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# Population & Societies

## World population outlook: Explosion or implosion?

Henri Leridon\*

Could world population growth stop by 2050 or even decrease before then? Drawing on United Nations projections, Henri Leridon examines the conditions for such a reversal, notably the crises in mortality and declines in fertility that it would imply, as well as their plausibility.

Public opinion is regularly presented with contradictory prognoses of how the world population may change. Some believe growth will continue at its current rate (1% per year, down from 2% in the 1960s) and that the population 'explosion' is ongoing. Others announce the earth will soon reach its limits in terms of food supplies, natural resources and pollution, and the world population will inevitably decline or even collapse due to successive uncontrollable crises. But these assertions rarely factor in the internal constraints shaping population dynamics, which we will examine here from a global perspective.<sup>(1)</sup>

### Current trends: United Nations population prospects and their variants

Demographers have long sought to forecast population change, but the task is not simple. From the 1960s, substantial progress was achieved with the adoption of the 'cohort-component' method. Under this approach, the population is projected based on fertility, mortality, and migration assumptions, with projections from one year to the next calculated separately for males and females and for each age group. This method is much more reliable than a simple extrapolation of the total population or its growth rate. It explicitly incorporates the three determinants of population change, namely trends in mortality, fertility,

and migration, taking account of possible changes in the sex- and age-specific rates of each component over the projection period. The art (and difficulty) of projection thus lies in making realistic assumptions about their future trends, although these choices can be guided by predicted changes in other factors such as contraceptive use or progress in healthcare, making it possible to envisage a range of scenarios.

The United Nations Population Division makes projections of this kind every 2 years. The results obtained at the global level are an aggregate of the projections produced at the national level for all countries of the world [1]. Under the medium variant of the most recent projections [2], the world population is forecast to increase by 2 billion between now and 2050, rising from 7.7 billion in 2019 to 9.7 billion in 2050, before peaking at 10.9 billion slightly after 2100. UN experts propose two forms of variability around this medium variant. The first is probabilistic and is based on the variability introduced into the fertility estimate due to the diversity of past trends: the 95% confidence interval thus generated for the world population is [9.4, 10.1] billion in 2050 and [9.4, 12.7] billion in 2100. The second involves envisaging arbitrary changes in fertility, with a decrease or increase of 0.5 children per woman with respect to the medium variant to produce 'low' and 'high' variants. This gives projected population sizes ranging from [8.9, 10.6] billion in 2050 and [7.3, 15.6] billion in 2100. The 2050 estimate is not greatly affected by these different approaches, both giving a result close to the

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(1) Migration questions will not be covered, as migration flows cancel each other out at the global level.

Populations of the major world regions in 2050 and 2100 under different assumptions (United Nations, 2019) (in millions)						
	2050			2100		
	Fertility variant			Fertility variant		
	Medium	Low	Instant-replacement*	Medium	Low	Instant-replacement*
<b>World</b>	<b>9,735</b>	<b>8,907</b>	<b>9,418</b>	<b>10,875</b>	<b>7,322</b>	<b>10,415</b>
Sub-Saharan Africa	2,118	1,944	1,557	3,775	2,683	1,879
Rest of Africa	372	340	327	505	348	380
Asia	5,290	4,832	5,460	4,719	3,025	5,764
Europe	710	655	763	630	428	831
Latin America and Caribbean	762	693	804	680	434	886
North America	425	391	450	491	350	598
Oceania	57	53	57	75	54	78

\* Immediate transition (in 2020) to replacement level fertility.  
Source: United Nations [2].

medium variant (9.7 billion). Uncertainty is much greater for 2100. Let us look at these assumptions in more detail.

### Could world population growth diverge from the UN trajectories?

Until today, and since the 1950s, the world population has evolved in line with or slightly below the successive UN medium-variant projections. But could its future trajectory diverge much more sharply from those predicted in the latest projections? Might the slowdown be much faster than expected due to a rapid decline in fertility or a sharp increase in mortality?

#### A rapid fertility decline?

The UN medium-variant projection assumes relatively rapid fertility reduction, consistent with the trend already observed over the last decades. Current fertility levels (2015–2020) in the major regions of the world are as follows: 1.61 children per woman in Europe, 1.75 in North America (United States and Canada), 2.04 in Latin America (1.74 in Brazil), 2.15 in Asia (1.69 in China, 2.24 in India, but 4.56 in Afghanistan). Only in sub-Saharan Africa does fertility remain high, at 4.72 children per woman.

Under the UN medium variant, fertility should decline slightly further in Asia and Latin America, soon falling below 2.0 children per woman. In Europe and North America, where it is already below this threshold, it may rebound somewhat while remaining well below 2.0. In sub-Saharan Africa, fertility is projected to fall sharply, from its current level of 4.72 children per woman to 3.17 in the next 30 years and 2.16 by the end of the century. Under the low variant, sub-Saharan fertility even falls to 2.67 within the next 3 decades,

about two children fewer than today. A change of this magnitude within a single generation would be enormous, but not impossible. Yet its effect on the size of the sub-Saharan population would be limited (Table): by 2050, the difference between the low and medium variants is –8.2% (1.94 billion vs. 2.12 billion).

If we focus on the populations of industrialized countries, the world’s greatest polluters, we note that under the low variant, the population of Europe and North America is 89 million lower than under the medium variant, i.e. barely more than 10% of the global decline despite fertility of just 1.2 children per woman.

Another variant proposed by the UN is that of an almost instantaneous transition to replacement fertility level, i.e. 2.1 children per woman (‘instant-replacement’ in the

Table). Compared with the low variant, the sharper decline in the sub-Saharan population (1.56 billion vs. 1.94) would not be sufficient to offset the increase in other world regions now below replacement level. At the global level, the population would be closer to the medium variant than the low variant.

It is therefore illusory to expect that the world population will fall by 2050 unless entire generations of young people refuse to have children and fertility thus plummets. This inertia is due largely to the demographic momentum acquired over the period of rapid population increase. The age structure of the world population still bears the trace of those years: despite a relatively low level of fertility per woman, birth numbers remain high because the cohorts of reproductive age are still very large.

#### Towards a disaster mortality?

The UN scenarios presented above all assume that the mortality decline observed over many decades will continue unabated. But under a ‘constant mortality’ assumption in which all the other medium variant assumptions remain unchanged, the population would rise to just 9.33 billion in 2050 and fall back to 8.92 billion in 2100, nearly two billion below the medium variant projection for that same year. But it would be a brutal outcome if life expectancy were to stagnate in developing countries, notably sub-Saharan Africa, where it currently stands at 61 years and is projected to approach 69 years in 2050.

The most pessimistic prognoses of world population growth are based on substantial increases in mortality. How large would such increases have to be before this growth was significantly affected? At the global level, annual births currently outnumber deaths by

83 million (140 million births minus 57 million deaths on average over the period 2015–2020). One catastrophe on this scale, i.e. 83 million additional deaths, even spread over several years, would thus cancel out the population growth of one year, i.e. 1/30th, or 0.033% of the expected increase between now and 2050, and would be barely visible on the curve of world population change.<sup>(2)</sup>

To illustrate this point, we can look at the demographic impact of several disasters that have struck the world in recent times. Between its onset in the 1980s and 2018, the HIV-AIDS epidemic caused 35 million deaths worldwide. In a more distant past, it is estimated that the great famines of the USSR in 1918–1920 and of China in 1958–1961 caused several tens of millions of deaths over a period of 3 to 5 years. The Second World War, the most deadly conflict of the 20th century, took 50–80 million lives, again in 5 years. The Spanish flu epidemic in 1918–1919 killed 40–100 million people across the world, representing between 2% and 6% of the global population at that time. Likewise, the world famine of 1876–1879 wiped out between 2% and 4% of humanity, with an estimated 30–60 million deaths. Clearly, such past disasters have had a devastating effect on the populations of particular countries or regions, but their global impact has always been limited. Might there be worse to come? Some believe that if climate change is not held in check (and time is running short), agricultural production may well collapse, resulting in catastrophic famine across the world. Are such famines a realistic prospect? If global warming remains within reasonable limits (no more than 2 °C on average), estimates based on current trends in population growth and food output indicate there should be enough food for the world population until 2050 if demand, notably for animal products, remains reasonable and efforts are made to reduce waste [3, 4]. More severe climate change could certainly affect agricultural yields. The Intergovernmental Panel on Climate Change (IPCC) has pointed this out while showing that solutions exist and that the process would be progressive [5]. Deterioration would have to be very sudden and widespread to trigger serious conflict between populations for access to resources and water. Here, projections of demographic or other trends reach their limits. A disaster of unprecedented amplitude (such as a nuclear war) cannot be predicted nor its consequences taken into account.

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(2) This effect could also be compounded by a reduction in births if the excess deaths affected the population below age 50. During the First World War, births fell by half in France, lowering the growth rate (excluding mortality) from around 2% to 1% over 4 years, although this was due mainly to the mobilization of young men rather than their deaths.

## What about the ‘world model’?

In 1972, on the initiative of the Club of Rome international think tank [6], a ‘world model’ was developed by an MIT team led by J. Forrester. Forgotten for a while, it is now coming back into fashion [7]. Its return to favour is interesting for several reasons. First, it was—and still is—one of the rare attempts ever made to build a global model including demographic, social, economic, and environmental variables; second, most of the model variants culminate in ‘endogenous collapse’, in accordance with the theories advocated by present-day ‘collapsologists’.

In the 1972 model, the five key variables are food, natural resources (oil, minerals, etc.), industrial output and capital investments, pollution levels, and world population. Population is just one variable among others, and each variable interacts with all the others, sometimes with a time lag. Fertility, for example, depends on desired family size, living standards, life expectancy, contraceptive efficacy, access to information on available contraceptive methods, etc. Of course, the population size obtained at each stage acts on the other variables.<sup>(3)</sup>

Figure 1 shows the world population curve resulting from the so-called ‘standard’ (but already catastrophic) scenario supposedly based on a continuation of the trends observed in the 1960s and 1970s.<sup>(4)</sup> Population, agricultural output, and industrial production continue to increase at an exponential rate until the end of the 20th century, but natural resources then become scarce and their prices soar. The collapse of industry in turn brings down the farming system (highly mechanized and dependant on chemical fertilizers), leading to famine and an explosion of mortality, such that by 2100 the population has fallen back to the level of 2005. In each of the dozen other variants, the constraints are lifted on one variable, but those still imposed upon the others always produce a catastrophic outcome. It is only under the assumptions of unlimited natural resources, strict pollution controls, a doubling of agricultural yields, and ‘perfect’ birth control that the population levels off between 2030 and 2080 at around 7 billion.

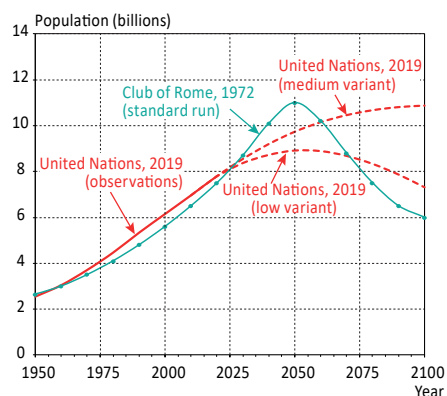
Figure 1 compares the ‘standard’ scenario with the latest UN projections [2]. The Club of Rome projection is quite similar to those of the UN up until 2025. But according to the MIT model, the population will peak at 11 billion by 2050 before collapsing, while in the UN medium-variant projection, the population gradually

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(3) The difficulty of quantifying all these causal relationships (more than 200 in all) is a major limitation of the model.

(4) In the book *The Limits to Growth*, the results are presented as curves with no scales – deliberately so according to the authors. We therefore had to reconstitute the scale for population size based on the period for which figures are known (1900–1970). The ‘standard’ scenario reproduced by Turner [7] was updated in 2005 and is not that of the original book [8].

**Figure 1. United Nations projections (2019) and Club of Rome 'standard' scenario (1972)**



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Sources: United Nations [2]; Meadows et al. [6] [8].

stabilizes at this level by around 2100. So it is true to say that up to now, the Club of Rome 'standard' projection has been accurate, although mainly because it correctly takes account of the momentum that already existed in 1970. The two projections will start diverging in future years because fertility has already declined sharply, agricultural yields have improved (under the Club of Rome scenario, per capita agricultural output falls rapidly from 2010), and energy reserves are larger than predicted at the time the model was produced. The conditions for a population collapse in 2050 have not been met. And the better apparent fit between the UN low-variant projection and that of the Club of Rome (Figure 1) is due to a rapid fertility decline, and not an increase in mortality.

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World population growth started slowing in the 1960s, and the trend should continue over the coming decades. The risk of 'explosion' is behind us; two-thirds of the growth expected between now and 2050 will be attributable to the current population age structure. This slowdown could accelerate if fertility in sub-Saharan Africa falls more quickly. This is not impossible, but sub-Saharan fertility is already projected to fall from 4.72 children per woman to 3.17 within 3 decades under the UN medium-variant projection and even to 2.67 under the low variant. Unless the entire world is hit by severe disasters on an unprecedented scale, with a devastating impact on human life before 2050, it is

difficult to imagine a world population much below 9 billion in the middle of this century. For now, our priority should be to ensure adequate food supplies for a future population of 9 billion people and to address the challenges of global warming.

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## Abstract

The world population was 7.7 billion in 2019, and the United Nations projects 9.7 billion in its medium-variant scenario, which assumes that world fertility continues to decline (from 2.5 children per woman in 2019 to 2.2 in 2050), and only 8.9 billion in its low-variant scenario in which fertility would decline even faster. Unless the entire world is hit by severe disasters on an unprecedented scale, it is difficult to imagine a world population much below 9 billion by 2050.

## Keywords

World population, population projections, United Nations, Club of Rome, disaster scenarios