


Review

Advancing the Welfare of People and the Planet with a Common Agenda for Reproductive Justice, Population, and the Environment

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Abstract: Driven by increasing consumption and population numbers, human demands are depleting natural resources essential to support human life, causing damage to crop lands, fresh water supplies, fisheries, and forests, and driving climate change. Within this century, world population could increase by as little as 15% or by more than 50%, depending largely on how we respond. We must face the challenge of accommodating these additional people at the same time as virtually eliminating the use of fossil fuels and other activities that generate greenhouse gases, reversing environmental degradation and supporting improved living standards for billions of impoverished people. The response to this challenge is handicapped by a lack of common understanding and an integrated agenda among those contributing to the response. This report offers a strategy to protect natural systems and improve welfare through expansion of reproductive justice, a concept that includes family planning, reproductive health, and gender equity, and preservation of the environment and climate.

Keywords: population growth; reproductive justice; demography; family planning; reproductive health; contraception; overpopulation; biodiversity; food security; climate change adaptation and mitigation; environmental sustainability



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1. Introduction: The Challenge of Sustainable Development

The welfare of most of the planet's eight billion people is unacceptable. In 2021, an estimated 828 million people suffered from food insecurity [1]. Half of the world's people are poor with an income of less than USD 5.50 a day [2]. Millions of us do not have adequate health care, education, housing, or employment or enjoy the benefits of good governance, personal freedom, and security from crime and violence.

In 1992, in a statement titled *World Scientists' Warning to Humanity*, a majority of Nobel prize winners in science, together with an additional 1700 of the world's leading scientists, considered the future of the world's population and environment. The scientists warned: "If we do not stabilize population in voluntary, humane ways, it will be done for us by Nature; it will be done brutally, relentlessly and whether we wish it or not" [3].

Twenty-five years later in 2017, more than 15,000 world scientists issued a "second notice" of the warning, documenting the lack of progress in addressing foreseen environmental problems [4]. Especially of concern was the failure to mitigate potentially catastrophic climate change [5], deforestation [6], and the harms from agriculture—including from raising ruminants for meat consumption [7]. The report noted that, "we have unleashed a mass extinction event, the sixth in roughly 540 million years, wherein many current life forms could be annihilated or at least committed to extinction by the end of this century".

Driven by increasing consumption and population numbers, human demands are degrading and depleting many of the planetary natural resources that are essential to

support human life, causing damage to crop lands, fresh water supplies, fisheries, and forests, and driving climate change—the existential challenge of modern history. According to United Nations (UN) projections, Earth’s biosphere will be required to support an additional 1.7 billion people by 2050, and 2.4 billion (an increase of 30%) before world population reaches its peak [8]. At the same time, humanity aspires to support an improved standard of living for billions of impoverished people and provide for increasing affluence and consumption in both rich and poor countries.

This review describes how humanity is not on a trajectory toward sustainable development, commonly defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs,” [9] and offers a strategy to improve our prospects to both protect the natural systems that all life depends on and improve the welfare of people.

The policies and programs to address reproductive justice, population, and the environment that are advanced here are neglected. They indirectly address many other aspects of what is needed to improve human and planetary welfare, such as avoiding conflict, good governance, and equitable access to food, shelter, health care, and employment, since all of these issues reflect competition for scarce resources.

2. A Common Agenda for Policy and Action Is Needed

The communities, organisations, and governments concerned with advocacy and action relating to reproductive justice, abortion rights, family planning, population dynamics, climate, food security, and ecosystem preservation have differing goals and agendas. This review argues that they should adopt a common agenda that is consistent with the UN sustainable development goals [10], and recognize the closely linked issues of reproductive health and rights, population dynamics, environmental preservation, and addressing climate change. This will make it more likely that the necessary beneficial policies will be adopted, workable programs will be initiated, and the needed funds will be forthcoming.

Advocates for women’s rights, health, and welfare have adopted reproductive justice as a policy framework. It calls for the right to have children or not have children, to choose their number and timing, and the right to live in supportive environments that provide reproductive rights, equal opportunities for women, education, fair wages, housing, and health care [11–13]. These advocates warn against repeating the past coercive history of some family planning/population programs—notably mandatory birth limitation and forced abortions in China and involuntary sterilization in India and the U.S. However, they do not always recognize that limiting population size and environmental degradation is fundamental to the attainment and preservation of safe, healthy and autonomous lives, a goal of reproductive justice.

Family planning advocates espouse the public health, social, and economic benefits of family planning and focus on ensuring the universal availability of contraceptive services and safe abortion care. Even so, major non-governmental organisations (NGOs), governments, and foreign aid programs providing family planning and reproductive health services often severely limit access for certain categories of people—for example, teenagers, unmarried women, and women who need abortion care.

Many, but certainly not all, advocates for the preservation of the environment downplay the environmental impact of population growth, or consider the trajectory of population growth to either be immutable or not requiring intervention, believing population will stabilize in size in the near future. They typically advance solutions to environmental problems that rely on regulatory and behaviour changes to lower consumption and adopt “greener” environmentally friendly technologies, but forego the synergistic benefit of lower national and global populations.

Environmentalists in rich countries often state that they have no moral standing to deal with international population issues because the per capita consumption of rich countries far exceeds that of the developing world. In the several high-consumption countries with rapid population growth, such as the U.S. which is estimated to add 38 million residents

by 2050 [14], population is seldom addressed as a contributor to increased consumption and ecosystem degradation.

Advocates for the environment seldom consider that as the five times more populous developing countries gain wealth and consume more, as they deserve to do, their contribution to environmental damage could greatly exceed that of currently wealthy countries. For example, although still a middle-income country, China now consumes more natural resources and emits more greenhouse gases than any other country [15–17]. One estimate is that by 2030, China, India, Brazil, Indonesia, and other developing countries will have been responsible for half of cumulative atmospheric carbon loading [18].

Environmentalists also have relied on UN population projections that indicate that, in the relatively near term, world population size will level off, even though UN projections have repeatedly underestimated future world population growth [19]. For example, the 2022 UN projection for Africa's population size in 2050 is 2.9 billion [14]; this is more than one billion higher than the UN projection made in 2002 [20].

The environmental community also has been wary of addressing population, contraception, and abortion because of fears that it would unnecessarily enmesh their programs in controversial topics. They have failed to sufficiently recognize that full access to both contraception and safe abortion care are essential to reproductive justice, and that slowing world population growth will reduce poverty and disadvantage as well as benefiting the environment [21].

As explained by Karen Newman and coworkers, tensions between these groups are long-standing and remain to this day, but it is appropriate to both care about population dynamics and about sexual and reproductive health and rights and about the environment simultaneously [22]. Probably some influential voices will not join in supporting a common agenda, but undoubtedly there is a “big tent” that could bring many of the adherents of these communities together, strengthen their voices in the public arena, and move advantageous policies, funding, and programs forward.

It is particularly important in the era of “alternative facts” and vigorous attacks on important issues such as abortion rights and climate change to build allegiances that endorse each other's priorities and integrate responses where appropriate. As Benjamin Franklin (1706–1790) opined, “We must, indeed, all hang together or, most assuredly, we shall all hang separately”.

3. Links between Reproductive Justice, Sexual and Reproductive Health, Population, and the Environment

3.1. Reproductive Justice

At UN conferences in 1994 in Cairo and in 1995 in Beijing, participants considered the status of women, population, and development. They adopted the principles of reproductive justice, i.e., that it is a fundamental right to be able to control the number and timing of childbearing [23,24]. This requires access to family planning information, contraceptive services, and abortion. However, developing country surveys show that as many as a quarter of women who want to either delay or stop childbearing altogether lack access to contraception or have concerns about the safety and side effects of available methods [25].

Unintended pregnancies (those occurring too soon or which are not wanted) are common in all countries. In 2015–2019, there were 121 million unintended pregnancies worldwide annually, and more than half (61%) of unintended pregnancies ended in abortion [26].

3.2. Population Dynamics—Past and Future

After the Second World War, the green revolution improved food security, and better public health measures and broader access to health services reduced infant and overall death rates in many developing countries. However, for many years contraceptive services were not included in health programs. The rapid fall in mortality without a matching fall in birth rates led to unprecedented population growth [27].

Between 1950 and 2022, the world population increased from 2.5 billion to eight billion and more than half of us now live in urban areas [14,28]. The population of wealthy regions, mainly North America, Europe, and Japan, increased from 722 million to 1.28 billion. However, the developing regions increased more rapidly, from 1.8 billion people to 6.7 billion. The fastest growing region, Africa, increased six-fold, from 229 million to 1.4 billion.

World population was increasing by more than 80 million per year before the COVID-19 pandemic caused it to dip briefly below 70 million [14]. Future population growth rates and population size depend on total fertility rates (TFR), defined as the average number of children born per woman in her lifetime, as well as on the timing of births (generation length) and mortality rates. Over decades, small differences in fertility result in large differences in total population size. According to the UN, if global average fertility and mortality rates stayed at their current levels, by 2100 world population would reach 19 billion. Conversely, the UN low variant projection is that if fertility levels were consistently half a child lower than expected in the 'medium fertility' projection, world population would rise only to 8.9 billion in 2050 and decline to 7 billion in 2100 [14].

Recent UN projections find a 95% probability that world population will increase to between 9.4 and 10.1 billion in 2050 and between 9.4 and 12.7 billion in 2100 [8,14]. UN population projections are shown in Figures 1 and 2.

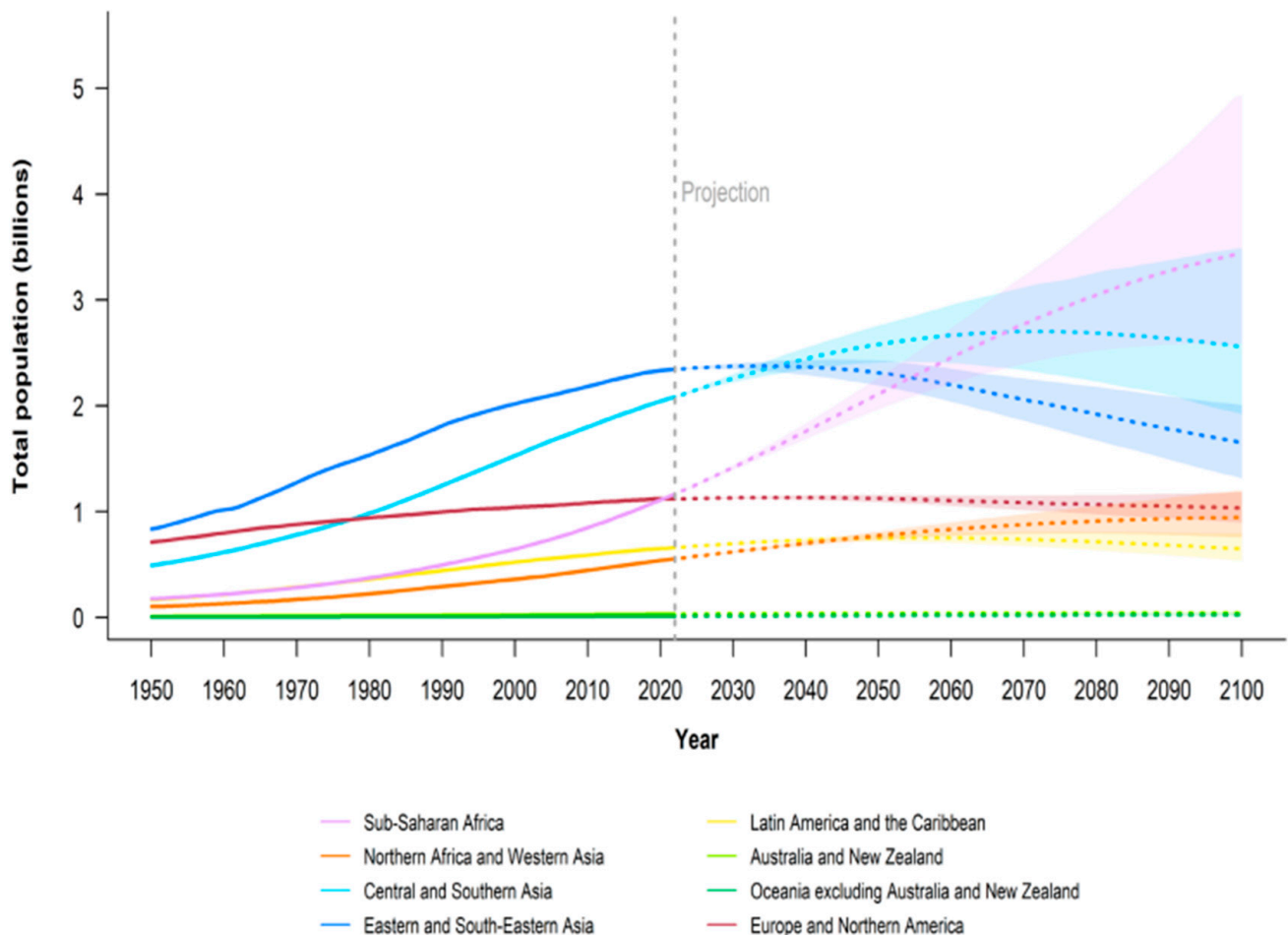


Figure 1. Population estimates, 1950–2022, and medium fertility projections with 95 per cent prediction intervals, 2022–2100, by SDG region. Source: United Nations Department of Economic and Social Affairs, Population Division. *World Population Prospects 2022: Summary of Results*. UN DESA/POP/2022/TR/NO. 3. 2022, United Nations: New York, NY, USA, 2022. https://www.un.org/development/desa/pd/sites/www.un.org.development.desa.pd/files/wpp2022_summary_of_results.pdf (accessed on 1 May 2023) [8].

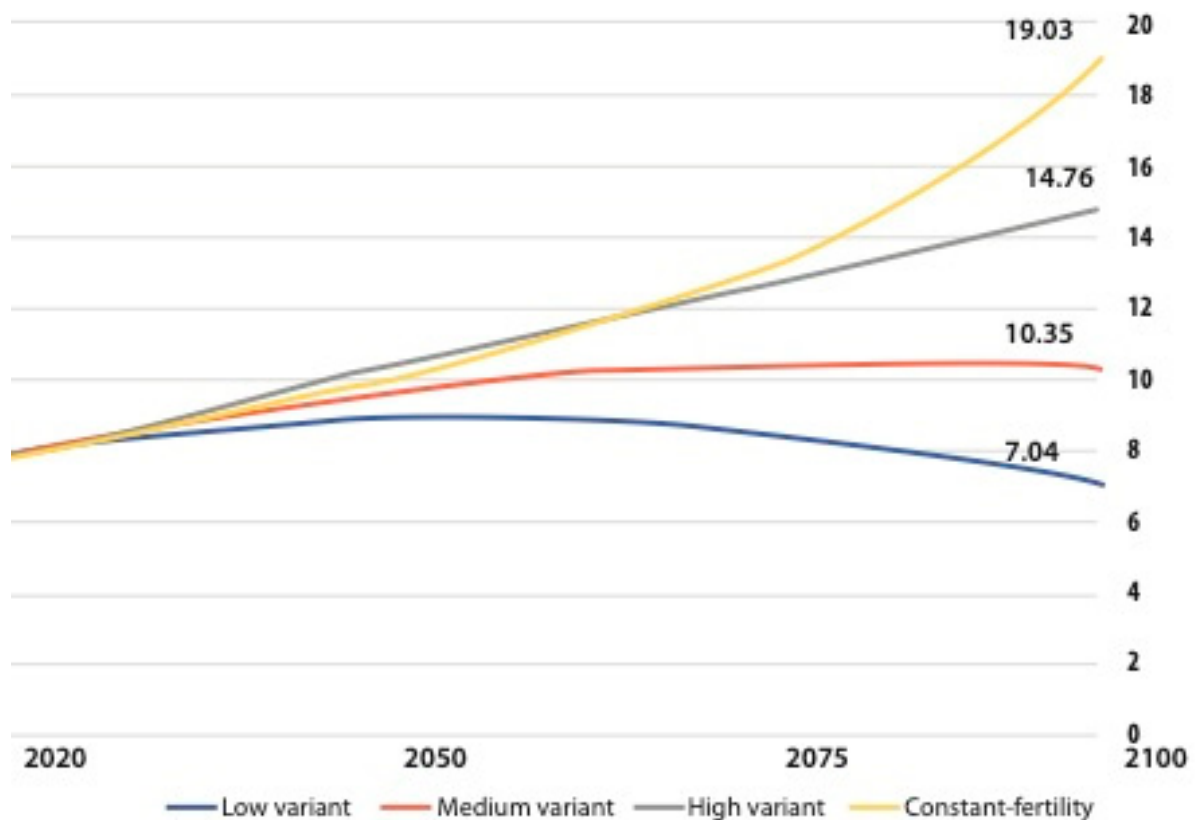


Figure 2. United Nations projections of world population to the year 2100, in billions, under four scenarios differing in assumptions about national fertility levels. Source of data United Nations, Department of Economic and Social Affairs, Population Division. *World Population Prospects 2022, Online Edition*. <https://population.un.org/wpp/> (accessed on 13 April 2023) [14].

UN projections of future population size assuming low, medium, high, and constant (unchanged) levels of fertility in the Latin America, Asia, and Africa regions in 2022, 2050, and 2100 are shown in Figure 3, below.

A group of 46 countries, including 32 in sub-Saharan Africa, are designated “least developed” by the UN. These countries are growing rapidly, and their rapid growth is a major cause of their underdevelopment [29–31]. They are projected to increase from 1.1 billion in 2022 to three billion in 2100 [8,14].

The UN projects that almost two thirds of growth between 2022 and 2050 will be the result of current age structures that are characterized by a very large generation of young people entering their reproductive years [32]. This “population momentum” effect could be attenuated by delaying initiation of childbearing, longer birth spacing, and decisions to have fewer than two children.

The UN’s 2022 “medium variant” projection assumes there will be rapid and substantial declines in fertility. For example, they assume that average TFR in Africa will decline from the current 4.24 children per woman, to 1.99 by 2100 [14].

In contrast, close to two thirds of the world’s population lives in countries or areas with below-replacement-level fertility of about 2.1 births per woman, a level that, over many decades and without much immigration, would lead to zero growth. The UN projects the populations of 61 of these countries will decline during the 21st century [8].

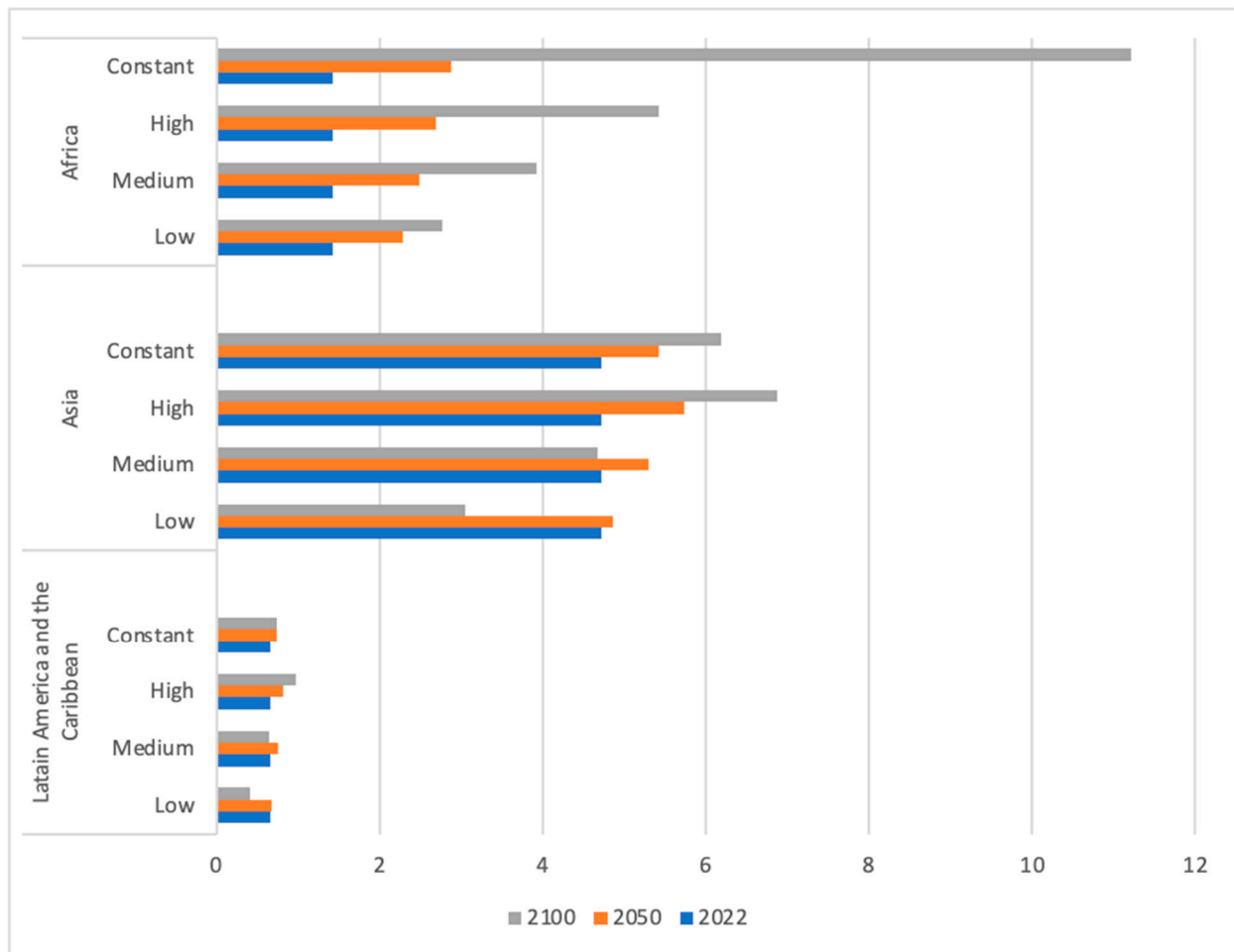


Figure 3. Population of Africa, Asia, and Latin America in 2022 and Low, Medium, High, and Constant Fertility UN Population Projections for 2050 and 2100 in billions. Source of data: United Nations, Department of Economic and Social Affairs, Population Division. *World Population Prospects 2022, Online Edition*. <https://population.un.org/wpp/> (accessed on 1 May 2023) [14].

3.3. The Current High Rate of Population Growth Cannot Continue

Most sub-Saharan African countries face the challenges of poverty and rapid population growth. For example, the UN medium projection for Nigeria, Africa's most populous country, is growth from 219 million in 2022 to 546 million by 2100 [14]. This would be a population 64% larger than that of the entire U.S., currently about 333 million [14], living on an area only about one third larger than the U.S. state of Texas. In 2022, Texas had a population of 30 million.

Agriculture and environment expert Stephen Warren has noted that throughout history, population size has often been limited by food supply [33]. The projections of population growth for Nigeria suggest that unless access to family planning is strengthened, it will be extremely challenging for Nigeria to rely on its own farmers, or afford world food purchases, or get aid to feed their large population. Nigeria's population size might be constrained by hunger, causing increased death rates and large flows of emigrants.

The 2022 Ecological Threat Report by the Institute for Economics and Peace (IEP) found that 37 of the 52 sub-Saharan African countries recorded an extremely high level of food insecurity [34]. Food insecurity is highly correlated with violent conflict, and both are associated with high population growth. According to the IEP report, "The 40 least peaceful countries will have an additional 1.3 billion people by 2050, accounting for almost half of the world's population".

Even this disturbing projection assumes a rapid decline in family size. But what if fertility does not decline? In 2011, the UN projected future population size based on unchanged fertility and mortality up to the year 2300. As is shown in Figure 4 below, Asia's population would reach 325 billion in 2300 and Africa's population would reach 16.2 billion in 2100 and an impossible 3.2 trillion in 2300 [35].

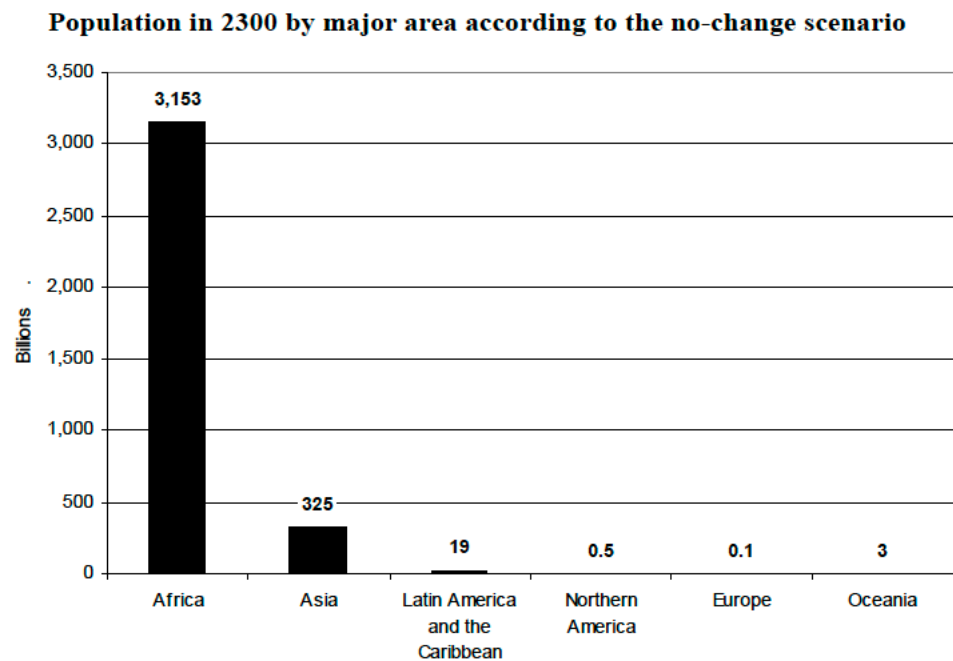


Figure 4. Population in the year 2300 in the year 2300 according to a scenario in which fertility of each country remained at 2011 levels. Source: United Nations. *World demographic trends, report of the secretary general to the commission on population and development. E/CN9/2011/6*. UN Economic and Social Council: New York, NY, USA, January 2011. <https://digitallibrary.un.org/record/698211> (accessed on 1 May 2023) [35].

These long-term projections make it clear that eventually either birth rates will decline through the benefits of family planning and reproductive justice or death rates will rise because of food shortages, disease, political instability, or other problems beyond the capability of developing nations to withstand [36]. Countries with rapid population growth already struggle to eradicate poverty, reduce inequality, combat hunger, and provide adequate standards of education, health, and other basic services.

3.4. Preserving the Environment—The Role of Human Impacts

Year after year, scientific reports have documented ongoing and unsustainable damage to life-supporting ecosystems. The UN-sponsored Millennium Ecosystem Assessment (MEA) found that about half of the productivity of Earth's biosystems is used by humans for food, fresh water, timber, fiber, and fuel, and an estimated 60% of ecosystem services—the benefits people obtain from ecosystems such as providing food, water, raw materials and regulating climate—are being degraded or used unsustainably [37].

The 1992 *World Scientists' Warning to Humanity* (mentioned above) recorded negative trends in a number of environmental indicators. Twenty-five years on, the *World Scientists' Second Warning to Humanity* revised data on these indicators up to 2016 (Figure 5). The review concluded that, with the exception of ozone depletors, humanity had failed to make sufficient progress in reversing environmental damage [4].

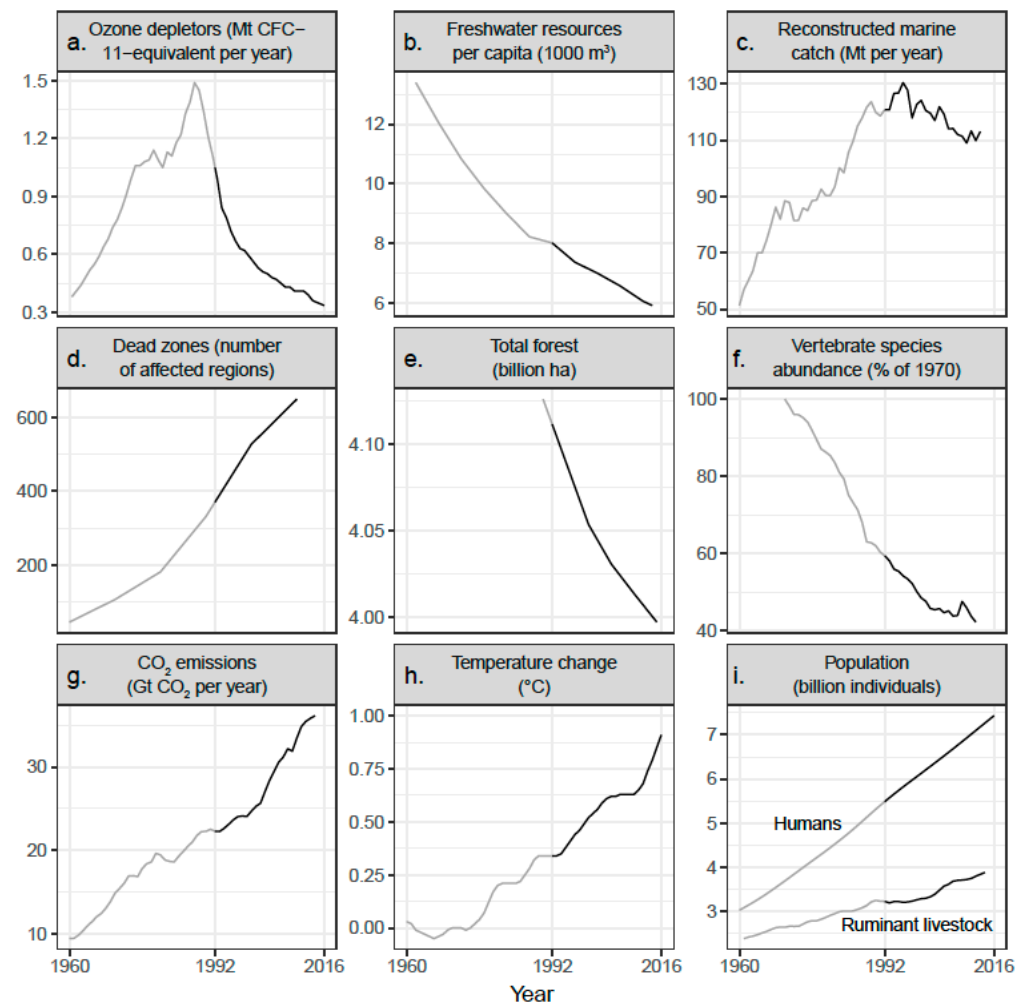


Figure 5. 2016 update of trends over time for environmental issues identified in the 1992 scientists' warning to humanity. Source: Ripple, W.J.; Wolf, C.; Newsome, T.M.; Galetti, M.; Alamgir, M.; Crist, E.; Mahmoud, M.I.; Laurance, W.F.; 15,364 scientist signatories from 184 countries. World Scientists' Warning to Humanity: A Second Notice, *BioScience* **2017**, *67*(12), 1026–1028. <https://doi.org/10.1093/biosci/bix125> Reprinted with permission from Ref. [4], 2023, Oxford University Press.

A “Scientific consensus on maintaining humanity’s life support systems in the 21st Century” made by world scientists in 2013 concluded that there is strong scientific evidence that humans are depleting the earth’s natural resources and harming life-supporting ecosystems [38].

The Consensus Statement groups human impacts into five key areas of concern:

- Climate disruption, driven mainly by extensive use of fossil fuels and the release of greenhouse gases. Food security is threatened by shortage of fresh water, extreme temperatures and storms, flooding, and drought.
- Extinctions—more rapid than since the dinosaurs went extinct.
- Massive loss of ecosystems—more than 40% of ice-free land has been transformed by human use.
- Pollution—increasing levels of environmental contaminants in the air, water (including marine litter and ocean acidification), and land are harming people and other living things. Air pollution alone contributes to six to seven million premature deaths annually [39].
- Human population growth and consumption patterns. Higher levels of unsustainable consumption are likely as world population increases, people emerge from poverty, and increasing numbers of people become middle class and wealthy. According to the Consensus Statement, humans now consume from 23% to 40% of all the net primary

productivity (NPP is a measure of the “natural energy” available to power the global biosphere) [38]. The more NPP that humans use, the less is available for other species.

The 2019 UN report Global Environmental Outlook (GEO-6) concluded that “unsustainable human activities globally have degraded the Earth’s ecosystems, endangering the ecological foundations of society” [40].

As GEO-6 noted, “Society-wide risks associated with environmental degradation and climate change effects are generally more profound for people in a disadvantaged situation, particularly women and children in developing countries”. The livelihoods of 70% of people living in poverty directly depend on natural resources. Environmental impacts may lead to economic stress and loss of livelihood, intolerable heat waves, and increased morbidity and mortality. Environmental degradation increases the potential for violent conflict, extensive human mass migration, and decreasing social resilience.

Also in 2019, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) released a *Global assessment report on biodiversity and ecosystem services* [41] which notes that, “While more food, energy and materials than ever before are now being supplied to people in most places, this is increasingly at the expense of nature’s ability to provide such contributions in the future . . . The biosphere, upon which humanity as a whole depends, is being altered to an unparalleled degree . . . Biodiversity . . . is declining faster than at any time in human history . . . The great expansion in the production of food, feed, fiber, and bioenergy has occurred at the cost of many other contributions of nature to quality of life, including regulation of air and water quality, climate regulation and habitat provision”.

The IPBES describes the rate of global change in nature during the past 50 years as unprecedented. The indirect drivers include the growth of human populations, production, and consumption patterns, trade, technological innovations, and governance. Over this time span, the human population doubled, the global economy increased nearly four-fold, and global trade grew 10-fold. The indirect drivers have increased demands for energy and materials and led to five direct drivers of biodiversity loss: changes in land use (clearing land for urban expansion and agriculture), direct exploitation of organisms (terrestrial and aquatic), climate change, pollution, and invasion of alien species.

3.5. Climate Change

According to GEO-6 and the Intergovernmental Panel on Climate Change (IPCC), human-driven greenhouse gas (GHG) emissions, primarily carbon dioxide (CO₂), nitrous oxide (N₂O), and methane (CH₄), will cause an extended period of climate change [40,42]. Among the likely effects are global warming of air and oceans; rising sea levels; melting of glaciers, permafrost, and Arctic Sea ice; changes in carbon and water cycles; food security crises; fresh water scarcity; ocean acidification and disruption of aquatic ecosystems; and more frequent and extreme weather events including storms, droughts, and heavy precipitation. Little time remains to prevent the hazardous and irreversible impacts of climate change.

GEO-6 concluded, “The cumulative scientific evidence is unequivocal: Climate change is a threat to human well-being and planetary health. Any further delay in concerted anticipatory global action on adaptation and mitigation will miss a brief and rapidly closing window of opportunity to secure a livable and sustainable future for all”.

According to the IPCC Assessment Reports (e.g., AR6), increasing GHG emissions are mainly driven by human activities. Their magnitude relates to population size, economic activity, lifestyle, energy use, land use patterns, transport, food production, technology, and climate policy [43,44]. Best-case emissions scenarios project that Earth will be hotter than modern humans have ever experienced by the year 2070, and possibly sooner [45,46]. A 2018 IPCC Special report estimated that a continuation of the current warming rate would cause human-induced global warming of 1.5 °C by about 2040 [47].

In 2021, AR6 provided five new illustrative emissions scenarios. Under all scenarios considered, global surface temperature will continue to increase until at least mid-

century [42]. Without deep reductions in GHG emissions, global warming of 2 °C higher than the average of 1850–1900 will be exceeded during the 21st century. In the very low GHG scenario, global surface temperature averaged over 2081–2100 is very likely to be 1.0 °C to 1.8 °C higher; in the intermediate scenario, 2.1 °C to 3.5 °C higher; and 3.3 °C to 5.7 °C higher in the very high GHG emissions scenario. It has been three million years since global surface temperature was sustained at or above 2.5 °C higher than the average of 1850–1900.

As is shown by the data from 2009 in Figure 6, fossil fuel retrieval and energy production are the greatest sources of greenhouse gas emissions [48]. Nearly as great are livestock production and agriculture which account for about 30% of global emissions. Emissions from agriculture have been increasing because of increased affluence and population growth that requires greater food production. Expansion of agricultural lands causes up to 80% of all deforestation, releasing the CO₂ stored in trees and soils. In addition, global economic growth has led to significant increases in global livestock production for consumption of meat, the source of about 18% of greenhouse gas emissions [49]. A more recent 2019 IPCC assessment concluded that the global food system is responsible for 21–37% of human-caused GHG emissions when pre- and post-production activities are included [50].

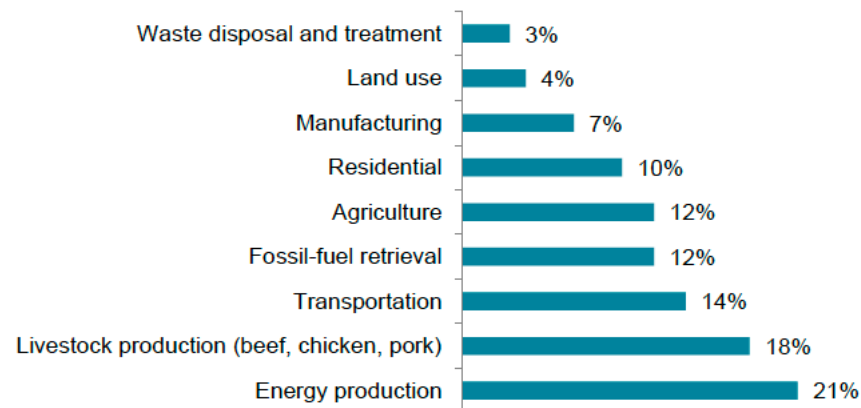


Figure 6. Greenhouse gas emissions, as a percentage of the total from each source. Source: Fiala, N. The greenhouse hamburger: producing beef for the table has a surprising environmental cost: it releases prodigious amounts of heat-trapping greenhouse gases. *Scientific American* 2009, 300(2), 72–75 [48].

3.6. Ecosystem Transformation

As of 2012, more than 36% of the earth’s land surface (41% of ice-free land) had been converted to farms, ranches, cities, suburbs, roads, mines, and other human uses [51]. This equates to around two acres (0.8 ha) per person. Land degradation hotspots and areas of desertification cover approximately 29% of global land, home to some 3.2 billion people. Around one third of forests and 40% of all wetlands have been lost since 1970. The quality of the areas remaining is impacted by people to varying extents.

According to the UN Food and Agriculture Organisation (FAO), “Forests provide habitat for 80 percent of amphibian species, 75 percent of bird species and 68 percent of mammal species, and tropical forests contain about 60 percent of all vascular plant species” [52]. Global forests still cover 31 percent of the Earth’s land surface (4 billion ha), but this is less than 68% of pre-industrial levels. About 22% of forests were lost between 1900 and 2000 [53,54]. Between 2000 and 2012, half of tropical deforestation occurred in Brazil and Indonesia, in large part driven by logging, cattle, soy, and oil palm production [55,56]. Although 9% (420 million ha) of the world’s forest was lost through deforestation between 1990 and 2020 (an average of 14 million ha per year), deforestation decreased to 10 million ha per year in 2015–2020 [52]. Forest losses are being partially offset by a combination of regrowth on abandoned agricultural land and the establishment of planted forests, but not with equivalent biodiversity. Even with a continued reduction in area, in 2011–2020, forests absorbed more carbon than they emitted [52].

Overfishing has decreased the availability of wild-caught fish, which will be increasingly impacted by ocean acidification, temperature increases, and pollution. More than 3.1 billion people rely on fish for 20% of their protein, yet 93% of global fisheries have been over-fished (33%) or fished to their biological limits (60%) [41,57]. The loss of half the world's mangroves and coral reefs has reduced the breeding grounds of many fish species that humans consume [58].

3.7. Pollution

In addition to greenhouse gases, traces of other human-produced environmental contaminants, including pesticides, industrial pollutants, and tiny fragments of plastics, are found everywhere on earth. Environmental pollution with pharmaceuticals, hormone-disruptors, and cancer-causing chemicals is widespread and ends up in the bodies of humans. At least 125 million people are now at direct risk from toxic wastes produced by mining, manufacturing, and recycling of electronic equipment [59]. As of 2010, smog and other forms of air pollution caused up to six million premature deaths per year [60]. Farm fertilizers, sewage plants, animal pens, and coal plants produce excess nitrogen that ends up in the oceans, where it stimulates algal growth, depletion of oxygen, and large dead zones.

Significant reductions in pollution from agriculture and manufacturing require better technology and better regulation and oversight of industries using and producing hazardous wastes. Air pollution and GHG emissions can be reduced by phasing out coal-fired power plants and high-emissions vehicles and by replacing most fossil fuel sources of energy with clean energy. Agricultural pollution can be minimized by efficient use of fertilizers, pesticides, and antibiotics. A challenge for industrial chemistry must be the development of a new generation of inherently safer materials [38,61].

3.8. Extinctions

Between 1970 and 2014, wildlife populations decreased by half and those of vertebrate species (mammals, birds, reptiles, amphibians, and fish), by on average 60% [39,62,63]. The proportion of insect species in decline is 41%, nearly twice that of vertebrates [64]. A global temperature increase of 1.5–2.5 °C (2.7–4.5 °F) would put an estimated 20–40% of assessed species at increased risk of extinction [65].

Losing the world's plants, animals, insects, fungi, and microbes imposes direct economic losses (at least 40% of the world's economy and 80% of the needs of the poor are derived from biological resources) and, regardless of their intrinsic value, lessens the effectiveness of nature to serve human needs [66].

Threatened ecosystem services include moderating and stabilizing weather; stabilizing water supplies; protecting agricultural soils; disposing of wastes; pollinating crops and wild plants; providing food; controlling spread of pathogens; and helping to reduce atmospheric greenhouse gases. Continuing extinction at the present pace would threaten food supplies and jobs, and considerably degrade the parks and wildlife that provide emotional and aesthetic enjoyment.

The principal sources of human-caused extinction are:

- Ecosystems transformed by environmental contamination and habitat destruction.
- Climate change. Projections suggest that by 2100, 12% to 39% of the planet will have climates never experienced by any species, and the climate that many species currently live in will disappear from 10% to 48% of Earth's surface [67]. In the oceans, acidification from absorption of atmospheric CO₂ disrupts growth and development of marine animals with shells such as clams and oysters, and causes collapse of physical reef infrastructure on which most marine species ultimately depend.
- Intensive exploitation of wild species for profit. Animals are being hunted to extinction to serve as pets (tropical birds), to make trophies and curios (elephant ivory), for purported health products (rhino horn, pangolin scales) or food (bluefin tuna).

Measures advocated to protect biodiversity include the economic valuation of natural capital and ecosystem services; protection of forests and other undisturbed areas from logging and conversion to agriculture, adoption and enforcement of national laws and international agreements to prevent illegal trafficking in timber and wildlife products; enhanced protection of species in oceanic and terrestrial reserves; development and implementation of effective policies to ensure sustainable fisheries; and the establishment of interconnected well-funded and well-managed reserves for a significant proportion of the world's terrestrial, marine, fresh water, and aerial habitats [38].

The targets adopted in the UN Convention on Biodiversity (CBD) *2011–2020 Strategic Plan for Biodiversity* (referred to as the Aichi targets) were criticized for adopting indicators that did not adequately draw attention to and measure all of the drivers of the biodiversity crisis [68]. Particularly neglected was human population growth, despite being named as a fundamental driver. Indicators were also lacking for several threats connected with population growth, including residential and commercial development, energy production and mining, transport corridors, and human intrusion and disturbance. The 2022 UN Biodiversity Conference (COP15 of the CBD) adopted the Kunming–Montreal Global Biodiversity Framework (GBF), superseding the Aichi targets. The plan includes putting 30 per cent of the planet and 30 per cent of degraded ecosystems under protection by 2030, while protecting indigenous rights [69]. However, it is no less neglectful than the Aichi targets of human population expansion as a driver of biodiversity loss.

3.9. Population Growth and Resource Limits

Population growth exacerbates all of the above impacts. According to GEO-6, population pressure, economic development, and climate change are the primary drivers of environmental change [38]. Most countries, both rich and poor, have production and consumption patterns that exceed their territorial biocapacity [70]. The need to feed, house, and provide an acceptably high standard of living for the eight billion people that are now on the planet plus the billions yet to be added, conflicts with the need to avoid increased consumption of resources and concomitant degradation of the environment.

The environmental impact of humanity is often summarized by the “IPAT” equation: I [impact] = P [population size] \times A [affluence/consumption] \times T [technology] [71]. However, sustainable limits to resource use and pollutants cannot be aggregated in this way: the law of the minimum teaches us that a deficit in only one essential factor will limit growth, and cannot be compensated by excesses of others. Once the sustainable level is exceeded, environmental degradation grows even more rapidly than in direct proportion to population size (assuming constant per capita consumption and modes of production) because of deleterious feedbacks [72].

Another way of quantifying each human's use of resources and environmental impact is to calculate their ‘ecological footprint’ [73]. While this measure suffers from the same problem of aggregating non-substitutable factors, it serves to emphasise the wide disparity in the ecological footprint between rich and poor. This disparity is largely due to the use of fossil fuels, consumption of meat, and impacts of mining. Other environmental impacts, from wild species harvesting and deforestation to nutrient run-off and plastic pollution, are less related to wealth.

Whether rich or poor, a person's environmental legacy is amplified by the number of descendants they produce. One estimate for a person living in the U.S. is that the summed carbon emissions of the person's genetic share of each child and their descendants would eventually exceed five times their own lifetime emissions [74]. Not only carbon emissions, but all environmental impacts would be multiplied by a similar factor, if current behaviours continued into the future. This estimate assumed U.S. fertility remained below the ‘replacement’ level (around 2.1 children per woman) so each parent's genetic contribution to future generations gradually dwindled. Where the fertility of each child is assumed to be above replacement, impacts further magnify in each generation. Due to high fertility, the average

person in Niger in 1950 has a legacy of ten people alive today, and potentially 66 people by 2100 according to the UN's projection.

Fresh water is an example of a limited resource with no substitute. Worldwide, agriculture uses an average of 70% of all fresh water withdrawals [75]. Over 1.7 billion people are directly threatened by groundwater depletion [76]. More broadly, depletion of aquifers in the world's top grain-supplying countries—China, India, and the U.S.—threatens the sufficiency of the entire global food system. In some Indian states, water tables have fallen by at least 1 m (3.3 feet) each year, putting nearly one quarter of the nation's food crop at risk [77]. Increasing glacial and snowpack melt as a result of global warming will affect regional and seasonal water availability, especially in Asian and Latin American rivers, which provide water for some 20% of the global population. By 2025, due mainly to population growth, three out of four people worldwide will face some degree of water scarcity [78].

We are jeopardizing our future by not moderating material consumption and by not acting to attenuate continued rapid population growth as a primary driver behind many ecological and even societal threats [79].

4. Meeting the Challenge of Advancing the Welfare of People and the Planet with a Common Agenda for Reproductive Justice, Population, and the Environment

Clearly, the problems documented in the above sections of this report are daunting, but fortunately there is much within the scope of existing knowledge, technology, and availability of resources that can be done to address them.

4.1. Adaptation to Climate Change

So far, most adaptation to climate change addresses flooding and other water-related risks. Less intensive adaptation relating to food systems, energy system transformation, and natural forests is also underway. However, despite the acknowledged impacts of population growth on the vulnerability of communities to climate change, measures to reduce population growth have not been included in the climate adaptation agenda. A 2010 review of national adaptation programs of action (NAPAs) submitted to the United Nations Framework Convention on Climate Change (UNFCCC) by Least Developed Countries (LDC) found that, among the 41 NAPAs submitted, 37 highlighted population growth and density as factors increasing vulnerability. However, only two proposed projects included a population component, and none were funded [80]. More recently, under the Paris Agreement, all nations were requested to submit their climate change plans as Nationally Determined Contributions (NDCs). In a 2022 review of 164 NDCs, one third link population growth to negative trends but none propose implementing measures to slow population growth [81].

4.2. Mitigation of Climate Change

Avoiding the worst impacts of human-caused climate change will require rapidly reducing emissions of greenhouse gases until they are below the rate of carbon sequestration (negative net emissions) [82]. In modelled pathways that limit warming to 1.5 °C (>50% probability and with no or limited overshoot), global net zero CO₂ emissions are reached in the early 2050s, and around the early 2070s in modelled pathways that limit warming to 2 °C (>67% probability). Many of these pathways continue to net negative CO₂ emissions by deploying carbon dioxide removal (CDR) methods to counterbalance residual GHG emissions [83] (p. 23). Without a strengthening of policies beyond those that are implemented by the end of 2020, GHG emissions are projected to continue rising for some time, leading to a median global warming of 3.2 (2.2 to 3.5) °C by 2100 [83] (p. 17).

In 2022, the IPCC's Sixth Assessment Report (AR6) assessed the scientific, technological, environmental, economic, and social aspects of mitigation of climate change. The IPCC considers below 2 °C warming to be possible through intensified innovation and scale-up of carbon-neutral energy production (solar, wind, hydro, geothermal, hydrogen fuel-cells, possibly nuclear, microbe-based biofuels), increased efficiency in energy use (e.g., more

energy-efficient vehicles and buildings) and carbon capture and storage (CCS) from major emitters such as cement and steel plants.

The report calls for climate change mitigation action in the context of sustainable development, equity, and poverty eradication [83]. Emissions-free development is a huge challenge, since more than half of emissions growth since 1992 has come from increasing consumption in emerging economies, many of which still have a long way to go to reach 'developed' status. The rest of the increase has come from population growth, mainly from demographic momentum in middle-income countries (most of which now have below-replacement or near-replacement fertility) but also from net immigration to high-income countries, where the impact of each added person is greatest [84]. These estimates use only the 'energy and process' emissions, to which low-income countries barely contribute. However, their rapidly growing populations constitute a large call on the future emissions budget if poverty eradication is to be achieved. Low-income countries nevertheless contribute CO₂ from land clearing and soil carbon loss, methane from livestock and rice paddies, and black carbon from biomass burning, all sources commonly omitted from international comparisons due to incomplete data.

AR6 noted that historical cumulative net CO₂ emissions between 1850 and 2019 amount to about four fifths of the total carbon budget for a 50% probability of limiting global warming to 1.5 °C, or about two thirds of the total carbon budget for a 67% probability to limit global warming to 2 °C [83] (p. 6).

Projected cumulative future CO₂ emissions over the lifetime of existing and currently planned fossil fuel infrastructure are approximately equal to the total budget for 2 °C [83] (p. 16). Any new fossil fuel mining projects exceed this budget. If existing facilities are not retired early, additional carbon sequestration is needed to offset all non-fossil fuel emissions. Unfortunately, as of 2019, construction of more than 1000 coal-fired power plants is planned or being built. It is unlikely energy decarbonisation will reach a sufficient pace until the trillion-dollar subsidies to fossil fuels are phased out by national governments [85].

In modelled pathways that reach global net zero GHG emissions, around 74% of emissions reductions are achieved by CO₂ reductions in energy supply and demand, 13% by CO₂ mitigation in the Agriculture, Forestry, and Other Land Use (AFOLU) sector, and 13% through the reduction of non-CO₂ emissions [83] (p. 25). However, these scenarios incorporate assumptions about global population growth that are much lower than the UN's projections. Climate models use a set of "shared socioeconomic pathways" (SSPs) that incorporate assumptions about population and development patterns [86], with the 'standard run' (SSP2) well below current population trends [87]. A comparison of mitigation scenarios across numerous models found that limiting warming below 2 °C was infeasible using SSP3 [88], the only SSP scenario framework with global population within the UN's 90% probability range. The reason for infeasibility was the need to expand agriculture to feed the larger population, making further decline in forested areas inevitable.

The global food system generates more than 25% of greenhouse gas emissions [89]. Current trends in yield improvement will not be sufficient to meet rising food demand, generating pressure to expand agricultural areas and further displacing natural habitats [90]. To stem agriculture's impacts on the climate and biodiversity, food demand must be reduced [91]. Reducing meat consumption and food waste are needed alongside more efficient use of water, energy, and fertilizers [92]. However, even highly ambitious targets for food system efficiency gains will be insufficient if the global population exceeds 10 billion [92].

The IPCC's overview of mitigation measures in Figure 7 does not present important mitigation options that relate to limiting population growth and adopting more modest lifestyles. It exemplifies the techno-optimist view that current economic development patterns can continue in a decarbonised world. This view is increasingly challenged as unrealistic [93].

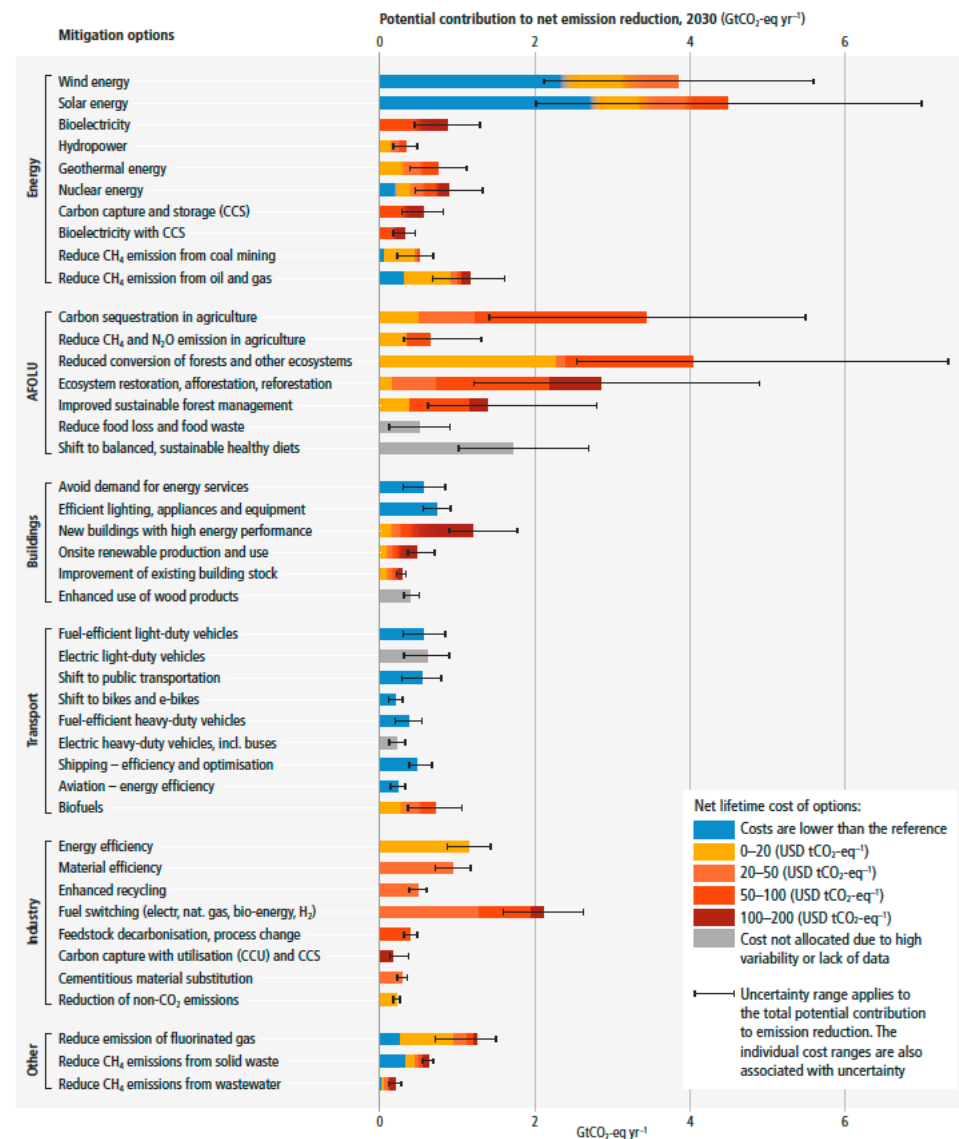


Figure 7. Overview of mitigation options and their estimated ranges of costs and potentials in 2030. Source: IPCC, Summary for Policymakers. In *Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, Shukla, P.R., Skea, J., Slade, R., Al Khouradajie, A., van Diemen, R., McCollum, D., Pathak, M., Some, S., Vyas, P., Fradera, R., Belkacemi, M., Hasija, A., Lisboa, G., Luz, S., Malley, J., Eds., Cambridge University Press: Cambridge, UK and New York, NY, USA, 2022 [83].

4.3. Needed Action on Reproductive Justice, Family Planning, and Population

When women (and men) experience the benefits of reproductive justice, especially education, empowerment, and access to affordable, fully voluntary family planning and abortion services, they tend to make decisions about fertility that benefit their families, communities, and nations.

Reproductive justice ensures that women are free to choose the number and timing of childbearing. Some women will have large families, others will choose to remain childless, but the experience of many countries suggests that where contraception services are provided and promoted, average family size markedly declines.

Many low-income countries saw rapid fertility decline resulting from voluntary family planning programs, even where low education levels dominated [94,95]. When India's national fertility fell below 2.1 in 2020, it tipped the proportion of people in countries with below-replacement fertility from one half to two thirds. However, high fertility in the

remaining third of the global population requires an urgent increase in investment in family planning and reproductive health services. In addition to most of Africa and most Pacific Island states, the following countries have high birth rates. In Central America and the Caribbean: Belize, Guatemala, Honduras, Panama, and Haiti; in South America: Bolivia, Ecuador, Paraguay, and Peru; in Asia: Mongolia, Philippines, Cambodia, and Laos; and in the Middle East: Iraq, Afghanistan, Syria, Palestine, Yemen, Tajikistan, and Pakistan.

Low fertility is advantageous for individuals, families, nations, and the environment. Family planning enables individuals and couples to plan and manage their sexual and reproductive lives. It fosters gender equality by empowering women and freeing them to pursue education, employment and other life opportunities [96]. Contraception prevents unintended, often high-risk pregnancies—such as those among adolescent women. Spacing births by two years or longer is associated with a 30% reduction in maternal deaths and a 10% decrease in newborn and infant mortality [97,98]. In addition to the health and social benefits of preventing unintended pregnancies, contraception contributes to a pleasurable and anxiety-free sexual life [99].

Strong family planning programs in Thailand, South Korea, Indonesia, Taiwan, and Singapore brought about rapid declines in average family size. This allowed household budgets to go further, achieving better nutrition and education of children, and greater investment in enterprises [31]. Nationally, it reduced the dependency ratio—the number of workers in the labor force compared to children, youth, and elderly who are not as economically productive. Fewer nonworking dependents resulted in a *demographic dividend* that, together with sound economic policies, is believed to have contributed to the *Asian economic miracle* in these countries [100].

In 2015, over a quarter of the world's population earned less than the international poverty line of USD 3.30 per day. Nearly half of the world lived on less than USD 5.50 per day [2]. Family planning is doubtless insufficient, but it is necessary to reduce poverty: *With the exception of a few oil-rich nations, no country has lifted itself out of poverty without first reducing its fertility rate* [31].

As shown in Figure 8, female secondary school enrollment is strongly correlated with fertility rates [101]. However, the provision of high-quality family planning services, as occurred in Thailand, virtually eliminated the difference in adoption of family planning between those with little education and those who were better educated. Potts and Marsh have observed that, “Education reduces family size because more educated women are better able to surmount the many barriers separating them from the information and technologies they need to manage their childbearing. When these barriers are removed, then differences in fertility between illiterate and educated women largely disappear” [102].

The UN Educational, Scientific, and Cultural Organisation (UNESCO) estimates that the cost of achieving universal pre-primary, primary, and secondary education in LMICs is projected to increase from USD 149 billion annually in 2012 to USD 340 billion annually, between 2015 and 2030 [103]. The projected increases reflect a combination of greater numbers of students and higher per-student expenditure to improve quality. One of the benefits that countries with strong family planning programs have enjoyed is improved quality of education as the challenges of rapidly expanding school capacity eased [31].

According to the Guttmacher Institute, by satisfying the unmet need for modern contraception in developing countries, the currently high numbers of unintended pregnancies, unplanned births, and abortions would drop by almost three fourths [104]. This in turn will slow population growth, foster economic development, and reduce the pressure of a burgeoning human population on the environment.

Counting only its benefit for carbon emissions reduction, studies have concluded that decreased population growth through investment in family planning and female education would cost less per tonne of carbon abatement than all options for low-carbon energy such as solar and wind [105]. In 2010, O'Neil estimated that reaching what was then the UN's lower-fertility scenario could contribute 16% to 29% of the reduction in greenhouse gas

emissions needed by 2050 and 37–41% of that needed by 2100, to avoid global warming of 2 °C [106].

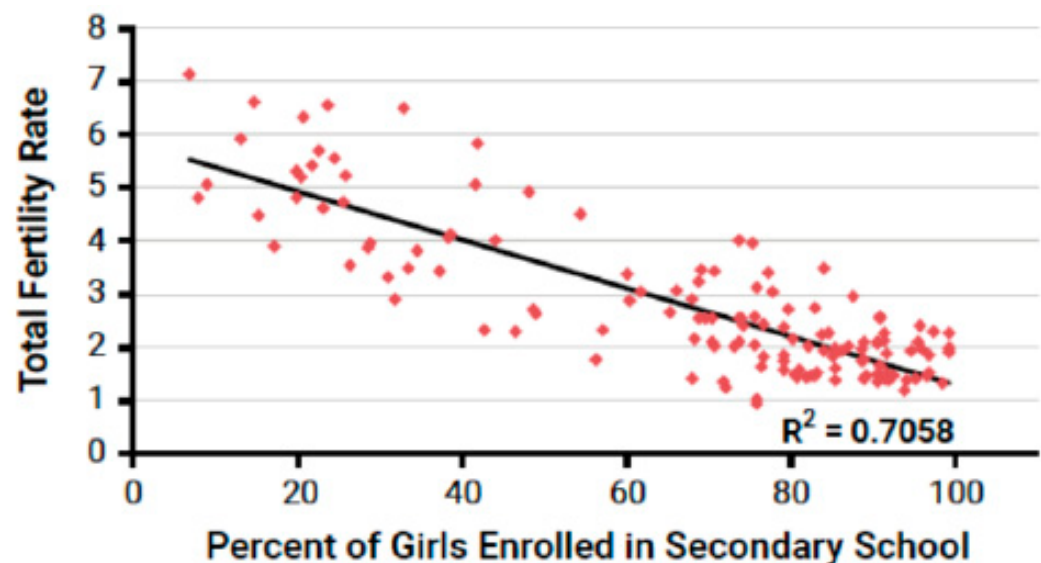


Figure 8. Correlation between secondary school enrolment and TFR (2009 data). Source: Reading BF. Education Leads to Lower Fertility and Increased Prosperity. Earth Policy Institute. 12 May 2011. <https://www.earth-policy.org/mobile/releases/highlights13> (accessed on 1 May 2023) [101].

4.4. The Characteristics of Successful Family Planning Programs

Voluntary family planning programs require appropriate *policies*, potential users of family planning must be *motivated* to limit fertility, and accessible and affordable contraceptive and abortion *services* must be available. In general, access to family planning is better in wealthy countries than in the developing world but often abortion care is limited in both rich and poor countries.

Surveys in developing countries show that most women want to limit childbearing. The Guttmacher Institute estimates that, as of 2019, of the 1.64 billion women of reproductive age (15–49) who live in LMICs, 923 million wanted to avoid a pregnancy. Of these women, 705 million had access to and were using modern contraceptives and an estimated 218 million women (24%) had an unmet need for modern contraception [104].

Of an estimated 228 million pregnancies in 2019 in LMICs, 111 million (49%) were unintended (occurring too soon or not wanted). About three quarters (77%) of the unintended pregnancies occurred among women who for various reasons were not using effective modern contraception.

However, these same surveys suggest that a sizable number of women desire large numbers of children and others avoid family planning for reasons such as fears about the safety and side effects of contraceptives or fatalism about childbearing [107]. Although declining, cultural pressure for large families, based on traditional gender roles, and opposition from spouses and other family members is still widespread in some countries [108]. Research has found that more schooling, higher survival of children, and higher incomes are associated with lower desired family size, but the relationship is tempered by social norms, and causation runs in both directions: lower fertility enables more schooling, higher child survival, and better incomes. Family planning programs can play a crucial role in reducing desired family size and shifting social norms around women's roles and rights [109].

Well managed family planning programs provide women with information about birth control methods, how to obtain them, and the health and other advantages of small families. This information increases the social acceptability of birth control and counters unfounded rumors and negative perceptions of contraceptive methods. Their messages, especially on radio and television, have a substantial impact on fertility preferences and increase demand for family planning [110].

It is not necessary to wait for progress in improving social and economic development to reduce preferences for large families [109]. However, as John Bongaarts has pointed out, family planning programs must go beyond simply providing supplies and services; they must also help reduce or eliminate other social and cultural obstacles [30].

Robert Engelman cites the example of Tunisia as evidence that social change together with access to contraception and abortion are crucial to the acceptance of family planning and lower fertility. He notes that in 1957, Tunisia's first president, Habib Bourguiba, "... guaranteed women full citizenship rights, including the right to vote and to remove the veil. He pledged universal primary school attendance for girls as well as boys, banned polygamy, raised minimum marriage ages and granted women the right to divorce. He legalized contraception and then subsidized abortions for women with large families. By the mid-1960s mobile family-planning clinics were offering oral contraceptives throughout the country". By the early 2000s, Tunisian fertility had declined from seven children to two. Engelman notes that, "... women who can raise their sights high and manage their own lives also decide—and manage—to have fewer children and to have them later in life" [111].

Organised family planning programs have been responsible for much of the fertility decline in both developed and developing countries. *Significant fertility decline has not been observed in a poor and largely illiterate country in the absence of a strong family planning program* [112].

The experience of many countries has taught us the keys to effective family planning programs [98]:

- High-level political commitment, especially from national governments.
- Broad support from leadership groups such as religious leaders.
- Smaller families and modern contraception legitimized by mass media, e.g., through serial dramas (soap operas).
- Availability of a broad choice of contraceptive methods including sterilization and long-acting reversible contraceptive (LARC) methods, the intrauterine devices (IUD) and implant.
- Woman-centered counseling, information, and services from a variety of convenient sources, e.g., medical facilities, social marketing, and outreach services through field workers.
- Access to safe abortion care.
- Adequate funding to ensure contraceptive and abortion availability at an affordable cost.

An analysis of Demographic and Health Surveys in 52 countries found that among married women who wanted to avoid a pregnancy, the most common reason for not using contraception was concern about contraceptive side effects and health risks [113]. A multi-country survey found that 25% to 50% of women had stopped using a contraceptive because they experienced or feared side effects and adverse health consequences from their use [114]. Further research to improve contraceptive technology and service delivery is needed.

Considerable deficits also exist in the delivery of wider reproductive health services, including avoidance and treatment of sexually transmitted diseases, and neonatal care for mothers and infants. According to the Guttmacher Institute, of the 127 million women who gave birth in 2019 in LMICs, 35 million did not deliver in a health facility [104]. The disparities in use of maternal and newborn health care across regions are substantial. The proportion of women delivering in a health facility was lowest (59%) in low-income countries and highest (97%) in upper-middle-income countries. An estimated 299,000 women died annually from pregnancy-related causes, and 2.5 million babies died in the first month of life. Most of these deaths could have been prevented with full access to contraceptive, maternal, and newborn health care.

4.5. Access to Abortion Services Is Essential to the Success of Family Planning

Although contraception reduces the need for abortion, contraception is not always available, it may not be used, or it may fail. Methods such as oral contraceptives are

highly effective when used perfectly, but frequently fail under typical conditions of use. To achieve their fertility goals and avoid the social and economic burdens caused by an unintended pregnancy, worldwide each year millions of women with unintended pregnancies turn to abortion regardless of its legal status [115]. Medically supervised abortion causes few complications and only rarely causes fatalities—it is about ten times safer than childbirth [116,117]. Countries where abortion access is legally restricted tend to have more abortions, not fewer, than those where abortion is broadly legal [26].

The Guttmacher study estimated that of the 111 million unintended pregnancies in 2019 in LMICs, 69 million were aborted and there were 30 million unplanned births [104]. If women's contraceptive needs were fully met in LMICs, annually there would be:

- A 62% decline in safe abortions, from 33 million to 13 million;
- A 72% decline in unsafe abortions, from 35 million to 10 million;
- A 74% decline in the number of women needing medical care for complications from unsafe abortion, from 20 million to five million;
- A 78% decline in maternal deaths due to unsafe abortion, from 23,000 to 5000;
- A 70% decline in unplanned births from 30 million to 9 million;
- A 46% decline in the cost of abortion-related care from USD 2.8 billion to USD 1.5 billion.

Demographers Christopher Tietze and John Bongaarts documented that it is unlikely that any population ever attained low fertility ($TFR \leq 2.2$) without abortion, legal or illegal [118]. As Malcolm Potts has noted: “All societies with unconstrained access to fertility regulation, including abortion, experience a rapid decline to replacement levels of fertility, and often lower” [119]. Safe abortion should be an integral part of the services provided by family planning programs [120].

4.6. Cost and Benefit of Contraceptive and Reproductive Health Services

The Guttmacher Institute estimates that increasing annual expenditures from the USD 7.1 billion spent in 2019 to USD 12.6 billion would satisfy all unmet need for modern contraception in LMICs. This equates to spending from an average of USD 1.10 to USD 1.94 per capita (USD 10.10 to USD 13.64 per contraceptive user) [104]. It would increase the number of contraceptive users from 705 million to 923 million and decrease unintended pregnancies from 111 million to 35 million per year and unplanned births from 30 million to nine million per year. It would lower induced abortions from 69 million to 23 million per year and would result in an estimated 70,000 fewer maternal deaths each year.

In addition, meeting the World Health Organisation-recommended level of care for pregnant women and newborn health care would require increasing expenditures for these services from the current USD 30.3 billion in 2019 to USD 70.2 billion [104]. This would reduce maternal deaths by 51%, from 299,000 to 148,000 per year, assuming no change in contraceptive use or in the number of unintended pregnancies. Newborn deaths would drop by 69%, from 2.5 million to 755,000.

However, significant synergies exist when combining investments in family planning and neonatal care. Fully meeting the needs for both modern contraception and maternal and newborn care would require increasing expenditures from USD 37.4 billion to USD 66.6 billion, less than the amount required for maternal and newborn care alone, due to savings on care related to unintended pregnancies. By jointly investing in contraceptive, pregnancy-related and newborn care, 186,000 maternal deaths would be averted. This represents a decline of 62% (from 299,000 to 113,000 per year) [104].

Every additional USD 1 spent on contraceptive services saves an average of USD 3 in the cost of maternal, newborn, and abortion care because of a reduction in unintended pregnancies [104]. Furthermore, because smaller families improve household finances and children's educational and employment opportunities while easing resource and infrastructure constraints, all boosting national economic development, the return on this initial investment magnifies over time. Hans-Peter Kohler and Jere R. Behrman estimate

that an annual investment of USD 3.6 billion to address the unmet need for family planning in developing countries would provide annual benefits of USD 326–USD 470 billion [121].

5. Business as Usual Is Not an Option for Sustainable Development—A New Green Economy Is Needed

Sustaining the quality of life that exists in wealthy countries while improving living standards in developing countries and at the same time adding billions of people to the planet is a formidable challenge. At a minimum, it requires greatly reducing the per-capita human footprint in wealthy countries and not increasing it excessively in developing countries, while shifting energy, industrial, and food systems to sustainable technologies [122]. Neither developed countries nor the developing world can continue the current unsustainable path of economic progress based upon ever-expanding growth and consumption. We need to evolve a new economy and culture that preserves and restores natural systems [123].

Surely people deserve to emerge from poverty, but so far when they have done so, their consumption and environmental impacts have increased. Since five times as many people live in developing countries as in developed countries, as they emerge from poverty, it is essential to avoid the possibility of catastrophic environmental degradation.

5.1. *The Indispensable Role of Population Minimisation*

Minimising further growth in the human population and accelerating its decline toward a sustainable population, can greatly assist in meeting the challenge of equitable development within planetary boundaries for resource use and environmental impacts. However, few studies exploring pathways to sustainable resource use consider ways to lessen population growth. Often, the role of population is dismissed because it is considered less important than consumption by the world's rich. This argument neglects the reality that this environmental crisis requires us to use all the tools at our disposal. Ignoring one, such as birth reduction measures, could make the difference between success and failure. Eileen Crist and coauthors urge advocates and policymakers to “move beyond the prevailing dichotomy of whether it is excessive consumption or unsustainable population that fundamentally underlies humanity's impact” [79]. They note that, “Humanity is using Earth excessively both as source (for land cultivation and grazing, fresh water, wild fish, bushmeat, fossil fuels, wood products, and so on) and as sink (for non-absorbable wastes such as trash, nitrogen, pesticides, confined livestock manure, plastic, and industrial chemicals). Stabilizing and lowering our numbers globally—non-coercively, through the exercise of reproductive rights—is a strategy for scaling down consumption on all fronts”.

Crist et al. point out that, “International developments further contradict binary arguments of excessive consumption as a developed-world problem and population concerns as a developing-world issue. A crisp dichotomy between the global North and the global South is becoming outmoded by the growth of a global consumer class, which has increased by hundreds of millions of people in the past two decades and will grow by billions in the decades ahead. A global middle class of 3.2 billion people in 2016 is expected to rise to roughly 5 billion by 2030”.

They go on to observe, “As the middle class in Africa, Asia, and Latin America continues to grow—an equitable expectation and policy orientation—the stress added to that of the developed world on the biosphere will become extreme. As the global middle class grows, the world is converging in the direction of increased consumption. Rising meat consumption, increasing purchases of processed and packaged foods, more international travel, and burgeoning numbers of automobiles, personal computers, and electronic devices are only a few areas in which the impacts from consumer demand for food, energy, materials, and infrastructure are poised to escalate. The global consumer society emerging in our time invites recognition that stabilizing and eventually reducing the global population is crucial for lowering total consumption”.

As GEO-6 noted, “Unequal access to education, and lack of empowerment of women, as well as their lack of access to sexual and reproductive health services, all contribute to high birth rates. Without changes in production and consumption patterns, population growth will continue to increase environmental pressures” [39].

5.2. *The Key Elements of a Common Agenda Support the UN 2030 Agenda for Sustainable Development Goals (SDGs)*

The UN’s Agenda 2030 for Sustainable Development Goals (SDGs) includes reproductive health, including access to contraceptive services and information, under Goal 3: *Ensure healthy lives and promote well-being for all at all ages*, and reproductive rights under Goal 5, *Achieve gender equality and empower all women and girls* [10]. However, as former head of the UN Population Division, Joseph Chamie observes, it does not address population growth. Chamie observes, “Certainly lowering high rates of population growth to manageable levels is not a panacea ensuring sustainable development for the least developed countries. However, reducing rapid rates of population growth would contribute substantially to the developmental efforts of those countries by making national goals easier and less costly to achieve . . . There is not a single issue among the sustainable development goals—including poverty, hunger, housing, education, employment, health, gender equality, human rights and environment—that would not benefit from reducing high rates of population growth” [124].

Overall, the world is not on track to achieve the SDGs [125]. Neglect of population stabilization is only one contributing factor. The SDGs have elsewhere been criticized for their adherence to “sustained economic growth” as a panacea [126,127] and for not challenging the political structures that entrench poverty and suppress environmental agenda [128]. The failure is indicative of the interconnectedness of environmental and social pressures, generating cascading crises [129]. For example, the IPBES notes that the current negative trends in biodiversity and ecosystems will undermine progress towards 35 out of 44 targets of goals related to poverty, hunger, health, water, cities, climate, oceans, and land [41]. Such interdependencies require an integrated approach under a common agenda, and cannot succeed when a major driver such as population growth is neglected.

As Ellen Starbird and coauthors observe, “Voluntary family planning brings transformational benefits to women, families, communities, and countries. Investing in family planning is a development “best buy” that can accelerate achievement across the five Sustainable Development Goal themes of People, Planet, Prosperity, Peace, and Partnership” [96].

5.3. *Green Shoots of an Integrated Agenda*

In the past two decades, some environmental and reproductive health organisations have embraced the *Population, Health, and Environment* (PHE) model for development interventions. PHE projects emphasise multisector, community-driven approaches to integrate natural resource management with livelihood diversification, gender equity, health and hygiene, and family planning [130]. Relating family size to environmental limits has proven compelling in increasing men’s support for family planning [131]. PHE projects also tend to build male support for women’s roles in livelihood enterprises and natural resource management, and greater gender equity in household decisions [132].

PHE projects have been more successful than single-sector interventions at achieving behavioural change, including strengthening social participation, raising awareness of environmental change and conservation measures, improved hygiene and health management, income diversification, and reducing child marriage, female genital mutilation, and violence against women, as well as the effects of fewer, more widely spaced births on women’s health and children’s nutrition, and lessening demands on natural resources [133–135]. As Tianna Scozzaro and coworkers explain, PHE programs address many of the SDGs simultaneously, and provide many lessons for other sectoral interventions [136]. They argue, “We need to step out of sectoral comfort zones and learn from the experience of PHE in integrated design and implementation. If done right, we can reap great benefits for

human, ecosystem, and planetary wellbeing". However, these projects have depended on short-term donor funding, and rely on building relationships with existing community and sectoral organisations, creating challenges for scaling up [137].

In September 2021, the International Union for the Conservation of Nature and Natural Resources (IUCN) passed a resolution titled *Importance for the conservation of nature of removing barriers to rights-based voluntary family planning* [138]. The motion urges member organisations, which include governments, environmental NGOs, and indigenous organisations, to "consider internal training and awareness programs on how improved reproductive health benefits women's and girls' health and empowerment, reduces pressures on ecosystems and ecosystem services, and enhances sustainable development, and how such issues can be included in project planning" and "to encourage the implementation of PHE programs and to ensure integrated funding streams and multi-sector collaboration". The motion created a *Biodiversity & Family Planning Task Force* to assist the IUCN to develop guidance on how and why removing barriers to rights-based voluntary family planning can strengthen conservation outcomes in addition to promoting the health, well-being and empowerment of women and girls". This landmark initiative was spearheaded by the Margaret Pyke Trust, a family planning training and advocacy organisation whose skillful diplomacy within the environmental movement has managed to avoid the hostility commonly aroused against any discussion of "population" and build broad acknowledgement of the connections between reproductive and environmental health. We hope this initiative leads to greater cross-sectoral programming and sets a standard that others will follow.

6. Conclusions

Addressing the problems described in this report will require recognition of their urgency by people and governments at all levels and in all countries. The science supporting the need for comprehensive and transformative action is clear, and technological expertise is available to mitigate many of the harms that are now occurring, but it remains up to society to summon the needed political will to take the needed actions. With each passing year of inaction, the problems not only become worse, but they also become more expensive and difficult to solve, and the chances of avoiding the worst outcomes diminish [139].

However, the work of environmental advocates and architects of the climate change response is hampered by their neglect of measures that would minimise global population growth. This neglect is often founded on the misconception that programs directly addressing birth rates contravene human rights, and that measures that indirectly affect fertility, including education and poverty reduction, are sufficiently effective. Unfortunately, reliance on indirect means over the past three decades has not only slowed fertility decline [140], but has hampered reproductive justice and deepened poverty in high-fertility countries [98,124].

More than 80 countries have reached fertility levels that are below replacement. Among almost all the low-income countries in this group, this has been made possible by voluntary, non-coercive family planning programs that are consistent with the principles of reproductive justice. Many achieved low fertility despite high levels of poverty and illiteracy, but none have done so without a strong family planning program [112].

An integrated agenda on environmental remediation and reproductive justice aligns social and environmental imperatives synergistically. As Newman and coworkers observed, "the challenge is to ensure that the agenda is built in ways that include sexual and reproductive health and rights, and gender and empowerment issues" [22]. We should recognize that concern about population growth is not about blame-shifting or controlling the poor, but exactly the opposite, fulfilling the goals of reproductive justice, supporting equity, human rights, and sustainable development [79,141]. Attaining a global population trajectory similar to the UN's low projection (or the IPCC's SSP1 pathway), peaking around nine billion, is possible through extension of the benefits of reproductive justice to all communities in all countries. It is very unlikely without increased funding and commitment to family-planning service provision and addressing cultural barriers to fertility regula-

tion [31,95]. It is less likely if low-fertility countries continue to promote higher birth rates to combat population ageing instead of embracing the benefits of population decline [142].

The International Renewable Energy Agency has called for outlays of USD 120 trillion between 2015 and 2050 to combat climate change [143]. The worldwide costs of climate adaptation are likely to be between USD 280 billion and USD 500 billion per year by 2050 [144]. Within this budget, the extra USD 6 billion per year needed to meet unmet needs for contraception services in LMICs represents a ‘best buy’, increasing the effectiveness of all other efforts for climate change mitigation and adaptation, poverty reduction, food security, and ecosystem protection.

The chance of achieving the needed policies and programs, and avoiding counterproductive actions to boost population growth, would be enhanced if people and organisations working for environmental protection, climate mitigation, and human development acknowledged the significance of population growth and the vital contribution of reproductive justice in their advocacy, and integrated reproductive health and family planning, wherever it is needed, in their field programs. This is the common agenda we need.

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