



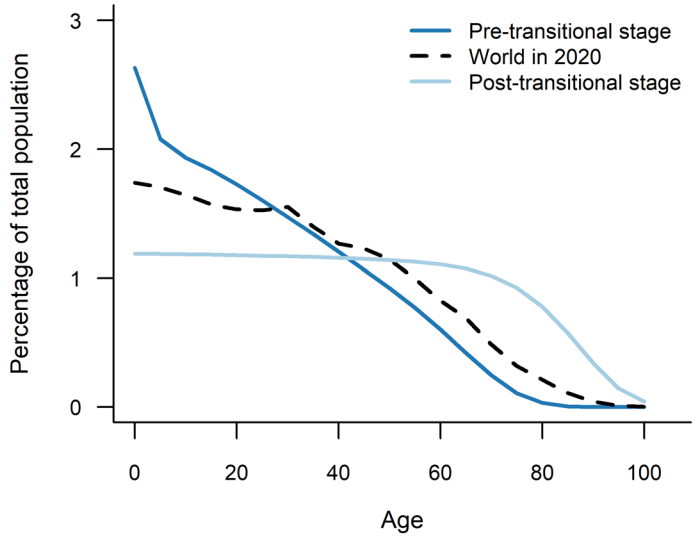
Source: Calculations by the United Nations (2019).

Notes: (1) The crude birth (or death) rate is the annual number of live births (or deaths) divided by the population size at the midpoint of the observation period. Both rates are expressed as the number of births or deaths per 1,000 population per year. (2) The schematic representation of the demographic transition refers to a population that is closed to migration, in which growth is due entirely to the gap between births and deaths.

In addition to its impact on population size, the demographic transition also has a profound effect on the age distribution of a population (figure 1.2). Prior to the transition, when levels of both fertility and mortality are high, many people die before reaching adulthood, and few survive to advanced ages. As more and more children survive the perils of early life, the proportion of the population at younger ages increases; however, this effect is temporary and lasts only until the fertility level declines as well. In the later stages of the transition, when both fertility and mortality have fallen substantially, each successive generation is similar in size to the previous one, and most people survive to advanced ages.

Figure 1.2

Population age distribution: Schematic representation before and after the demographic transition, and as observed for the world in 2020



Source: Calculations by the United Nations (2019).

Although the schematic representation of the demographic transition may differ from reality for many populations (figure 1.1), an historic shift from high to low levels of fertility and mortality has been a universal feature of the economic and social development of the industrial era (Davis, 1945; Livi-Bacci, 2017). Today, no country is in the pre-transitional stage, with historically high levels of mortality and fertility. Some 40 countries and areas, or about 20 per cent of the total, are still in an early stage of the transition.[1] In such countries or areas, located almost exclusively in sub-Saharan Africa, the population is projected to continue growing through the end of the current century.

Roughly one third of countries and areas globally (34 per cent) are now in an intermediate stage of the demographic transition, including most of Northern Africa and Western Asia, Central and Southern Asia, and Oceania excluding Australia and New Zealand, and about half of the countries and areas in Latin America and the Caribbean. Nearly half of all countries and areas worldwide (46 per cent) are in a late stage of the transition or in a post-transitional stage, including Australia and New Zealand, all parts of Europe and Northern America, most of Eastern and South-Eastern Asia and about half of the countries and areas in Latin America and the Caribbean.

[1] A country or area was considered at an early stage of the demographic transition in 2015-2020 if its life expectancy at birth (LE) was lower than 65 years and its total fertility rate (TFR) was at least 4 live births per woman over her reproductive lifetime; at an intermediate stage when LE was between 65 and 75 and the TFR was between 2.1 and 4; and at a late stage when LE was 75 or higher and TFR was below 2.1. However, for 53 countries, the stage implied by its TFR differed from that suggested by its level of LE. In such cases, the fertility level was given precedence in determining the appropriate classification.

While the mortality decline drove growth, reductions in fertility have slowed down the pace of global population growth, which reached a peak in the late 1960s (chap. 6). Improvements in child survival and the creation or expansion of social protection systems have reshaped parental attitudes towards large families (Caldwell, 2006; chap. 9). Parents' higher aspirations regarding education, standards of living and material well-being, both for themselves and for their children, along with the opportunity costs of bearing and rearing children, especially for women, are other factors that have reduced the number of children that parents desire (Schultz, 2001; Cette and others, 2007; Galor, 2012; Kirk, 1996; Demeny, 2011; chaps. 13, 14 and 15). At the same time, advances in the recognition of women's rights and the increased availability of safe and effective methods of contraception have enabled people, women in particular, to make decisions and to exercise effective control over the number of children that they bear and the timing of their births (Cleland and Wilson, 1987; Bongaarts and Watkins, 1996).

Today, all countries and areas have seen at least the start of a transition towards low levels of fertility. While some completed the transition more than a century ago, others are still in the early phases with relatively high total fertility rates, including many countries in sub-Saharan Africa. By the end of the century, all regions except sub-Saharan Africa are projected to have fertility rates below the replacement level (box 6.1). With its fertility expected to remain relatively high throughout the century, sub-Saharan Africa will have a significant impact on the future growth of the global population (chaps. 4 and 6).

The annual number of births in a population depends both on the fertility level and on the number of women of reproductive age. The relative youthfulness of today's global population (a result of both the mortality decline at younger ages and the historically high levels of fertility that persisted until recently in many countries) ensures that the number of women of reproductive age will continue to increase for years and even decades. Fully two thirds of the anticipated increase in world population between 2020 and 2050 will be driven by the relatively youthful age distribution of the global population in 2020 (chap. 8). Given the large number of women and girls already living on the planet who are, or will soon be, of childbearing age, a slowdown in global growth over the next three or four decades that is substantially faster than anticipated in the population projections of the United Nations is unlikely even with an accelerated drop in the average number of births per woman (chap. 3). With a longer time horizon, the influence of today's age structure will fade, and population growth will depend increasingly on the future course of mortality and, especially, fertility.

Although international migration does not have a direct impact on population growth globally, in some countries and regions, its direct contribution to growth has been significant — in particular for countries of the Gulf Cooperation Council, but also for many countries in Europe and Northern America as well as for Australia and New Zealand. In addition, immigration can also contribute indirectly to population growth, both by lowering the average age of the population and by temporarily raising the average level of fertility in countries of destination (Adserà and Ferrer, 2015; Woldemicael and Beaujot, 2012). Among countries where fertility levels are very low, immigration has in some cases attenuated or even reversed an actual or potential decline in population size (chap. 7).

Population trends in the long run are highly uncertain, especially for high-fertility countries still in the early stages of the demographic transition. Increasing uncertainty over time is reflected in a widening band of prediction intervals for projections of the number of births and of the size of the total population at dates farther into the future (chap. 3). Even though reductions in fertility over the next few years can have only a limited effect on population growth between now and 2050 or 2060, a fertility decline in the near term will

have important consequences for growth in the last decades of the century, as its impact on population size cumulates from one generation to the next. "In a very real sense, today's births are tomorrow's momentum. The more concerned we are with long-range futures, the more important are population policies in the array of strategies for enhancing the human condition" (Preston, 1994).

One consequence of a rapid and sustained decline in fertility is the so-called demographic dividend (box 1.2). The dividend is usually described as a window of opportunity for countries with relatively youthful populations to accelerate their economic and social development by redirecting resources freed up by having fewer children, at both the societal and familial levels, towards improving educational and health outcomes and raising standards of living (Bloom and others, 2003; chaps. 12 and 13). While the demographic circumstances underlying the dividend are conducive to rapid economic growth on a per capita basis, reaping the maximum potential benefit requires sufficient improvements in education, health, gender equality and gainful employment (chap. 15).

Because of the temporary nature of the demographic dividend, it is important to take advantage of the favourable age distribution while it lasts (Lee and Reher, 2011; Guengant, 2012). In many high-income and upper-middle-income countries, this demographic window of opportunity has already closed. Countries still in an early stage of the demographic transition, however, have an opportunity to maximize the boost in economic growth made possible by the decline in fertility by promoting investments to support the formation human capital and to strengthen capacities across the age range (chaps. 9 and 15).

Box 1.2

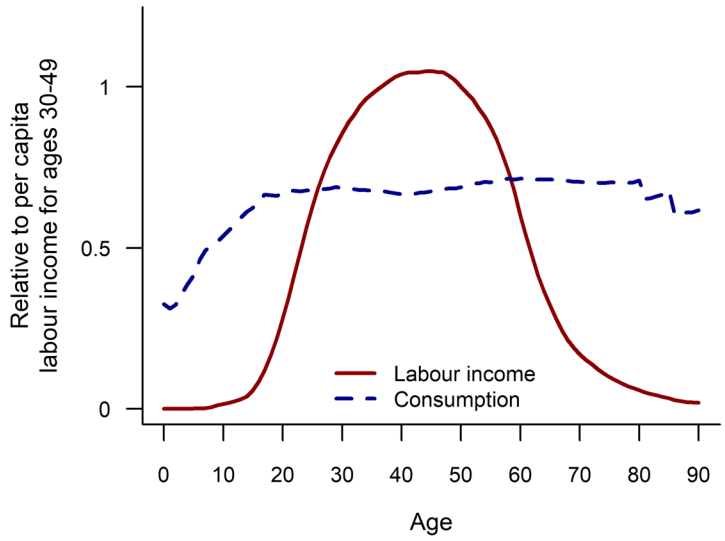
The demographic dividend

The demographic transition profoundly transforms the age distribution of a population. In the intermediate stage of the transition, the base of the population pyramid starts to narrow, as the relative size of successive birth cohorts begins to decline due to the ongoing reduction of fertility. Since the decline at younger ages is not immediately counterbalanced by increases at older ages, the share of population in the working ages grows temporarily relative to the combined shares at younger and older ages. The population of working-age adults remains relatively large for several decades, until eventually population ageing generates a substantial increase in the percentage of persons at older ages (Lee and Mason, 2006).

In most societies, children and older persons consume on average more than they produce through their current labour. This deficit must be balanced by excess production among persons in the prime working ages (roughly, between ages 25 and 60), for whom the amount of labour income exceeds expenditures for consumption on average (figure 1.3). A rapid and sustained reduction in the fertility level results in a population age distribution in which the most highly productive years are temporarily overrepresented. The enlarged share of potential workers leads automatically to an increase in income per capita, assuming that output per worker and levels of engagement in the labour force remain unchanged (Bloom and others, 2003; Mason and Lee, 2018).

Figure 1.3

Age patterns of labour income and consumption, averaged across 41 countries using latest available data (between 1994 and 2016)



Source: Computed using data from the National Transfer Accounts project. Available at https://ntaccounts.org. Accessed on 23 August 2021.

Note: Age patterns of consumption and labour income are shown relative to the average labour income for ages 30-49.

References

Adserà, A., and A. Ferrer (2015). Immigrants and demography: Marriage, divorce, and fertility. In *Handbook of the economics of international migration,* vol. 1, pp. 315–374. B. R. Chiswick and P. W. Miller eds. North Holland: Elsevier.

Bloom, D. E. D., and others (2003). *The demographic dividend: A new perspective on the economic consequences of population change*. RAND Population Matters Program, N° MR1274. Santa Monica. Available at https://rand.org/content/dam/rand/pubs/monograph_reports/2007/MR1274.pdf.

Bongaarts, J. (2009). Human population growth and the demographic transition. *Philosophical Transactions of the Royal Society*, vol. 364, pp. 2985-2990.

Bongaarts J., and W. S. Cotts (1996). Social interactions and contemporary fertility transitions. *Population and Development Review*, vol. 22, No. 4, pp. 639-682.

Caldwell, J. C. (2006). *Demographic Transition Theory.* Springer. Available at https://link.springer.com/content/pdf/bfm%3A978-1-4020-4498-4%2F1.pdf.

Cette, G., and others (2007). Opportunity costs of having a child, financial constraints and fertility. *Applied Economics Letters*, vol. 14, No. 4, pp. 239-244.

Cleland, J., and C. Wilson (1987). Demand theories of the fertility transition: An iconoclastic view. *Population Studies*, vol. 41, pp. 5-30.

Davis, K. (1945). The world demographic transition. *The Annals of the American Academy of Political and Social Science*, vol. 237, No. 1945, pp. 1-11.

Demeny, P. (2011). Population policy and the demographic transition: Performance, prospects, and options. *Population and Development Review*, vol. 37, Issue s1, vii, pp. 249-274.

Desai, S., and S. Alva (1998). Maternal education and child health: Is there a strong causal relationship? *Demography,* vol. 35, pp. 71–81.

Galor, O. (2012). The Demographic Transition: Causes and Consequences. *Cliometrica*, vol. 6, No. 1, pp.1-28.

Guengant, J.P. (2012). How Can We Capitalize on the Demographic Dividend? *A Savoir*, L'Agence Française de Développement. Available at https://afd.fr/en/ressources/how-can-we-capitalize-demographic-dividend-demographics-heart-development-pathways.

Kirk, D. (1996). Demographic transition theory. *Population Studies*, vol. 50, No. 3, pp. 361-387.

Lleras-Muney, A. (2005). The relationship between education and adult mortality in the United States. *Review of Economic Studies*, vol. 72, pp. 189–221.

Lee, R. D., and D. S. Reher (2011). Transition and Its Aftermath. *Population and Development Review*, vol. 37, Issue s1, pp. 1-7.

Lee, R., and A. Mason (2006). What is demographic dividend? *Finance and Development*, vol. 43, No. 3. Available at www.imf.org/external/pubs/ft/fandd/2006/09/basics.htm.

Livi-Bacci, M. (2017). *A Concise History of World Population*. Wiley-Blackwell; 6th edition.

Mason, A., and R. Lee (2018). Intergenerational transfers and the older population. In *Future Directions for the Demography of Aging: Proceedings of a Workshop*, M.D. Hayward and M.K. Majmundar, eds. National Academies of Sciences, Engineering, and Medicine. The National Academies Press.

Preston, S. (1994). Population and the Environment. International Union for the Scientific Study of Population. *Distinguished Lecture Series on Population and Development*.

Santow, G. (2001). Mortality, epidemiological, and health transitions. In *International Encyclopedia of the Social and Behavioral Sciences*, Neil J. Smelser, Paul B. Baltes, eds. Pergamon, pp. 10071-10075.

Schultz, P. (2001). The Fertility Transition: Economic Explanations. Economic Growth Center, Yale University, Working Papers.

United Nations (2019). *World Population Prospects. Online edition. Rev.1*. Available at https://population.un.org/wpp/. Accessed on 15 October 2020.

Woldemicael, G., and R. Beaujot (2012). Fertility behavior of immigrants in Canada: Converging trends. *Journal of International Migration and Integration*, vol. 13, No. 3, pp. 325-341.

Chapter 2. Why population growth matters for sustainable development

Charting a path towards a more sustainable future requires demographic foresight: anticipating the nature and the consequences of major population shifts before and while they occur and adopting forward-looking and proactive policies guided by such analysis. Today, in many low-income and lower-middle-income countries, rapid population growth adds to the challenges of achieving social and economic development. The continuing high levels of fertility that drive such growth are both a symptom and a cause of slow progress in development, often linked to a lack of choice and empowerment among women and girls. Achieving the Goals and targets of the 2030 Agenda, especially those related to reproductive health, education, women's empowerment and gender equality, would likely contribute to slowing the pace of global population growth. Yet, changes in population trends alone will do little to resolve unsustainable patterns of resource use. Achieving sustainability will depend critically on humanity's capacity and willingness to increase resource efficiency in consumption and production and to decouple economic growth from damage to the environment, with high-income and upper-middle-income countries taking responsibility and leading by example.

Rapid population growth is both a cause and a consequence of slow progress in development. In low-income and lower-middle-income countries facing multiple challenges with limited resources, rapid population increase may slow progress in reaching certain Goals and targets of the 2030 Agenda for Sustainable Development (box 2.1). Although it is only one of many factors, the continuing growth of population in resource-poor settings enlarges the scale of existing challenges, such as eradicating poverty, ending hunger and ensuring that all people have sufficient access to safe and nutritious food (chaps. 10 and 11). In a similar manner, rapid population growth may also add to the difficulties of ending preventable and treatable diseases and conditions, ensuring inclusive and equitable education and schooling, and promoting full and productive employment and decent work for all (chaps. 9, 12, 13 and 15).

The world's poorest countries have some of the fastest growing populations: the total population of low-income countries is projected almost to double in size between 2020 and 2050 (chap. 4), and sub-Saharan Africa will account for most of the global increase expected by the end of the century (figure 2.1; chap. 4). In these countries, a rapid rise in public expenditures on a per capita basis will be needed to eradicate poverty, end hunger and malnutrition, and ensure universal access to health care, education and other essential services. In such settings, rapid population growth adds to the urgency of achieving these objectives while also magnifying the scale of the investments and effort required (chaps. 10, 11, 12 and 13).

Box 2.1

Population and sustainable development at the United Nations conferences on population

The debate about whether or for how long the planet can sustain a growing population has a long history. Concerns that population growth might outstrip food production inspired Thomas Malthus in 1798 to call on people to limit their fertility by delaying marriage and practicing abstinence within marriage. Although technological innovation foiled some of Malthus' more dire predictions (Trewavas, 2002), a similar narrative about the rapid growth of the human population has played an important role in shaping more recent discussions of environmental sustainability and overpopulation (Robertson, 2012). The notion that human numbers, even more than human behaviours, comprise the central obstacle to a sustainable future is well entrenched.

In addition to concerns about the aggregate impact of population growth on the planet, discussions of the nexus between population growth and development have been shaped by a parallel discussion of women's rights, including reproductive rights. The latter include the right to make decisions concerning reproduction free of discrimination, coercion and violence. Gender equality, reproductive rights and universal access to sexual and reproductive health-care services, including for family planning, information and education, have been identified as critical elements for the achievement of social and economic development (Das Gupta, Bongaarts and Cleland, 2011; Eager, 2004).

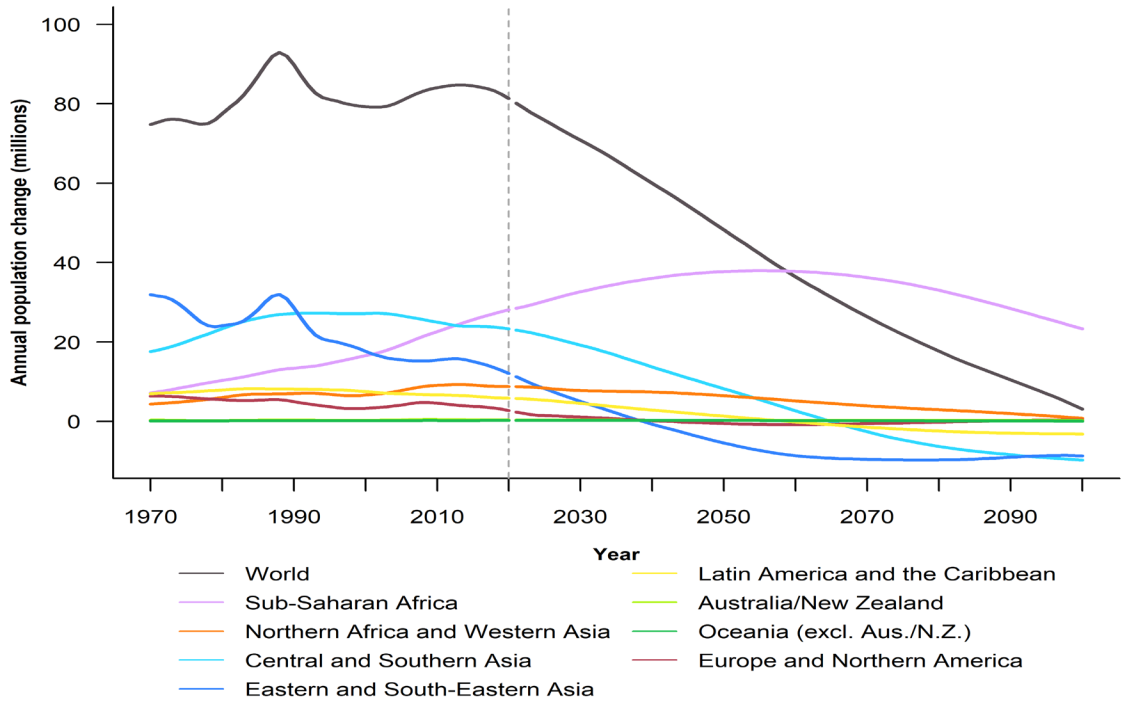
Concerns about the economic situation of developing countries, about the sustainability of human economic activity and about the promotion and protection of reproductive rights have all been prominent topics at the United Nations conferences on population. These conferences showcased a range of views, with some identifying population growth as a serious impediment to development, some regarding it as a consequence rather than a cause of slow progress in development, and others describing the causal relationship between population growth and sustainable development as bi-directional (Critchlow, 1995; McIntosh and Finkle, 1995).

The International Conference on Population and Development (ICPD), held in Cairo in 1994, embraced the latter position, recognizing that efforts to slow population growth, reduce poverty, achieve economic progress, improve environmental protection, and reduce unsustainable consumption and production patterns were mutually reinforcing. The Programme of Action adopted in Cairo explicitly recognizes issues of women's empowerment, gender equality and reproductive rights, as well as the importance of male responsibility in domains traditionally regarded as a woman's sphere (Pollack Petchesky, 1995).

The 2030 Agenda for Sustainable Development, adopted by the General Assembly in 2015, echoes the ideals set forth in the Cairo document. The 2030 Agenda also reiterates the commitment to ensuring universal access to sexual and reproductive health care and to protecting and promoting reproductive rights, in accordance with the Cairo Programme of Action and the Beijing Platform for Action and with the outcome documents of their review conferences.

Figure 2.1

Annual population change: estimates, 1970-2020, and projections, 2020-2100, world and regions



Source: United Nations (2019a).

For many low-income countries, including some Small Island Developing States (SIDS), the challenges of achieving sustainable development in the context of a rapidly growing population are compounded by their vulnerability to the adverse impacts of climate change, including rising sea levels. People living in these countries are often more vulnerable because they lack access to the resources needed for adaptation and coping. As the world's population continues to grow, improving the lives of those farthest behind should include efforts to reduce their vulnerability and increase their resilience in the face of environmental change, including extreme climate conditions and variability (chaps. 9 and 17).

In addition to compounding the difficulties of achieving sustainable development in some countries, in some situations rapid population growth and associated high levels of fertility are also a symptom of slow progress in development. People trapped in poverty may lack access to the information and services needed to control the number and timing of their children (chaps. 10 and 14). Women and girls who are denied access to education, or who live in societies where they cannot exercise their full range of rights, may be forced into a marriage or other union at a young age and may have their first experience of pregnancy and childbirth starting in adolescence. Such circumstances often result in higher levels of fertility over the life course and bring greater risks of poor health and educational outcomes for both mothers and their children. Achieving the Goals and targets of the 2030 Agenda, particularly those related to reproductive health, education and empowerment of women and girls, could in the long run accelerate the ongoing slowdown in population growth worldwide; this would have the effect of moving forward the date when the world's population may stop growing and of reducing its peak size (Abel and others, 2016; Banerjee and Duflo, 2011).

Although the environmental and ecological impacts of human activity have been studied extensively, there is no scientific consensus about the planet's ultimate carrying capacity for human life (Cohen, 1995; Pengra, 2012; de Sherbinin and others, 2007). Holding other factors constant, a growing global population places increasing pressure on the earth's natural resources, in particular common property resources like air and water, whose use is not well regulated by market forces. However, population increase is not the only factor underlying this pressure: rising living standards and changing patterns of production and consumption are typically just as important as, and often much more important than, population increase as a cause of environmental damage (chap. 16).

While there remains great uncertainty about future consumption and production patterns, according to the United Nations' International Resources Panel, about 70 per cent of the anticipated global increase in the use of natural resources through 2050 will be attributable to an increase in consumption per capita, while about 30 per cent will be attributable to population growth (UNEP, 2017). In short, satisfying the increasing demand for resources and managing the aftereffects of their use would pose major challenges even if global population growth came immediately to an end.

A central challenge of sustainable development is how to promote sustained economic growth without further increasing the adverse impacts of economic activity on the environment (chaps. 15 and 16). Strategies to decouple trends in economic growth and human development from trends in resource use and environmental degradation are essential. These can involve lessening the reliance on fossil fuels and other non-renewable, high-intensity resources; increasing the efficiency of resource use; reducing emissions and waste from extraction, production, consumption and disposal; extending product life cycles through intelligent product design and standardization to encourage reuse, recycling and re-manufacturing; and promoting a shift in consumption patterns towards goods and services with lower energy and material intensity.

One measure of the global impact of economic activity is the material footprint of the human population, defined as the total amount of primary materials required to meet basic needs for food, clothing, water, shelter, infrastructure and other aspects of life. The footprint, which serves as an indicator for monitoring progress towards SDG 8 on sustained, inclusive and sustainable economic growth, and SDG 12 on sustainable consumption and production, has been growing faster globally than both population and the gross domestic product (GDP) (IRP, 2017; United Nations, 2019 and 2021a). Decoupling growth in the material footprint from growth in population and GDP will require a global economic system designed to reduce or eliminate waste and pollution, recycle or reuse existing products and materials, and regenerate natural systems (United Nations, 2019b and 2021b).

The commitment of high-income and upper-middle-income countries to reduce their collective material footprint is critical. Even though in most cases their populations are not expected to grow rapidly (chap. 4), these countries are likely to be responsible for most of the additional pressures that humans will exert on the global environment over the next few decades (Wiedmann and others, 2015; United Nations, 2017a). Continued technological innovation and greatly increased investments in renewable energy, especially solar and wind power, will be needed if low-income and lower-middle-income countries are to achieve sustained economic growth and continuing progress in human development while minimizing the impact of human activity on climate and other natural systems (chap. 17).

Box 2.2

Strengthening the demographic evidence base for sustainable development

Demographic data are essential for development planning and for assessing progress towards the achievement of the Goals and targets of the 2030 Agenda for Sustainable Development. Around a quarter of the indicators approved for use in the global and regional monitoring of progress are calculated using population data produced by the Population Division of the United Nations Department of Economic and Social Affairs. Such data are based on country-specific information derived from population censuses and sample surveys as well as civil registration and vital statistics systems.

Information gathered in a population census is critical for national planning and policymaking, as censuses almost always involve a complete enumeration of the population. Together with sample surveys administered at the household level, censuses provide essential information for assessing progress in the implementation of the 2030 Agenda, including data disaggregated by sex, age and other individual attributes.

Civil registration systems are the preferred source of information for computing statistics on levels and trends in the fertility and mortality of a population, and for tracking changes between censuses in the size of a population and in its distribution by age and sex. In addition to being a source of essential population statistics, the universal registration of births and deaths also helps to ensure access to legal identity for all persons, as called for in SDG target 16.9 on "legal identity for all, including birth registration".

It is critical to strengthen national capacities to collect, use, analyse and disseminate demographic data gathered through civil registration systems and other administrative registers, as well as data coming from population censuses and household surveys. The COVID-19 pandemic disrupted the planning and conduct of population censuses during 2020 and 2021 and has impaired the functioning of registration and reporting systems in many countries. It is important to assess the negative impacts of the pandemic on the timely production of complete and reliable population data and to learn from these experiences how to build more efficient and resilient data systems.

References

Abel, G., and others (2016). Meeting the Sustainable Development Goals leads to lower world population growth. *Proceedings of the National Academy of Sciences*, December, vol. 113, No. 50, pp. 14294-14299.

Banerjee, A., and E. Duflo (2011). *Poor economics: A radical rethinking of the way to fight global poverty*. Public Affairs, New York, 2011.

Cohen, J. E. (1995). *How many people can the earth support?* W. W. Norton, New York, New York, USA.

Critchlow, D. T. (1995). Birth control, population control, and family planning: an overview. *Journal of Policy History*, vol. 7, No. 1, pp. 1-21.

Das Gupta, M., J. Bongaarts, and J. Cleland (2011). Population, poverty, and sustainable development: A review of the evidence. Policy Research Working Paper, No. WPS 5719, World Bank.

de Sherbinin, A., and others (2007). Population and Environment. Annual Review of Environment and Resources, vol. 32, pp. 345–373.

Eager, P. W. (2004). *Global Population Policy. From Population Control to Reproductive Rights*. Ashgate, Aldershot.

International Resource Panel (IRP) (2017). Assessing global resource use: A systems approach to resource efficiency and pollution reduction. A Report of the International Resource Panel. United Nations Environment Programme. Nairobi, Kenya. Available at https://resourcepanel.org/reports/assessing-global-resource-use.

McIntosh, C. A., and J. L. Finkle (1995). The Cairo Conference on Population and Development: A New Paradigm? *Population and Development Review*, vol. 21, No. 2, pp. 223-260.

Pollack Petchesky, R. (1995). From population control to reproductive rights: feminist fault lines. *Reproductive Health Matters*, vol. 3, No. 6, pp. 152-161.

Pengra, B. (2012). *One planet, how many people? A review of earth's carrying capacity*. Available at https://na.unep.net/geas/archive/pdfs/GEAS_Jun_12_Carrying_Capacity.pdf.

Robertson, T. (2012). *The Malthusian Moment: Global Population Growth and the Birth of American Environmentalism*. Rutgers University Press.

Trewavas, A. (2002). Malthus foiled again and again. *Nature*, vol. 418, pp. 668-670.

United Nations (2014). *Principles and Recommendations for a Vital Statistics System, Revision 3*. ST/ESA/STAT/SER.M/19/Rev.3. Available at https://unstats.un.org/.

_____ (2017a). *The Sustainable Development Goals Report 2017*. Available at https://unstats.un.org/sdgs/files/report/2017/TheSustainableDevelopmentGoalsReport2017.pdf.

_____ (2017b). *Principles and Recommendations for Population and Housing Censuses, Revision 3*. ST/ESA/STAT/SER.M/67/Rev.3. Available at https://unstats.un.org/.

_____ (2019a). *World Population Prospects. Online edition. Rev.1*. Available at https://population.un.org/wpp/. Accessed on 15 October 2020.

_____ (2019b). *The Sustainable Development Goals Report 2019*. Available at: https://unstats.un.org/sdgs/report/2019/The-Sustainable-Development-Goals-Report-2019.pdf.

_____ (2021a). *World Social Report 2021: Reconsidering rural development*. Available at: https://un.org/development/desa/dspd/wp-content/uploads/sites/22/2021/05/World-Social-Report-2021_web_FINAL.pdf

United Nations (2021b). *The Sustainable Development Goals Report 2021*. Available at https://unstats.un.org/sdgs/report/2021/The-Sustainable-Development-Goals-Report-2021.pdf.

United Nations Environment Programme (UNEP) (2017). *Resource Efficiency: Potential and Economic Implications. A report of the International Resource Panel*. Ekins, P., Hughes, N., et al. Available at https://resourcepanel.org/sites/default/files/documents/document/media/resource_efficiency_report_march_2017_web_res.pdf.

Wiedmann, T. O., and others (2015). The material footprint of nations. *Proceedings of the National Academy of Sciences*, vol. 112, No. 20, pp. 6271-6276, 19 May 2015.

Part B. Population growth and its drivers

"Provincial Baby Home in DPRK" supported by UNICEF, WFP, UN Photo/David Ohana

KEY MESSAGES

- Since the middle of the twentieth century, the world has experienced unprecedented population growth.
- This growth is projected to continue at a progressively slower pace, until world population reaches a peak around 2100, when the global population is projected to be more than four times as large as in 1950.
- Due to the youthful age distribution of today's global population, the potential impact of fertility reductions on population trends within the next few decades is limited; because of the momentum of past growth, it is unlikely that the reduction in global population increase over the next 30 or 40 years will happen substantially faster than already anticipated in population projections by the United Nations.
- Most of the world's future population growth is expected to take place in low-income and lower-middle-income countries.
- Rapid population growth is a typical feature of the demographic transition from high to low levels of mortality and fertility.
- For many countries, this transition has already ended, and the population is no longer growing; for many others, however, the demographic transition is still at an early stage, and the population is projected to grow rapidly.
- Rapid population growth is a result of one of the greatest successes of social and economic development: the substantial lengthening of the average human lifespan due to improvements in public health, nutrition, personal hygiene and medicine.
- Continuing rapid population growth is partly the result of a failure to ensure that all people, everywhere, have the knowledge, ability and means to determine whether and when to have children.

Chapter 3. Global trends in population growth

The world's population more than tripled in size between 1950 and 2020. Over the coming decades, it is expected to continue growing due to further gains in average life span, continuing high levels of fertility in some countries and a youthful global age distribution. The pace of world population growth has slowed considerably over the past 50 years and is expected to continue to decelerate. Much of the growth anticipated over the next few decades will be driven by the relative youthfulness of the current population age distribution and is therefore very likely to occur. By the end of the twenty-first century, the global population is projected to reach almost 11 billion people. Although such forecasts are inherently uncertain, a substantially faster reduction in global growth is unlikely.

The world's population reached 7.8 billion in mid-2020, 1 billion more than in 2008 and 2 billion above its level in 1996. According to the latest assessment by the United Nations (2019a), the global population is expected to reach 8.5 billion in 2030, the target date for achieving the Sustainable Development Goals. From there, it is projected to continue rising to around 9.7 billion in 2050 and 10.9 billion in 2100.

The growth rate of the world's population reached a peak between 1965 and 1970, when human numbers were increasing by an average of 2.1 per cent per year. Since then, the pace of global population growth has been cut almost in half, falling to reach an average of 1.1 per cent per year in the period from 2015 to 2020. Global population growth is projected to continue slowing down throughout the current century, reaching an annual rate of increase of about 0.5 per cent by 2050 and less than 0.03 per cent by 2100 (figure 3.1). After 1950, it took around 37 years for the world's population to double, surpassing 5 billion inhabitants in 1987. Thereafter, it is estimated that more than 70 years will be required for the global population to double again, rising to over 10 billion by 2060.

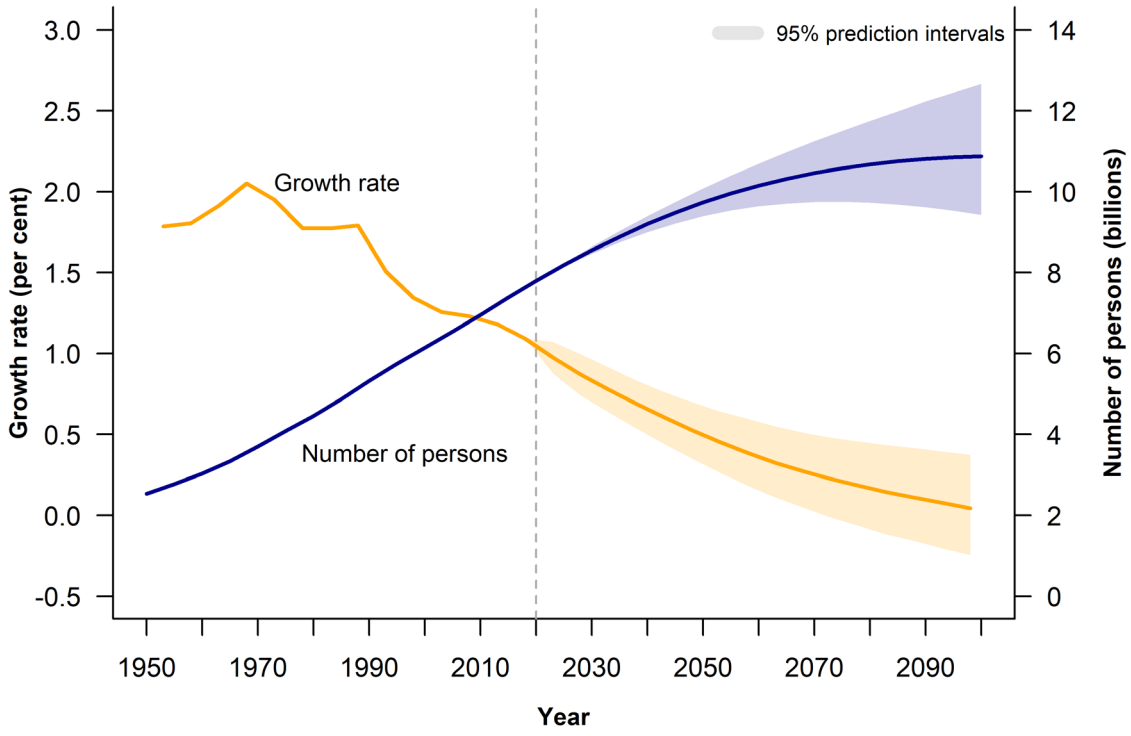
The growth of the human population is embedded within a gradual and universal process of demographic transition during which population growth first accelerates and then slows down (chap. 1). During 2020, the world's population increased by 81 million people, adding to the demand for food, housing, infrastructure, services and decent work, and increasing the pressure on the environment. The increase of 81 million resulted from the difference between 140 million births and 59 million deaths worldwide. By this measure, the peak growth of the human population occurred in the late 1980s, when the annual increment was 92 million. By comparison, the annual growth of the global population is projected to decline to 70 million persons in 2030 and to continue declining throughout the remainder of the twenty-first century, dropping to around 48 million persons in 2050 and 4 million in 2100.

Globally, more than two thirds of the projected increase in population from 2020 until 2050 will be attributable to the momentum associated with today's youthful age distribution, which is itself a product of past growth (chap. 8). Thus, despite an ongoing drop in the average number of births per woman over a lifetime, the annual number of births worldwide is projected to remain around 140 million until 2050, and then to fall steadily through the end of the century (figure 3.2). Similarly, even though mortality rates are expected to continue falling over this period, the total number of deaths worldwide is projected to increase to nearly 93 million in 2050 as a result of population ageing, which shifts the population toward older ages where mortality risks are higher (chap. 5). The balance between more than 140 million births and just under

93 million deaths will yield an annual addition to the global population of almost 48 million persons in 2050. In summary, the growth of the human population is slowing down, and it is expected that it will continue to decelerate, due both to an ongoing gradual increase in the number of deaths due to population ageing and to an eventual reduction in the annual number of births as a result of fertility decline.

Figure 3.1

Global population size and annual growth rate: estimates, 1950-2020, and projections with prediction intervals, 2020-2100



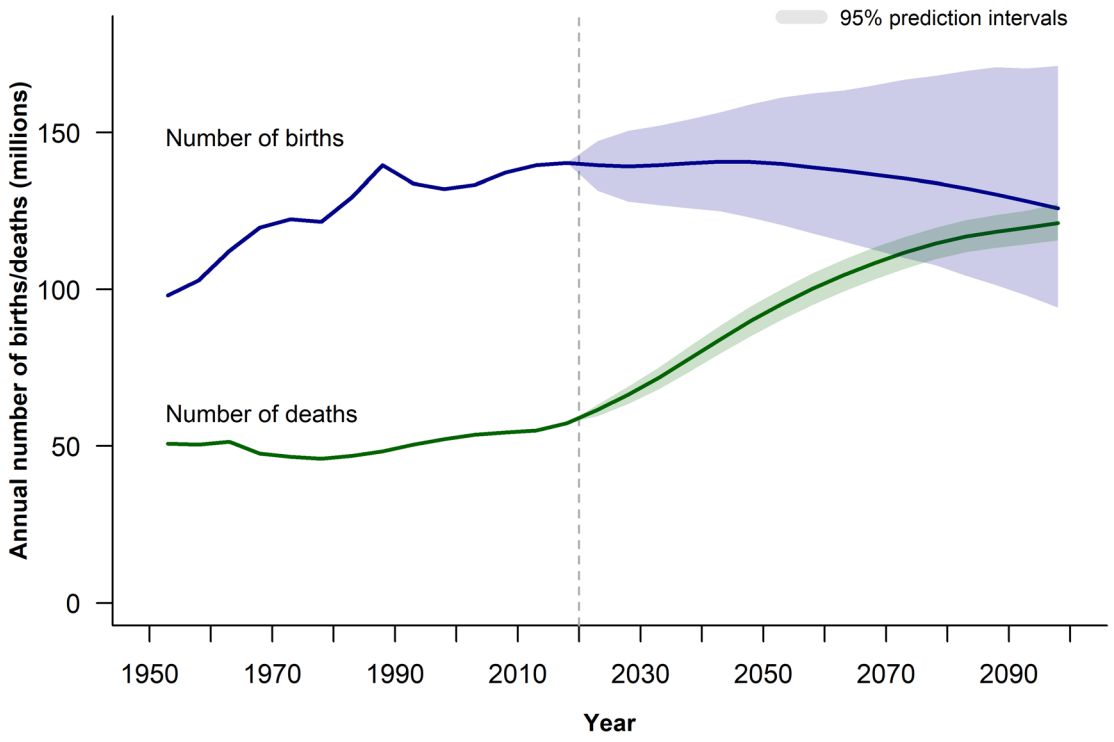
Source: United Nations (2019a).

Note: Prediction intervals (shaded area around a projected trend) were derived from a probabilistic assessment of projection uncertainty (see box 3.1). For a given year, the future trend is expected to lie within the predicted range with a probability of 95 per cent.

The projected trajectory of the human population over the coming decades is based on assumptions of a continuing decline in fertility for countries where large families are still prevalent, a slight increase in fertility for countries where women are having, on average, fewer than two live births over a lifetime and continued reductions in mortality for all countries. Given the reliance on such assumptions, population projections are inherently uncertain. The magnitude of such uncertainty can be assessed using statistical methods (box 3.1).

Figure 3.2

Global annual number of births and deaths: estimates, 1950-2020, and projections with prediction intervals, 2020-2100



Source: United Nations (2019a).
Note: Prediction intervals (shaded area around a projected trend) were derived from a probabilistic assessment of projection uncertainty (see box 3.1). For a given year, the future trend is expected to lie within the predicted range with a probability of 95 per cent.

Box 3.1

Projecting the world's population: assessing uncertainty

The medium projection of the United Nations population projections can be interpreted as the most likely future trend among the various projections presented in *World Population Prospects 2019* (United Nations, 2019b). It corresponds to the median of several thousand simulated future trends, each one based on distinct trajectories of fertility and mortality for individual countries and areas. The predictive model was derived from a probabilistic analysis of the variability of observed changes over time in levels of fertility and mortality.[1] Since these models have been calibrated using historical data on trends in fertility and mortality (box 3.2), an implicit assumption that underlies the medium projection is that the pace of change in these variables will be similar in the future to what it has been in the past. The prediction intervals shown in figure 3.1 reflect the spread in the distribution of the simulated population trajectories and thus provide an assessment of the magnitude of the uncertainty inherent in the medium projection.

A key conclusion of this analysis is that there is a probability of 95 per cent that the size of the global population will lie between 8.5 and 8.6 billion in 2030, between 9.4 and 10.1 billion in 2050 and between 9.4 and 12.7 billion in 2100. Thus, the size of the world population is almost certain to rise over the next few decades, as is the associated degree of uncertainty. Later in the century, although a continued increase is considered the most likely outcome, there is roughly a 27 per cent chance that the size of the world's population will stabilize or begin to decrease before 2100. As fertility is the most important determinant of future population trends, uncertainty around the number of children to be born in populous high-fertility countries is a major source of the uncertainty inherent in these projections (chap. 6).

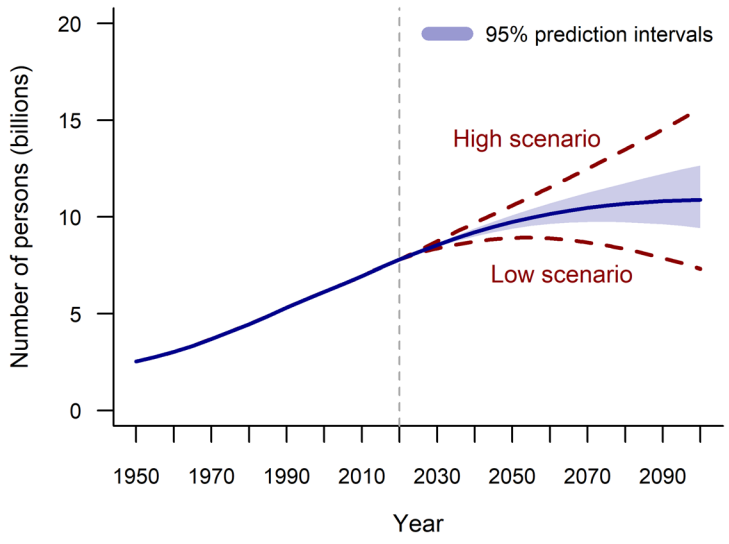
In addition to this probabilistic assessment, the medium scenario of the United Nations population projections is accompanied by eight alternative scenarios that illustrate the sensitivity of the medium projection to changes in the underlying assumptions. For example, in the high- and low-fertility variants, the future fertility level for each country or area is assumed to be consistently higher or lower than in the medium scenario by exactly one half (0.5) of a birth per woman, on average, while retaining the same assumptions with respect to mortality and international migration. As illustrated in figure 3.3, the trends in global population size associated with the high- and low-fertility variants diverge considerably from the trajectory of the medium projection and imply a range of future outcomes that is much broader than the prediction intervals of the probabilistic analysis.

The probabilistic assessment of projection uncertainty suggests that the range between the high and low scenarios may be implausibly large, especially in the latter decades of the century. The medium projection of global trends is derived by aggregating the "best guess" projections for individual countries and areas. Although a deviation of minus half (-0.5) of a birth between actual and projected fertility levels is entirely plausible for a given country or area in a given year, it is unlikely that this would be the case for all countries and areas and for all future years, as implied by the traditional low scenario of the United Nations population projections (Gerland and others, 2014).

[1] See chapters 5 and 6 for an assessment of uncertainty in the projected number of deaths and births in figure 3.2.

Figure 3.3

Global population size: estimates, 1950-2020, and projections with prediction intervals and high/low scenarios, 2020-2100



Recognizing that the high and low scenarios may depict unlikely outcomes for regional and global aggregates, the United Nations has emphasized the probabilistic analysis of projection uncertainty in recent editions of the *World Population Prospects*. In fact, since the 2015 revision, the high and low scenarios have not been included in published summaries of the United Nations population projections.

Source: United Nations (2019a).

There has been considerable variation in the pace of population growth in countries and regions in recent years. During the period from 2000 to 2020, even though the global population grew at an average annual rate of 1.2 per cent, 48 countries or areas grew at least twice as fast: these included 33 countries or areas in Africa and 12 in Asia, which together accounted for 14 per cent of world population in 2020. Half of the fastest-growing countries in Asia comprise the six member states of the Gulf Cooperation Council, which have undergone major economic and demographic transformations in recent decades and where international migration has acted as the principal driver of population growth.[2] Apart from these six countries, most of the fastest-growing populations are found in the group of least developed countries,[3] which collectively grew at around 2.4 per cent annually between 2000 and 2020 (chap. 4).

[2] Five out of 6 member states of the Gulf Cooperation Council are among the 10 countries with the world's highest population growth rates during the period from 2000 to 2020.

[3] The group of least developed countries includes 46 countries located in sub-Saharan Africa (32), Northern Africa and Western Asia (2), Central and Southern Asia (4), Eastern and South-Eastern Asia (4), Latin America and the Caribbean (1) and Oceania (3). Further information is available at http://unohrlls.org/about-ldcs/.

Box 3.2

Estimating the world's population: key data sources

The United Nations publishes population estimates and projections for 235 countries or areas, comprising the entire population of the world. For 201 countries or areas that had at least 90,000 inhabitants in 2019, the data set contains complete time series of population size by age and sex and of the components of population change—fertility, mortality and international migration—from 1950 until 2100. Recent and historical data on the size of the population and its composition by age and sex, as well as information on levels and patterns of the components of population change, are used for the preparation of population estimates for each country or area.

Recent population counts are critical for obtaining accurate estimates of population size and its composition by age and sex. The principal data source for this purpose is the population census. Most countries conduct a census approximately once per decade. For the 2019 assessment of world's population, data from 1,690 population censuses conducted between 1950 and 2018, as well as information on births and deaths from vital registration systems for 163 countries, and demographic indicators from 2,700 surveys, were considered in the evaluation (United Nations, 2019b). In some countries, population registers based on administrative data systems provided the necessary information. Population data from censuses or registers referring to 2010 or later were available for 188 countries or areas, representing 80 per cent of the 235 countries or areas included in this analysis. For 39 countries or areas, the most recent population count data available were from the period 2000-2009. For the remaining 9 countries or areas, the most recent available census data were from before 2000.

When available, post-enumeration surveys are used to evaluate the quality of census data. If necessary, adjusted data are obtained from national statistical offices or derived using standard demographic techniques, such as accounting for under-enumeration of young children or smoothing of age distributions distorted by age-heaping (Ewbank, 1981; Moultrie and others, 2013). Furthermore, when countries have conducted several censuses, the results can be analysed not only for each census independently, but also by following birth cohorts as they age through time and are counted in successive censuses. A key task, therefore, is to ensure for each country that past, current and future trends in fertility, mortality and international migration are consistent with changes in the size of the population and its distribution by age and sex. Various techniques are used to identify the most likely trends in fertility, mortality and international migration. For countries where no or only minimal data are available, demographic and statistical models are used to estimate levels of fertility, mortality and migration. Time series of population estimates, and of the components of population change, are critical inputs for the creation of population projections, as they provide a starting point for the projected future trends.

References

Ewbank, D. C. (1981). *Age Misreporting and Age-Selective Underenumeration: Sources, Patterns, and Consequences for Demographic Analysis*. Washington, DC: National Academy Press.

Gerland, P., and others (2014). World population stabilization unlikely this century. *Science*, vol. 346, No. 6206, pp. 234-237.

Moultrie, T. A., and others (2013). *Tools for Demographic Estimation*. International Union for the Scientific Study of Population. Available at http://demographicestimation.iussp.org/.

United Nations (2017). *Principles and Recommendations for Population and Housing Censuses. Revision 3.* ST/ESA/STAT/SER.M/67/Rev.3. Available at www.unstats.un.org/unsd/demographic-social/Standards-and-Methods.

_____ (2019a). *World Population Prospects 2019. Online edition. Rev. 1.* Available at https://population.un.org/wpp. Accessed on 15 October 2020.

_____ (2019b). *World Population Prospects 2019: Methodology of the United Nations population estimates and projections.* ST/ESA/SER.A/425. Available at www.un.org/development/desa/pd/content/publications.

Chapter 4. Spatial patterns of population growth

The Goals and the narrative of the 2030 Agenda for Sustainable Development emphasize the importance of the spatial dimension of sustainable development. Most of the world's low-income countries are experiencing rapid population growth. Some middle-income countries are also among the fastest growing. Projections suggest a diverging world over the next few decades, with some countries experiencing continued population increase and others, population decline. The population of Europe is expected to fall by 5 per cent between 2020 and 2050, while the population of sub-Saharan Africa is projected to double in size over the same period. Expected future changes in population size in the other world regions fall in between these two extremes.

Population dynamics determine how human numbers change over time across countries and regions. In 2020, the continent of Asia was home to 60 per cent of the world's population of 7.8 billion (figure 4.1). Eastern and South-Eastern Asia, the most populous region, comprised 30 per cent of the total; it had 2.3 billion people in 2020, of which 1.4 billion lived in China. Another 26 per cent of the global population was concentrated in Central and Southern Asia, the second largest region; it had 2 billion people in 2020, of which almost 1.4 billion were in India. The populations of both regions have grown rapidly since the middle of the twentieth century and are expected to reach their peak size within a few decades. According to projections by the United Nations, the population of Eastern and South-Eastern Asia is likely to peak at 2.4 billion people around 2040, while Central and Southern Asia is projected to reach its maximum population some 25 years later, rising to around 2.6 billion in 2065 (United Nations, 2019).

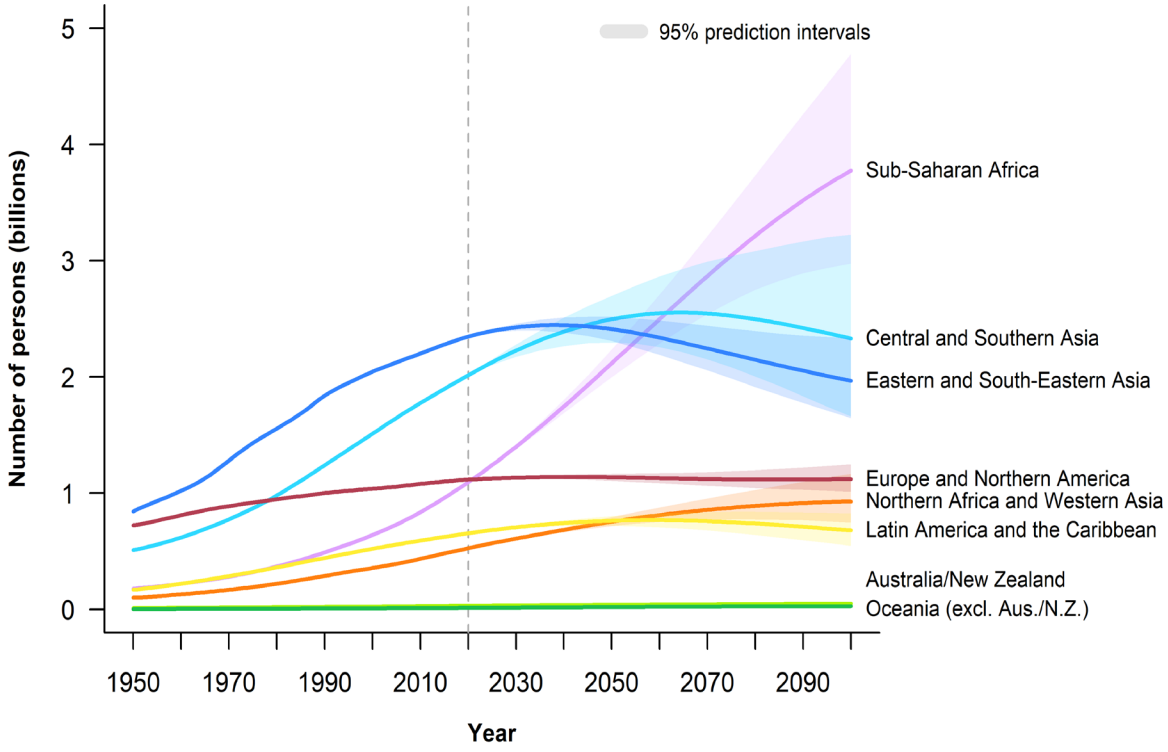
Population projections have varying degrees of certainty, and they typically become less certain over time, as illustrated by the shaded areas surrounding the projected trends in figure 4.1. Of the two most populous regions, the range containing 95 per cent of likely population sizes is especially wide for sub-Saharan Africa and Central and Southern Asia, mostly as a result of uncertainty around the pace of future reductions in fertility.[1] Despite the inherent uncertainty of these projections, it seems likely that the region of Eastern and South-Eastern Asia will reach its peak population earlier than Central and Southern Asia.

The current population of sub-Saharan Africa is comparable in size to the population of Europe and Northern America combined, with each comprising about 1.1 billion people in 2020 or 14 per cent of the global population. However, because the two regions are at different stages of the demographic transition, their future populations are expected to follow divergent paths. Sub-Saharan Africa is currently growing at an annual rate of 2.6 per cent, the highest among the eight regions and more than twice the global average of 1.1 per cent per year. The region is projected to continue growing relatively fast: by 2050, the size of the population of sub-Saharan Africa will likely stand between 2.0 and 2.2 billion people, roughly twice its size in 2020. The region is expected to become the most populous region worldwide in the early 2060s, when it will comprise about one quarter of the global population. However, the pace of the decline in birth rates in sub-Saharan Africa remains uncertain, and consequently the range of plausible population sizes grows with the length of the projection horizon. By the end of the century, the region's population is expected to lie between 3.0 and 4.8 billion with a likelihood of 95 per cent.

[1] See box 3.1. for details about assessing uncertainty for the projection of the global population.

Figure 4.1

Population estimates, 1950-2020, and projections with prediction intervals, 2020-2100, by region



Source: United Nations (2019).

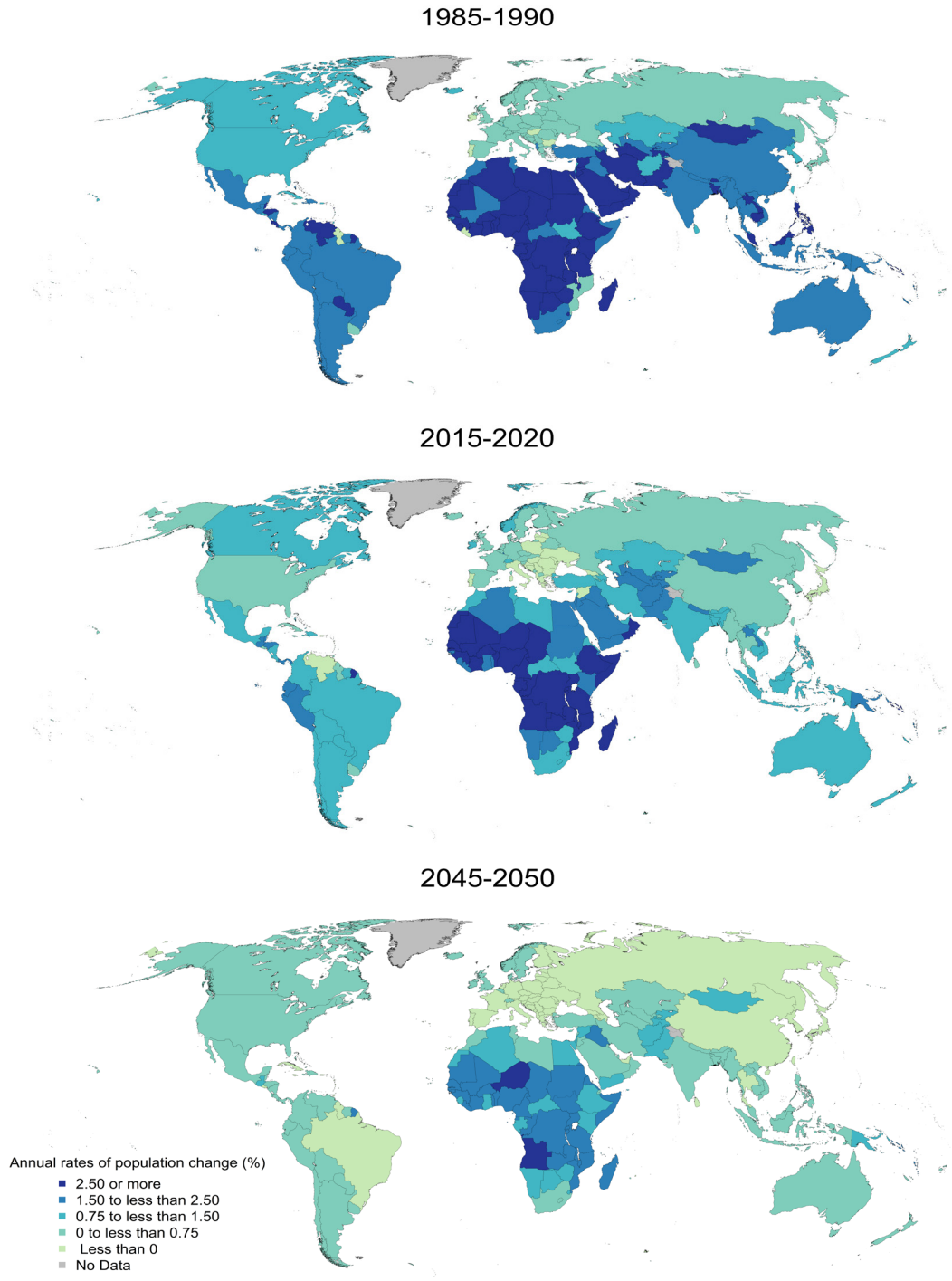
Note: Prediction intervals (shaded area around a projected trend) were derived from a probabilistic assessment of projection uncertainty (see box 3.1). For a given year, the future trend is expected to lie within the predicted range with a probability of 95 per cent.

The number of persons residing in Europe and Northern America is now stabilizing. Their combined population is projected to grow more slowly than the world average, reaching just under 1.14 billion in 2040 and remaining stable or declining slightly through the rest of the century. The population of Latin America and the Caribbean is also projected to grow more slowly than the global average in the coming decades and will likely start decreasing in the second half of the century. By contrast, it is expected that the populations of Northern Africa and Western Asia, and Oceania will sustain their current pace of growth throughout the century.

The diverse population trends across geographic regions coalesced to bring about a considerable slowing of global population growth over the past 50 years, with growth rates dropping for a rising number of countries in all regions of the world (figure 4.2). As recently as 35 years ago, 73 countries or areas were growing at 2.5 per cent or more per year. Today, however, the number growing at such rates has fallen by more than half to just 34. By contrast, an increasing number of countries or areas are growing at a slow pace today or have even seen their populations shrink in the last few decades. In the late 1980s, the populations of just 10 countries or areas were declining in size; by 2020, that number had more than doubled to 23, with most being located in Eastern and Southern Europe.

Figure 4.2

Annual rates of population change (percentage), selected periods, by country



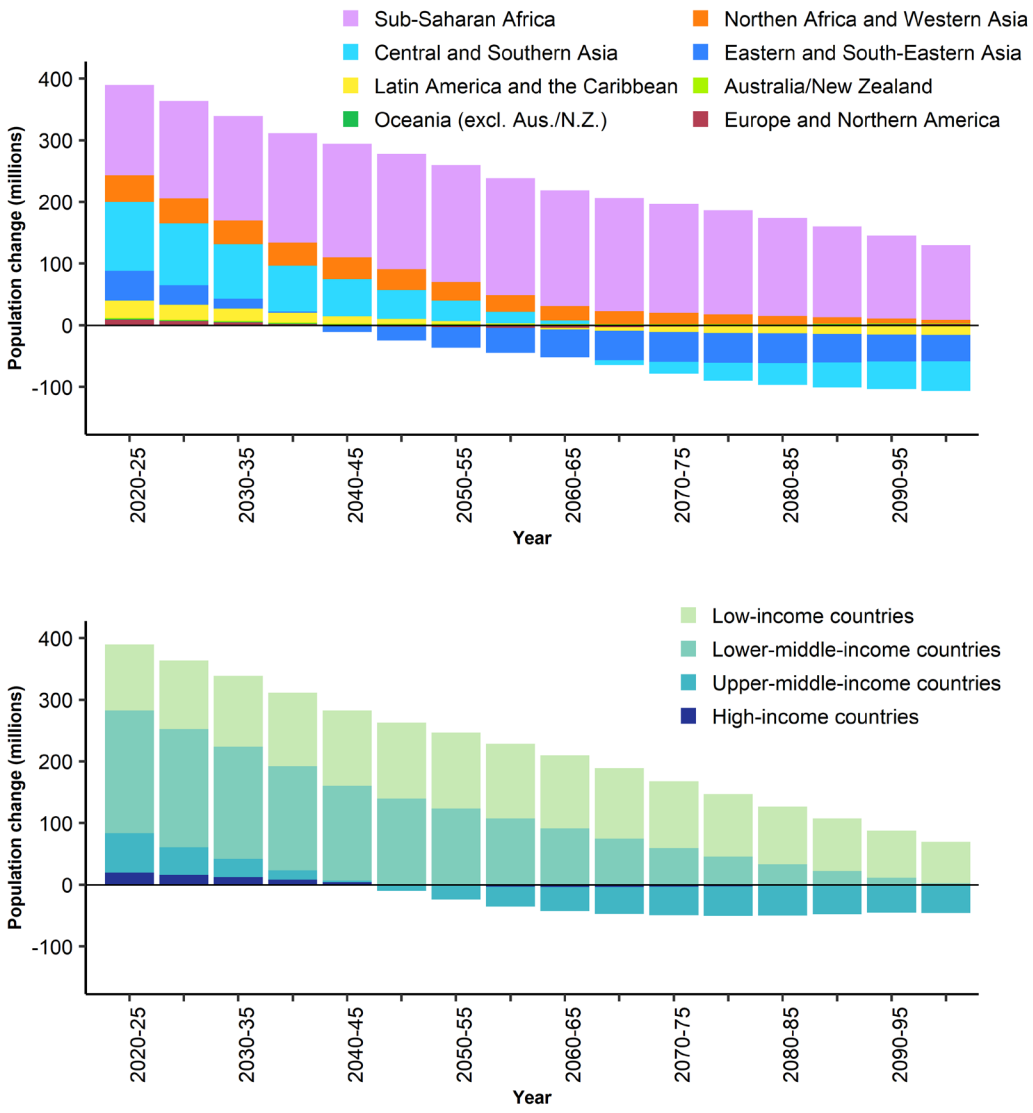
Source: United Nations (2019).

Note: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations. Dotted line represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties. Final boundary between the Republic of Sudan the Republic of South Sudan has not yet been determined. A dispute exists between the Governments of Argentina and the United Kingdom of Great Britain and Northern Ireland concerning sovereignty over the Falkland Islands (Malvinas).

In 2050, the world's population will be around 1.94 billion larger than today; the countries and areas whose populations are projected to increase between 2020 and 2050 will add a total of 2.06 billion, while those projected to decrease in size will lose 122 million persons. The deceleration of global growth is likely to continue throughout the current century, but with significant differences across regions. The highest growth rates are expected in parts of sub-Saharan Africa. Three fourths of the projected increase in world population during the next three decades will take place in sub-Saharan Africa and in Central and Southern Asia (figure 4.3). Sub-Saharan Africa is expected to account for most of the global increase until the end of the century, adding between 23 and 38 million people per year between 2020 and 2100. The contribution to growth of all other regions is likely to decrease substantially over time. Two regions, Eastern and South-Eastern Asia, and Europe and Northern America, are projected to switch from population growth to population decline during the 2040s. Two other regions, Latin America and the Caribbean, and Central and Southern Asia, are likely to follow suit in the 2060s.

Figure 4.3

Population change by five-year periods, 2020-2100, by region and income group



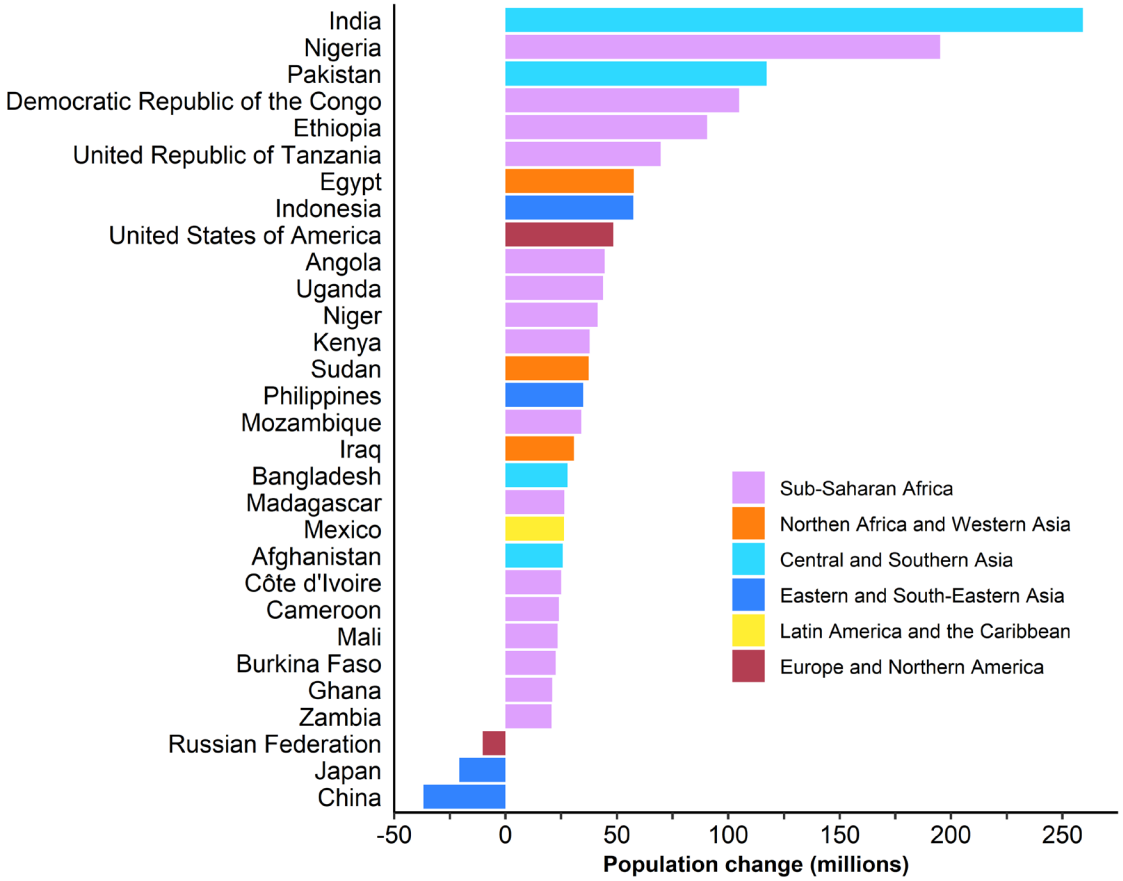
Source: United Nations (2019).

The group of lower-middle-income countries are currently the main contributors to population increase. The slowdown in population growth is expected to extend eventually to all low-income and lower-middle-income countries. By 2050, the populations of just two countries, Angola and Niger, are projected to have annual growth rates in excess of 2.5 per cent, while the number of countries or areas with declining populations (i.e., negative growth rates) is projected to rise to 60, including 30 in Europe, 15 in Latin America and the Caribbean, and 8 in Eastern and South-Eastern Asia. In places where fertility is projected to remain below the replacement level (chaps. 1 and 6), immigration may play a significant role in sustaining population numbers (chap. 7).

Nine countries are projected to account for more than half of the increase in global population between 2020 and 2050 (figure 4.4). Seven of them are among the 15 most populous countries of the world: India, United States of America, Indonesia, Pakistan, Nigeria, Ethiopia and Egypt (in order of population size in 2020). Two of the nine, the Democratic Republic of the Congo and the United Republic of Tanzania, have smaller populations but are growing by close to 3 per cent per year. Four of these nine major contributors are located in sub-Saharan Africa, two in Southern Asia, one in Northern Africa, one in South-Eastern Asia and one in Northern America. The top four contributors to growth are expected to add more than 100 million people each: India, Nigeria, Pakistan and the Democratic Republic of the Congo (in order of expected growth). Together, these four will account for over one third (676 million) of the global increase until mid-century.

Figure 4.4

Largest population increases and decreases by country, 2020-2050 (millions)



Source: United Nations (2019).

Note: The figure depicts countries that are projected to add 20 million people or more, and those projected to reduce their population by 10 million people or more, between 2020 and 2050.

By contrast, it is anticipated that China, the country currently with the largest population, will record the largest population loss between 2020 and 2050 (37 million), followed by Japan and the Russian Federation (21 and 10 million, respectively). Due to its large size and sustained low level of fertility, China also seems likely to record the largest population loss of any country through the end of the century (337 million people); by 2100, China is projected to have lost more than a quarter of its current population.

Although long-term population projections involve a considerable degree of uncertainty, some key features are worth noting in the projected trends for the second half of the twenty-first century. Countries and areas with declining populations are projected to lose a total of 910 million people between 2050 and 2100, while those growing are expected to add 2.05 billion over the same period, yielding a net global growth of 1.14 billion. Seventeen countries are projected to lose at least 10 million in population between 2050 and 2100, compared to just three countries for which a similar decline is expected in the previous period, between 2020 and 2050. With the projected slowdown in growth of the lower-middle-income countries, global population increase will be driven increasingly by low-income countries, whose growth is projected to decelerate towards the end of the century (figure 4.3). A net decrease in population size during the second half of the century will be experienced mostly by high-income and upper-middle-income countries.

Reference

United Nations (2019). *World Population Prospects 2019. Online edition. Rev.1*. Available at https://population.un.org/wpp. Accessed on 15 October 2020.

Chapter 5. Mortality

Increases in survival and longevity have led to rapid population growth throughout the world, though regions and countries have experienced these changes at different paces and at different points in time. Mortality has fallen significantly worldwide since 1950, and the global gap in life expectancy at birth has narrowed slightly. Nevertheless, large disparities remain across countries and regions. Between 2020 and 2050, the number of deaths worldwide is expected to increase faster than the number of births due in large part to population ageing, further slowing the pace of global population growth. Nonetheless, it is expected that continuing reductions in mortality rates will contribute about 15 per cent of the total growth in global population over this period.

Increasing survival rates have been widely acknowledged as a marker of progress in human development.[1] During the initial phases of the demographic transition, when birth rates remain high, declining mortality drives population growth by widening the gap between annual numbers of births and deaths (chap. 3). In subsequent phases of the transition, despite further reductions in death rates, declining birth rates and the progressive ageing of the population work in tandem to narrow this gap, gradually lowering the rate of population increase.

Accompanying the global transition from higher to lower rates of mortality is a fundamental change in the leading causes of illness and death, which shift gradually from infectious and parasitic diseases towards chronic and degenerative disorders as part of a process known as the epidemiologic transition. Socioeconomic development is at the core of these changes, with better nutrition and improvements in public health and personal hygiene as proximate causes, and economic growth and advances in education and scientific understanding as the main enablers of change (chaps. 11, 12 and 13). As populations go through this health transition, a change in the age pattern of mortality occurs as well, with death rates falling first among children and then gradually among adults and older persons as well. Once life expectancy at birth reaches around 70 years, further gains in longevity are driven primarily by mortality reductions at older ages.

Worldwide, the number of deaths relative to the size of the population has been declining since the 1950s, as shown by the trend in the global crude death rate (figure 5.1). Despite the decrease in the crude death rate, however, the number of deaths globally has been increasing steadily since the 1980s. This increase reflects the net impact of a decline in mortality on a growing population. The ongoing pandemic caused by COVID-19 has put decades of global progress to end preventable deaths at risk. Its ultimate impact on mortality rates across countries remains uncertain, as its direct and indirect effects continue to deteriorate the health and well-being of both the older and younger populations worldwide (box 5.1).

Over the next several decades, projections by the United Nations assume a continuing gradual decrease in age-specific mortality rates.[2] However, as a relatively larger proportion of the population becomes concentrated in older age groups with higher mortality risks, the crude death rate is projected to increase from its record-low level of 7.5 deaths per 1,000 population in 2015-2020, reaching 9.7 per 1,000 in 2050 and 11.2 per 1,000 in 2100.

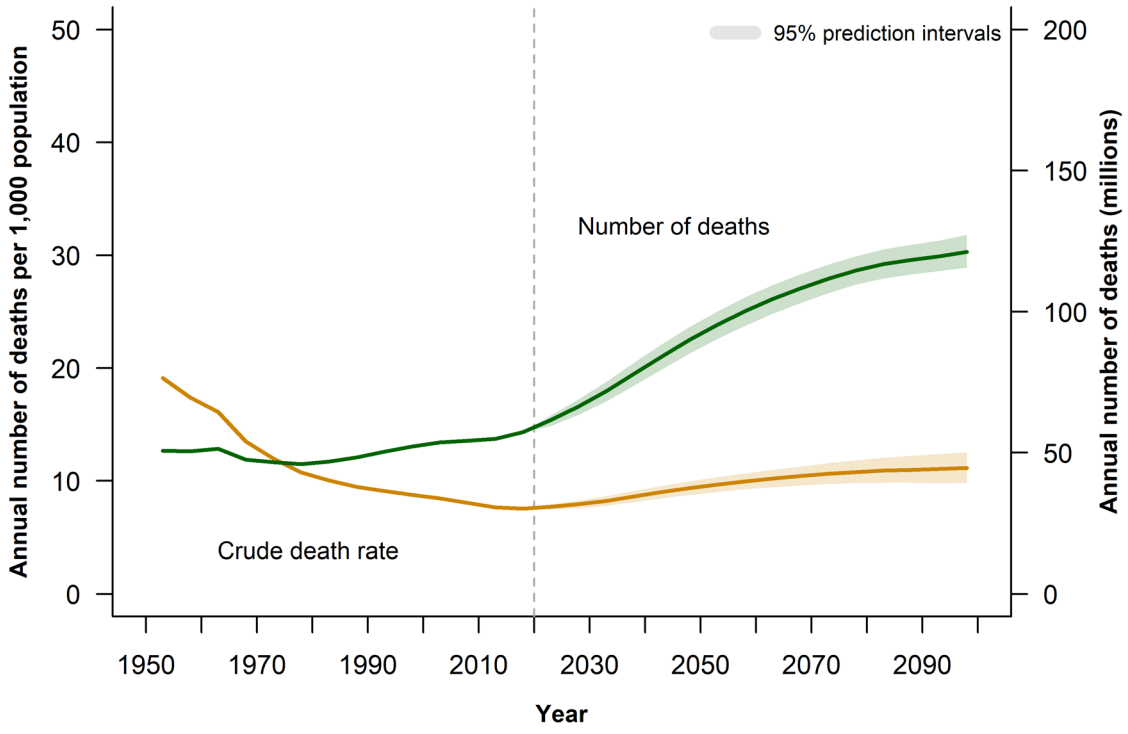
[1] Human development, "a process of enlarging people's choices" (UNDP, 1990, p.10), has been measured using the Human Development Index (HDI), which incorporates three dimensions of progress: health, education and income. Life expectancy at birth, describing the average longevity of a population, is used as the proxy indicator for health.

[2] Deaths from COVID-19 have not been factored into estimates and projections of mortality for 2020 and beyond, as the information provided here relies on an assessment of global population trends completed in 2019 (United Nations, 2019a).

The increase of the crude death rate as a result of population ageing, combined with continuing population growth, will accelerate the increase in numbers of deaths over the next decades. Globally in 2020, there were around 59 million deaths, which was less than half of the 140 million births occurring in the same year. The number of deaths worldwide is projected to increase by more than half by 2050 (close to 93 million) and to double in size by 2100 (122 million), when it will be approaching the projected number of births (125 million) (chap. 6).

Figure 5.1

Global annual number of deaths and crude death rate: estimates, 1950-2020, and projections with prediction intervals, 2020-2100



Source: United Nations (2019a).
Note: Prediction intervals (shaded area around a projected trend) were derived from a probabilistic assessment of projection uncertainty (see box 3.1). For a given year, the future trend is expected to lie within the predicted range with a probability of 95 per cent.

The uncertainty around future numbers of deaths is relatively small, especially in comparison to the uncertainty around future numbers of births (see chap. 6). The range of plausible values with a probability of 95 per cent is about ±5 per cent of the medium projection through most of the century (figure 5.1).[3]

The increase of longevity over the past seven decades was achieved in large part by substantial reductions in mortality risks during childhood, especially in developing countries. Worldwide, the mortality rate among children under 5 years of age fell from 223 deaths per 1,000 live births in 1950 to 38 per 1,000 in 2020, a reduction of 83 per cent. Whereas 1 in 4 children died before their fifth birthday in 1950, the risk of dying before age 5 had fallen to 1 in 26 by 2020. At the same time, among deaths in the first 5 years of life, the share of infant deaths —those occurring during the first year— has increased over time. Similarly, infant deaths

[3] For further details on the estimation of mortality trends and the assumptions used to project future mortality trends, see United Nations, 2019b.

have become increasingly concentrated in the first month of life, which now accounts for roughly half of all infant deaths (UN-IGME, 2019). This shift in the distribution of child deaths toward younger ages is due largely to the successful control of infectious diseases, which led to a larger proportion of deaths in the first year of life being due to birth defects, preterm births, complications of pregnancy and other causes that affect mainly infants and neonates in particular.

Progress in preventing premature mortality among both children and adults is one component of the increase of life expectancy at birth that has been observed globally since 1950 (figure 5.2). Life expectancy at birth provides a summary of the prevailing mortality level in a population.[4] Unlike the crude death rate, it provides a snapshot of mortality that is independent of the age distribution and therefore is directly comparable across populations and over time. In 1950, global life expectancy at birth stood at 46 years. The next decades brought major improvements in survival: by 1980, life expectancy at birth for the world reached 61 years, a gain of 15 years in just three decades.

After 1980, global life expectancy continued to increase, adding another 12 years to reach 73 years in 2020. This upward trend was at its slowest in the 1990s, due primarily to increasing mortality in sub-Saharan Africa caused by the HIV epidemic and in Eastern Europe due to a health crisis linked to social and political changes following the dissolution of the Soviet Bloc (Caselli, Meslé and Vallin, 2006).

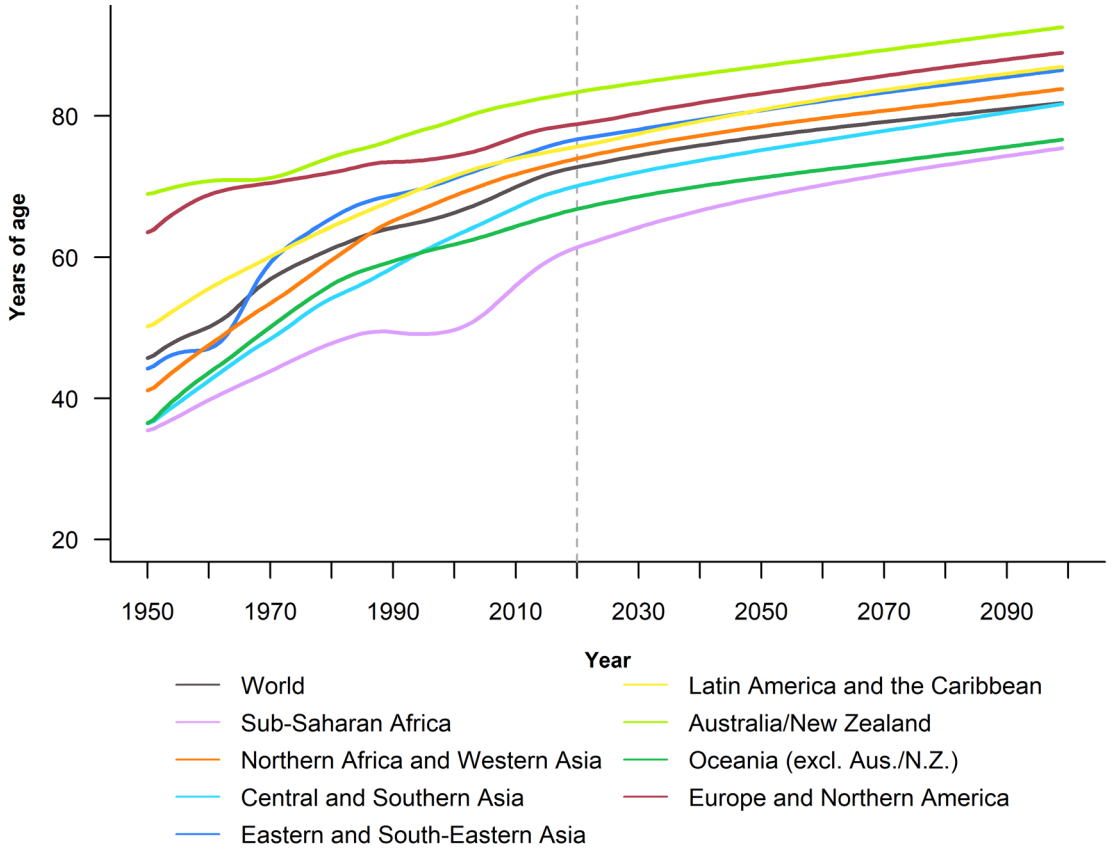
The gap in life expectancy at birth among regions has narrowed since the mid-twentieth century, except during the 1990s when it widened due to the drop in life expectancy in sub-Saharan Africa. The inter-regional difference in life expectancy between sub-Saharan Africa and Australia and New Zealand—with the world's lowest and highest levels, respectively—fell from 33 years in 1950 to 22 years in 2020. The convergence between these two regions was due largely to the fact that, as countries complete the demographic transition and reach historically low levels of mortality, further reductions in death rates become more difficult to achieve and the rise in life expectancy slows down. By contrast, the gap in life expectancy between sub-Saharan Africa and the other less developed regions actually increased by just over half a year between 1950 and 2020, from 14.7 years to 15.3 years.[5] This divergence predates the emergence of the HIV epidemic in the late 1980s, which temporarily increased the size of the gap in life expectancy among the less developed regions (figure 5.2).

Global disparities in the average length of life remained large in 2020. Life expectancy in countries with the highest mortality, such as the Central African Republic, Chad or Lesotho, was about 30 years lower than in countries or areas with the lowest mortality, such as Japan or Hong Kong Special Administrative Region of China. Over the coming decades, further increases in survival for all regions are expected to narrow but not to eliminate these differences. By 2050, life expectancy at birth is projected to reach 77 years worldwide, with a gap of 27 years remaining between the countries with the lowest and the highest values.

[4] Life expectancy at birth is defined as the average number of years of life a person born in a given year would live if current death rates do not change throughout his or her lifetime.
[5] This refers to the gap in life expectancy at birth between the regions of the world with life expectancies lower than 60 years in 1950, which includes all regions except Europe and Northern America and Australia and New Zealand.

Figure 5.2

Life expectancy at birth: estimates, 1950-2020, and projections, 2020-2100, world and regions



Source: United Nations (2019a).

Future declines in mortality will have a small but non-negligible impact on population growth. The global population is expected to be almost 25 per cent larger in 2050 than it is today, increasing from 7.8 billion to 9.7 billion people. Anticipated reductions in mortality alone would bring an increase of about 289 million, roughly 15 per cent of the projected total increase (further discussed in chap. 8).

Box 5.1

Mortality risks of the coronavirus disease 2019 (COVID-19)

In December 2019, a new infectious disease known as COVID-19, caused by the novel coronavirus, SARS-CoV-2, emerged as a major threat to global health. On 11 March 2020, the rapid spread of the virus worldwide caused the World Health Organization to declare a pandemic. By mid-October 2021, about 238.5 million cases and almost 5 million deaths attributable to COVID-19 had been recorded worldwide (WHO, 2021).

Mortality risks associated with communicable diseases typically comprise multiple components: the risk of becoming infected, the risk of developing symptoms once infected, the risk of progressing to severe disease and hospitalization, and the risk of subsequently succumbing to the disease. The risk of becoming infected depends on the frequency, duration and intensity of contact between individuals. A few countries implemented effective containment or mitigation measures early in the pandemic and were able to control the spread of the virus and minimize the death toll from the disease, at least in the early phases of the pandemic. Most countries, however, have experienced prolonged outbreaks that have overburdened health systems and caused large numbers of deaths.

The risk of severe illness and death from COVID-19 increases rapidly with age and is also related to underlying health conditions affecting the cardiovascular, respiratory and immune systems. Like many causes of death, the disease is responsible for many more deaths among older persons than at younger ages. Many high-income countries with low levels of mortality and large older populations have recorded disproportionate numbers of deaths relative to population size. Data from 29 countries, mostly in Europe and the Americas, indicate that life expectancy at birth declined from 2019 to 2020 by more than a year in 11 countries for men and in 8 countries among women. These reductions are attributable mostly to increased mortality at older ages linked to COVID-19 (Aburto and others, 2021; Arias and others, 2021).

By comparison, many low-income and middle-income countries with more youthful populations have reported fewer deaths per capita from COVID-19. Substantial variation exists across countries, possibly related to the capacity of national health systems, the prevalence of co-morbidities in their populations, and the presence of physical or environmental factors affecting the efficiency of viral spread (Marois, Muttarak and Scherbov, 2020; ECLAC, 2021). However, the pandemic has also highlighted deficiencies in health reporting and death registration systems, many of which broke down during the pandemic, severely complicating the task of ascertaining the global death toll.

The pandemic has also had indirect effects on health and mortality, in particular among vulnerable and disadvantaged populations. Overburdened health systems had difficulty delivering care for acute conditions other than COVID-19; preventative measures were often neglected, including routine childhood immunization; treatments were delayed or foregone due to lockdown measures or other pandemic conditions; food insecurity and poverty have increased in many settings. At the same time, there may have been protective effects for some causes of death, including road accidents, due to pandemic-related changes (Morgan and others, 2020).

By mid-December 2020, the first vaccines were approved for emergency use, and many countries initially gave priority access to health-care workers and other vulnerable or highly exposed groups. By mid-October 2021, almost 6.5 billion vaccine doses have been administered worldwide (WHO, 2021). However, large disparities across countries and regions in accessibility and capacity to deliver vaccines to their populations have resulted in severe inequities. Whereas in high-income countries roughly half the population has been vaccinated with at least one dose, in low-income countries just 1 of every 26 people have been.[6] Today, inequity in vaccine supply, allocation and administration is undermining global economic recovery, while facilitating the emergence of potentially more dangerous variants of the virus to emerge and spread (UNDP, 2021). Greater equity in vaccine distribution and access is necessary to bring an end to the pandemic and create conditions for the full recovery of economies and societies.

[6] UNDP Global Dashboard for Vaccine Equity. Available at https://data.undp.org/vaccine-equity/accessibility/. Accessed on 14 October 2021.

References

Aburto, J. M., and others (2021). Quantifying impacts of the COVID-19 pandemic through life-expectancy losses: a population-level study of 29 countries. *International Journal of Epidemiology*, dyab207, September. Available at https://academic.oup.com/ije/advance-article/doi/10.1093/ije/dyab207/6375510.

Arias, E., and others (2021). Provisional Life Expectancy Estimates for 2020. Vital Statistics Rapid Release, National Center for Health Statistics, Report No. 015, July. Available at https://cdc.gov/nchs/data/vsrr/vsrr015-508.pdf.

Caselli, G., F. Meslé, and J. Vallin (2002). Epidemiologic transition theory exceptions. *Genus*, vol. 58, No. 1, pp. 9-51.

Economic Commission for Latin America and the Caribbean (ECLAC) (2021). Demographic Observatory, 2020. LC/PUB.2020/20-P, Santiago. Available at https:// cepal.org/sites/default/files/publication/files/46641/S2000897_en.pdf.

Marois G, R. Muttarak, and S. Scherbov (2020). Assessing the potential impact of COVID-19 on life expectancy. PLOS ONE 15(9): e0238678. Available at https://doi.org/10.1371/journal.pone.0238678.

Morgan, D., and others (2020). Excess mortality: measuring the direct and indirect impact of COVID-19. OECD, Health Working Paper No. 122.

Omran, A. R. (1971). The epidemiologic transition. A theory of the epidemiology of population change. *Milbank Memorial Fund Quarterly*, vol. 49, No. 4, pp. 509-538.

United Nations Development Programme (UNDP) (1990). *Human Development Report 1990*. New York: Oxford University Press. Available at http://hdr.undp.org/en/reports/global/hdr1990.

_____ (2019). *Human Development Report 2019*. Beyond income, beyond averages, beyond today: Inequalities in human development in the 21st century. Available at http://hdr.undp.org/sites/default/files/hdr2019.pdf.

United Nations (2019a). *World Population Prospects 2019. Online edition. Rev. 1*. Available at https://population.un.org/wpp. Accessed on 15 October 2020.

_____ (2019b). *World Population Prospects 2019: Methodology of the United Nations population estimates and projections*, ST/ESA/SER.A/425. Available at www.un.org/development/desa/pd/content/publications.

_____ (2019c). *World Mortality 2019: Highlights*, ST/ESA/SER.A/432. Available at www.un.org/development/desa/pd/content/publications.

_____ (2021). *Support to Vaccine Equity. Beyond Recovery: Towards 2030*. Available at https://undp.org/publications/support-vaccine-equity-beyond-recovery-towards-2030.

United Nations Inter-agency Group for Child Mortality Estimation (UN-IGME) (2019). *Levels and Trends in Child Mortality. Report 2019*. UNICEF. Available at https://childmortality.org/reports.

World Health Organisation (WHO) (2021). Coronavirus Disease (COVID-19) Dashboard. Available at https://covid19.who.int. Accessed on 14 October 2021.

Chapter 6. Fertility

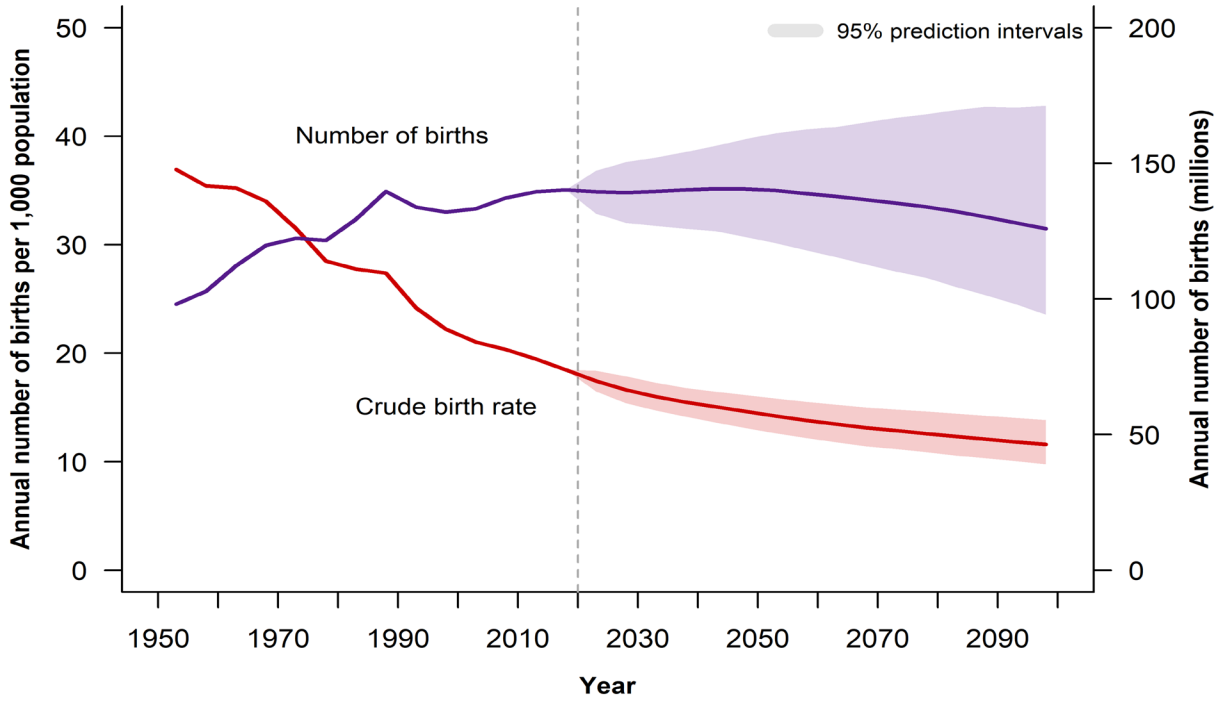
The transition towards historically low levels of fertility has touched all world regions. In some regions, this transition ended in the first half of the twentieth century, while in others, it began near the end of the that century. Over the next several decades, this continuing shift will help reduce the rate of global population growth further. The speed and scale of global population growth in the second half of the twenty-first century will depend largely on the future path of fertility in countries that are still in the early stages of the transition. Until mid-century, however, the annual number of births globally is expected to remain around current levels, even as the world's average level of fertility continues to drop, due to the youthful age distribution of today's global population.

In 2020, roughly 140 million babies were born worldwide. Most of these births occurred in three regions—Central and Southern Asia, sub-Saharan Africa, and Eastern and South-Eastern Asia—accounting for 27 per cent, 26 per cent and 22 per cent, respectively, of global births. The rest of the world contributed the remaining 25 per cent of the total.

The annual global number of births reached a plateau just above 120 million in the 1970s, following a rise during the "baby boom" observed in some countries during the 1950s and 1960s; it approached 139 million in the late 1980s, when the large cohorts of the earlier baby boom were having their children (figure 6.1).

Figure 6.1

Global number of live births and the crude birth rate: estimates, 1950-2020, and projections with prediction intervals, 2020-2100



Source: United Nations (2019a).

Note: Prediction intervals (shaded area around a projected trend) were derived from a probabilistic assessment of projection uncertainty (see box 3.1). For a given year, the future trend is expected to lie within the predicted range with a probability of 95 per cent.

More recently, the number of births worldwide has been roughly 2.5 times as high as the number of deaths, yielding an average annual increment to the global population of around 83 million people between 2015 and 2020 (chaps. 3 and 5).

Smaller families have gradually become the norm for contemporary societies in almost all regions, reflecting changes in the economic and social costs and benefits of childbearing, as well as in cultural values around families and children (Cleland and Wilson, 1987). The transition to historically low levels of fertility has been closely related to several key aspects of human development (Bongaarts, 2017; Bryant, 2007; Caldwell, 1982, 2001; Tsui, 2001). These include reductions in child mortality, increased levels of education, expanded access to family planning services, women's growing labour force participation, and the changing conditions and motivations for raising children as life becomes more urban. The expansion of education is particularly important, because when families raise fewer children, it becomes possible to increase the investment in education for each child. Formal education also competes for time with income-earning activities and is often associated with legal restrictions against child labour. Moreover, at the secondary and higher levels, education helps to motivate a delay in marriage and family formation, especially for girls and young women.

Relative to the size of the total population, the number of births has been declining at the global level (figure 6.1). The crude birth rate, which equals the annual number of live births divided by the average number of persons in a population, dropped from around 38 births per 1,000 persons per year in the mid-twentieth century to 18 per 1,000 in 2020; it is expected to continue falling through 2100.

Similarly, from the perspective of individual women and families, the level of fertility has experienced a downward trend over the past 70 years (figure 6.2). Globally, the total fertility rate, which equals the average number of live births per woman over a lifetime,[1] fell from about 5 births per woman in 1950 to an estimated 2.4 births per woman in 2020. However, despite these decreasing rates, due to the youthful age distribution of the global population, the annual number of births has been increasing until recently and is expected to remain around 140 million until 2050; thereafter, it is projected to decline gradually to about 125 million in 2100.[2]

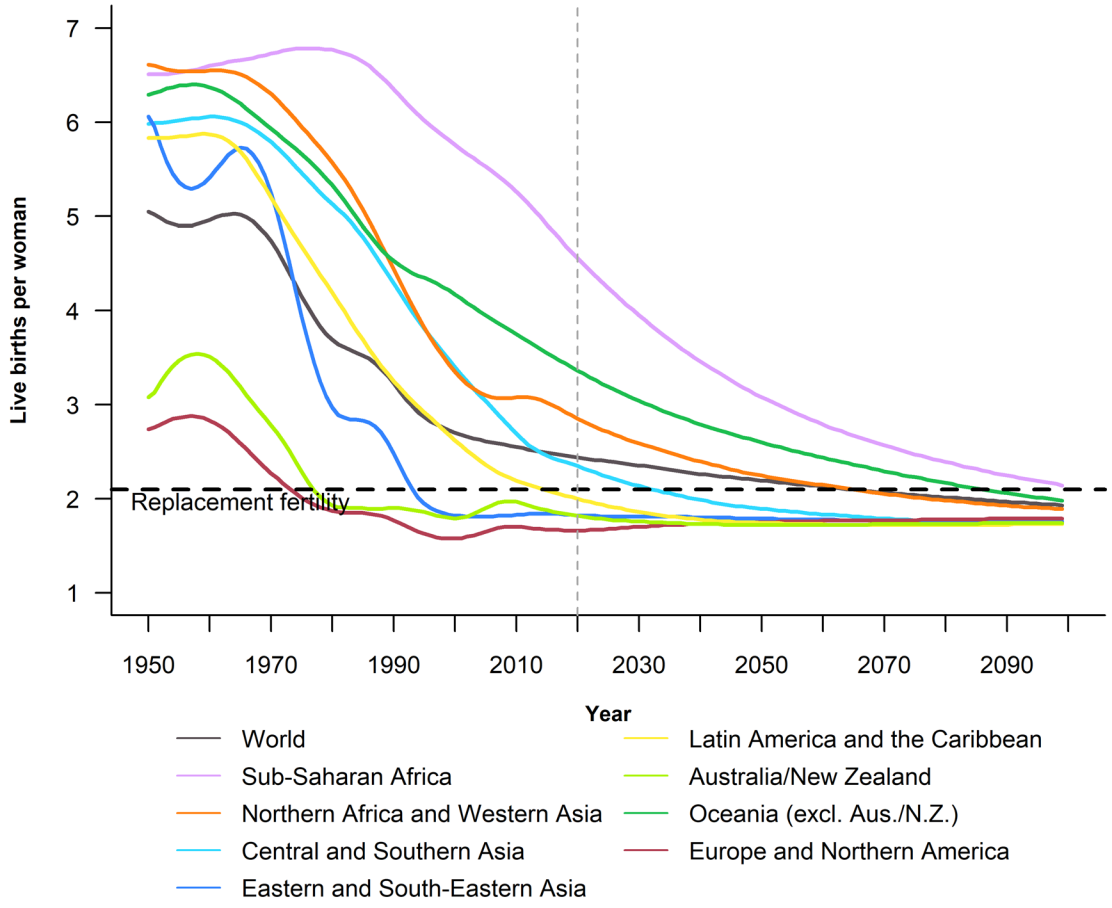
As a result of the assumed pace of decline in fertility rates, the global total fertility rate is expected to fall but to remain above 2.1 live births per woman, the conventional replacement level, until the early 2060s (see box 6.1). Between 2020 and 2050, fertility above the replacement level is expected to contribute about one sixth of the total growth in world population from 7.8 to 9.7 billion (chap. 8). Most of the projected increase over that period will be attributable to the momentum of growth embedded in the current youthful age distribution of the global population. This momentum can be countered, in part, by postponing childbearing and increasing the interval between births, which lengthens the time between generations without necessarily changing the completed family size (United Nations, 2019c).

[1] The total fertility rate (TFR) represents the fertility level of a given year or period, expressed as the average number of births that a woman would have during her reproductive years (by convention, between 15 and 49 years of age), if her propensity to bear a child at each age were the same as observed at that time. Thus, the TFR describes the fertility level of a hypothetical or fictitious group of women; it differs, typically, from the average number of births among women born in any particular year.

[2] A youthful age distribution implies an elevated percentage of the population in the reproductive age range, both now and in years to come. A relatively youthful population will produce an elevated number of births for a period of a few decades.

Figure 6.2

Total fertility rate: estimates, 1950-2020, and projections, 2020-2100, world and regions



Source: United Nations (2019a).

Population projections are subject to multiple sources of uncertainty. They require assumptions regarding future patterns and trends in fertility, mortality and international migration. For the projections produced by the United Nations, assumptions about future fertility, the component that has the greatest influence on the future size of the population in the long run, are calibrated based on historical changes in fertility levels observed in all regions of the world. The medium projection assumes implicitly that populations currently with high levels of fertility will follow a path of decline similar to that observed in countries that started the transition earlier (see discussion of the demographic transition in chap. 1 and United Nations, 2019b).

Uncertainty about future trends in fertility increases over the long run. The effect on population size of a deviation from the assumed future trajectory of fertility is cumulative because the newborns of one generation become the parents of the next. At the global level, the range of uncertainty around the projected number of births widens to approximately ±9 per cent in 2030-2035 and spreads out further to around ±15 per cent in 2050-2055, as illustrated by the shaded areas surrounding the medium projection in figure 6.1.

Box 6.1

What is replacement fertility?

Replacement-level fertility refers to the level of childbearing at which each generation exactly replaces the previous one in terms of size; in other words, when the children of the current generation of parents grow up to become an equivalent number of potential parents in the next generation. This idea has particular importance in the context of population growth: if fertility remains at the replacement level for several decades, the growth rate will fall gradually to zero and the population will stop growing (in the absence of international migration). If fertility remains below the replacement level over the long run, the population will eventually decline in size (unless the negative balance of births and deaths is countered by a sufficient level of immigration).

For populations at late stages of the demographic transition with low levels of mortality, the replacement level of fertility is approximated by a total fertility rate of 2.1 live births per woman. At higher levels of mortality, more than 2.1 births per woman are needed to ensure that successive generations are as large as their predecessors (Smallwood and Chamberlain, 2005).

Many populations continue to grow for several decades beyond the time when their fertility falls to the replacement level. This is because growing populations have relatively large numbers of people at younger ages, including women in the prime childbearing years. Therefore, the number of births typically exceeds the number of deaths for a few years or even decades after a population reaches replacement-level fertility. Conversely, a decreasing population with an older age distribution will continue to decline in size for many years even if fertility rises quickly to the replacement level (Blue and Espenshade, 2011). In sum, whenever a population is growing or declining in size, the history of growth or decline is reflected in the current population age distribution, which helps to reinforce and sustain the current trend.

Today, all countries and areas have seen at least the start of a transition towards low levels of fertility. While some completed the transition more than a century ago, other are still in the early phases with relatively high total fertility rates (figure 6.2).[3] Thirty-two of the 35 countries or areas where the average woman bears more than 4 children over a lifetime are located in sub-Saharan Africa. For most countries in this region, the total fertility rate began to fall steadily in the late 1980s. In 2020, it stood at 4.6 births per woman for the region as a whole, which is expected to experience the largest future reduction in fertility, falling to just over 3 births per women by 2050 and to little more than 2 births per woman by 2100. By the end of the century, all regions except sub-Saharan Africa are projected to have a total fertility rate below 2.1. With its fertility expected to remain relatively high throughout the century, sub-Saharan Africa will have a significant impact on the future growth of the global population (chap. 4).

By contrast, in most countries and areas where the transition to historically low levels of fertility and mortality is complete, the total fertility rate has fallen below 2 births per women and has been fluctuating in recent years, typically in a range between 1.4 and 2 births per woman. Today, such countries are home to nearly half of the world's population. Most countries in Europe and Northern America, as well as Australia

[3] The historical context of the transition to low fertility is further discussed in chap. 1.

and New Zealand, have experienced persistent low levels of fertility since the late 1970s, with several falling at least temporarily below 1.4 births per woman. In some of these countries, fertility has increased slightly in recent decades.

Starting in the 1960s, the fertility decline in Eastern and South-Eastern Asia occurred more rapidly than it had in Europe and other regions where the decline happened earlier, owing both to the rapid pace of socioeconomic development and to the effectiveness of state-sponsored family planning programmes in supporting behavioural change. More recently, in 2015-2020, Latin America and the Caribbean joined the list of regions where fertility has fallen below the replacement level.

Because of concerns over rapid population ageing and, in more extreme cases, population decline, some governments have sought to address very low fertility with policies to support families and to encourage childbearing. Many criteria affect the ultimate impact of family policies on fertility trends. In addition to policies providing financial support to low-income families, policies fostering reconciliation between paid work and childrearing, including by providing flexible working arrangements and access to high-quality childcare, have proven to be among the most effective. The impact of other family policies, such as one-time financial incentives and paid parental leave limited to the period around birth, has been less clear-cut (United Nations, 2017, 2015; Lutz, Skirbekk and Testa, 2006; McDonald, 2006; Sobotka, Matysiak and Brzozowska, 2019).

Uncertainty about future trends in fertility is most significant in countries where the transition to historically low levels of fertility is still ongoing and where the range of plausible outcomes remains large. By contrast, in locations where the demographic transition is largely complete, fertility tends to fluctuate within a narrow range at low levels and thus the uncertainty of future trends is smaller. Because today's fertility will largely determine the size of the next generation of women in the reproductive age range, the impact of fertility trends on population size is cumulative, and therefore the plausible or likely range for future numbers of births is much wider than for future numbers of deaths. Globally, and for most countries and areas, future levels and trends in fertility are the largest source of the uncertainty around future growth rates and the trend in population size.

In most high-fertility countries, governments have put in place policies and programmes that contribute to lowering fertility levels through various mechanisms, including by reducing women's unmet need for family planning, by raising the minimum legal age at marriage, by integrating family planning and safe motherhood measures into primary health care, or by improving female education and employment opportunities (United Nations, 2017). However, policy implementation has often been slow because of competing governmental priorities and severe financial and institutional constraints. Strengthened efforts to implement such policies, especially if supported by increased donor assistance, could help ensure that the future trend in births develops at a pace closer to the lower boundary of the range of uncertainty associated with the United Nations population projections (figure 6.1). A more rapid fertility decline in high-fertility countries would also advance the timing of the demographic dividend and the opportunity that it offers for accelerated economic growth (chap. 15; see also box 1.2 in chap. 1).

References

Blue, L., and T. J. Espenshade (2011). Population momentum across the demographic transition. *Population and Development Review*, vol. 37, No. 4, pp. 721-47.

Bongaarts, J. (2017). Africa's unique fertility transition. *Population and Development Review*, vol. 43, Supplement: Fertility Transition in sub-Saharan Africa, pp. 39-58.

Bryant, J. (2007). Theories of fertility decline and the evidence from development indicators. *Population and Development Review*, vol. 33, No. 1, pp. 101-127.

Caldwell, J. (1982). *Theory of Fertility Decline*. London: Academic Press.

_____ (2001). Global fertility transition. *Population and Development Review*, vol. 27, Supplement: Global Fertility Transition, pp. 93-115.

Cleland, J., and C. Wilson (1987). Demand theories of the fertility transition: An iconoclastic view. *Population Studies*, vol. 41, No. 1, pp. 5-30.

Lutz, W., V. Skirbekk and M. R. Testa (2006). The low fertility trap hypothesis: Forces that may lead to further postponement and fewer births in Europe. *Vienna Yearbook of Population Research*, vol. 4, Postponement of Childbearing in Europe, pp. 167-192.

McDonald, P. (2006). Low fertility and the State: The efficacy of policy. *Population and Development Review*, vol. 32, No. 3, pp. 485-510.

Smallwood, S., and J. Chamberlain (2005). Replacement fertility, what has it been and what does it mean? *Population Trends*, vol. 119, pp. 16-27.

Sobotka, T., A. Matysiak and Z. Brzozowska (2019). *Policy responses to low fertility: How effective are they?* United Nations Population Fund (UNFPA), Technical Division, Working Paper No. 1.

Tsui, A. O. (2001). Population policies, family planning programs, and fertility: The record. *Population and Development Review*, vol. 27, Supplement: Global Fertility Transition, pp. 184-204.

United Nations (2015). Report of the United Nations Expert Group Meeting on Policy Responses to Low Fertility. New York, 2-3 November 2015. ESA/P/WP/246. Available at www.un.org/development/desa/pd/content/publications.

_____ (2017). *Government policies to raise or lower the fertility level. Population Facts* No. 2017/10. Available at www.un.org/development/desa/pd/content/publications.

_____ (2019a). *World Population Prospects. Online edition. Rev.1*. Available at https://population.un.org/wpp/. Accessed on 15 October 2020.

_____ (2019b). *World Population Prospects 2019: Methodology of the United Nations population estimates and projections.* ST/ESA/SER.A/425. Available at www.un.org/development/desa/pd/content/publications.

_____ (2019c). *Potential impact of later childbearing on future population, Population Facts*, No. 2019/5, December. Available at www.un.org/development/desa/pd/content/publications.

_____ (2020). *World Fertility and Family Planning 2020: Highlights.* ST/ESA/SER.A/440. Available at www.un.org/development/desa/pd/content/publications.

Chapter 7. International migration

Compared to births and deaths, international migration plays a smaller role in population growth or decline in most countries and regions. Nonetheless, international migration can have a sizeable effect on population change under certain circumstances. In several high-income countries, immigration has made significant contributions to population growth. Over the next few decades, immigration is expected to continue to drive growth in some countries, while in others it will attenuate or counteract a potential decline in population size due to sustained low levels of fertility. With a few notable exceptions, emigration does not have a major impact on population change in countries and regions of origin.

As people migrate from one location to another, changing their place of residence, they add to the population counted at destination and are subtracted from the population in the location of origin. Compared to other demographic components, the impact of international migration on population growth tends to be small. Nevertheless, for some countries with rapid growth, immigration has contributed significantly to population increase. In the states of the Gulf Cooperation Council, for instance, the demand for migrant workers in the construction, hospitality, retail and transportation sectors has fuelled rapid population growth even while fertility levels remained low. In some other countries, rapid population growth has resulted from a combination of high levels of fertility and a positive net inflow of migrants. By contrast, for some countries with small populations and low birth rates, including some small island developing states, emigration has contributed to slow growth or even a decline in population numbers (United Nations, 2020a).

Most countries with rapidly growing populations are losing more people through emigration than they are gaining through immigration. The economic and social circumstances often associated with rapid population growth, including poverty, lack of decent work and gender inequality, motivate some people to seek opportunities elsewhere through emigration, while providing a disincentive for voluntary immigration from other countries or regions (chaps. 2 and 9). In most cases, however, international migration does little to alleviate the demographic pressures caused by rapid population growth in low-income and lower-middle-income countries (United Nations, 2019, 2020b), where the balance of births over deaths is typically much larger than the net outflow of migrants (figure 7.1).

In countries or areas with relatively low levels of fertility, immigration from abroad can help to offset a tendency toward population decline. Between 2010 and 2020, for example, due to the prevailing low birth rates across countries of Europe, the population of that region would have declined in size without the inflow of international migrants from other regions. With the balance of births and deaths turning negative in an increasing number of countries, immigration has become a progressively more important component of population growth. In fact, immigration is expected to become the main driver of population growth in high-income countries in the near future (figure 7.1).

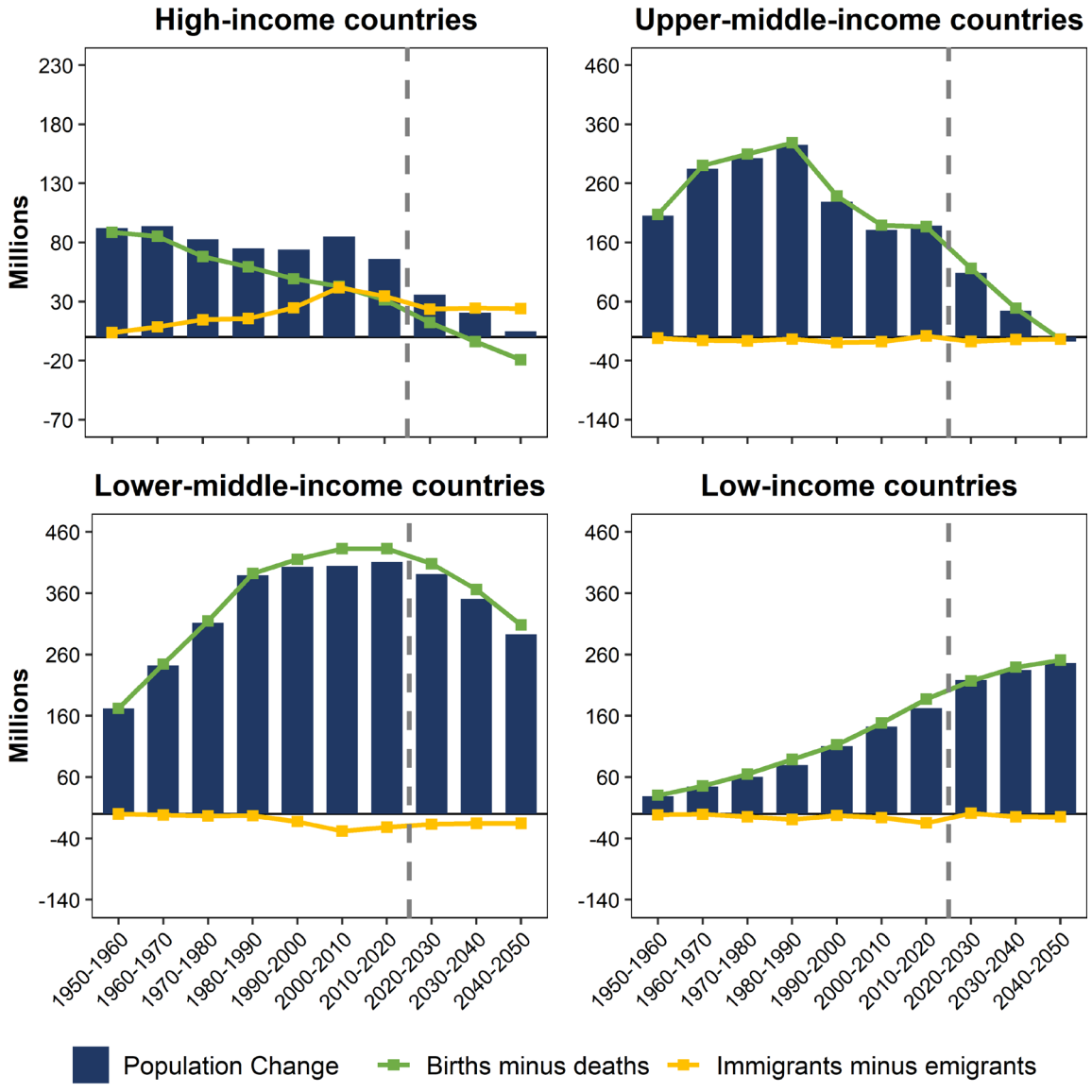
Immigration often contributes to a higher birth rate in countries of destination. In many cases, fertility rates at a given age are higher among recent immigrants than among the native-born population (Adserà and Ferrer, 2015; Pailhé, 2017). In addition, migration tends to have an indirect impact on the overall birth rate in such situations owing to the age distribution of the immigrant population. Because migrants tend to be concentrated between ages 20 and 40—the age range in which women bear most of their children—immigration typically increases the annual number of births per capita in a country of destination. Subsequently, the children of immigrants enlarge the cohort of persons moving into the reproductive age range; as they begin to have children of their own, they may help to sustain a higher birth rate than would

have been observed in the absence of migration, even as individual reproductive behaviours in the migrant community converge towards local norms.

Although international migration does not change the overall number of people living on the planet, it changes the spatial distribution of the human population, which can have implications for global population trends. For example, because the fertility norms and behaviours of migrant populations tend to converge over time towards those of their host society (Desiderio, 2020; Dubuc, 2012; Woldemicael and Beaujot, 2012), international migration from high-fertility countries may reduce the number of births globally, and therefore the future size of the world's population, when it involves movement towards countries with lower levels of fertility.

Figure 7.1

Contributions to total population change of the balance of births over deaths and of immigration over emigration, by income group, from 1950-1960 to 2040-2050



Source: United Nations (2019).

References

Adserà, A., and A. Ferrer (2015). Immigrants and demography: Marriage, divorce, and fertility. In *Handbook of the Economics of International Migration*. B. R. Chiswick and P. W. Miller, eds., vol. 1, pp. 315–374. North Holland: Elsevier.

Desiderio, R. (2020). The Impact of International Migration on Fertility: An Empirical Study. *KNOMAD Paper 36*, Global Knowledge Partnership on Migration and Development (KNOMAD). Available at https://www.knomad.org/.

Dubuc, S. (2012). Immigration to the UK from high-fertility countries: Intergenerational adaptation and fertility convergence. *Population and Development Review*, vol. 38, No. 2, pp. 353-368. The Population Council, Inc.

McKenzie, D. (2017). Poverty, inequality, and international migration: Insights from 10 years of migration and development conferences. *Revue d'économie du développement*, vol. 25, No. 3, pp. 13-28.

Pailhé, A. (2017). The convergence of second-generation immigrants' fertility patterns in France: The role of sociocultural distance between parents' and host country. *Demographic Research*, vol. 36, pp. 1361-398.

United Nations (2019). *World Population Prospects 2019. Online Edition. Rev. 1.* Available at https://population.un.org/wpp. Accessed on 15 October 2020.

_____ (2020a). *International Migration 2020 Highlights.* ST/ESA/SER.A/452. Available at www.unmigration.org.

_____ (2020b). *International Migrant Stock 2020*. United Nations database. POP/DB/MIG/Stock/Rev.2020. Available at www.unmigration.org. Accessed on 20 June 2020.

Woldemicael, G. and R. Beaujot (2012). Fertility behavior of immigrants in Canada: Converging trends. *Journal of International Migration and Integration*, vol. 13, No. 3, pp. 325-341.

Chapter 8. The momentum of population growth

The age distribution of a population plays an important role in determining its future trajectory of growth or decline. In a growing, youthful population, a phenomenon known as "population momentum" can be a major yet temporary driver of growth. Even if fertility in such a population drops immediately to the replacement level, the momentum generated by past growth, which is reflected in the youthful age distribution of the current population, ensures that the population will continue to grow for a few decades. An analysis of the relative weight of the four factors that drive population growth—fertility, mortality, migration and momentum—is essential for understanding population trends and their relevance for sustainable development.

Levels of mortality, fertility and migration shape changes in the size of a population and its distribution by age. In addition, the current age distribution of a population, which is itself a product of past trends in mortality, fertility and migration, can have a major yet temporary impact on population trends, due to a phenomenon known as "population momentum" (Keyfitz, 1971).

The annual number of births in a population depends on both the number of women of reproductive age and the fertility level (average number of births per woman over a lifetime). In a growing population, the number of births increases from year to year, resulting in increasing numbers of children over time. If such growth continues, eventually the number of persons in each age group will be increasing over time, including the number of women in the reproductive age range.[1] A growing population—with a youthful age distribution and an increasing number of women of reproductive age—will maintain a positive growth rate for many years even if the number of births per woman drops immediately to the replacement level.[2]

The impact of this momentum on population growth dissipates over time and typically becomes negligible after a few decades. While it lasts, however, the momentum of past growth, as embodied in a relatively youthful age distribution, contributes to an excess of births over deaths and prolongs the period of population increase that is a central feature of the demographic transition. Such momentum can be a powerful driver of future population growth in addition to the other three factors of demographic change.

The population age distribution varies significantly across countries and regions (figure 8.1). For example, the share of female population under age 15 in 2020 was more than twice as high in sub-Saharan Africa compared to Europe, Northern America, Eastern and South-Eastern Asia, or Australia and New Zealand; in these regions, the average age of the population was also much higher in 2020 than in sub-Saharan Africa (chap. 4).

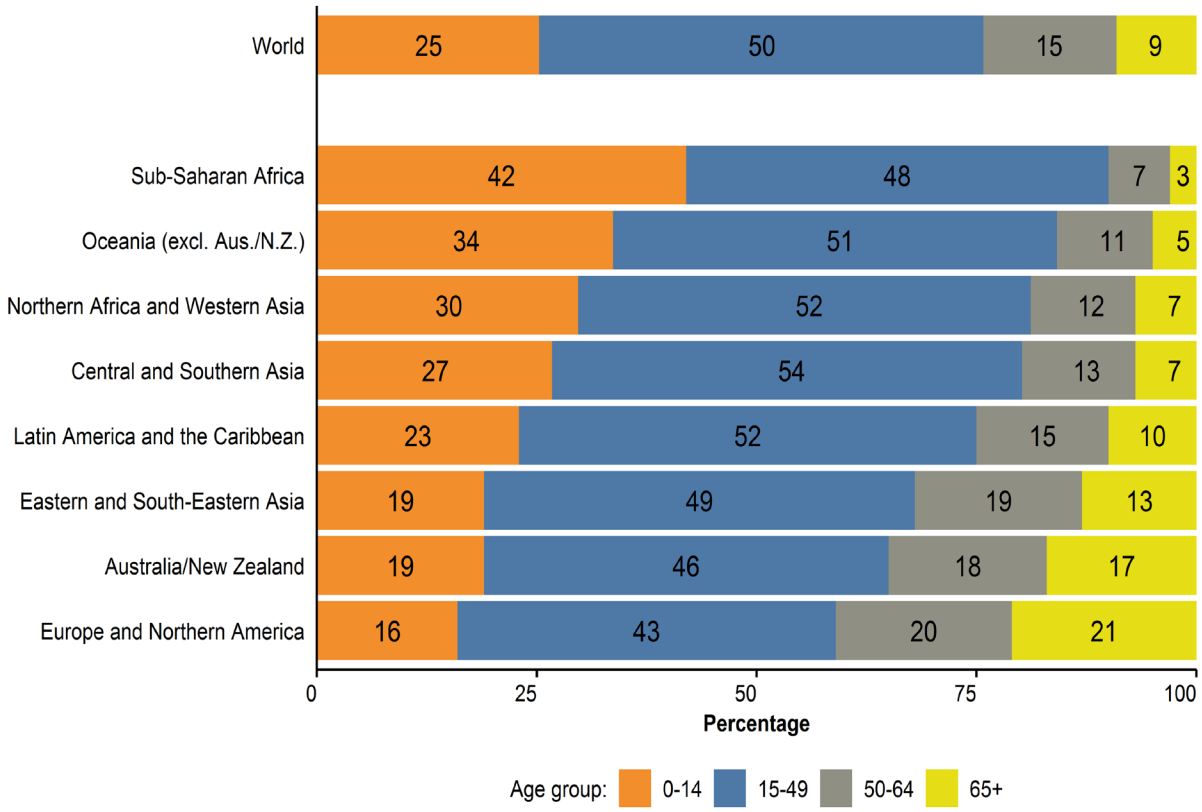
The share of female population under age 15 is an important indicator of the potential for future population growth. These girls form the cohorts who will enter the reproductive age range in the coming years and whose childbearing will contribute to population growth for the next few decades. In general, a larger share of female population below age 15 implies a greater potential for future growth.

[1] For women, the reproductive age range extends, by convention, from age 15 to age 49 years, even though a small proportion of births occur before or after these ages.

[2] In this hypothetical scenario, it is also assumed that mortality remains constant at current levels and that there is no international migration. Given these assumptions, future population growth is driven entirely by the momentum associated with a youthful age distribution. (For a definition and discussion of replacement-level fertility, see chap. 6).

Figure 8.1

Distribution of the female population by age, 2020, world and regions



Source: United Nations (2019).
Note: Regions are sorted by the relative size of the female population in age group 0-14.

Over the next three decades, it is projected that the size of the world's population will rise from 7.8 billion in 2020 to around 9.7 billion in 2050—an increase of 1.9 billion, or nearly 25 per cent (chap. 3). Globally, the main driver of this growth will be the momentum of past growth that is embedded in the current age distribution, which on its own would bring an increase in total population of around 1.3 billion persons over this period (a 17 per cent increase over the 2020 population size, or slightly more than two thirds of the projected increase) (figure 8.2).

The impact of momentum on population growth between 2020 and 2050 is rather certain, since most of the women whose offspring will contribute to that growth are already alive. For example, women who were 25 years old in 2020 may bear their children until around 2045, when they will reach age 50. By contrast, further reductions in levels of mortality and continuing high levels of fertility will have much smaller and less certain impacts on global population growth over this period, with each component expected to contribute an increase of around 300 million persons worldwide from 2020 to 2050 (roughly 4 per cent of the 2020 level, or just under one sixth of the total increase projected over 30 years).[3]

Even though populations are expected to grow over the next three decades in all regions except Europe, the role of momentum as a component of growth will vary considerably by region (Andreev, Kantorová and

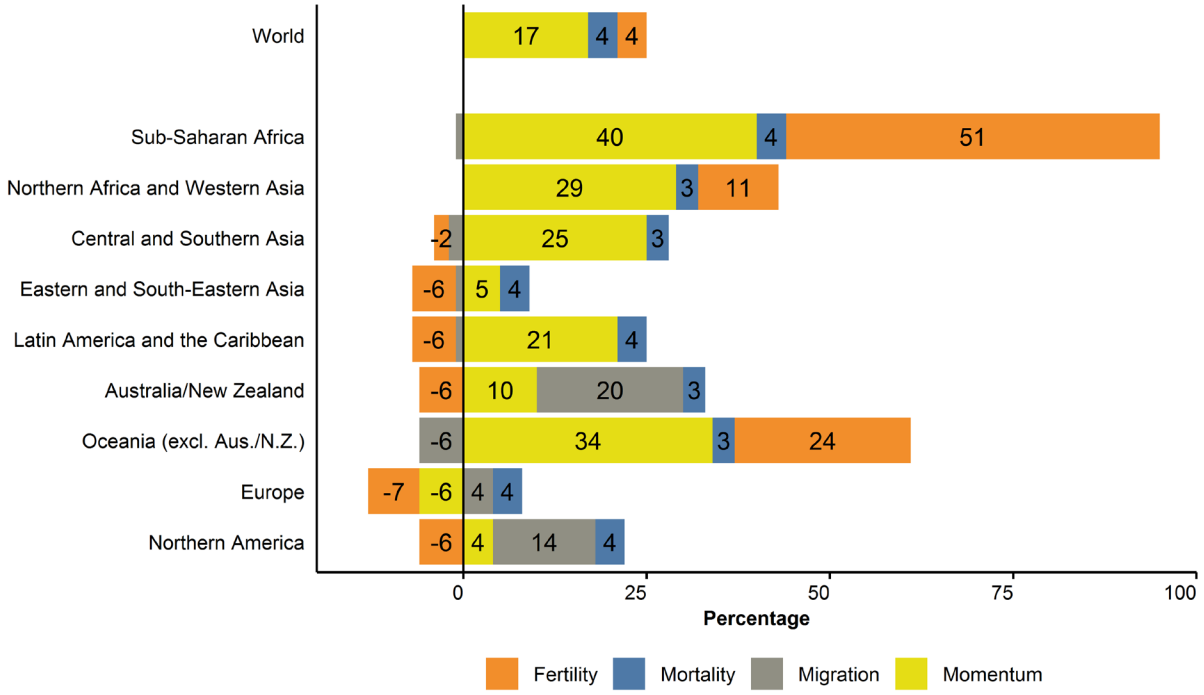
[3] At the global level, the direct effect of international migration on population growth is nil.

Bongaarts, 2013; Bongaarts, 2009). In this period, it is anticipated that the change in population size due to momentum will be positive everywhere except in Europe (figure 8.2). The projected population increase attributable to momentum between 2020 and 2050 ranges from 4 per cent in Northern America to 40 per cent in sub-Saharan Africa, compared to 17 per cent globally (see above).

In populations where fertility has been below the replacement level for several decades, the age distribution has been shifting toward older ages and the number of women in the reproductive age range may now be decreasing. In such situations, momentum contributes to slower growth or, in extreme cases, to population decline (Blue and Espenshade, 2011; Bongaarts and Bulatao, 1999). Due to its advanced process of demographic ageing, Europe, where fertility has been below the replacement level since the late 1970s, is the only region where the age distribution is expected to have a negative impact (-6 per cent) on the change in total population between 2020 and 2050.

Figure 8.2

Contributions attributable to four components of population growth from 2020 to 2050, relative to population size in 2020, world and regions



Source: Computed using data from United Nations (2019).
Notes: (1) For small numeric values, labels are not displayed. (2) Europe and Northern America were considered separately for this analysis, as the two sub-regions display distinctive patterns.

While momentum is expected to be the most important driver of change in population size worldwide and for most regions in the coming decades, sub-Saharan Africa is the only region where continuing high levels of fertility are projected to remain the leading factor driving population growth over this period. That region's population is projected to nearly double between 2020 and 2050, with an expected increase of 1.023 billion persons, or close to 94 per cent of its population in 2020. Fertility above the level required for population replacement will add 563 million persons between 2020 and 2050 (51 per cent of the 2020 level, or 55 per cent of the total projected increase), while the momentum associated with the region's youthful age

distribution will contribute an additional 433 million (40 per cent of the 2020 population, or 42 per cent of the growth projected over this period). Ongoing mortality reductions in sub-Saharan Africa are expected to make a much smaller contribution to future growth of around 42 million (4 per cent of the 2020 population, or 4 per cent of the total increase), while a net outflow of migrants over 30 years is expected to reduce the region's population in 2050 by 15 million (1 per cent of the 2020 level, or 1 per cent of projected growth).[4]

The contribution of mortality decline to future population growth is projected to be small (under 5 per cent of population size in 2020) in all regions. Such changes will be relatively unimportant except in Europe and in Eastern and South-Eastern Asia, where the combined effect of the other three factors is likely to be negative in the coming decades. For those two regions, the ongoing decline in mortality is expected to help mitigate or reverse population losses resulting from decades of low fertility.

International migration is expected to have a limited impact on population growth in most regions.[5] According to projections by the United Nations, only in Australia and New Zealand and in Northern America will immigration contribute significantly to future growth. International migration is projected to increase the combined population of Australia and New Zealand in 2050 by 20 per cent, or three quarters of the region's anticipated growth over 30 years. The population of Northern America is projected to grow by 14 per cent above its 2020 level due to international migration, accounting for close to 90 per cent of the total expected increase between 2020 and 2050.

In summary, a breakdown of the impact of the four components of population growth confirms that the momentum of growth that is embodied in the current age distribution will be the most important driver of population growth on a global scale until at least 2050. Because of demographic momentum, in regions with youthful and growing populations, growth will continue for many years even if there is a rapid drop in the average number of births per woman over a lifetime. In short, the momentum resulting from past growth severely limits the potential impact of fertility reductions on population trends within the next few decades. Nevertheless, lower levels of fertility between now and 2050 would diminish the amount of momentum generated by growth over that period, creating conditions conducive to a more substantial deceleration of growth in the second half of the century.

[4] Numbers and percentages have been rounded and therefore do not necessarily sum to the respective totals.
[5] Chapter 7 presents a complementary analysis covering a longer time span, where the effect of population momentum is not isolated.

References

Andreev, K., V. Kantorová and J. Bongaarts (2013). Demographic components of future population growth. Technical Paper No. 2013/3. United Nations, New York. Available at www.un.org/en/development/desa/population/publications/pdf/technical/TP2013-3.pdf.

Blue, L., and T. J. Espenshade (2011). Population momentum across the demographic transition. *Population and Development Review*, vol. 37, No. 4, pp. 721-47.

Bongaarts, J., and R. A. Bulatao (1999). Completing the demographic transition. *Population and Development Review,* vol. 25, No. 3, pp. 515-529, DOI: 10.1111/j.1728-4457.1999.00515.x.

Bongaarts, J. (2009). Human population growth and the demographic transition. Philosophical Transactions of the Royal Society, vol. 364, pp. 2985-2990.

Keyfitz, N. (1971). On the momentum of population growth. *Demography,* vol. 8, No. 1, pp. 71-80. DOI: 10.2307/2060339.

United Nations (2019). *World Population Prospects 2019. Online edition. Rev.1* Available at https://population.un.org/wpp/. Accessed on 15 October 2020.

“University of Ghana students listen to their political science professor, Dr. Evans Aggrey-Darkoh in Accra, Ghana”, Photo Dominic Chavez/World Bank

Part C. Socioeconomic causes and consequences of population growth

"Outside of classroom", Photo, World Bank/Curt Carnemark

KEY MESSAGES

- Rapid population growth is both a cause and a consequence of slow progress in development; rapid population increase can exacerbate the challenge of ensuring that future development is both sustainable and inclusive.

- Achieving the Sustainable Development Goals, particularly those related to health, education and gender equality, can contribute to slowing global population growth.

- Enough food is currently being produced worldwide to feed everyone living on the planet, yet hunger, malnutrition and food insecurity remain major concerns due to failures of distribution and unequal access.

- Achieving universal health coverage in poor countries where populations are growing rapidly will require a concerted effort to improve and expand access to high-quality health care, including for sexual and reproductive health and family planning.

- Ensuring that individuals, in particular women, have the ability to decide the number of children that they will have and the timing of their births can markedly improve well-being and help to disrupt intergenerational cycles of poverty.

- Increased access to high-quality reproductive health-care services and safe and effective methods of family planning could encourage a fertility decline and help to accelerate countries' economic and social development.

- Changes in the population age structure resulting from a sustained reduction in fertility open a time-bound window of opportunity for accelerated economic growth, often referred to as the "demographic dividend".

- Investments in education and health and the promotion of full and productive employment for all, including for women, can double the positive economic impact of the favourable age structure created by a sustained decline in fertility.

Chapter 9. Leaving no one behind

Ensuring that no one is left behind is one of the key principles of the 2030 Agenda for Sustainable Development. It affirms that the benefits of sustainable development must be shared by all members of society, including the most vulnerable. Rapid population growth can exacerbate the challenges of ensuring that future development is both sustainable and inclusive. Forward-looking policies and programmes that take into account current and future population dynamics are essential to fulfil the pledge that no one will be left behind.

The world's success in achieving the Sustainable Development Goals (SDGs) will be largely contingent upon how well the needs of persons living in vulnerable situations are addressed. Rapid population growth, particularly in low-income countries, may hinder the realization of the pledge that no one will be left behind. A growing population magnifies the demand for resources and investments required to meet the needs of all people, especially the poor and the most vulnerable.

The size of the population of children and youth matters greatly for sustainable development (United Nations, 2018). Over the next three decades, this population is projected to continue to grow globally. However, owing to pronounced differences in population trends across countries, nearly all of this growth is expected to take place in the low-income or lower-middle-income countries. For upper-middle-income and high-income countries, the number of children and youth is projected to decline between 2020 and 2050 (United Nations, 2019a). As a result, an increasing share of young people worldwide are expected to live in countries confronting substantial structural barriers to sustainable development (UNDP, 2003).

Even though a growing population of children and youth creates various social and economic challenges, it also presents an opportunity for accelerated economic growth (chaps. 2 and 15). Reaping the benefits of a youthful population depends critically on a country's ability to promote young people's health and well-being, provide them with opportunities for quality education and decent work, and remove barriers that prevent young people from participating fully in society (United Nations, 2018; Kharas, McArthur and Ohno, 2020). The returns of investing in young people's human capital are manifold, generating virtuous cycles that can lift individuals, families and societies out of poverty, reduce inequality, and help build more resilient and peaceful societies (chaps. 13 and 15). These returns are particularly large in low-income countries (World Bank, 2019). Nevertheless, many low-income countries lack the institutions, resources, macroeconomic policies and investment climate necessary to meet the needs of their young people (United Nations, 2019b). Unless adequate public and private funds are mobilized and invested wisely, the growth of the population of children and youth may also present a burden to such countries. The COVID-19 pandemic, which has disrupted education and employment opportunities across the globe, presents additional obstacles to ensuring that no one is left behind, particularly for low-income countries (ILO, 2020a).

In countries where large numbers of young people are entering the labour force, the lack of decent work may compel some to migrate in search of better opportunities (ILO, 2020b). While out-migration tends to have a modest impact on population size and age structure in countries experiencing rapid population growth (United Nations, 2019c; chaps. 7 and 8), minimizing the adverse drivers and structural factors that induce young people to leave their countries are important policy priorities both for the countries themselves and for the international community.[1] Harnessing the demographic dividend (box 1.2),

[1] Minimizing the adverse drivers and structural factors that compel people to leave their country of origin is one of the 23 objectives of the Global Compact for Safe, Orderly and Regular Migration (A/RES/73/195).

investing in human capital development and slowing the emigration of skilled workers ("brain drain") will require countries to invest in the creation of productive employment, aligned with local and national labour market needs and with the skills acquired by young people, and to promote education, vocational training and entrepreneurship.[2] Countries and the international community must also take steps to address the root causes of forced migration and displacement, including human rights violations and abuses, political violence, natural disasters and environmental degradation. Enhancing access to safe, orderly and regular migration, while protecting the rights of migrants, promoting their economic and social integration, and reducing their vulnerability to various forms of abuse, exploitation and discrimination, may also attenuate some of the demographic challenges faced by countries of destination, many of which are experiencing rapid population ageing and, in more extreme cases, population decline (chap. 7).

Over the coming decades, the number of older persons is projected to grow globally, faster than all younger age groups. Among the countries where the number of older persons is expected to grow most rapidly, many do not have well-established systems of social protection (United Nations, 2020a). In sub-Saharan Africa and Southern Asia, for instance, two of the regions where the population of older persons is expected to grow the fastest, less than one fourth of those who are legally eligible receive a pension (ILO, 2017). Older women are often especially vulnerable due to exclusions from, or limitations in access to, social security entitlements, financial resources, property ownership and inheritance rights. Inequalities in income, health, and access to education and decent work also accumulate over the life cycle, exposing women to higher risks of poverty in old age. Establishing universal social protection with adequate benefits is central to reducing levels of poverty and inequality among older persons, and particularly older women (United Nations, 2019d). Eliminating age-related barriers to employment, including barriers to recruitment and hiring, and creating opportunities for lifelong learning are other measures that can increase financial security in old age and prevent older persons from falling into poverty.

Increasingly, countries with rapidly growing populations are faced with a rising burden of chronic illness and disability associated with old age (Kämpfen, Wijemunige and Evangelista, 2018; chap. 12). Health systems in low-income and lower-middle-income countries often lack the specialized personnel and infrastructure needed to provide comprehensive care for an ageing population (Nortey and others, 2017). To meet the health demands of ageing societies, all countries, even those with youthful populations today, should embrace forward-looking policies to promote healthy ageing and develop systems to provide long-term care. Filling critical shortages of health-care personnel is another priority: currently, owing to such shortages, more than half of all older persons globally do not have access to quality long-term care, with Africa having the highest percentage of excluded persons (ILO, 2017). Greater efforts are needed to increase health-care financing and to train, recruit and retain skilled professionals in developing countries.[3] Doing so could generate millions of jobs, particularly in low-income countries where shortages in the health-care workforce are most severe.

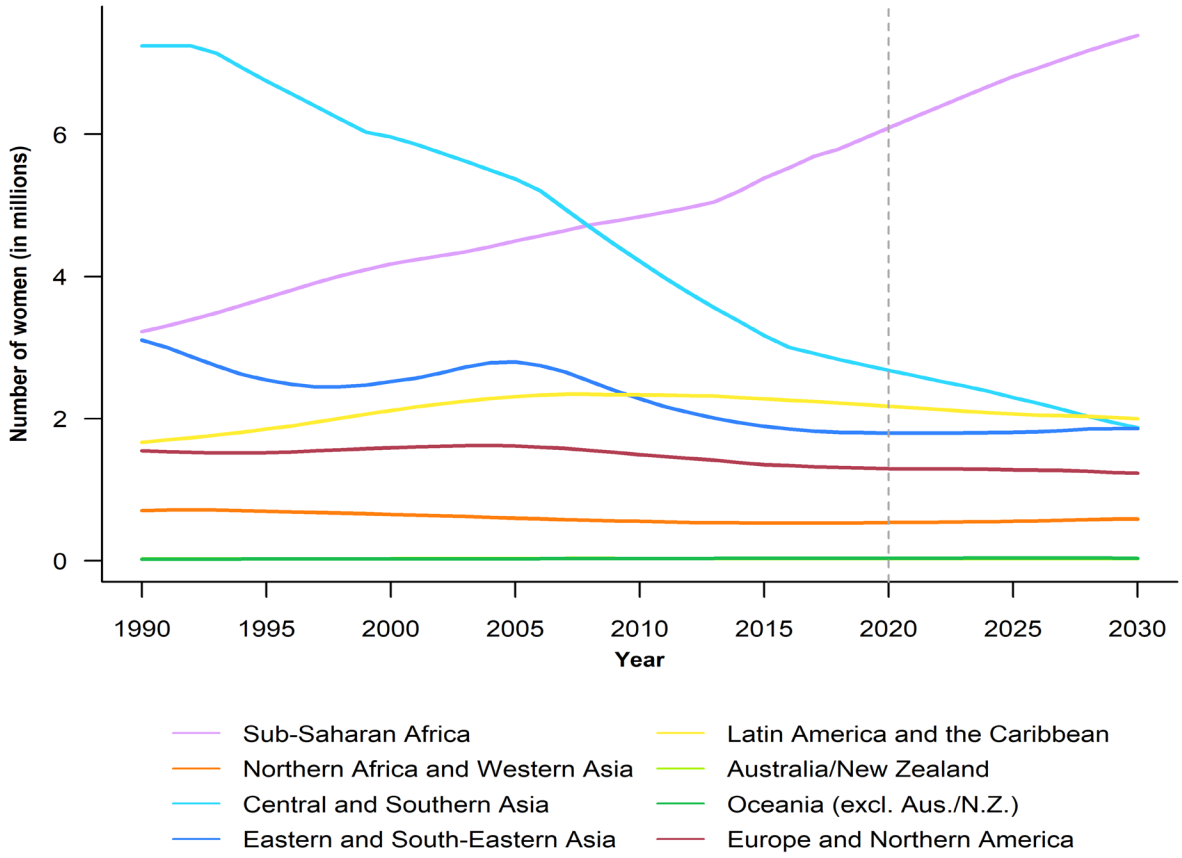
Empowerment of women is central to achieving the SDGs. Yet, in many countries, women face barriers to the exercise of their basic human rights, depriving them of agency and often trapping them and their children in vicious cycles of poverty, exclusion and inequality (chap. 10). In many low-income countries with rapidly growing populations, women and girls are often required to forego formal education and employment opportunities to provide full-time care to family members and perform household chores, such as collecting water and fuel (chaps. 13 and 15). In such settings, policies promoting better educational outcomes for women and girls and higher female labour force participation are likely to result in lower levels of fertility and slower population growth, as well as greater equality of women and men in society and more sustained and inclusive economic growth.

[2] Global Compact for Safe, Orderly and Regular Migration, objective 2(e).
[3] Sustainable Development Goal 3(c).

Childbirth and marriage before the age of 18 continue to be common in many parts of the world (United Nations, 2020b). In such settings, women and adolescents tend to face numerous forms of discrimination or legal barriers that prevent them from making autonomous decisions about their sexual and reproductive health, including for family planning (figure 9.1; chap. 14). To achieve the SDG target of universal access to sexual and reproductive health care by 2030, various legal, medical and regulatory barriers must be removed (UNFPA, 2020). In sub-Saharan Africa, for example, both population growth and changing preferences regarding family size are expected to contribute to a rapid increase in the total demand for family planning (chap. 12). Unless access is expanded rapidly in such settings, the availability of family planning services, including for modern methods of contraception, will continue to fall short of the projected demand (United Nations, 2020c).

Figure 9.1

Number of women aged 15-19 with an unmet need for family planning, by region, 1990-2030



Source: United Nations (2020d).

Note: The unmet need for family planning measures the gap between women's reproductive intentions and their contraceptive behaviour. It is defined as the proportion of women who want to stop or delay childbearing but are not using any method of contraception.

References

International Labour Office (ILO) (2017). *World Social Protection Report 2017–19: Universal social protection to achieve the Sustainable Development Goals*. International Labour Office – Geneva: ILO. Available at https://ilo.org/global/publications/books/WCMS_604882/lang--en/index.htm.

_____ (2020a). *ILO Monitor: COVID-19 and the world of work. Fourth edition*. Updated estimates and analysis. Available at https://ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/documents/briefingnote/wcms_745963.pdf.

_____ (2020b). *World Employment and Social Outlook: Trends 2020*. International Labour Office – Geneva: ILO, 2020. Available at https://ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/---publ/documents/publication/wcms_734455.pdf .

Kämpfen, F., N. Wijemunige, and B. Evangelista (2018). Aging, non-communicable diseases, and old-age disability in low- and middle-income countries: a challenge for global health. *International Journal of Public Health*, vol.63, No. 9, pp. 1011-1012. Available at https://doi.org/10.1007/s00038-018-1137-z.

Kharas, H., J. McArthur, and I. Ohno, eds. (2020). *Leave No One Behind: Time for Specifics on the Sustainable Development Goals*. Washington, D.C.: Brookings Institution Press.

Nortey, S.T., and others (2017). Economic burden of family caregiving for elderly population in southern Ghana: the case of a peri-urban district. *International Journal for Equity in Health*, vol. 16, No.16.

United Nations Development Programme (UNDP) (2003). "Overcoming structural barriers to growth to achieve the goals", *in Human Development Report* 2003, pp. 67-84.

United Nations Population Fund (UNFPA) (2020). *Ensure universal access to sexual and reproductive health and reproductive rights. Measuring SDG Target 5.6*. Available at https://unfpa.org/sites/default/files/pub-pdf/UNFPA-SDG561562Combined-v4.15.pdf.

United Nations (2018). *World Youth Report: Youth and the 2030 Agenda for Sustainable Development*. Available at https://un.org/development/desa/youth/wp-content/uploads/sites/21/2018/12/WorldYouthReport-2030Agenda.pdf.

_____ (2019a). *World Population Prospects 2019. Online Edition. Rev. 1*. Available at https://population.un.org/wpp/Download/Standard/Population/. Accessed on 15 October 2020.

_____ (2019b). *Report of the Secretary-General on SDG Progress 2019: Special Edition*. Available from https://sustainabledevelopment.un.org/content/documents/24978Report_of_the_SG_on_SDG_Progress_2019.pdf.

_____ (2019c). *International Migration 2019: Report*. ST/ESA/SER.A/438. Available at www.un.org.development.desa.pd/files/files/documents/2020/Jun/international_migration_2019_report_june20.pdf.

_____ (2019d). *World Population Ageing 2019: Highlights*. ST/ESA/SER.A/430. Available at https://un.org/en/development/desa/population/---publications/pdf/ageing/WorldPopulationAgeing2019-Highlights.pdf.

_____ (2019e). *Living arrangements of older persons around the world. Population Facts*, April 2019 No. 2019/2. Available at https://un.org/en/development/desa/population/publications/pdf/popfacts/PopFacts_2019-2.pdf.

_____ (2020a). *SDG Indicators Global Database*. SDG indicator 1.3.1. Available at https://unstats.un.org/sdgs/indicators/database/. Accessed on 1 July 2020.

United Nations (2020b). *Fertility among young adolescents at ages 10-14 years – A global assessment*. ST/ESA/SER.A/453.

_____ (2020c). *World Family Planning 2020 Highlights: Ensuring universal access to family planning: The need for accelerated action*. Available at https://un.org/development/desa/pd/sites/www.un.org.development.desa.pd/files/files/documents/2020/Sep/unpd_2020_worldfamilyplanning_highlights.pdf.

_____ (2020d). *World Contraceptive Use 2020*. POP/DB/CP/REV2020. Available at https://un.org/en/development/desa/population/---publications/dataset/contraception/. Accessed on 1 July 2020.

World Bank (2019). *World Development Report 2019: The Changing Nature of Work*. Washington, DC: World Bank.

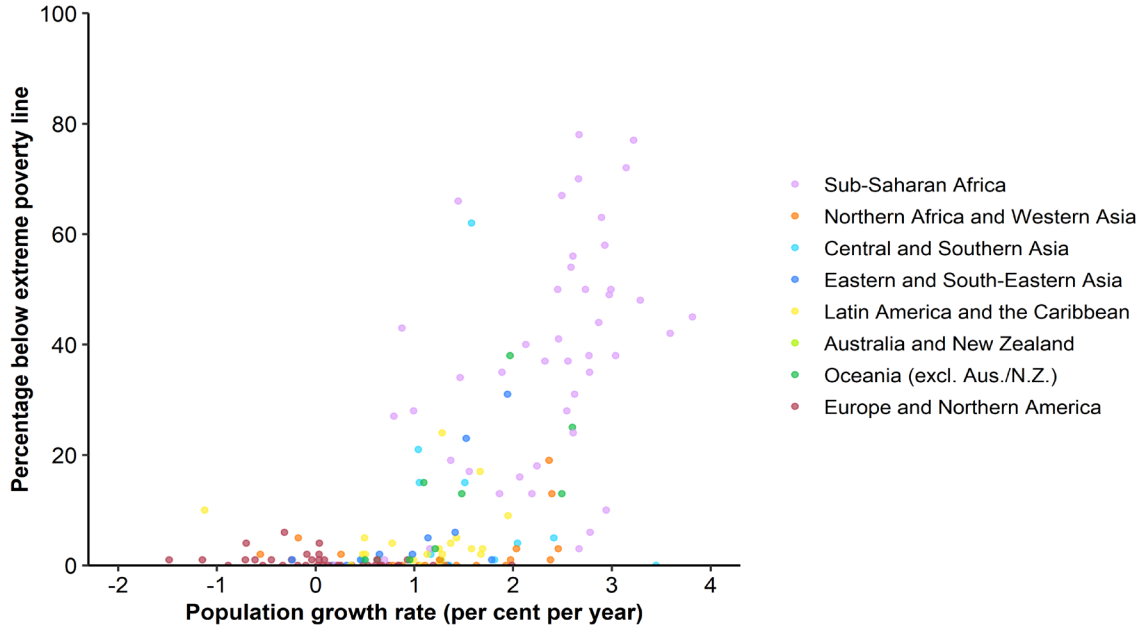
Chapter 10. Poverty and inequality

High levels of fertility, rapid population growth and widespread poverty often go hand in hand, trapping countries, communities and individuals in a vicious cycle. In such cases, accelerating the transition from high to low levels of fertility, together with appropriate social and economic policies, can lead to sustained economic growth and poverty reduction. Universal and equitable access to quality education and to sexual and reproductive health care, including for family planning, information and education, can help individuals and societies to escape from intergenerational cycles of poverty.

Rapid population growth and slow progress in development tend to go hand in hand and may even be mutually reinforcing (figure 10.1).[1] For example, rapid population growth can exacerbate the challenge of eradicating poverty, potentially trapping countries and communities in a vicious cycle where economic growth may not keep pace with population growth, and where therefore the increase in per capita income may be insufficient to eradicate poverty, end hunger and malnutrition, and ensure universal access to health care, education and other essential services. At the same time, poverty, lack of education and gender inequality can deprive individuals of opportunities and choices, limiting their ability to control their fertility, perpetuating high levels of childbearing often starting early in life and ensuring the continued rapid growth of the population.

Figure 10.1

Population growth rate, 2015-2020, by the proportion of the population living below the international poverty line, 2003-2018



Sources: United Nations (2019; 2020).

Notes: (1) SDG indicator 1.1.1 is the proportion of the population living below the international poverty line, which the World Bank has defined as a per capita income of U.S. dollars 1.90 per day in terms of purchasing power parity (PPP). (2) Based on the most recent data available for the period 2003-2018.

[1] Rapid population growth does not guarantee high levels of poverty and is sometimes associated with economic success. Examples of the latter include members of the Cooperation Council for the Arab States of the Gulf (GCC), where the rapid population growth of recent years has been driven mostly by labour migration fuelled by rapid economic expansion (chap. 7).

Over the past decades, there has been remarkable progress globally in reducing both the number and the proportion of persons living below the international poverty line, currently defined as an income of U.S. dollars 1.90 per person per day in terms of purchasing power parity (PPP). Yet in many countries, especially in sub-Saharan Africa, the number of persons living in extreme poverty has continued to rise in recent years. Rapid population growth, combined with high levels of inequality, inadequate investments in human capital, limited access to infrastructure and, in some cases, ongoing political fragility and civil conflict, has added to the challenge of ending poverty in the world's poorest regions.

In the coming decades, extreme poverty is projected to become increasingly concentrated in regions where the population continues to grow rapidly (World Bank, 2018; United Nations, 2021; chap. 3). The COVID-19 pandemic may further compound this trend (Lakner and others, 2020; Mahler and others, 2020). In these fast-growing regions, expanded access to education and health-care services, including for reproductive health and family planning, would likely accelerate the transition from high to low levels of fertility, with positive repercussions for economic growth and eradication of extreme poverty (Das Gupta, Bongaarts and Cleland, 2011; Stover and others, 2016; Bloom, 2020; Wietzke, 2020).

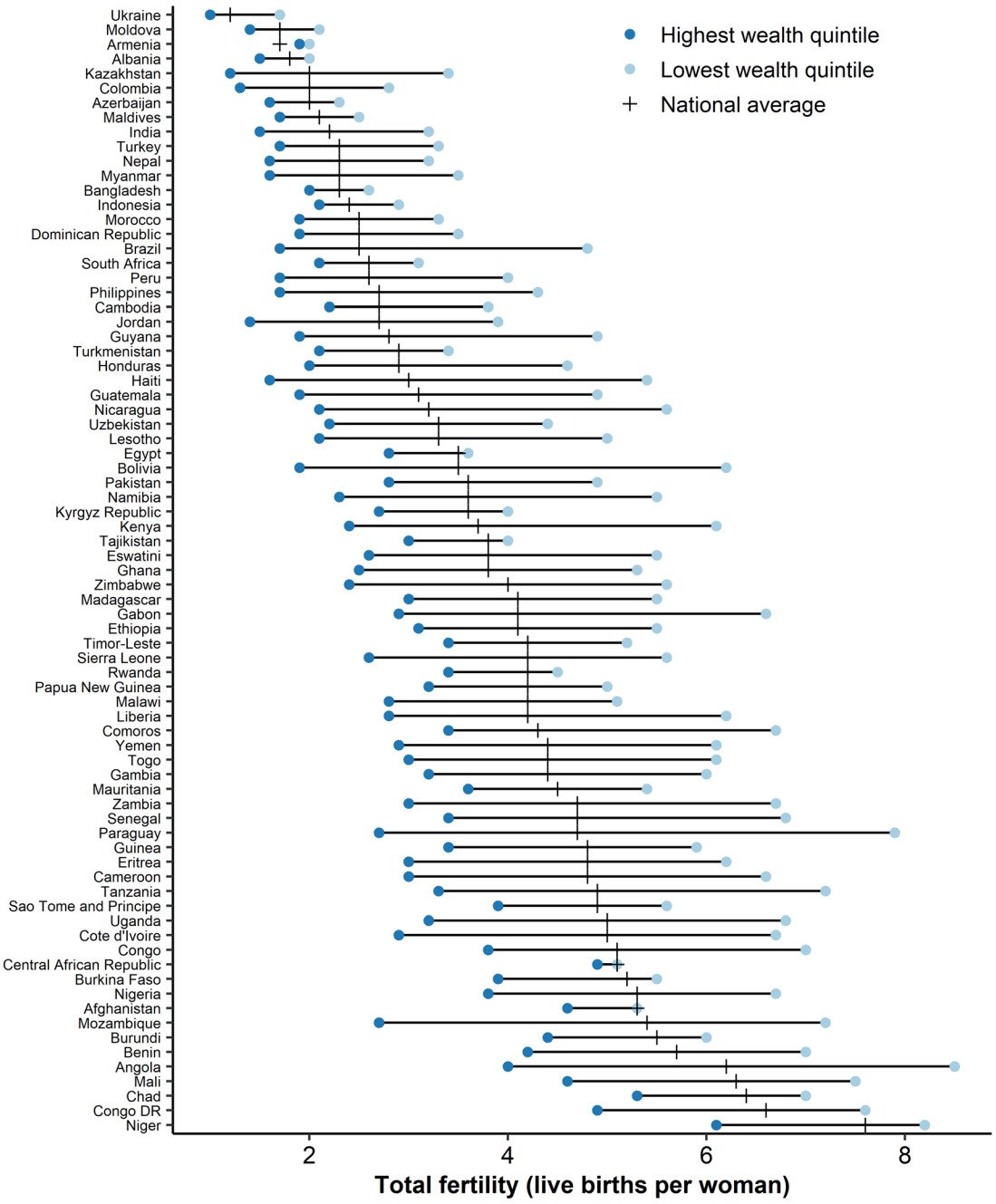
Poverty disproportionately affects persons living in vulnerable situations. In a world where economic success is closely tied to educational achievement, having a large family tends to increase the vulnerability of poor households, making them less resilient when faced with health crises, economic shocks or natural disasters (Shahabuddin and Ali, 2006). Households with smaller families tend to have more resources to invest in the well-being and education of children (chaps. 13 and 15), increasing their future productivity and enabling more inclusive participation in the process of economic growth and transformation.

Children are twice as likely as adults to live in poverty, in part because poorer households are typically larger and include more children than wealthier households (figure 10.2; World Bank, 2018). Poverty in childhood often has adverse ramifications over the life course, including negative impacts on health, education and employment. Countries whose populations are growing rapidly tend to have low proportions of children and youth covered by social protection systems, potentially exposing them to multiple forms of poverty and exclusion (ILO, 2017). Therefore, as the global share of population below age 25 becomes increasingly concentrated in low-income and lower-middle-income countries, universal access to social protection for all, including children and youth, becomes more and more critical for ensuring that no one is left behind (chap. 9).

As a result of discrimination in access to education and employment as well as other factors, women tend to be disproportionately vulnerable to living in poverty. Removing barriers to women's full participation in social, economic and political life is important for promoting sustained economic growth and ending poverty (chap. 14). Ensuring that individuals, in particular women, have the ability to decide the number of children that they will have and the timing of their births can markedly improve current well-being and future prospects, including opportunities for the advancement of both women and their children, and can help to disrupt cycles of poverty over the life course and across generations (Canning and Schultz, 2012; Merrick, 2002).

Figure 10.2

Total fertility rate by wealth quintiles, countries with available data, 1990-2019



Source: ICF, The DHS Program STATcompiler.
Note: Based on the most recent available data from the Demographic and Health Surveys (DHS) conducted in the period 1990-2019.

Effective social protection schemes and policies, along with programmes to ensure universal access to education, health care, food security, housing, sanitation and clean drinking water, are critical for reducing inequality, alleviating poverty and supporting inclusive and sustainable growth. At present, more than half of the world's population lacks access to social protection benefits (ILO, 2017; 2019). Coverage gaps are particularly pronounced in countries and regions with fast-growing populations. In the absence of other institutional mechanisms to deliver social protection over the life course, family remains the primary source of economic and material security for most people. In this context, children are invaluable to parents, especially at older ages. Additionally, households facing poverty and economic insecurity often rely on child labour as a coping strategy (ILO, 2018).

Legislation to encourage or require families to keep children in school combined with the provision of public pensions and social protection floors can diminish the perceived economic benefits of raising children while increasing the expected costs, resulting in a smaller desired family size (Bongaarts, 2017). When policies are enacted that change personal incentives, social norms favouring large families tend to change as well, leading to lower fertility and slower population growth (chaps. 9 and 14).

References

Bloom, D. E. (2020). Population 2020. Demographics can be a potent driver of the pace and process of economic development. *Finance and Development*, 2020, vol. 57, No. 1, pp. 4-9.

Bongaarts, J. (2017). Africa's unique fertility transition. *Population and Development Review*. vol. 43, Issue S1, pp. 39-58.

Canning, D., and P. Schultz (2012). The economic consequences of reproductive health and family planning. *The Lancet*, vol. 380, Issue 9837, pp. 165-171.

Das Gupta, M., J. Bongaarts, and J. Cleland (2011). Population, poverty, and sustainable development: A review of the evidence. Policy Research Working Papers. The World Bank Group: Washington DC. Available at https://doi.org/10.1596/1813-9450-5719.

International Labour Office (ILO) (2017). *World Social Protection Report 2017–19: Universal social protection to achieve the Sustainable Development Goals*. International Labour Office – Geneva: ILO. Available at https://ilo.org/global/publications/books/WCMS_604882/lang--en/index.htm.

_____ (2018). *Ending child labour by 2025: A review of policies and programmes*. International Labour Office: Geneva, Switzerland, Second edition. Available at www.ilo.org/publns.

_____ (2019). Universal social protection for human dignity, social justice and sustainable development. *General Survey concerning the Social Protection Floors Recommendation, 2012* (No. 202). International Labour Office: Geneva, Switzerland. Available at https://ilo.org/wcmsp5/groups/public/ed_norm/relconf/documents/meetingdocument/wcms_673680.pdf.

Lakner, C., and others (2020). How much does reducing inequality matter for global poverty? *Global Poverty Monitoring Technical Note*. World Bank, Washington DC, June 2020, Available at https://openknowledge.worldbank.org/handle/10986/33902.

Mahler, D., and others (2020). Updated estimates of the impact of COVID-19 on global poverty, *World Bank Blogs*, 8 June 2020. Available at https://blogs.worldbank.org/opendata/updated-estimates-impact-covid-19-global-poverty.

Merrick, T. W. (2002). Population and poverty: New views on an old controversy. *International Family Planning Perspectives*, vol. 28, No. 1, p. 41.

Shahabuddin, Q., and Z. Ali (2006). Natural disasters, risks, vulnerability and persistence of poverty: An analysis of household-level data (February 1, 2006). Chronic Poverty Research Centre Working Paper, Available at http://dx.doi.org/10.2139/ssrn.1757885.

Stover, J., and others (2016). Interventions to improve reproductive health. In: Black RE, Laxminarayan R, Temmerman M, and others, editors. *Reproductive, Maternal, Newborn, and Child Health: Disease Control Priorities*, Third Edition (Volume 2). The International Bank for Reconstruction and Development, The World Bank Group: Washington DC, Apr 5, Chapter 6.

United Nations (2019). *World Population Prospects 2019, Online Edition. Rev. 1.* Available at https://population.un.org/wpp/. Accessed on 15 October 2020.

_____ (2020). *SDG Indicators Global Database.* Available at https://unstats.un.org/sdgs/indicators/database/. Accessed on 1 August 2020.

_____ (2021). *World Economic Situation and Prospects as of mid-2021*. Available at https:// un.org/en/desa. Accessed on 15 May 2021.

Wietzke, F. B. (2020). Poverty, inequality, and fertility: The contribution of demographic change to global poverty reduction. *Population and Development Review*, vol. 46, No. 1, pp. 65-99.

World Bank (2018). *Piecing Together the Poverty Puzzle. Poverty and Shared Prosperity*. The World Bank Group: Washington DC.

Chapter 11. Hunger, food security and nutrition

Despite continued global population growth, enough food is currently being produced worldwide to feed everyone on the planet. Yet, due to failures of distribution and unequal access, hunger, malnutrition and food insecurity remain major concerns in some parts of the world, especially in countries experiencing rapid population growth. Moreover, obesity and unhealthy diets are contributing to ill-health in a growing number of countries worldwide. Transformative changes to the world's food systems, including agricultural production systems, are needed to feed the growing global population in a sustainable manner. Measures to reduce inequities are also critical to ensure that safe, nutritious and sufficient food is available, affordable and accessible to all.

The world produces enough food to feed everyone on the planet. Yet, in 2020, an estimated 786 million persons suffered from hunger and some 2.4 billion people worldwide experienced moderate or severe food insecurity (box 11.1) (FAO and others, 2021). Hunger and food insecurity are closely linked with poverty, and many of the people who face the greatest barriers to obtaining sufficient amounts of safe and nutritious food live in low-income or lower-middle-income countries. In many such countries, rapid population growth exacerbates the challenge of ending hunger and ensuring that all people have sufficient access to food (figure 11.1). As a result of conflict, economic shocks, and environmental and climate crises, millions of people are in need of food and nutritional assistance. Even before the onset of the COVID-19 epidemic, progress towards eliminating hunger had stalled. The COVID-19 pandemic is estimated to have increased the number of people who are moderately or severely food insecure by almost 320 million in just one year, making the global targets of ending hunger and all forms of malnutrition by 2030 even more difficult to achieve.

Box 11.1

Hunger, food insecurity and malnutrition: How are they defined?

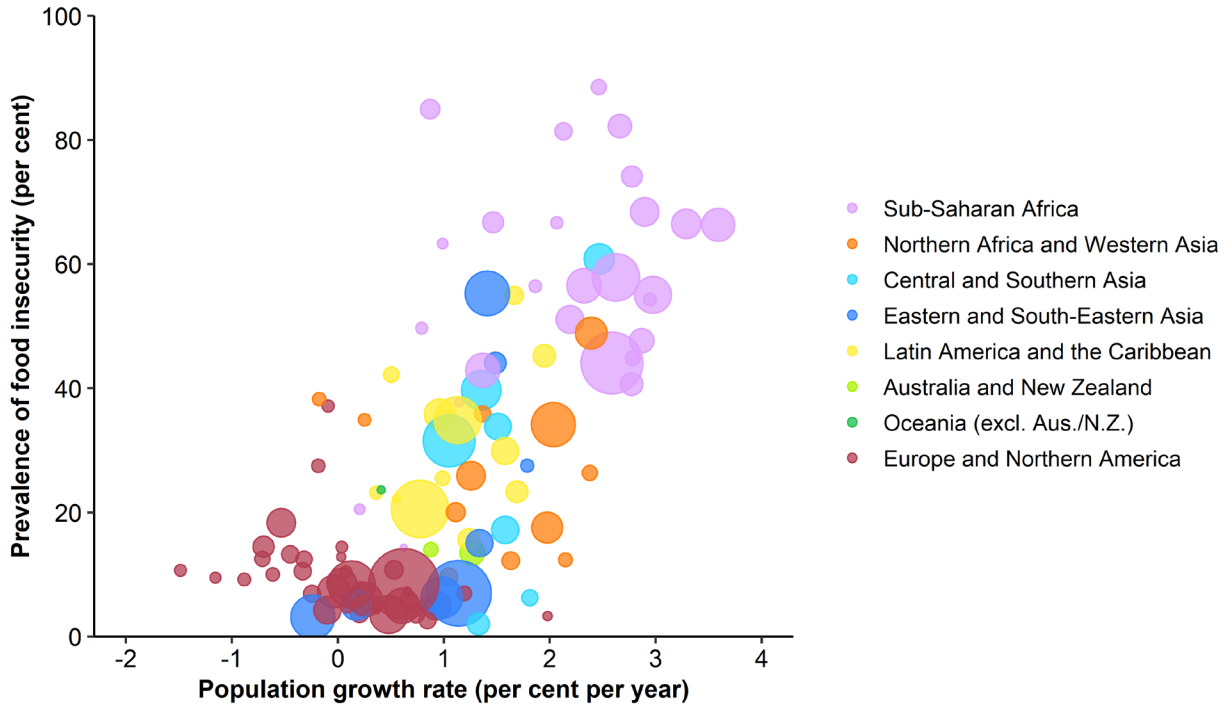
Hunger is defined as an uncomfortable or painful physical sensation caused by insufficient consumption of dietary energy. The term "hunger" is often used as a synonym for undernourishment.

Food insecurity refers to the lack of secure access to sufficient amounts of safe and nutritious food for normal human growth and development and an active and healthy life. Food insecurity can result both from the unavailability of food and from the lack of resources to obtain, store or prepare it. Food insecurity is often experienced at different levels of severity. Severe food insecurity takes place when a person's inability to consume adequate food puts their health, life, well-being or livelihood at grave risk. Moderate food insecurity refers to a lack of consistent access to food, which diminishes dietary quality, disrupts normal eating patterns and can have negative consequences for nutrition, health and well-being. Chronic food insecurity refers to a long-term or persistent inability to meet dietary energy requirements.

Malnutrition refers to deficiencies, imbalances or excesses in a person's intake of energy or nutrients. Undernutrition relates to a combination of factors including insufficient energy, protein or micronutrients and can be measured among young children in terms of wasting (low weight-for-height), stunting (low height-for-age) and micronutrient deficiencies (a lack of important vitamins and minerals). Overweight and obesity refer to excessive weight for height. Abnormal or excessive fat accumulation may impair health.

Figure 11.1

Prevalence of moderate or severe food insecurity around 2018 by annual rate of population growth, 2015-2020



Sources: United Nations (2019; 2020).

Notes: (1) The measure of food insecurity presented here corresponds to SDG indicator 2.1.2, defined as the prevalence of moderate or severe food insecurity in a population, based on the Food Insecurity Experience Scale (FIES). (2) Bubble size is proportional to a country's projected population size in 2030.

Malnutrition affects millions of people worldwide. Undernutrition in childhood represents a particular challenge not only because it increases children's vulnerability to disease and death (chap. 12), but also because it has serious implications for children's education and acquisition of human capital. Globally, nearly half of all deaths among children under 5 years of age are linked to undernutrition (UNICEF, 2019). Most of these deaths occur in low-income and middle-income countries. Addressing the burden of communicable diseases, such as diarrhoeal disease and malaria, and providing access to clean water and sanitation can break the vicious cycle of malnutrition and disease that is responsible for many deaths in this age range.

Undernutrition among young children is often associated with poor maternal nutrition and suboptimal breastfeeding practices (Shekar and others, 2017). Ensuring sufficient access to nutritious foods and preventing micronutrient deficiencies, particularly among pregnant women, nursing mothers and young children, are critical. Micronutrient deficiencies, including deficiencies in iron, vitamin A or iodine, can be successfully addressed through dietary supplementation, especially during pregnancy and lactation, and through the fortification of staple foods (Kassebaum and others, 2014). Measures that enable couples and individuals to decide the number of children and the timing of their births are also important, since large family size and short intervals between births are often associated with higher levels of malnutrition in childhood (Akombi and others, 2017).

Increasingly, many low-income and lower-middle-income countries experiencing rapid population growth are facing the co-occurrence of multiple forms of malnutrition (Development Initiatives, 2020). Rising prevalence of overweight among children, adolescents and adults in these countries is contributing to a double burden of communicable and noncommunicable diseases (chaps. 5 and 12; UNICEF, 2019; FAO and others, 2021). Overweight and obesity are major risk factors for noncommunicable diseases such as cardiovascular disease, cancer and diabetes.

Persistent inequalities in access to food and a nutritious diet exist within all societies, hampering the 2030 Agenda's central objective of leaving no one behind (chap. 9). Women, children, older persons, persons with disabilities and indigenous people, for instance, often face greater challenges in gaining access to safe, nutritious and sufficient food, and require nutrition-sensitive social protection efforts (UNICEF, 2019; FAO and others, 2019; Development Initiatives, 2020). Refugees and other people affected by humanitarian crises are also vulnerable to food insecurity (FSIN, 2020). Ensuring that no one is left behind will require scaling up programmatic interventions to improve food and nutrition security, including through nutritional support to pregnant women and infants, and school-feeding programmes. These interventions are especially important in low-income and lower-middle-income countries where population numbers are rising rapidly.

As the world looks to scale up food production to feed a growing population over the coming decades, it is important to recognize that current food and agricultural systems are unsustainable due to their devastating impacts on the planet and on human health (Willett and others, 2019). A "business as usual" approach will lead to increases in malnourishment and will bring further damage to the environment (chap. 18). Ending hunger and addressing food insecurity will require a holistic approach that focuses on sustainably increasing agricultural productivity, reducing food loss and waste, and strengthening food supply chains and infrastructure. To achieve these goals, greater efforts are also needed to eradicate extreme poverty, promote decent work and inclusive economic growth, and reduce inequalities within and among countries (FAO and others, 2019). Given that current agricultural practices contribute significantly to greenhouse gas emissions, loss of biodiversity and pollution of freshwater bodies and soil, it is critical to adopt more sustainable approaches to food production and to promote a shift towards healthy diets that are rich in plant-based foods (Willett and others, 2019). Given current inequities in the availability of safe, nutritious and sufficient food and the continuing growth of the world's population, a shift towards more sustainable food production and consumption patterns and a more efficient and equitable use of resources is critical to end hunger and all forms of malnutrition by 2030 (chap. 18).

References

Akombi, B. J., and others (2017). Stunting, wasting and underweight in Sub-Saharan Africa: A systematic review. *International journal of environmental research and public health*, vol. 14, No. 8, p. 863.

Development Initiatives (2020). *Global nutrition report: Action on equity to end malnutrition*. Bristol, UK: Development Initiatives. Available at https://globalnutritionreport.org/reports/2020-global-nutrition-report/endorsements-and-acknowledgements/.

Food and Agriculture Organization of the United Nations (FAO), and others (2019). *The state of food security and nutrition in the world 2019. Safeguarding against economic slowdowns and downturns*. Rome, FAO. Available at http://fao.org/3/ca5162en/ca5162en.pdf.

_____ (2020). *The state of food security and nutrition in the world 2020. Transforming food systems for affordable healthy diets*. Rome, FAO. Available at http://fao.org/3/ca9692en/CA9692EN.pdf.

_____ (2021). *The state of food security and nutrition in the world 2020. Transforming food systems for food security, improved nutrition and affordable healthy diets for all*. Rome, FAO. Available at http://fao.org/3/cb4474en/cb4474en.pdf.

Food Security Information Network (FSIN) (2020). *Global report on food crises. Joint analysis for better decisions*. Available at https://fsinplatform.org/sites/default/files/resources/files/GRFC _2020_ONLINE_200420.pdf.

Kassebaum, N. J., and others (2014). A systematic analysis of global anemia burden from 1990 to 2010. *Blood*, vol. 123, No. 5, pp. 615–624.

Shekar, M., and others (2017). *An investment framework for nutrition: Reaching the global targets for stunting, anemia, breastfeeding, and wasting. Directions in Development--Human Development*. Washington, DC: World Bank. Available at http://hdl.handle.net/10986/26069.

United Nations Children's Fund (UNICEF) (2019). *The State of the World's Children 2019. Children, food and nutrition: Growing well in a changing world*. UNICEF, New York. Available at https://unicef.org/sites/default/files/2019-12/SOWC-2019.pdf.

United Nations (2019). *World Population Prospects 2019, Online Edition. Rev. 1*. Available at https://population.un.org/wpp/. Accessed on 15 October 2020.

_____ (2020). *SDG Indicators Global Database*. Available at https://unstats.un.org/sdgs/indicators/database/. Accessed on 1 August 2020.

Willett, W., and others (2019). Food in the Anthropocene: the EAT-Lancet Commission on healthy diets from sustainable food systems. *The Lancet*, vol. 393, No. 10170, pp. 447-492.

Chapter 12. Health and well-being

In low-income and lower-middle-income countries experiencing rapid population growth, communicable diseases as well as maternal, neonatal, and nutritional conditions continue to be among the most common causes of death. Increasingly, many of these countries face a double burden of disease, as noncommunicable diseases are also becoming more common. Achieving universal health coverage in these countries will require a concerted effort to improve and expand access to essential medicines, vaccines and services, including for sexual and reproductive health care, and to address acute shortages of qualified health-care professionals.

Communicable diseases, conditions arising during pregnancy and childbirth, and nutritional deficiencies are among the leading causes of death and illness in many of the low-income and lower-middle-income countries where the population is growing rapidly (Naghavi and others, 2017). Noncommunicable diseases (NCDs), including cardiovascular disease, cancer and chronic respiratory disease, comprise a relatively small share of deaths in those countries. Increasingly, however, such countries are faced with a double burden of disease, given the continued high prevalence of infectious diseases and the emerging burden posed by NCDs (Boutayeb, 2006; Gouda and others, 2019). A rapid rise in NCDs and associated risk factors, in particular diabetes and obesity, is occurring while the diseases and causes of deaths associated with early stages of the epidemiological transition are still quite common (Omran, 1971; Niessen and others, 2018). Many of the countries confronting this double burden of disease are in sub-Saharan Africa. In those countries, individuals have among the highest probabilities in the world of dying from either an infectious disease or an NCD (Bennett and others, 2018). Rapid changes in lifestyle and behavioural factors, including diet, tobacco use and physical activity, as well as environmental factors such as household and outdoor air pollution, are associated with the surge in NCDs in those countries.

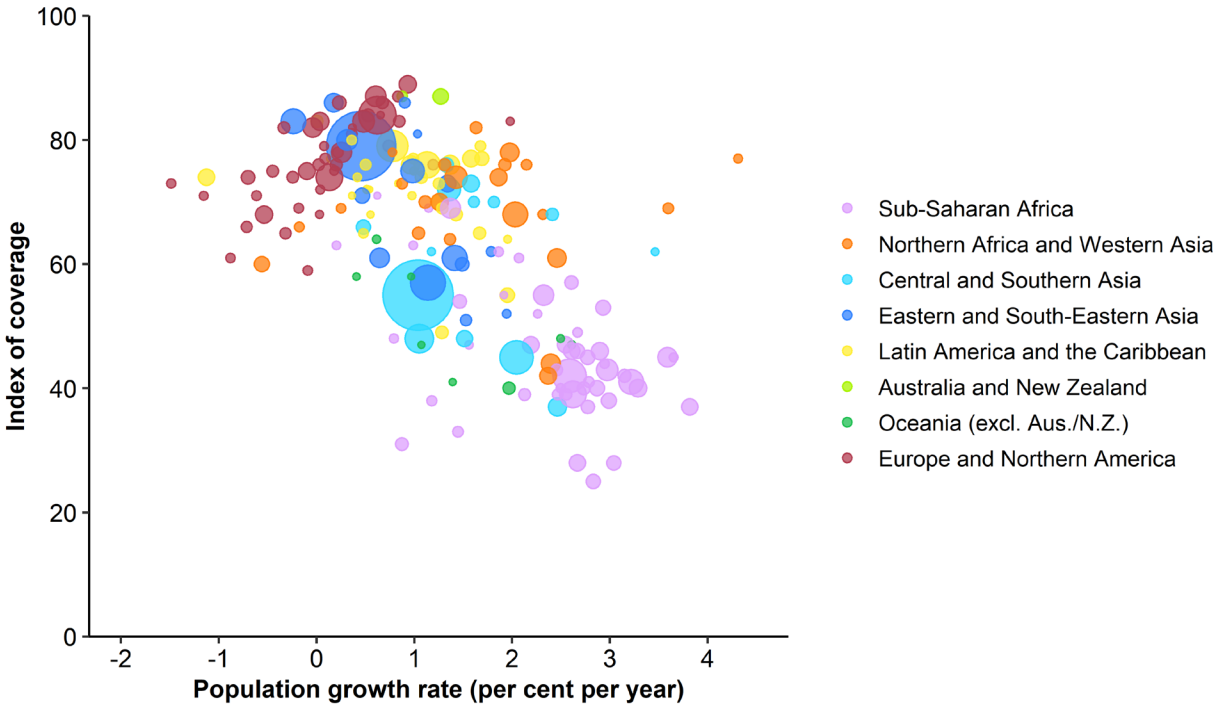
Many of the diseases and conditions that disproportionately affect poor countries with rapidly growing populations are preventable and treatable. For instance, HIV/AIDS and its complications, which remain among the most common causes of death in many of these countries, can be effectively prevented and treated through a combination of measures that include counseling, voluntary testing, increased availability of condoms, information campaigns and access to effective antiretroviral treatments (ART). Likewise, other leading causes of morbidity and mortality in such countries, including diarrhoeal disease, lower respiratory tract infections and malaria, can be reduced dramatically through better nutrition (chap. 11), improved access to quality health-care services, safe drinking-water, adequate sanitation, and vector-control interventions such as insecticide-treated mosquito nets. Effective strategies to reduce maternal and child mortality are also well known. Providing skilled attendance at birth, quality care both during and after pregnancy and childbirth, and access to emergency obstetrical care when needed are vital for reducing maternal and infant mortality, particularly during the first 28 days of life (the neonatal period). Ensuring access to safe and effective methods of contraception and family planning are also critical for preventing complications and deaths arising from unintended and mistimed pregnancies and high-risk births. These measures are especially critical for adolescents under age 15, who face higher risks of complications and death as a result of pregnancy compared to older adolescents and young women (chap. 14).

Achieving universal health coverage is critical for reducing inequalities in health both between and within countries and for ensuring healthy lives and promoting well-being. Countries experiencing rapid population growth tend to have low coverage of essential health-care services (figure 12.1). As a result, individuals in those countries are less likely to have financial risk protection and access to quality health-care services, including for essential medicines and vaccines. Most of the countries with the lowest coverage of essential

health-care services are in sub-Saharan Africa. For many low-income and lower-middle-income countries where essential services are lacking, rapid population growth may pose a significant challenge to achieving the target of universal access to health care. Because of their rapid population growth, these countries will need to invest substantially in their health-care systems just to maintain current levels of coverage. Even greater investments will be needed to make progress towards achieving universal health coverage in line with SDG target 3.8. If countries are successful in this regard, in addition to a healthier population, there would be the added benefit of generating millions of jobs in the health-care sector (ILO, 2017).

Figure 12.1

Index of coverage of essential health-care services in 2017 versus average population growth rate for 2015-2020, by region



Sources: United Nations (2019; 2020a).

Notes: (1) Data covers 201 countries or areas with a population of 90,000 or larger in 2019. (2) Index equals SDG indicator 3.8.1, defined as the average coverage of essential services based on tracer interventions in four domains (reproductive, maternal, newborn and child health; infectious diseases; noncommunicable diseases; service capacity and access). (3) Size of bubbles proportional to projected population size in 2030.

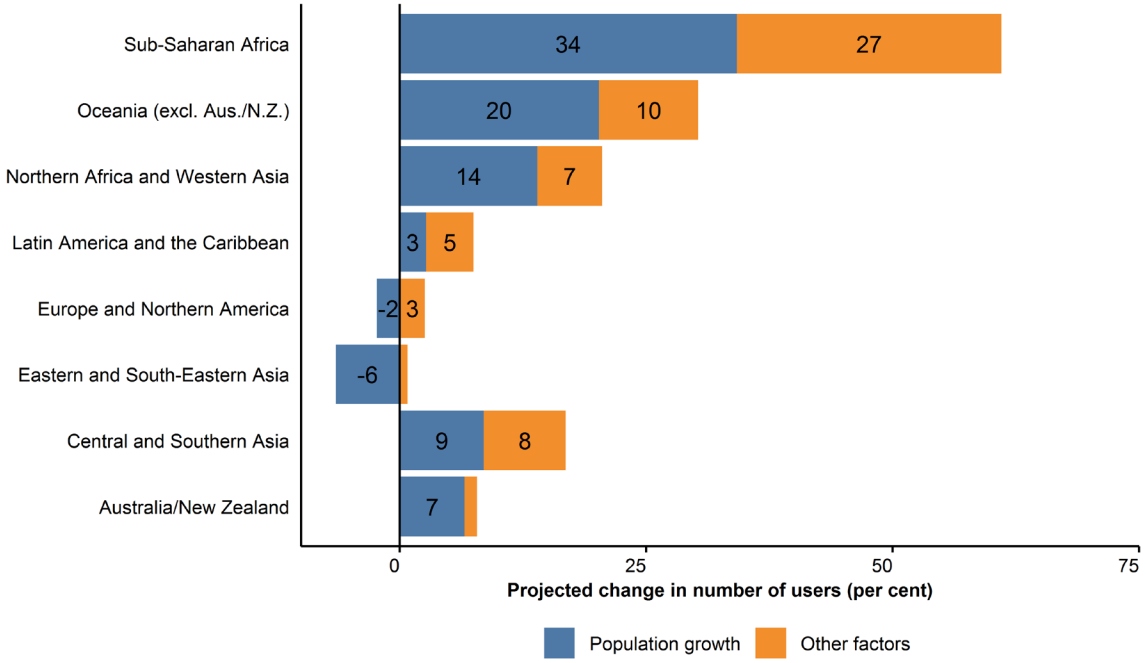
Meeting the health-care needs of rapidly growing populations will depend on a host of factors. The countries experiencing such growth will need to allocate larger shares of their national budgets to health care. Increased lending from the international community as well as innovative funding mechanisms may also be required. The existing health-care infrastructure will need to be expanded to increase service availability and broaden distribution networks for medicines and vaccines. Education systems will require more resources to train greater numbers of qualified health-care personnel and other cadres of workers. Countries, particularly low-income and lower-middle-income countries where these shortages are most acute, will need to recruit and hire large numbers of qualified providers, including doctors and nurses and to support their retention in underserved areas, through financial incentives and other measures.[1] In addition, continued investments in sanitation and quality housing, and increased efforts to reduce poverty and malnutrition will remain critical for improving health and well-being in these countries.

[1] The WHO Global Code of Practice on the International Recruitment of Health Personnel, para. 5.7 (WHA63.16).

Addressing the need for sexual and reproductive health care is a crucial component of achieving universal health coverage. In countries where continuing high fertility is a major driver of population growth, meeting the contraceptive needs of women and men will require a significant expansion of service provision to ensure that contraceptives, in particular highly effective modern methods, are universally available and accessible, in line with SDG target 3.7. Over the next decade, the number of women using modern contraception is projected to increase worldwide, with the largest gains expected in regions with high rates of population growth (figure 12.2). If national family planning programmes lack the resources needed to keep pace with population growth, progress in meeting the demand for family planning through the use of modern contraceptive methods may stall.

Figure 12.2

Contribution of population growth to the change in numbers of women projected to use modern methods of contraception, 2020-2030



Source: United Nations (2020b).

Notes: (1) "Other factors" include projected changes in the proportion of married women, who tend to use contraception more often, and in rates of contraceptive use. (2) For small numeric values, labels are not displayed.

The COVID-19 pandemic risks reversing many of the gains made in recent decades in promoting the health and well-being of the global population. Disruptions in the provision of care during pregnancy and childbirth, interruption of childhood immunization campaigns, in particular for measles and polio, increased food insecurity (chap. 11) and other adverse impacts of the pandemic may cause setbacks for many countries in their continuing efforts to reduce maternal and child mortality. Initiatives to control and eradicate communicable diseases, such as HIV/AIDS, tuberculosis and malaria, may also be upended by the pandemic. For low-income and lower-middle-income countries whose populations are growing rapidly, the pandemic presents an additional challenge that may be difficult to overcome without significant assistance from wealthier countries and the international community. Vulnerable populations and persons living in vulnerable situations, including older persons, persons living in institutions, the poor, persons with disabilities, refugees and other displaced populations, are at the greatest risk of experiencing a deterioration of health and well-being during the COVID-19 pandemic. The health crisis may also have disproportionately negative impacts on persons who, owing to stigma and discrimination, may be less able to obtain care when needed, including persons living with HIV/AIDS, indigenous peoples, Afrodescendants and migrants.

References

Bennett, J. E., and others (2018). NCD Countdown 2030: worldwide trends in non-communicable disease mortality and progress towards Sustainable Development Goal target 3.4. *The Lancet*, vol. 392, No. 10152, pp. 1072-1088.

Boutayeb, A. (2006). The double burden of communicable and non-communicable diseases in developing countries. *Transactions of the Royal society of Tropical Medicine and Hygiene*, vol. 100, No. 3, pp. 191-199.

International Labour Office (ILO) (2017). *World Social Protection Report 2017–19: Universal social protection to achieve the Sustainable Development Goals*. International Labour Office – Geneva: ILO. Available at https://ilo.org/global/publications/books/WCMS_604882/lang--en/index.htm.

Gouda, H, N., and others (2019). Burden of non-communicable diseases in sub-Saharan Africa, 1990–2017: results from the Global Burden of Disease Study 2017. *Lancet Glob Health*, vol. 7, No. 10, pp. e1375–8.

Naghavi, M., and others (2017). Global, regional, and national age-sex specific mortality for 264 causes of death, 1980–2016: a systematic analysis for the Global Burden of Disease Study 2016. *The Lancet*, vol. 390, No. 10100, pp.1151-1210.

Niessen, L. W., and others (2018). Tackling socioeconomic inequalities and non-communicable diseases in low-income and middle-income countries under the Sustainable Development agenda. *The Lancet*, vol. 391, No. 10134, pp. 2036-2046.

Omran, A. R. (1971). The epidemiologic transition: A theory of the epidemiology of population change. *Milbank Quarterly,* vol. 49, No. 4, part. 1, pp. 509-538.

United Nations (2019). *World Population Prospects 2019. Online Edition. Rev. 1.* Available at https://population.un.org/wpp/. Accessed on 15 October 2020.

_____ (2020a). *SDG Indicators Global Database.* Available at https://unstats.un.org/sdgs/indicators/database/. Accessed on 1 August 2020.

_____ (2020b). *Estimates and projections of family planning indicators 2020.* Available at https://un.org/en/development/desa/population/theme/family-planning/cp_model.asp. Accessed on 1 July 2020.

Chapter 13. Education

Quality education is a critical component of sustainable development. Rapid population growth can hamper the goal of ensuring inclusive and equitable education and schooling for all. Increased funding for education is a top priority, particularly in countries experiencing rapid population growth. Further progress towards gender parity in education is required, especially at the secondary education levels and in low-income and lower-middle-income countries. Providing greater educational opportunities, particularly for women, can help ease demographic pressures related to rapid population growth. Better educated women tend to marry at a later age and to have fewer children. They are also likely to have greater control over reproductive decision-making.

Education is one of the most important investments that a country can make to promote sustainable development. Education boosts the accumulation of human capital, promotes faster economic growth and greater productivity, advances gender equality and improves health outcomes (Hanushek and Woessmann, 2010). Yet, in spite of the well-established social and economic returns to education, a quarter of a billion children, adolescents and youth in 2018 did not have access to education (UNESCO, 2020a). The overwhelming majority lived in countries with limited resources and rapid growth of the population.

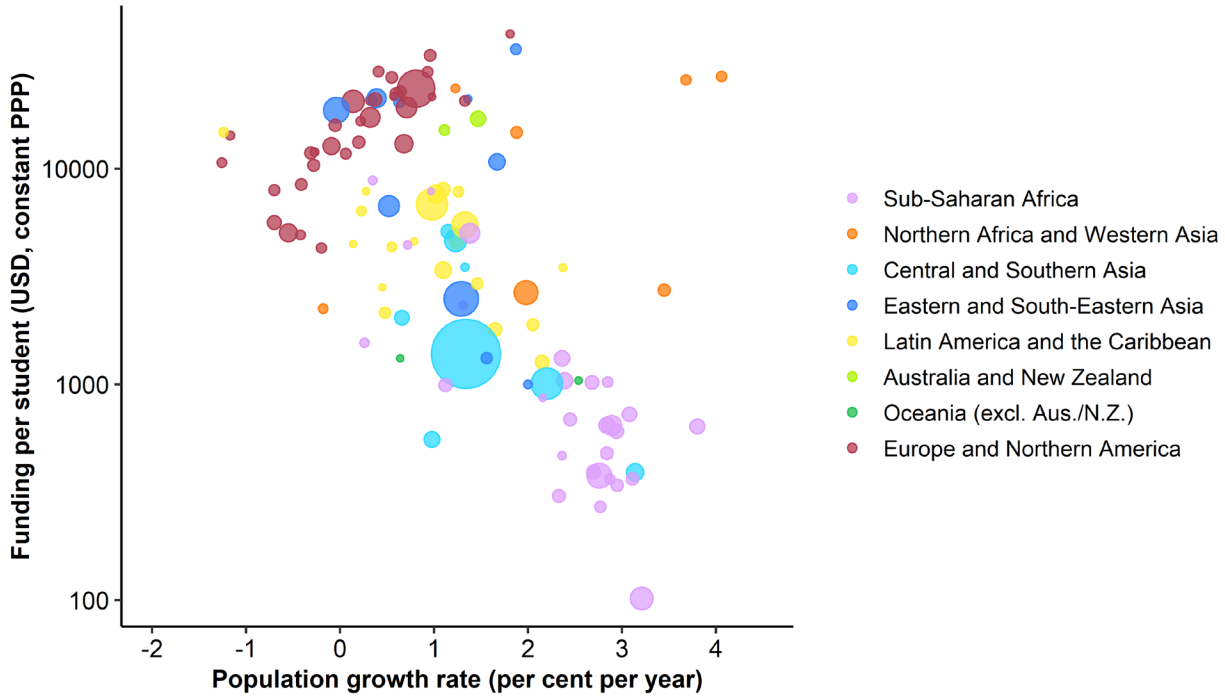
For low-income and lower-middle-income countries with growing cohorts of children and youth, ensuring access to a quality education presents a significant challenge. In sub-Saharan Africa, for instance, despite robust gains in school enrolment percentages in recent decades, the number of children who are not in school has remained largely unchanged owing to continued population growth (UNESCO, 2020a). Many of these countries also lag critically behind in key indicators of the collective investment in education, including pupil-to-teacher ratios, shares of adequately trained teachers, and government funding per student in primary or secondary education (figure 13.1). In addition, many countries struggle to provide adequate school infrastructure, including basic resources such as drinking water, electricity, computers and access to the Internet.

In the coming decades, as the global school-age population becomes increasingly clustered in countries with limited resources to support the rapidly rising demand for education due to population growth, a significant increase in public expenditures will be required just to maintain current levels of funding per student. Even before the COVID-19 crisis, low-income and lower-middle-income countries were facing a financing gap of $148 billion annually to meet the goal of ensuring inclusive and equitable quality education for all by 2030 (UNESCO, 2020b). The COVID-19 pandemic is expected to widen the existing gap in education financing, requiring even greater investments by governments and the international community to ensure continuing progress in broadening access to education.

In many low-income and lower-middle-income countries, poverty presents a major barrier to school attendance and completion. When government spending on education is insufficient, attending school can place a significant financial burden on students and their families. Providing subsidies, grants and scholarships to poor households can reduce direct expenditures related to tuition, books, supplies and transportation and boost student participation and retention in school (UNESCO, 2011). Enacting legislation and implementing programmes to provide financial incentives, cash transfers and social protection floors to families that depend on the labour or earnings of their children can also improve educational outcomes, particularly in poor rural areas (Van der Berg, 2008).

Figure 13.1

Average funding per student in primary or secondary education, 2013-2017 and population growth rate, 2000-2020, by region



Sources: United Nations (2019); UNESCO (2020c).
Notes: (1) Average government expenditure per student in primary and secondary education, expressed in terms of purchasing power parity (PPP) in U.S. dollars at constant prices. The constant prices base year is 2014. (2) Size of bubbles reflects a country's population size in 2020.

Promoting education for girls and women remains one of the surest ways to lift families and societies out of poverty and to advance gender equality. Education is vital for improving the health and well-being of women and girls and promoting their participation in formal labour markets (Lutz and KC, 2011). Increased education for women has other positive impacts, including improving the nutritional status and survival prospects of their children (Gakidou and others, 2010). Despite a considerable reduction in the number of girls who are out of school, large gender gaps persist in access to education and in learning achievements. It is no coincidence that many of the countries with the largest gender gaps in education also have relatively high levels of fertility and rapid population growth. In many cases, pro-male biases in the allocation of resources and in domestic work within households, including for the collection of fuel and water, hinder progress toward gender parity in educational participation and achievement (Ombati and Mokua, 2012). Changing traditional attitudes about the status and roles of women in society can help women and girls to exercise their right to education. Ensuring that schools have appropriate sanitation and hygiene facilities to meet the particular needs of adolescent girls and ending gender-based violence linked to school attendance can also result in better educational outcomes for girls and young women (Sommer and others, 2015; Parkes and others, 2016).

Expanding educational opportunities, especially for girls and women, can also help to ease demographic pressures related to high fertility and rapid growth (Osili and Long, 2008; Kim, 2016; Snopkowski and others, 2016; Liu and Raftery, 2020). Better educated women tend to have fewer children compared to their

less educated counterparts, in part because they marry later and are older when they begin childbearing (Breierova and Duflo, 2004; Bongaarts, 2010). Better educated women also tend to have greater autonomy in reproductive decision-making and to use contraception more effectively (Bongaarts, 2010). Having access to secondary and higher levels of education increases the opportunity costs of childbearing, especially when motherhood means forgoing gainful employment (chap. 15), making large families a less desirable option (Liu and Raftery, 2020). Increasing returns to education can also shape parental attitudes, shifting preferences towards smaller families to permit a greater investment in the formation of each individual child (Axinn and Barber, 2001; de Bruijn, 2006).

At a societal level, a sustained decline in fertility creates, temporarily, a demographic situation conducive to rapid economic growth on a per capita basis. The relative bulge in the working age range, which may last for a few decades, offers a window of opportunity for countries to accelerate their economic and social development, especially when the demographic shift is accompanied by policies to promote education, health, gender equality and gainful employment (chaps. 1 and 15).

An early start to childbearing often leads to higher levels of lifetime fertility and thus contributes to more rapid population growth. Each year, millions of girls are married or give birth before reaching adulthood. Around three quarters of these early marriages or births take place in low-income or lower-middle-income countries (United Nations, 2019 and 2020). In addition to the health risks associated with early pregnancy and childbirth (chap. 12), marriage and pregnancy at young ages can negatively impact a woman's ability to complete her education (Ferre and others, 2013). Such missed educational opportunities have major costs in terms of forgone future employment and income. Young women are more likely to complete primary and secondary education if they are empowered to delay union formation and childbearing. Likewise, additional years of schooling tend to lower the probability of early marriage and childbearing (Pradhan and Canning, 2015).

Education endows people with the knowledge and skills needed to live a life of dignity. Yet, inequality and discrimination continue to prevent millions of children and young people worldwide from reaping the benefits of education and contributing fully to society. In many countries, children and youth are excluded from learning opportunities due to various factors, including income, sex, age, race, ethnicity, migration status, disability and geographic location. These factors often overlap, creating intersecting forms of discrimination and exclusion. As educational attainment becomes more and more critical for securing full and productive employment and decent work in a competitive global marketplace, ensuring high-quality, inclusive, and equitable education and schooling for all, in line with Sustainable Development Goal (SDG) 3, becomes increasingly important, particularly in low-income and lower-middle-income countries with rapidly growing school-age populations.

References

Axinn, W., and J. Barber (2001). Mass education and fertility transition. *American Sociological Review*, vol. 66, No. 4, pp. 481-505.

Bongaarts, J. (2010). The causes of educational differences in fertility in Sub-Saharan Africa. *Vienna Yearbook of Population Research*, vol. 8, pp. 31-50.

Breierova, L., and E. Duflo (2004). The impact of education on fertility and child mortality: Do fathers really matter less than mothers? *NBER Working Paper 10513*. National Bureau of Economic Research.

de Bruijn, B. J. (2006). Fertility: Theories, frameworks, models, concepts. In *Demography: Analysis and synthesis: a treatise in population studies*, vol. I, pp. 549-569, G. Caselli, J. Vallin, and G. Wunsch, eds. New York, Academic Press.

Ferre, Z., and others (2013). The impact of teenage childbearing on educational outcomes. *The Journal of Developing Areas*, vol. 47, No. 2, pp. 159-174.

Gakidou, E., and others. (2010). Increased educational attainment and its effect on child mortality in 175 countries between 1970 and 2009: a systematic analysis. *The Lancet*, vol. 376, No. 9745, pp. 959-974.

Hanushek, E.A., and L. Woessmann. (2010). Education and economic growth. In *International encyclopedia of education*, vol. 2, pp. 245-252, P. Peterson, E. Baker, B. McGaw, eds. Oxford: Elsevier.

Kim, J. (2016). Female education and its impact on fertility. *IZA World of Labor*, vol. 228, pp. 1-10.

Liu, D.H., and A.E. Raftery (2020). How do education and family planning accelerate fertility decline? *Population and Development Review*, vol. 46, No. 3, pp. 409-441.

Lutz, W., and S. KC (2011). Global human capital: Integrating education and population. *Science*, vol. 333, No. 6042, pp. 587-592.

Ombati, V., and O. Mokua (2012). Gender inequality in education in sub-Saharan Africa. *Journal of Women's Entrepreneurship and Education*, No. 3-4, pp. 114-136. Institute of Economic Sciences.

Osili, U. O., and B. T. Long (2008). Does female schooling reduce fertility? Evidence from Nigeria. *Journal of Development Economics*, vol. 87, No.1, pp. 57-75.

Parkes, J., and others (2016). *A rigorous review of global research evidence on policy and practice on school-related gender-based violence*. Available at https://files.eric.ed.gov/fulltext/ED573791.pdf.

Pradhan, E., and D. Canning (2015). The effect of schooling on teenage fertility: Evidence from the 1994 education reform in Ethiopia. PGDA Working Paper No. 128. Harvard University. Available at https://cdn1.sph.harvard.edu/wp-content/uploads/sites/1288/2012/11/PGDA_WP_128_Pradhan_Canning.pdf.

Snopkowski, K., and others (2016). Pathways from education to fertility decline: a multi-site comparative study. Philosophical transactions of the Royal Society of London. *Series B, Biological Sciences*, vol. 371, No. 1692, p. 12.

Sommer, M., and others (2015). A comparison of the menstruation and education experiences of girls in Tanzania, Ghana, Cambodia and Ethiopia. *Compare: A Journal of Comparative and International Education*, vol. 45, No. 4, pp. 589-609.

United Nations Educational, Scientific and Cultural Organization (UNESCO) (2011). *Financing education in sub-Saharan Africa: Meeting the challenges of expansion, equity and quality*. Montreal, UNESCO Institute for Statistics.

United Nations Educational, Scientific and Cultural Organization (UNESCO) (2020a). *Global education monitoring report summary 2020. Inclusion and education: All means all*. Paris, UNESCO.

_____ (2020b). *Policy brief: Education during COVID-19 and beyond*. August 2020. Paris, UNESCO.

_____ (2020c). Sustainable Development Goals 1 and 4. Available at http://data.uis.unesco.org/. Accessed on 1 July 2020.

United Nations (2019). *World Population Prospects 2019, Online Edition. Rev. 1.* Available at https://population.un.org/wpp/. Accessed on 15 October 2020.

_____ (2020). *Estimates and projections of women of reproductive age who are married or in a union: 2020 Revision*. Available at https://un.org/development/desa/pd/themes/fertility-and-marriage. Accessed on 7 December 2020.

Van der Berg, S. (2008). Poverty and education. *Education policy series*, vol. 10, p. 28. The International Institute for Educational Planning (IIEP) and The International Academy of Education (IAE). Available at https://unesdoc.unesco.org/ark:/48223/pf0000181754.

Chapter 14. Gender equality and women's empowerment

As changing economic and social conditions diminish the desire for large families, the fertility level in a population tends to fall. The reduction in fertility desires contributes to changing expectations around motherhood and women's roles in society, and thus provides an opening for women to pursue higher levels of education and greater economic participation. At the same time, advances in gender equality and women's empowerment contribute to the decline of fertility through the delay of marriage and childbearing and through an improved realization of fertility intentions. Having access to safe and effective methods of family planning empowers individuals, and women in particular, to decide both the number of children and the timing of their births. Given the close connection between realization of fertility intentions and more egalitarian gender and family systems, such access is critical to achieving more sustainable and inclusive economies and societies.

Rapid population growth, high fertility and gender inequality often go hand in hand. Among the countries experiencing rapid population growth, many have high levels of gender inequality expressed in terms of fewer girls than boys going to school, high rates of girls giving birth before reaching adulthood, and fewer women than men in formal employment or political life (UNDP, 2020). In such countries, the promotion of more egalitarian gender and family systems and attitudes, as well as access to sexual and reproductive health-care services can enable women to better realize their fertility intentions, reducing the number of unintended pregnancies and leading to lower levels of fertility overall (Golmakani and others, 2015; Kiani and others, 2016; Prata and others, 2017; Upadhyay and others, 2014).

High levels of childbearing, often starting early in life, can deprive women and girls of opportunities through their life course, making it more difficult for them to meet their full potential and participate equally and fully in political, social, economic and family life. Early and frequent pregnancy and childbirth, for instance, can hinder women and girls' ability to attend school, complete their education and acquire the skills necessary for finding gainful employment outside of the home. Women who have numerous pregnancies can also face adverse health outcomes, including a greater lifetime risk of maternal death (WHO, 2019). As the transition from high to low levels of fertility unfolds, fundamental changes in expectations around women's roles in the family and motherhood tend to take place, often leading to a reduction in harmful and discriminatory norms and practices (chap. 6; Mason, 2001; Mcdonald, 2000). This, in turn, can lead to greater empowerment of women and girls and greater opportunities for them to pursue their aspiration in education, the labour force and political life (Phan, 2013; Stoebenau and others, 2013).

Box 14.1

What is gender equality?

Gender equality is achieved when women and men, as well as girls and boys, experience equal conditions, treatment and opportunities for realizing their full potential, human rights and dignity, and for contributing to, and benefitting from, economic, social, cultural and political development (UNICEF, 2017). Gender norms are informal rules and shared social expectations that prescribe behaviours on the basis of gender. Gender-responsive policies, laws, programmes and services address the different realities in the lives of women and men, and girls and boys, by promoting and protecting the human rights of all persons throughout the life course, while accounting for the specific needs, challenges and situations of vulnerability faced by women and girls. Key objectives in this regard include eliminating harmful practices, such as female genital mutilation and child marriage, ending gender-based violence and ensuring universal access to sexual and reproductive health care, including for family planning.

Child, early and forced marriages are prominent illustrations of the severe lack of agency and power among young women and girls in some parts of the world. Child marriage is associated with early and frequent pregnancy and childbirth starting from adolescence, often resulting in high levels of fertility over the life course. Early pregnancies have negative implications for women's health and well-being. Young adolescents, for instance, face a higher risk of complications and death as a result of pregnancy compared to older women (WHO, 2018 and 2019). Early marriage and childbearing can also expose adolescent girls to poverty and multiple forms of exclusion (chap. 13; Otoo-Oyortey and Pobi, 2003). Increasing the age of marriage and first childbearing in countries where these have an early onset, therefore, can have positive repercussions for women's health, educational attainment and labour force participation. To this end, raising the legal age of consent to 18 years protects girls from becoming married when they are not physically, mentally or emotionally ready to do so (UNFPA and UNICEF, 2020). While the prevalence of child marriage and early childbearing has been falling in recent years, the number of girls who find themselves in that situation has been increasing in many countries as a result of rapid population growth (UNICEF, 2014). The COVID-19 pandemic, by pushing millions into poverty and keeping girls out of school, could potentially reverse decades of progress in reducing the prevalence of child marriage (Cousins, 2020).

Access to sexual and reproductive health care and the protection of reproductive rights give women agency and control over their own bodies. Sexual and reproductive health care should include family planning services along with relevant information and education and should be supported by laws and regulations that guarantee full and equal access to such services and resources, which underpin the realization of individual choices and intentions for childbearing. In terms of access to family planning, the proportion of women of reproductive age who use some method of contraception has increased since 2000, while the proportion of those that have an unmet need for family planning, meaning that they want to avoid or postpone pregnancy but are not using any form of contraception, has declined (United Nations, 2020a). Yet, there are stark inequalities both between and within countries in women's access to reproductive health-care services. Over the next decade, despite expected declines in the percentage of women with an unmet need for family planning, sub-Saharan Africa is projected to witness an increase in the number of women with an unmet need for family planning as a result of the continued increase in the size of the population of women of reproductive age (United Nations, 2020a; chaps. 9 and 12). Reducing the unmet need for

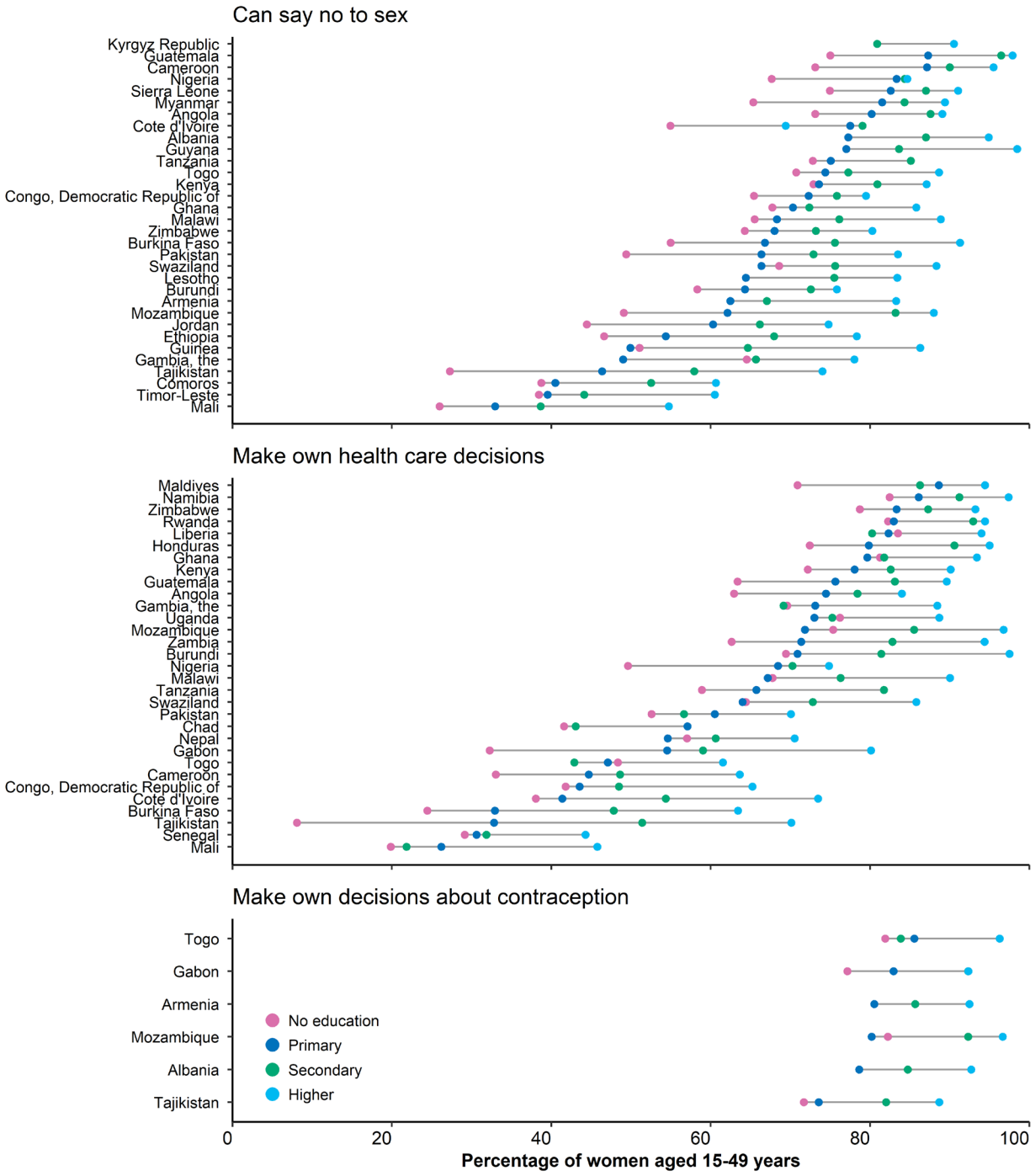
family planning in countries with rapid population growth will require increased commitment and support from the international community. Improving access to effective contraceptive methods is critical not only because it helps to prevent unintended and high-risk pregnancies but also because it reduces the risk of death for both mothers and their children (Bearak and others, 2020; chap. 12).

The ability to exercise agency and autonomy around issues of sexual and reproductive health is a critical component of gender equality. However, women's ability to make their own decisions regarding sexual relations, reproductive health care and family planning is highly dependent on the broader sociocultural environment and their status within it (UNFPA, 2019). In general, women with higher levels of education tend to have greater autonomy to make these decisions compared to women with no education living in the same country (figure 14.1; chap. 13). Conversely, women with disabilities, women from indigenous groups and those in crisis situations tend to confront additional barriers in obtaining access to sexual and reproductive health care.

Women's employment tends to be shaped by household and caregiving responsibilities in a way that is different from men's employment (UN Women, 2020). Supporting women's employment opportunities and ensuring access to independent income and social protection can have positive impacts on the well-being of women and their families. Adopting policies aimed at balancing family and work life, supporting affordable childcare options, encouraging a greater role of men in caregiving and household responsibilities, and changing gender norms in the workplace and at home can improve female labour force participation and lead to faster economic growth as well as increased economic security at older ages for many women (chaps. 9 and 15).

Figure 14.1

Proportion of married or in-union women aged 15-49 years who make their own decisions regarding sexual relations, personal health care and contraceptive use, by level of education, countries with available data, 2007-2018



Source: United Nations (2020b).

Notes: (1) SDG indicator 5.6.1 measures the proportion of women aged 15 to 49 years who are married or in union who can refuse unwanted sexual intercourse, who make their own decisions on their personal health care, and who usually decide on the use of contraception. (2) Based on Demographic and Health Surveys (DHS), Multiple Indicator Cluster Surveys (MICS) and other national surveys conducted in the period 2007-2018 in 57 countries. (3) Countries are ordered according to the proportion of women with primary education.

References

Bearak, J., and others (2020). Unintended pregnancy and abortion by income, region, and the legal status of abortion: estimates from a comprehensive model for 1990–2019, *The Lancet Global Health*, vol. 8, No. 9, pp. e1152-e1161.

Cousins, S. (2020). 2·5 million more child marriages due to COVID-19 pandemic. *The Lancet*, vol. 396, No. 10257, pp. 1059.

Golmakani, N., and others (2015). Relationship between gender role attitude and fertility rate in women referring to health centers in Mashhad in 2013. *Iranian journal of nursing and midwifery research*, vol. 20, No. 2, pp. 269-274.

Kiani, Z., and others (2016). Correlation between Social Determinants of Health and Women's Empowerment in Reproductive Decision-Making among Iranian Women. *Global Journal of Health Science*, vol. 8, No. 9, pp. 312–321.

Mason, K. O. (2001). Gender and family systems in the fertility transition. *Population and Development Review*, vol. 27, pp. 160-176.

Mcdonald, P. (2000). Gender equity in theories of fertility transition. *Population and Development Review*, vol. 26, No. 3, pp. 427-439.

Phan, L. (2013). Women's empowerment and fertility changes. *International Journal of Sociology of the Family*, vol. 39, No. 1/2, pp. 49-75.

Prata, N., and others (2017). Women's empowerment and family planning: A review of the literature. *Journal of Biosocial Science*, vol. 49, Issue 6, pp. 713-743.

Otoo-Oyortey, N., and S. Pobi (2003). Early marriage and poverty: Exploring links and key policy issues. *Gender and Development*, vol. 11, No. 2, pp. 42-51.

Stoebenau, K., and others (2013). Has fertility decline contributed to improvements in women's lives? International Center for Research on Women Fertility and Empowerment Working Paper Series. 012-2013-ICRW-FE, pp.1- 40. Available at https://icrw.org/wp-content/uploads/2016/10/ICRW_FEN_WPS_2013_FINAL.pdf.

United Nations Children's Fund (UNICEF) (2014). *Ending child marriage: Progress and prospects.* UNICEF, New York. Available at https://unicef.org/media/files/Child_Marriage_Report_7_17_LR.pdf.

_____ (2017). *Glossary of terms and concepts.* UNICEF Regional Office for South Asia. Available at https://unicef.org/rosa/media/1761/file/Gender%20glossary%20of%20terms%20and%20concepts%20.pdf.

United Nations Development Programme (UNDP) (2020). *The 2020 Human Development Report*. Available at http://hdr.undp.org/en/2020-report.

United Nations Population Fund (UNFPA) (2019). *Research on factors that determine women's ability to make decisions about sexual and reproductive health and rights Volume I: October 2019*. Available at https://unfpa.org/sites/default/files/resource-pdf/UNFPA_HERA_5-6-1_CLEAN_02_March1.pdf.

_____ (2020). *Tracking women's decision-making for sexual and reproductive health and reproductive rights*. Available at https://unfpa.org/resources/tracking-womens-decision-making-sexual-and-reproductive-health-and-reproductive-rights.

United Nations Population Fund (UNFPA) and United Nations Children's Fund (UNICEF) (2020). *Child marriage and the law: Technical note for the global programme to end child marriage*. Available at https://unicef.org/media/86311/file/Child-marriage-the-law-2020.pdf.

United Nations Entity for Gender Equality and the Empowerment of Women (UN Women) (2019). *Progress of the world's women 2019-2020: Families in a changing world*. Available at https://unwomen.org/en/digital-library/progress-of-the-worlds-women.

United Nations (2020a). *World Family Planning 2020 Highlights: Accelerating action to ensure universal access to family planning.* ST/ESA/SER.A/450.

_____ (2020b). *SDG Indicators Global Database*. Available at https://unstats.un.org/sdgs/indicators/database/. Accessed on 15 June 2020.

Upadhyay U.D., and others (2014). Women's empowerment and fertility: a review of the literature, *Social Science and Medicine*, vol. 115, pp. 111-120.

World Health Organization (WHO) (2018). *Global health estimates 2016: Deaths by cause, age, sex, by country and by region, 2000-2016*. Available at https://who.int/healthinfo/global_burden_disease/estimates/en/. Accessed on 1 July 2020.

_____ (2019). *Trends in maternal mortality 2000 to 2017: estimates by WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division*. Available at https://unfpa.org/featured-publication/trends-maternal-mortality-2000-2017. Accessed on 1 July 2020.

Chapter 15. Sustained economic growth and decent work

Changes in the age distribution resulting from fertility declines taking place in countries with rapidly growing populations can help set those countries onto a path of sustained economic growth on a per capita basis. Such growth is essential for creating jobs and lifting people out of poverty. Countries where the fertility level is high but declining can benefit from a "demographic dividend" resulting from the increased concentration of population in the working age range following the decline of fertility. The impact of the favourable age distribution on the rate of economic growth per capita can be amplified by enacting appropriate social and economic policies. Investments in education and health and the promotion of full and productive employment for all, including for women and other groups traditionally excluded from the labour force, can double or even triple the positive economic impact of the favourable age structure created by a decline in fertility.

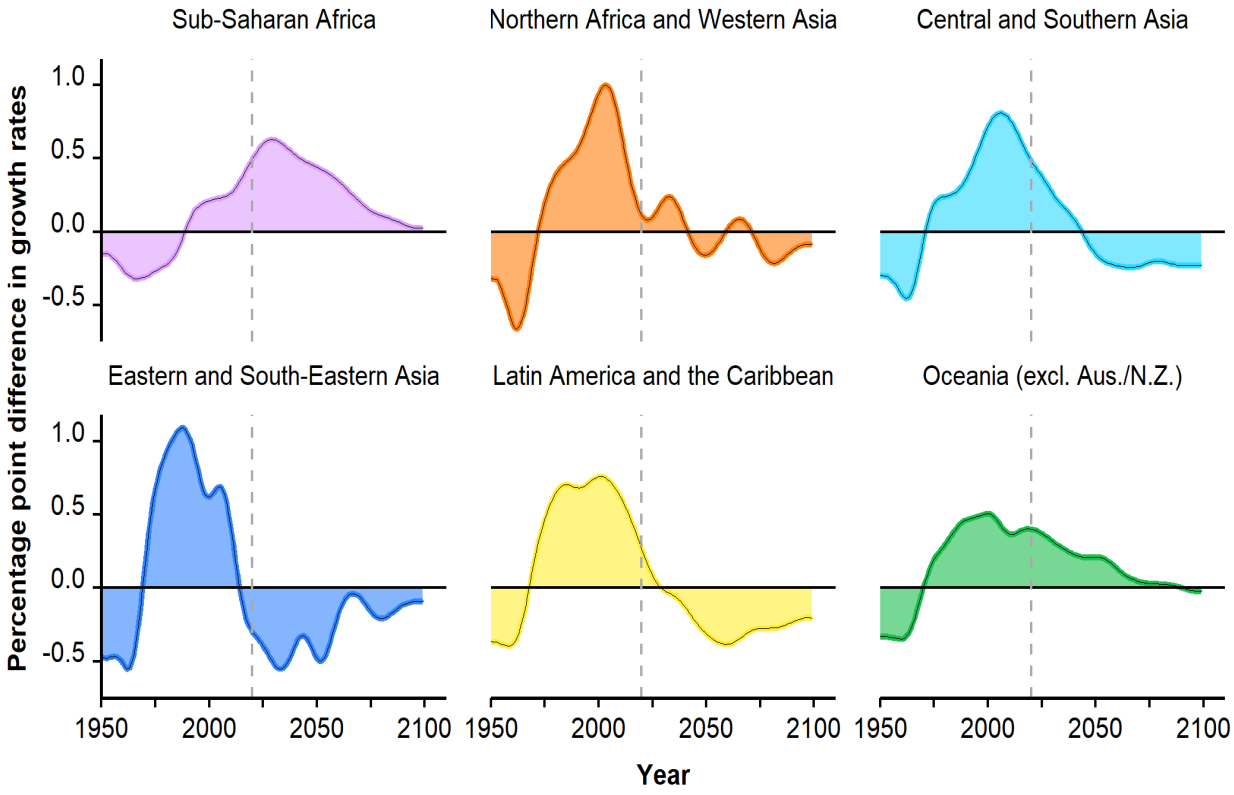
The relationship between population growth and economic growth has long been debated in academic and policy circles. While interpretations of the strength and even the direction of this relationship have diverged widely (Boserup, 1981; Ehrlich and Ehrlich, 1990; Simon, 1981), there is a growing consensus that the age distribution of a population matters for economic growth. This is because, in most societies, patterns of production and consumption vary by age, with children and older persons consuming, on average, more than they produce and working-age adults producing more than they consume (Lee and Mason, 2006).

Changes in the population age structure resulting from sustained reductions in fertility open a time-bound window of opportunity for accelerated economic growth, often referred to as the "demographic dividend" (box 1.2). A direct result of the sustained fall in fertility rates is that the annual number of births ceases to increase, and therefore the working-age population starts to grow in size relative to the population of children who depend on it for support, while the share of population at older ages remains low. In this situation, even if output per worker and levels of labour force participation remain unchanged, the temporary shift in the age distribution towards the working ages generates an increase in income per capita, expanding the resources available for investment to increase levels of human capital, improve standards of living and promote further economic development (Bloom and others, 2003). The economic growth attributable directly to this time-bound shift in the age distribution, while small compared to other factors, tends to be significant because it often lasts for a few decades. In Eastern and South-Eastern Asia, for instance, where fertility levels fell rapidly within a short time span during the late twentieth century, the increase in the size of the working-age population compared to the number of dependants at younger and older ages boosted gross domestic product (GDP) per capita by a total of 30 percentage points between 1970 and 2010 (figure 15.1).

To amplify and prolong the opportunity for accelerated economic growth resulting from a favourable population age structure, sound economic and social policies are needed. One essential policy is to redirect the resources liberated by raising fewer children, at both the familial and societal levels, towards improving educational and health outcomes (chaps. 12 and 13). As countries invest more in developing the human capital of their populations, workers become more productive, further boosting economic growth. The economic returns from increased levels of education may even outpace those resulting solely from changes in the age structure (Crespo Cuaresma and others, 2014). In fact, investments in education in countries witnessing sustained fertility declines can potentially double the positive economic impact of the demographic dividend (Rentería and others, 2016).

Figure 15.1

Difference between population growth rates in working ages and in total population, by region, estimates, 1950-2020 and projections, 2020-2100



Source: United Nations (2019).

Notes: (1) For analytical purposes, it is assumed that the working age range extends from 15 to 65 years. The difference between the growth rate of the population of working age and the growth rate of the total population equals the theoretical contribution of changes in the age distribution to the growth of GDP per capita. Such changes can be positive or negative. (2) Oceania excluding Australia and New Zealand. (3) The regions of Australia and New Zealand and of Europe and Northern America are not considered here since any comparable shift of population age structure in the context of the demographic transition occurred before 1950.

While for most regions the demographic window of opportunity has already closed or is nearing its end, many countries of sub-Saharan Africa and Oceania (excluding Australia and New Zealand) have another 40-50 years to reap the economic benefits of a favourable age distribution (figure 15.1). Many of those countries, however, face severe economic, social and structural impediments to growth. Many also lag critically behind in per capita investments in health, education and job creation and lack the labour-market flexibility, openness to trade, and savings required to fully capture the benefits of a changing population age structure (Bloom and others, 2003). In addition, economic gains from an increased share of working-age population cannot be achieved in the absence of good governance and sound macroeconomic policies. Transparent and efficient government institutions are needed to encourage local and foreign investment, maintain macroeconomic stability and foster savings. For most low- and lower-middle-income countries, substantial investments in infrastructure, including ports, roads, transportation, and communications, are essential for the successful integration of the national economy into international markets (Brookings Institution, 2019).

As the global population continues to grow, promoting full and productive employment and ensuring decent work for all, particularly among women and young people, form another critical area for policy intervention. At the current pace, not enough jobs are being generated to absorb all new entrants into the labour market. Globally in 2019, almost half a billion persons of working age lacked access to paid work or were working fewer hours for pay than they would have liked (ILO, 2020). At the same time, roughly 270 million young people, or 22 per cent of the total, were not in employment, education or training (ILO, 2020). Unemployment, labour underutilization and poorly paid jobs undermine economic growth. Given the projected increase in the population at ages 15-24 over the coming decades, the creation of sufficient opportunities for decent work is a pressing issue (chap. 9). This will also require technological upgrading and diversification to encourage a shift in employment from low-value-added sectors and activities, such as agriculture and extractive industries, to those with higher value-added, including manufacturing and knowledge-intensive services.

Sustained economic growth and decent work have an important gender dimension as well. In many societies, responsibility for informal caregiving falls predominantly to women, hindering their full participation in the labour market (chap. 9). Boosting female labour force participation can make a major contribution to the achievement of sustained and inclusive economic growth, especially following a decline in fertility levels. As women have fewer children, the burden of caring for large numbers of young dependents diminishes, liberating time for formal employment (Belohlav, 2016). A study focusing on 20 countries of Latin America and the Caribbean found that the economic impact of increased female labour force participation associated with rapid fertility declines was comparable in size to that of changes in the population age structure (Miller and others, 2016). Policies to promote full and productive employment for all, including for women and other groups traditionally excluded from the labour force, can double the economic impact of the demographic dividend while also advancing gender equality and social inclusion.

References

Belohlav, K. (2016). *Investing in Women and Girls for a Gender Dividend*. The Population Reference Bureau. June 2016. Available at https://prb.org/investing-women-girls-gender-dividend/.

Bloom, D. E., and others (2003). The demographic dividend: A new perspective on the economic consequences of population change. *RAND Population Matters Program*, N° MR-1274. Santa Monica. Available at https://rand.org/content/dam/rand/pubs/monograph_reports/2007/MR1274.pdf.

Boserup, E. (1981). Population and technological change: a study of long-term trends. Chicago: University of Chicago Press.

Brookings Institution (2019). Harnessing Africa's youth dividend: A new approach for large-scale job creation. In *Foresight Africa: Top Priorities for the Continent in 2019,* Coulibaly, Brahima S., ed. Available at https://brookings.edu/wp-content/uploads/2019/01/BLS18234_BRO_book_007_WEB.pdf.

Crespo Cuaresma, J., and others (2014). Is the demographic dividend an education dividend? *Demography*, vol. 51, No. 1, pp. 299-315.

Ehrlich, P. R., and A. H. Ehrlich (1990). *The population explosion*. New York: Simon and Schuster.

International Labour Office (ILO) (2020). *World Employment and Social Outlook: Trends 2020*. International Labour Office – Geneva: ILO. Available at https://ilo.org/global/research/global-reports/weso/2020/WCMS_734455/lang--en/index.htm.

Lee, R., and A. Mason (2006). What is demographic dividend? *Finance and Development*, vol. 43, No. 3.

Miller, T., and others (2016). Population ageing, demographic dividend and gender dividend: Assessing the long term impact of gender equality on economic growth and development in Latin America. In *Demographic Dividends: Emerging Challenges and Policy Implications. Demographic Transformation and Socio-Economic Development,* vol 6., Pace R., Ham-Chande R., eds., Springer.

Rentería, E., and others (2016). The effect of education on the demographic dividend. P*opulation and Development Review*, vol. 42, No. 4, pp. 651-671.

Simon, J. L. (1981). *The ultimate resource*. Princeton, New Jersey: Princeton University Press.

United Nations (2019). *World Population Prospects 2019, Online Edition. Rev. 1.* Available at https://population.un.org/wpp/. Accessed on 15 October 2020.

"Elderly man is examined, China", Photo Curt Carnemark / World Bank

Part D. Impacts of population growth on the environment

"Cycling for Sustainability: UN Bike Ride Promotes Low Carbon Transport", UN Photo/JC McIlwaine

KEY MESSAGES

- Environmental damage often arises from economic processes that lead to higher standards of living, especially when the full social and environmental costs, such as damage from pollution and habitat destruction, are not factored into producer and consumer prices.

- Population growth magnifies the environmental impact of harmful economic processes; yet rising per capita incomes have been more important than population growth in driving the increasing consumption of recent decades.

- Countries with the highest per capita consumption of material resources and emissions of greenhouse gases (GHGs) are generally those where income per capita is high, not those where the population is growing rapidly; for this reason, more affluent countries bear the greatest responsibility for moving rapidly to achieve net-zero GHG emissions and for implementing strategies to decouple human economic activity from environmental degradation.

- Population growth is a major driver of the increasing demand for food, but changes in the amount and types of food consumed also play important roles.

- The current system of global food production is unsustainable: it cannot be scaled up to feed a growing population without causing further grave damage to the environment.

- Throughout the food system, smart policies are needed to move to sustainable practices that preserve biodiversity and that help to mitigate climate change and adapt to its environmental and other impacts, while also ensuring access to safe, sufficient, affordable and nutritious food and the enjoyment of a diversified, balanced and healthy diet for all.

Chapter 16. Population, environment and sustainable development

Environmental damage often arises from the economic processes that lead to higher standards of living, especially when the full social and environmental costs, such as damage from pollution, are not factored into decisions about resource extraction, production and consumption. Population growth amplifies such environmental pressures by adding to total economic demand. However, the countries contributing most to unsustainable patterns of resource use are generally those where income per capita is high and populations are growing slowly if at all, not those where income per capita is low and populations are growing rapidly. Looking forward, countries that currently have relatively low per capita incomes and high levels of fertility will need to achieve robust and sustained economic growth if they are to meet the Goals and targets of the 2030 Agenda for Sustainable Development. Promoting sustained economic growth in such countries without further damaging the environment will require support from the international community.

Since the middle of the twentieth century, the United Nations has held debates and issued recommendations concerning population, development and the environment. Debates have considered a wide range of environmental issues including the role of food production in land use, the future availability of non-renewable resources, the adverse impacts of pollution, and especially since the 1990s, the loss of biodiversity and the role of humans in global warming and climate change. Discussions have considered both the contribution of population trends to environmental problems and the threat that environmental issues pose to the well-being of current and future populations (United Nations, 2001).

Given that the Earth is finite, it seems clear that the human population cannot expand forever, and also that there must be limits to the quantity of material resources that humans could feasibly exploit. Where these population and resource limits may lie, however, has remained obscure. Estimates of Earth's capacity to sustain human life—often expressed as a population size, or "carrying capacity", that can be supported successfully in the long run—show an enormous range and have not tended to converge over time. However, of the scholars who have attempted to make estimates, over half thought that the upper limit was 12 billion or less (Cohen, 1995).

The number of people that the Earth can support depends to an important degree on how carefully the planet's resources are managed and how equitably they are shared. However, it has become clear that the planet could not sustainably support even its current population if everyone had levels of consumption similar to those found in today's high-income countries, relying on today's technologies. The level of development and well-being in many high-income countries today has been achieved largely through highly resource-intensive patterns of consumption and production, which are not sustainable or replicable in other parts of the world (UNEP, 2016).

Human economic activity, primarily through CO_2 emissions from the burning of fossil fuels, has already led to a warming of Earth's climate, with impacts that risk eroding the basis for sustainable development (chap. 17; IPCC, 2014). As part of Goal 8 of the Sustainable Development Goals (SDGs), world leaders have emphasized that the way forward must include greatly increased efforts towards decoupling economic growth from adverse environmental impacts (UNEP, 2019). Policies to decouple economic activity from environmental degradation and promote resource efficiency may involve lowering the reliance on non-renewable, high-intensity resources; reducing emissions and waste from extraction, production, consumption and disposal;

and promoting a shift of consumption habits towards goods and services with lower energy and material intensity. In this regard, the commitment of high-income and upper-middle-income countries to reducing their ecological footprints will be critical.

Environmental damage often arises from economic activities that lead to higher standards of living, especially when social and environmental costs are not factored into decisions about production. Pollution of air, water and soil, scarring of landscapes, destruction of habitats, waste and other aftereffects of production and consumption are often left out of economic decision making. In the language of economists, these activities have "negative externalities", since the responsible parties pay no price in the market for the adverse consequences of their economic actions (Helbling, 2010). In short, common property resources tend to become overused and degraded in the absence of economic incentives or effective regulatory mechanisms to discourage, prevent or remedy those problems. In such situations, although population growth itself may not be the direct cause of environmental damage, it may nevertheless exacerbate the problem or accelerate the timing of its emergence.

The degree to which slower population growth would make a difference depends on the problem in question, the timeframe considered, the available technology and the demographic, social and economic context. Many types of environmental damage, such as the release of toxic wastes from industry or mining, result mainly from the technologies employed by producers operating in the absence of effective incentives or regulations to limit or repair such damage. Reducing population growth would not, by itself, help to resolve those problems. For environmental problems linked to the expansion of agricultural land, such as habitat loss and reduced biodiversity, lower population growth would help reduce the need to bring more land under cultivation, although higher-yielding crop varieties and other land-sparing measures could also help in this regard (chap. 18).

Ensuring sustainable patterns of consumption and production (SDG 12) will require concerted efforts to address the environmental damage from waste and pollution associated both with material products' use and disposal and with the extraction and processing of materials to produce those products. Major concerns include the rapidly increasing volume of unrecycled electronic and plastic waste, food waste, the slow progress in eliminating governmental subsidies for fossil fuels, and the continuing expansion of the global material footprint[1] (United Nations, 2019, 2020, 2021). The per-capita material footprint is considered to be a good proxy for the average material standard of living in a country, while material use is also used as a proxy for environmental impacts across the life cycle of resource extraction, transformation, consumption and disposal (UNEP, 2016).

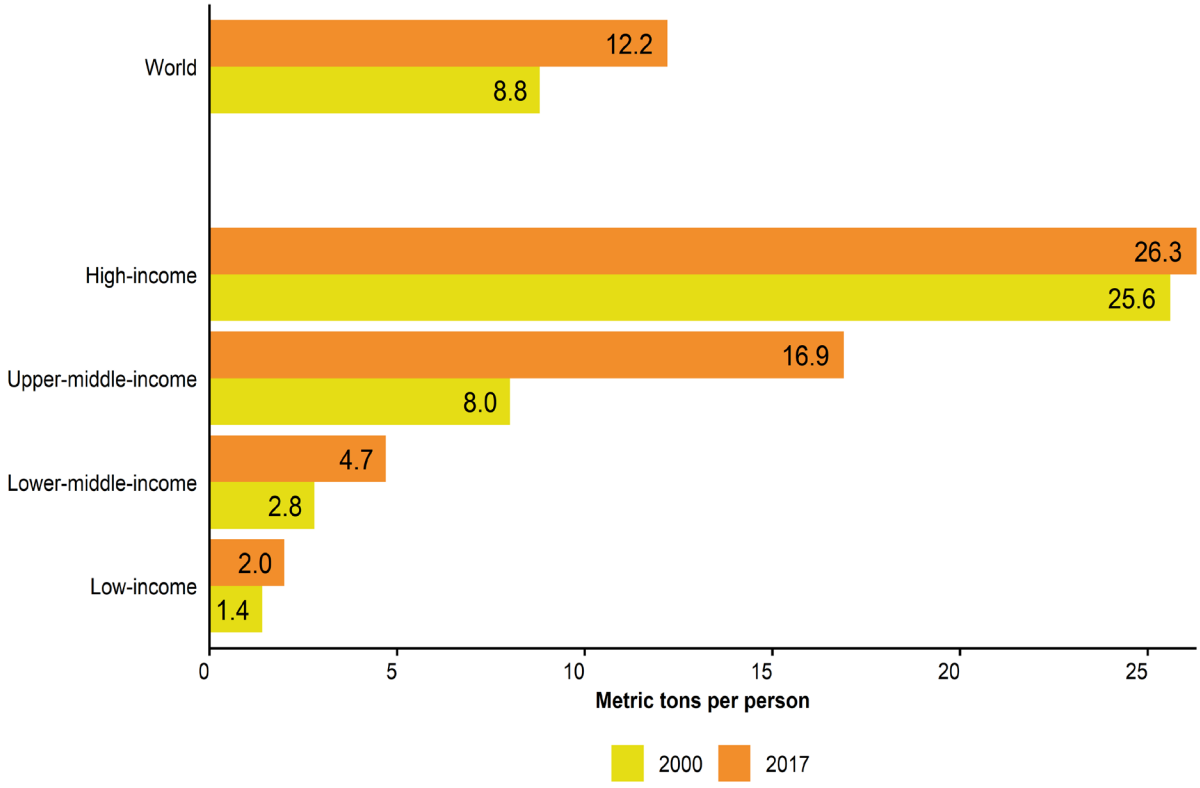
In 2017, the material footprint per capita of high-income countries was over 10 times that of low-income countries. The footprint has been increasing especially rapidly in the upper-middle-income countries as their GDP per capita grew rapidly (figure 16.1). Given the gap in material footprint per person between countries at different income levels, the primary responsibility for "doing more and better with less" lies with countries that have the most unsustainable patterns of resource use, namely the high-income and upper-middle-income countries, where populations are growing slowly if at all. Limiting the footprint of countries where resource consumption is highest will also help offset some of the environmental impacts of achieving more rapid economic growth in countries where income per capita is currently low and populations are growing rapidly (chap. 4). These countries will require sustained and inclusive economic growth if they are to eliminate poverty and hunger and advance other aspects of human well-being.

[1] The material footprint of a country is the attribution of global material extraction to domestic final demand, measured in tons. The country's total material footprint is the sum of the material footprint for biomass, fossil fuels, metal ores and non-metal ores. It is calculated as the raw material equivalent of imports plus domestic extraction minus raw material equivalents of exports.

Quantitative analyses of the impact of population size and growth on the environment have often employed variants of a simple multiplicative model, often expressed as I=PAT (box 16.1). Such models can be a useful tool for bringing population, economic and specific environmental trends together within one cohesive framework. For instance, UNEP's International Resource Panel (IRP) used the framework to assess the relative contributions of changes in population, GDP per capita and "material intensity" to recent trends in global and regional material footprints. In most regions, the analysis found that rising levels of income per capita has been more important than population growth in driving the increases in resource extraction and material consumption of recent decades, although both have contributed significantly (IRP, 2019). Although such analyses can be useful for providing a broad overview of basic trends in population, economic and environmental issues, a deeper understanding of relationships within countries and regions requires studying relationships at a much finer geographic scale, and this a focus of active methodological and analytic work (box 16.2).

Figure 16.1

Material footprint per capita, 2000 and 2017, for the world and income groups



Source: United Nations (2019).

In the coming decades, the role of population growth will gradually diminish as a driver of increased pressures on the environment. By 2100 the global population will have nearly stopped growing, according to United Nations projections, with the absolute number of people added each year entering a period of long-term decline (chap. 3). However, national trends differ greatly by region and by levels of social and economic development. In sub-Saharan Africa, the region with the smallest material footprint per capita, population is projected to continue growing through the end of the century. However, there is an especially wide range of uncertainty in the population projections for this region (chap. 4), primarily reflecting uncertainty about

how rapidly the fertility transition will proceed. Over a longer time horizon, a more rapid fertility transition than currently projected by the United Nations could make a substantial difference to the eventual maximum population size (chap. 1).

Box 16.1

Environmental impact equation

Ehrlich and Holdren (1971, 1972) introduced a simple multiplicative equation expressing humanity's **I**mpact on the environment as driven by **P**opulation size, the level of **A**ffluence and the nature of current **T**echnology:

$$I = P \times A \times T$$

The environmental impact of population is seen as amplifying the effects of affluence and technology in direct proportion to population size. In applications employing this framework, the environmental impact variable (I) generally measures either the utilization or degradation of a natural resource or the emission of a pollutant or waste product. Population is typically represented as total population size. Affluence (A) is often represented by a measure of consumption, output or income per person, while technology (T) is expressed as the environmental impact per unit of consumption, output or income. In many applications, the affluence term is GDP per capita, and the technology term is expressed in units of the impact variable per unit of GDP. Often there is a focus on the relative amount of change in each component over time rather than the absolute levels of the P, A and T components.

Many researchers have used the I = PAT formula as a tool for summarizing the relative importance of the main forces tending to increase or to moderate various environmental impacts. However, the model and its applications have been criticized on various grounds —for instance, that the framework does not allow for interactions or possible feedback effects among the terms over time, and that the model omits consideration of socio-cultural factors that may have a large influence on environmental outcomes within critical regional ecosystems (de Sherbinin and others, 2007). To address some of these concerns, other researchers have introduced modified versions of the model to allow for inclusion of additional variables and relationships that are not strictly multiplicative (York, Rosa and Dietz, 2003; Waggoner and Ausubel, 2002). For example, the ImPACT model was developed to provide a framework for linking the forces driving a particular environmental impact to the social, economic and political actors whose activities and choices can temper or counteract the impact over time (Waggoner and Ausubel, 2002).

Countries where the population is still growing rapidly tend also to have high levels of poverty and hunger and to face other serious challenges to social and economic development (chaps. 10-15). Because of their comparatively low levels of social and economic development, these countries are poorly equipped to mitigate and adapt to environmental threats. To eliminate poverty and hunger, meet the goals of the 2030 Agenda related to health, education and access to decent jobs, and enhance their ability to respond to environmental threats, their economies will need to grow much more rapidly than their populations, requiring greatly expanded investments in infrastructure as well as increased access to affordable energy and modern technology in all economic sectors. Strengthening the Global Partnership for Sustainable Development (SDG 17) can help advance economic growth in low-income countries while making use of the

most resource-efficient technologies available. Stronger efforts to reduce the unmet need for family planning, to raise the minimum legal age at marriage, to integrate family planning and safe motherhood programmes into primary health care and to improve female education and employment opportunities could help ensure a more rapid fertility decline in low-income countries with rapidly growing populations and thus accelerate their progression into the period of the demographic dividend, during which an increased concentration of population in the working ages is conducive to more rapid economic growth (chaps. 6 and 15).

Global resource assessments have concluded that, under a continuation of historical trends, material resource extraction would more than double between 2015 and 2060, with unsustainable impacts in terms of greenhouse gas (GHG) emissions, industrial extraction of water, loss of biodiversity and expansion of agricultural land at the expense of forests (IRP, 2019). Moving towards greater sustainability is possible but would require progressively decoupling the growth in population and economic activity from a further intensification of resource extraction, waste generation and environmental damage. Measures to achieve this include "circular economy" policies to encourage more efficient use of resources, recycling and reduction of waste; ensuring that the full costs of resource extraction, including environmental costs, are reflected in pricing; elimination of fossil fuel subsidies; climate policies to reduce GHG emissions and remove carbon from the atmosphere; and policies to protect life on land (IRP, 2019). A progressive decoupling of environmental impacts and resource use from economic activity and human well-being would ultimately support the achievement of the SDGs in all countries while staying within planetary boundaries (IRP, 2019).

Box 16.2

Population data and the environment

In assessing challenges to sustainable development, it is essential to link data about human settlements to information about the local environment. Recent decades have seen rapid progress in constructing spatially disaggregated population data sets at increasingly finer geographic scales, and these can be mapped and analyzed together with similarly disaggregated social, economic, and land-use data and measurements from remote sensing. Population and related data from censuses, sample surveys and administrative records are being linked to areal characteristics associated with various health risks and information about access to health care and other basic services. Such data are also being used to map human settlements in relation to climate-related hazards such as flooding in low-lying coastal areas and drought in dryland ecosystems. While these data sets require further development and analysis, they have a great potential for applications ranging from mobilizing responses to natural disasters and other emergencies; to policy planning and evaluation for ensuring that basic services are accessible to all; and to planning adaptive responses to climate change (Thematic Research Network on Data and Statistics, 2020; Gething and Burgert-Brucker, 2017; Leyk and others, 2019; Balk and others, 2009).

References

Balk, D., and others (2009). Understanding the Impacts of Climate Change: Linking Satellite and Other Spatial Data with Population Data. In *Population Dynamics and Climate Change,* pp. 206–217, Guzmán JM, Martine G, McGranahan G, and others, eds., New York, London: United Nations Population Fund (UNFPA), International Institute for Environment and Development (IIED), 2009.

Cohen, J. (1995). *How Many People Can the Earth Support?* New York: W. W. Norton and Company.

Commoner, B. (1972). On "The closing circle": Response. *Bulletin of the Atomic Scientists*, May 1972, pp. 17, 42- 56.

de Sherbinin, A., and others (2007). Population and Environment. *Annual Review of Environment and Resources*, vol. 32, pp. 345–373.

Ehrlich, P.R., and J.P. Holdren (1971). Impact of population growth. *Science*, vol. 171, No. 3977, pp. 1212-1217.

_____ (1972). One-dimensional ecology. *Bulletin of the Atomic Scientists*, May 1972, pp. 16, 18-27.

Gething, P. W., and C. R. Burgert-Brucker (2017). The DHS Program Modeled Map Surfaces: Understanding the Utility of Spatial Interpolation for Generating Indicators at Subnational Administrative Levels. DHS Spatial Analysis Reports No. 15. Rockville, Maryland, USA: ICF. Available at https://dhsprogram.com/pubs/pdf/SAR15/SAR15.pdf.

Helbling, Thomas (2010). What are externalities? *Finance & Development*, December 2010, vol. 0047, Issue 004. Available at https://imf.org/external/pubs/ft/fandd/basics/external.htm.

International Resource Panel (IRP) (2019). *Global Resources Outlook 2019: Natural Resources for the Future We Want*. UNEP. Nairobi, Kenya. Available at https://resourcepanel.org/reports/global-resources-outlook.

IPCC (2014). *Climate Change 2014: Synthesis Report.* Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.

Leyk, S., and others (2019). The spatial allocation of population: a review of large-scale gridded population data products and their fitness for use. *Earth System Science Data*, vol. 11, No. 3, pp. 1385–1409. Available at https://doi.org/10.5194/essd-11-1385-2019.

National Research Council (2003). *Cities Transformed: Demographic Change and Its Implications in the Developing World*. Washington, DC: The National Academies Press. Available at https://doi.org/10.17226/10693.

Thematic Research Network on Data and Statistics (2020). Leaving No One Off the Map. Available at https://static1.squarespace.com/static/5b4f63e14eddec374f416232/t/5eb2b65ec575060f0adb1feb/1588770424043/Leaving+no+one+off+the+map-4.pdf.

United Nations Environment Programme (UNEP) (2016). Global Material Flows and Resource Productivity Assessment. Report for the UNEP International Resource Panel, Paris, United Nations Environment Programme. Available at https:// resourcepanel.org/reports/global-material-flows-and-resource-productivity-database-link.

_____ Ed. (2019). Global Environment Outlook – GEO-6: Healthy Planet, Healthy People. Cambridge: Cambridge University Press.

United Nations (2001). *World Population Monitoring, 2001: Population, Environment and Development.* Sales No. E.01.XIII.17. New York.

_____ (2019). *The Sustainable Development Goals Report 2019.*

United Nations (2020). *The Sustainable Development Goals Report 2020*.

_____ (2021). *The Sustainable Development Goals Report 2021*.

Waggoner, P.E., and J.H. Ausubel (2002). A framework for sustainability science: A renovated IPAT identity. *Proceedings of the National Academy of Sciences,* June 2002, vol. 99, No. 12, pp. 7860-7865.

York, R., E. A. Rosa, and T. Dietz (2003). STIRPAT, IPAT and ImPACT – Analytic Tools for Unpacking the Driving Forces of Environmental Impacts. *Ecological Economics* vol. 46, Issue 3, pp. 351-365.

Chapter 17. Population growth and climate change

Economic and population growth are often identified as the main anthropogenic drivers of climate change, including global warming. Limiting such change in the future will require rapid progress towards decoupling economic activity from the current over-reliance on fossil fuels. Countries of the more developed regions have contributed the most to cumulative greenhouse gas emissions and, by international consensus, are expected to take the lead in reducing them. Yet, the populations of those countries are now growing slowly if at all, whereas countries with rapidly growing populations tend to have low incomes and low emissions. Although low-income countries have contributed little to climate change until now, their energy consumption will need to increase substantially if they are to develop economically and achieve the Goals and targets of the 2030 Agenda for Sustainable Development. It is essential that low-income and lower-middle-income countries receive the necessary financial and technical support to ensure that their economies can grow using technologies that minimize future environmental impacts.

With the continuing growth of populations and economies during the twentieth and twenty-first centuries, it has become increasingly clear that human activities are warming Earth's climate, mainly because the fossil fuels providing most of the energy that drives economic development are increasing the atmospheric concentration of greenhouse gases (GHGs).[1] Indeed, there is a near-linear relationship between cumulative anthropogenic carbon dioxide (CO_2) emissions and the global warming they cause (IPCC, 2021).

Although the combustion of fossil fuels has been adding CO_2 to the atmosphere for centuries, most of the emissions have occurred since 1950, and most have been contributed by today's high-income and upper-middle-income countries. As of 2020, high-income and upper-middle-income countries, which together contain half the world's population, were responsible for about 85 per cent of the CO_2 added to the atmosphere each year (figure 17.1). Lower-income and lower-middle-income countries, where most future population growth is projected to take place, have so far contributed significantly less to these emissions, both in total and on a per capita basis. There is also a strong correlation between income and emissions within countries, as the lifestyles of the rich tend to be much more energy-intensive than those of the less affluent. It is estimated that the richest 10 per cent of the global population accounts for nearly half of CO_2 emissions, and that the top 1 per cent alone is responsible for more annual emissions than the bottom half (UNEP, 2020; Chancel and Piketty, 2015; Oxfam and Stockholm Environmental Institute, 2020).

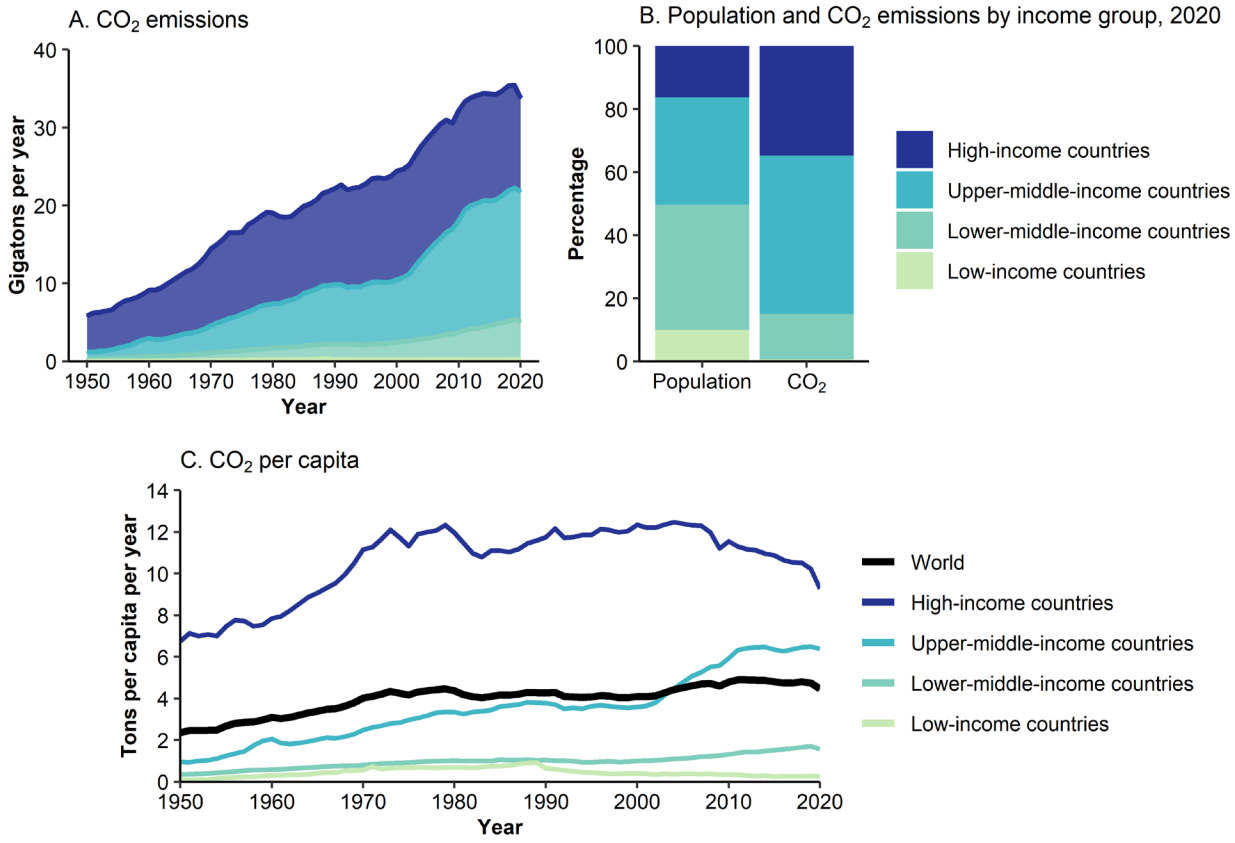
As of 2019, Earth's average temperature had already risen by about 1.1°C above pre-industrial levels, rapidly approaching the thresholds identified in the 2015 Paris Agreement[2] (IPCC, 2021). Climate change is likely both to amplify existing risks and to create new risks for natural and human systems such as human health, food security and security of societal conditions (IPCC, 2014b). While all parts of the world will be affected by rising surface and ocean temperatures as well as increased frequency of extreme weather events, including heat waves and severe storms and droughts, the negative impacts of global warming will be unevenly distributed and are likely to be greater for disadvantaged people and communities as well as for low-income countries that lack resources to adapt to a changing climate.

[1] GHG emissions from human activities include CO_2, the main contributor to global warming globally, as well as methane (CH_4) and nitrous oxide (N_2O), which often result from agricultural activities (chap. 18; Reay and others, 2012). Several long-lived halogenated gases also make a significant but smaller contribution to global warming (IPCC, 2021).

[2] The aim of the 2015 Paris Agreement is to strengthen the global response to the threat of climate change by keeping the global temperature rise well below 2°C compared to pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C.

Figure 17.1

Annual total and per-capita CO2 emissions, 1950-2020, and distribution of global population and CO2 emissions, 2020, by income group



Sources: United Nations (2019); Global Carbon Project (2021), excerpted in Ritchie and others (2021).
Note: Calculations by the United Nations. CO2 data represent annual production-based emissions.

The extent and severity of climate change will depend largely on the scope and effectiveness of measures intended to decouple economic activities from CO2 emissions, through improved energy efficiency and by switching away from fossil fuels to zero-carbon or low-carbon energy sources, including renewables, nuclear energy, and fossil or bioenergy coupled with carbon dioxide capture and storage (IPCC, 2014b). The United Nations Framework Convention on Climate Change (UNFCCC) recognized that all countries have a common responsibility in combating climate change and its adverse effects based on their capabilities, and that developed countries, which have contributed the most to cumulative GHG emissions, need to take the lead in combatting climate change.

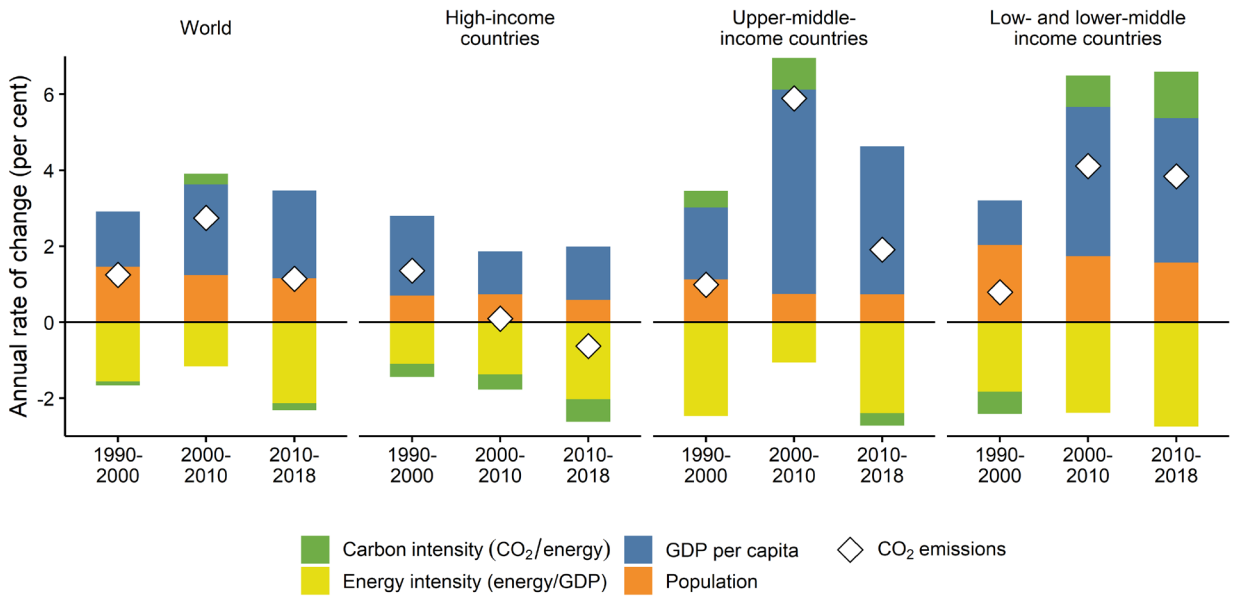
The Intergovernmental Panel on Climate Change (IPCC) has identified economic growth and increasing populations as the main drivers of rising GHG emissions (IPCC, 2014b). The Kaya identity[3] (Kaya, 1989) is a multiplicative model that can be used to summarize the role of population size and growth and other key determinants of such emissions. The identity can be used to illustrate how declines in energy intensity and in the carbon intensity of energy can potentially counter the effects of rising GDP per capita and increasing

[3] The identity is an extended version of the I=PAT equation (chap. 16). It depicts carbon dioxide emissions from human sources (CO2) as the product of (a) population size (P), (b) gross domestic product per capita (GDP/P), (c) energy intensity of economic activity (units of energy consumed (E) per unit of GDP, or E/GDP), and (d) carbon intensity of energy (CO2 emissions per unit of total energy consumption, CO2/E): CO2 = P × (GDP/P) × (E/GDP) × (CO2/E). The rate of change in CO2 emissions equals the sum of the rates of change in the four components (IPCC, 2000, p. 105).

population size. According to this framework, growth in gross domestic product per capita has been the main driver of the increase in CO_2 emissions in recent decades (figure 17.2).

Figure 17.2

Four components of the change in CO_2 emissions from fuel combustion, 1990-2018, for the world and income groups



Source: Calculated from IEA (2020a).

Notes: (1) Energy refers to total energy supply. (2) The data, which exclude some countries for which IEA does not maintain energy statistics, are estimated to cover up to 95 per cent of the total energy supply (see https://iea.org/areas-of-work/data-and-statistics). Since data were missing for many low-income countries, those with data have been grouped with lower-middle-income countries. (3) For each country grouping and time period, the average annual rate of change in CO_2 emissions equals the sum of the rates of change in the four components (IPCC, 2000, p. 105).

For high-income countries collectively, annual CO_2 emissions hardly changed during 2000-2010 and declined slightly after 2010. In those countries, the effects of further economic and population growth were largely countered by improvements in energy efficiency, due both to energy-saving improvements in economic processes and to the continuing sectoral shift away from manufacturing and towards the services sector, which generally has lower energy intensity. Carbon intensity also declined modestly. CO_2 emissions rose substantially in the group of middle-income countries, especially during 2000-2010 in the upper-middle-income countries, driven mainly by rapid growth in GDP per capita. Energy efficiency also improved substantially, but not enough to offset the combined effects of economic and population growth.

Low-income countries have contributed little to rising CO_2 emissions (figure 17.1), even though their populations are growing rapidly. However, their per capita energy consumption will need to increase substantially if these countries are to develop economically and achieve the Goals and targets of the 2030 Agenda for Sustainable Development. Today, over half of the population in low-income countries lacks access to electricity, and much energy consumption comes from burning traditional biomass fuels; access to clean-burning fuels and technologies for cooking and other household applications remains quite limited (World Bank, 2021; IEA and others, 2021). To meet the Sustainable Development Goals concerning health and poverty, low-income countries will need to increase their access to affordable and reliable energy. Although the poorest countries are unlikely to make a major contribution to total emissions in the near

term, it is important that they receive financial assistance, access to technologies and other forms of support to enable the rapid growth of their economies while minimizing emissions of CO_2 and other greenhouse gases.[4]

Recent improvements in energy efficiency have been below the pace needed to meet the target for 2030 established by SDG 7 (United Nations, 2020), and the carbon intensity of energy has hardly changed at the global level. Although solar and wind power have expanded rapidly in recent years, these sources currently account for no more than 2 per cent of the global energy supply, while the total consumption of fossil fuels has risen. In 2018, all non-fossil fuel sources, including nuclear power and biomass as well as hydro, solar and wind power, accounted for about 20 per cent of the total energy consumption globally (IEA, 2020b). Nevertheless, the coming decades are likely to see a rapid adoption of carbon-free fuels. In particular, solar power is now cost-competitive with construction of coal or gas-fired power plants in most countries (IEA, 2020c). The International Energy Agency's projected trend of carbon emissions for the coming decades has been successively revised downward, especially emissions due to coal, the most carbon-intensive type of fuel (Hausfather, 2020). In addition, the economic shock of the COVID-19 pandemic led to an estimated decline in fossil fuel-related CO_2 emissions of around 7 per cent during 2020; the long-term impact of the pandemic will depend in part on how rapidly economies recover (IEA, 2020c).

In the coming decades, as the rate of population growth continues to decline, population increase is expected to become less and less important as a driver of rising GHG emissions globally. Most of the uncertainty about the future course of GHG emissions rests with the other factors of the Kaya identity, including trends in GDP per capita, energy efficiency and carbon intensity. Those trends are difficult to predict, and projections by the IPCC and others have considered a wider range of possibilities for their trajectories than for population growth (box 17.1; Burgess and others, 2020; IPCC, 2014a). What is certain is that meeting the objectives of the Paris Agreement for limiting the rise in global temperature, while achieving the Goals and targets of the 2030 Agenda for Sustainable Development, will require a rapid decoupling of economic activity from the current over-reliance on fossil-fuel energy. Such decoupling will require major policy actions and investments by governments, the private sector and civil society in all regions, with strong support from the international community.

The number of countries that have pledged to achieve net-zero GHG emissions has grown rapidly and, as of April 2021, included countries responsible for around 70 per cent of global emissions of CO_2 (IEA, 2021). Thousands of local and regional governments and private businesses have made separate commitments (NewClimate Institute and others, 2021). However, most of the national pledges are not yet accompanied by concrete plans for achieving the stated goals. Moreover, even if all current pledges were met, the global temperature would probably rise to about 2.1°C above pre-industrial limits by 2100 (IEA, 2021). Without additional actions beyond the current national commitments for 2030,[5] the temperature could rise by around 2.7°C (UNEP, 2021; UNFCCC, 2021). Achieving the goal of limiting the increase in global temperatures to 1.5°C will require unprecedented international co-operation among governments, especially on innovation and investment, as well as commitment to reducing net global CO_2 emissions to zero by 2050 through a broad range of actions designed to transform the energy sector, increase energy efficiency, scale up solar and wind power, and deploy all available abatement measures (IEA, 2021).

[4] See General Assembly resolution 74/225.
[5] Refers to the unconditional nationally determined contributions under the Paris Agreement as of 12 October 2021 (UNFCCC, 2021).

Box 17.1

Population projections in the IPCC Shared Socioeconomic Pathways

For its current (sixth) assessment, the IPCC constructed five Shared Socioeconomic Pathways (SSPs) outlining possible ways that populations and economies could develop by the end of the twenty-first century. A single set of population, education, urbanization and GDP projections was chosen as a baseline scenario for each SSP. Baseline projections of emissions and land-use were also chosen to represent the scenario-specific changes expected to develop in the absence of new climate policies, and these serve as reference scenarios for use in developing and evaluating emissions and adaptations strategies (Riahi and others, 2017).

The five SSPs were designed to represent a wide range of possible futures, and they reflect the lesser uncertainty concerning future population size compared to other key trends. For instance, the projected size of the world's population in 2100 is 1.8 times as large for the highest compared to the lowest of the SSP baselines, while the extremes for global GDP differ by a factor of 3.8 and those for total annual CO_2 emissions by more than a factor of 5 (Hausfather, 2018; IIASA, 2018).

Of the five population projections used in the SSPs, four imply that global population growth will slow more rapidly than in the United Nations medium projection. In one SSP scenario, the trend in global population size lies close to the upper bound of the 95 per cent uncertainty interval of the United Nations projections (chap. 3, box 3.1); in two SSP scenarios, the trend is close to the lower bound of that interval; and in the other two scenarios, the trend runs well below the lower bound, peaking at 8.5 billion and then falling to 6.9 or 7.4 billion in 2100.

The SSP population projections were derived from assumptions about the evolution of fertility, mortality and migration in different groups of countries. The projected fertility trends are directly linked to assumptions about future trends in educational attainment and about the specific quantitative relationship between fertility and education in the coming decades (KC and Lutz, 2017). The two lowest pathways are built on an assumption that current high-fertility countries will experience a very rapid transition to low levels of fertility, due to accelerated improvements in women's educational attainment and large declines in education-specific fertility rates. In those pathways, nearly all the countries with high rates of population growth in 1995-2020 will have reached a peak population size and begun declining before the end of the century (IIASA, 2018).

At the global level, the lowest SSP trajectories lie close to the traditional "low" scenario of the United Nations projections. However, while the traditional "low" and "high" scenarios may be plausible for high-fertility countries individually, they depict rather unlikely outcomes for regional and global aggregates (Gerland and others, 2014).

If such assumptions are not realized, the eventual size of the world's population could be larger than in most SSP scenarios, requiring even greater efforts to decouple economic growth from negative environmental impacts.

References

Chancel, L., and T. Piketty (2015). *Carbon and inequality: from Kyoto to Paris*. Paris School of Economics. Available at https://doi.org/10.13140/RG.2.1.3536.0082.

Hausfather, Z. (2018). Explainer: How 'Shared Socioeconomic Pathways' explore future climate change. Carbon Brief. Available at https://carbonbrief.org/explainer-how-shared-socioeconomic-pathways-explore-future-climate-change.

_____ (2020). CO_2 Emissions from Fossil Fuels May Have Peaked in 2019. Available at https://thebreakthrough.org/issues/energy/peak-co2-emissions-2019. Accessed on October 16, 2020.

Gerland, P., and others (2014). World population stabilization unlikely this century. *Science,* vol. 346, No. 6206, pp. 234-237.

Global Carbon Project (2021). Supplemental data of Global Carbon Budget 2021 (Version 1.0) Dataset. Global Carbon Project. Available at https://icos-cp.eu/science-and-impact/global-carbon-budget/2021.

International Institute for Applied Systems Analysis (IIASA) (2018). SSP Public Database, ver. 2.0. Available at https://tntcat.iiasa.ac.at/SspDb/.

International Energy Agency (IEA) (2019). *World Economic Outlook 2019.* Available at https://iea.org/reports/world-energy-outlook-2019.

_____ (2020a). CO_2 Emissions from Fuel Combustion. Dataset. Available at https://iea.org/data-and-statistics. Accessed on 15 June 2021.

_____ (2020b). *Key World Economic Statistics 2020.* OECD Publishing, Paris. Available at https://iea.org/reports/key-world-energy-statistics-2020.

_____ (2020c). *World Economic Outlook 2020, Executive summary.* Available at https://iea.org/reports/world-energy-outlook-2020.

_____ (2021). *Net Zero by 2050: A Roadmap for the Global Energy Sector.* Available at https://iea.org/reports/net-zero-by-2050.

_____ and others (2021). *Tracking SDG 7: The Energy Progress Report*. World Bank, Washington DC. World Bank. Available at https://trackingsdg7.esmap.org/data/files/download-documents/2021_tracking_sdg7_report.pdf.

Intergovernmental Panel on Climate Change (IPCC) (2000). *Emissions Scenarios,* Nebojsa Nakicenovic and Rob Swart, eds. Cambridge University Press, UK.

_____ (2013). *Climate Change 2013: The Physical Science Basis.* Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.

_____ (2014a). *Climate Change 2014: Mitigation of Climate Change.* Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.

_____ (2014b). *Climate Change 2014: Synthesis Report.* Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.

_____ (2018). *Global warming of 1.5°C.* An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.

Intergovernmental Panel on Climate Change (IPCC) (2021). *Climate Change 2021: The Physical Science Basis.* Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. In Press. Available at https://www.ipcc.ch/report/ar6/wg1/.

Kaya, Y. (1989). Impact of carbon dioxide emission control on GNP growth: Interpretation of proposed scenarios. Intergovernmental Panel on Climate Change, Response Strategies Working Group.

KC, S., and W. Lutz (2017). The human core of the shared socioeconomic pathways: Population scenarios by age, sex and level of education for all countries to 2100. *Global Environmental Change,* (January), vol. 42, pp. 181-192.

Burgess, M., and others (2020). IPCC baseline scenarios have over-projected CO_2 emissions and economic growth. *Environmental Research Letters*, vol 16, No. 1. Available at https://iopscience.iop.org/article/10.1088/1748-9326/abcdd2.

Oxfam and Stockholm Environment Institute (2020). The Carbon Inequality Era: An Assessment of the Global Distribution of Consumption Emissions Among Individuals from 1990 to 2015 and Beyond. Available at https://oxfam.org.uk/publications/the-carbon-inequality-era-an-assessment-of-the-global-distributionof-consumpti-621049.

NewClimate Institute, and others (2021). *Global Climate Action from Cities, Regions and Businesses: Taking Stock of the Impact of Individual Actors and Cooperative Initiatives on Global Greenhouse Gas Emissions, Edition 3.* Available at https://newclimate.org/wp-content/uploads/2021/06/NewClimate_GCC_June21_2.pdf.

Reay, D., and others. (2012). Global agriculture and nitrous oxide emissions. *Nature Climate Change*, vol. 2, pp. 410–416.

Riahi, K., and others (2017). The Shared Socioeconomic Pathways and their energy, land use, and greenhouse gas emissions implications: An overview. *Global Environmental Change*, vol. 42, pp. 153-168.

Ritchie, H., and others (2021). Our World in Data CO_2 and Greenhouse Gas Emissions dataset. Available at https://github.com/owid/co2-data. Accessed on 7 November 2021.

United Nations (1999). *The World at 6 Billion.* ESA/P/WP.154.

_____ (2019). *World Population Prospects 2019. Online edition. Rev. 1*. Available at https://population.un.org/wpp. Accessed on 20 February 2021.

_____ (2020). *The Sustainable Development Goals Report 2020*. Available at https://unstats.un.org/sdgs/report/2020/The-Sustainable-Development-Goals-Report-2020.pdf.

United Nations Environment Programme (UNEP), ed. (2019). *Global Environment Outlook – GEO-6: Healthy Planet, Healthy People*. Cambridge: Cambridge University Press.

_____ (2020). *Emissions Gap Report 2020*. Nairobi.

_____ (2021). *Emissions Gap Report 2021*. Nairobi.

United Nations Framework Convention on Climate Change (FCCC) (2021). Nationally determined contributions under the Paris Agreement. Revised synthesis report by the secretariat. FCCC/PA/CMA/2021/8/Rev.1.

World Bank (2021). World Development Indicators (WDI). Available at https://databank.worldbank.org/source/world-development-indicators (updated 25 May 2021).

Chapter 18. Sustainable agriculture and food systems

Today's system of global food production is unsustainable: current practices cannot be scaled up to feed a growing population and accommodate changes in consumer preferences without causing further grave damage to the environment. Throughout the food system, smart policies are needed to foster sustainable practices that preserve biodiversity and that help societies to mitigate climate change and adapt to its environmental and other impacts. The overarching objective is to transform food systems to ensure that they provide access to safe, sufficient, affordable and nutritious foods and promote the enjoyment of a diversified, balanced and healthy diet for all, while protecting the planet and safeguarding its resources for future generations.

Population size has long been a major determinant of the total demand for food. In recent decades, however, the increase in global food production has substantially outpaced the growth of population. In 2018, the world's population was nearly 2.5 times as large as in 1961, yet the global food supply had more than tripled over the same period (FAO, 2021). This rapid expansion of agricultural production, known also as the Green Revolution, is a profound achievement, but one that has come with high environmental costs.

While average nutritional levels have improved since 1960, progress has recently stalled. Moreover, there remain vast inequalities, both between and within countries, in access to safe, sufficient and nutritious food, and these inequalities contribute to multiple forms of malnourishment worldwide. (E/CN.9/2021/2, chap. 11).

Together, these trends have grave implications for humanity and for the planet — implications that must be addressed if the world is to achieve the Sustainable Development Goals, in particular those focused on hunger, health and environmental sustainability.

Most estimates of Earth's carrying capacity for human life have been based on estimates of the potential amount of cropland and of the quantity of food that could be produced from it (Van den Bergh and Rietveld, 2004; Cohen, 1995). Prior to 1950, the dietary needs of a growing population were accommodated mainly by increasing the amount of agricultural land, because crop yields improved very slowly (Ritchie and Roser, 2021; Smil, 1997). Since the second half of the twentieth century, however, a combination of innovations and investments, including the development and dissemination of more productive plant varieties and animal breeds and the increased use of irrigation and agro-chemicals, has led to unprecedented improvements in agricultural yields. These higher yields made it possible to feed a growing global population and increase calories per capita at a much faster pace than the increase in the amount of agricultural land (FAO, 2018a). However, yields are likely to improve less rapidly in the future, given that such gains were often achieved through unsustainable practices such as excessive groundwater withdrawal. Indeed, for several major crops, the pace of improvement has slowed in recent years. At the same time, current crop yields are far below their potential in some countries, especially in sub-Saharan Africa. Closing yield gaps using sustainable land management practices will be among the changes needed for Africa to produce enough food for its growing population (ICCP, 2019; box 5.2; Van Ittersum and others, 2016).

Agriculture impacts many aspects of the environment. Appropriation of land for food production is the leading driver of biodiversity loss (Willett and others, 2019; Tilman and others, 2001). Food production currently takes up 50 per cent of habitable land worldwide and accounts for 70 per cent of freshwater withdrawals (UNEP, 2019). The global food system is responsible for between one fifth and one third of total

greenhouse gas (GHG) emissions, taking into account emissions from agriculture and from food storage, transport, packaging, processing and distribution.[1] Agriculture, forestry and other land use are responsible for an estimated 81 per cent of nitrous oxide, 44 per cent of methane and 13 per cent of carbon dioxide emissions from human activities (IPCC, 2019). Food loss and waste amount to about 25 to 30 per cent of total food produced, and thus about 8 to 10 per cent of global GHG emissions (IPCC, 2019). Overuse of nitrogen and phosphorus in fertilizers and runoff from pesticides and herbicides harm aquatic ecosystems and threaten marine life, while mismanagement of antibiotics, particularly in livestock, has led to the evolution and spread of antibiotic-resistant bacteria. Today, one third of the world's farmland is rated as moderately to highly degraded (FAO, 2017).

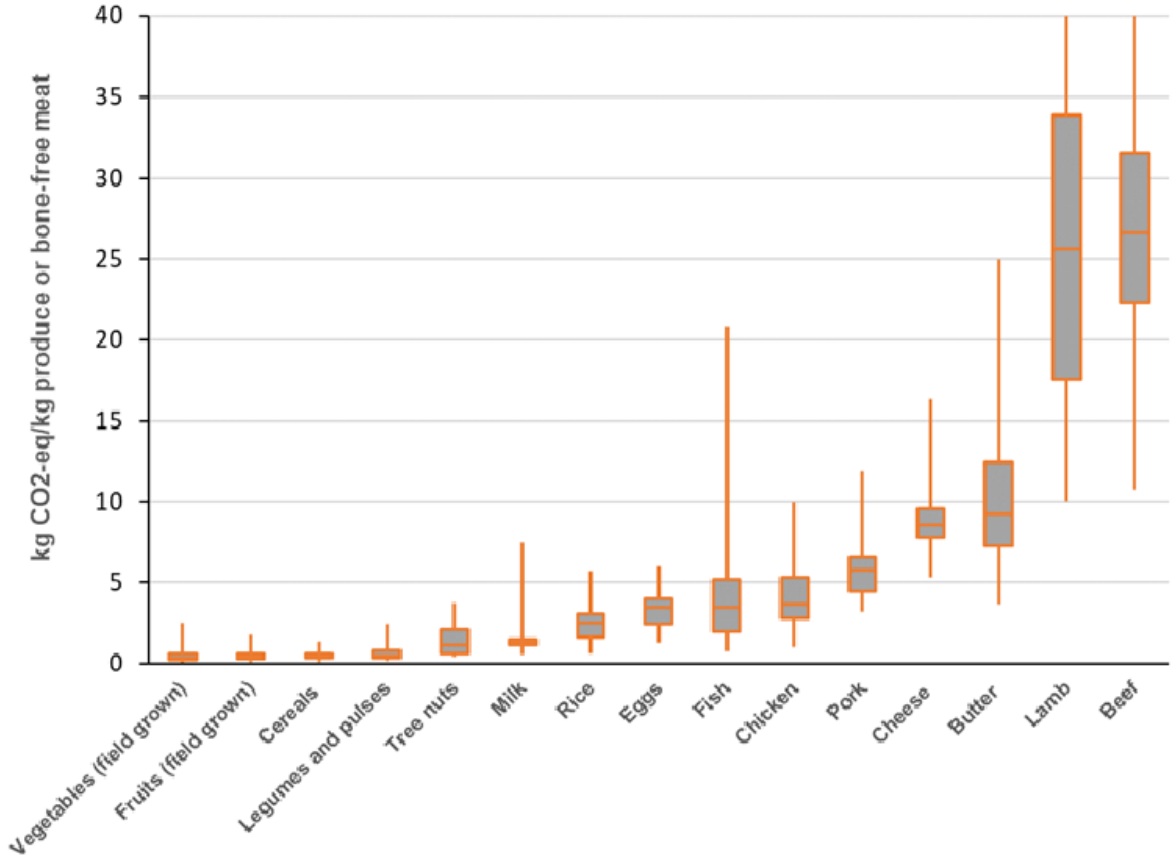
Continuing population growth, dietary changes and rising incomes will increase the demand for food by 2050 in many regions, especially in sub-Saharan Africa, yet the amount of uncultivated land that is highly suitable for agriculture is diminishing (FAO, 2018a). The amount of land devoted to agriculture has continued to expand in tropical and subtropical regions, especially in low-income countries whose populations are growing rapidly (Willett and others, 2019; FAO, 2017). The harvested area may increase by approximately 20 to 25 per cent globally between 2012 and 2050, and by approximately 60 to 75 per cent in sub-Saharan Africa (FAO, 2018a). In some regions, including Northern Africa and Western Asia, and much of Eastern and South-Eastern Asia and Oceania, nearly all of the unprotected land that is highly suitable for agriculture is currently in use. Shortages of highly suitable land may develop by 2050 in parts of sub-Saharan Africa and South Asia. In addition, climate change may significantly reduce yields in some regions—particularly in the tropics and subtropics.[2] Moreover, feeding a growing population, particularly in sub-Saharan Africa, will require additional investments to raise the productivity of crop varieties and animal breeds and to improve land and water use, restore degraded land, and reduce food loss by improving food processing, storage and infrastructure (ICCP, 2019; FAO, 2017).

The impact of population growth on the global demand for food is amplified by dietary changes.[3] As per capita income has increased, diets have shifted to include both more calories and more varied and expensive foods, in particular more foods from animal sources. Certain food choices have greater environmental impacts in terms of GHG emissions (figure 18.1), water, land and energy use, and nitrogen and phosphorus applications. Producing animal-source foods, especially meat of ruminant animals (cattle, sheep and goats), generally has higher environmental costs than producing plant-based foods. Diets rich in animal-source foods, sugars and fats have become common in high-income countries and are increasingly popular in middle-income countries as well. Such diets are linked to a rising prevalence of overweight and obesity and associated diseases, including cardiovascular disease, diabetes and various forms of cancer (Bodirsky and others, 2020; Willett and others, 2019; chap. 11). In such situations, shifting towards more healthy and sustainable diets could make an important contribution to reducing GHG emissions from food systems and would also improve human health outcomes (IPCC, 2019; Willet and others, 2019). At the same time, in low-income countries the current consumption of animal-source foods is often insufficient to meet micronutrient needs, especially among young children (chap. 11; FAO and others, 2020). Thus, a comprehensive but differentiated approach is required to promote healthier and more sustainable diets in different contexts and locations, with an urgent need for actions throughout the food chain to increase the supply and affordability of nutrient-rich foods, including fruits, vegetables and plant-based proteins (Global Panel on Agriculture and Food Systems for Nutrition, 2020).

[1] The IPCC estimated a range of 21 to 37 per cent (IPCC, 2019), whereas the Global Sustainable Development Report 2019 quotes a range of 19 to 29 per cent (Independent Group of Scientists, 2019).
[2] For the northern temperate zones, estimates show a larger share of potentially positive effects on crop yields (FAO, 2017; IPCC, 2019).
[3] The following discussion draws on the Secretary General's report to the Commission on Population and Development in 2021 (E/CN.9/2021/2), which also provides additional discussion concerning the issues of population, food security, nutrition and sustainable development.

Figure 18.1

Global warming potential values for selected broad food categories



Source: Clune, Crossin and Verghese (2017).

Note: The figure is based on a meta-analysis covering 369 studies that provided estimates of the global warming potential associated with production of specific types of food. For each food category, the box spans the range between the upper and lower quartile of the available estimates, with the median level marked. The vertical lines show the range between the maximum and minimum of the estimates.

The food system's interactions with human health, the environment and the economy have been brought together in integrated assessment models and foresight exercises that account simultaneously for multiple variables. According to a "business as usual" scenario, characterized by the continuation of recent trends and a failure to address many challenges facing food systems, including climate change, current practices are unsustainable and likely to lead to continued environmental deterioration while allowing significant undernourishment and malnutrition to persist through 2050 (FAO, 2018a). A more sustainable food and agriculture system is possible but not easily attainable. Some of the actions needed are likely to increase near-term costs in order to ensure long-term benefits (FAO, 2014, 2018a, 2018b). In addition to measures to foster sustainable growing practices and restore degraded land, policies aimed at producers, distributors and consumers in high-income countries could make an important contribution by reducing food waste and encouraging consumption of healthy diets less reliant on animal products.

An additional consideration is that food prices are likely to rise if production and consumption costs are fully taken into account, including the costs of resource degradation and GHG emissions (FAO, 2018a, 2019). While price increases reflecting such externalities would in theory lead to a more careful use of

available resources—by motivating reductions in food waste and restraining the demand for certain foods—they could also limit access to food among the poor. Ideally, with a more equitable distribution of income and food within and across countries, environmental sustainability, food security and better nutrition could be accomplished in parallel (FAO, 2018a). Achieving these desirable outcomes would require substantially increased investments, including for research, development and dissemination of improved agricultural technologies and sustainable growing practices and for physical infrastructure and human capital. It is essential that the benefits of such investments extend to smallholder farmers in low-income and middle-income countries and that such initiatives fully involve women, who make up over 40 per cent of the agricultural labour force in developing countries but who typically have had less access to the financial and other resources needed to boost agricultural productivity (FAO, 2011, 2017).[4]

Over the next few decades, growth of the global population is expected to continue to decelerate, gradually reducing the role of population growth as a driver of the increasing demand for food. Nevertheless, growth in population will continue to have a major impact on growth in the demand for food through 2050 and beyond. Meanwhile, the need to feed more people must be met while eliminating food deficits for hundreds of millions who currently go hungry and for many more who cannot afford a healthy diet (chap. 11). Meeting those needs, while simultaneously moving towards more sustainable growing practices and healthier diets, will require responses throughout the food system, not only from producers but also from those involved in the processing, distribution, preparation and consumption of food. These changes will require the active participation of businesses and other non-governmental actors, as well as decisive action by governments and strong support from the international community (United Nations, 2021; FAO and others, 2020; Willett and others, 2019).

[4] A detailed discussion of the actions needed to move towards sustainable agricultural and food systems is beyond the scope of the present report. Recent in-depth discussions of these topics, including measures to adapt to and mitigate climate change, can be found in the refences to this chapter and in other publications of FAO and UNEP, as well as other international and national and organizations engaged in research and actions on these topics.

References

Bodirsky, B. L., and others (2020). The ongoing nutrition transition thwarts long-term targets for food security, public health and environmental protection. Scientific Reports 10, No. 19778.

Clune, S. J., E. Crossin, and K. Verghese (2017). Systematic review of greenhouse gas emissions for different fresh food categories. *Journal of Cleaner Production*, vol. 140, Part 2, pp. 766-783.

Cohen, J. (1995). *How Many People Can the Earth Support?* New York: W. W. Norton and Company.

Food and Agriculture Organization of the United Nations (FAO) (2011). *The State of Food and Agriculture 2010-2011.* Rome.

_____ (2014). *Building a common vision for sustainable food and agriculture. Principles and approaches.* Rome.

_____ (2017). *The Future of Food and Agriculture: Trends and Challenges.* Rome.

_____ (2018a). *The Future of Food and Agriculture – Alternative Pathways to 2050.* Rome.

_____ (2018b). *Transforming Food and Agriculture to Achieve the SDGs.* Rome.

_____ (2019). *The State of Food and Agriculture 2019: Moving Forward on Food Loss and Waste.* Rome.

_____ (2021). FAOSTAT. Available at http://fao.org/faostat. Accessed on 16 May 2021.

_____ and others (2020). *The state of food security and nutrition in the world 2020.* Transforming food systems for affordable healthy diets. Rome, FAO. Available at http://fao.org/3/ca9692en/CA9692EN.pdf.

Global Panel on Agriculture and Food Systems for Nutrition (2020). *Future Food Systems: For People, Our Planet, and Prosperity.* London.

Independent Group of Scientists appointed by the Secretary-General (2019). *Global Sustainable Development Report 2019: The Future is Now – Science for Achieving Sustainable Development*, United Nations.

Intergovernmental Panel on Climate Change (2019). Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems. Available at https://ipcc.ch/srccl/download/.

Ritchie, H., and R. Max (2021). Crop Yields. Available at https://ourworldindata.org/crop-yields. Accessed on 18 October 2021.

Smil, V. (1997). Global population and the nitrogen cycle. *Scientific American*, vol. 277, No.1, pp. 76-81 (July).

Tilman D., and others. (2001). Forecasting agriculturally driven global environmental change. *Science*, vol. 292, pp. 281–84.

United Nations (2021). Secretary-General's Chair Summary and Statement of Action on the UN Food Systems Summit, 23 September. Available at https://un.org/en/food-systems-summit/news/making-food-systems-work-people-planet-and-prosperity.

United Nations Environment Programme (UNEP) (2019). *Global Environmental Outlook: GEO 6 – Healthy Planet, Healthy People.* Cambridge, Cambridge University Press.

Van Den Bergh, J., and P. Rietveld (2004). Reconsidering the Limits to World Population: Meta-analysis and Meta-prediction. *BioScience*, vol. 54, No. 3, pp. 195–204, March.

Van Ittersum, and others (2016). Can sub-Saharan Africa feed itself? *Proceedings of the National Academy of Sciences*, vol. 113, No. 52, pp. 14964-14969. Available at https://pnas.org/content/113/52/14964

Willett W., and others. (2019). Food in the Anthropocene: the EAT-Lancet Commission on healthy diets from sustainable food systems. *Lancet*, vol. 39, No. 10170, pp. 447-492.

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