Vienna Yearbook of Population Research 2024 (Vol. 22), pp. 1–7
https://doi.org/10.1553/p-624f-7c9a

DEBATE

Understanding the complex relationship between population and climate change mitigation

Nyovani J. Madise[1], Naa Dodua Dodoo[1], John A. Mushomi[1], and Chifuniro S. Mankhwala[1]

ABSTRACT The world is currently facing a climate crisis with associated health and planetary consequences, and human activity is central to this crisis. Debates on the relationship between population and climate change provide a mixed picture, ranging from demonstrating a clear link between large populous countries and greenhouse gas emissions to pointing to spurious associations between population growth and climate change. We submit that as the interaction between population dynamics and climate change is complex, a nuanced approach to climate mitigation and adaptation strategies is needed. Finding a solution to the climate crisis requires a concerted effort by all nations, whether rich or poor. While there is an urgent need for more industrialized nations to reduce their greenhouse gas (GHG) emissions, poorer countries with fast-growing populations must do their part in climate mitigation even as they pursue economic development. Addressing intertwined issues of population growth, economic development and climate change necessitates purposeful measures and long-term commitments to a world in harmony with nature.

KEYWORDS Population growth • Climate mitigation • Greenhouse gases emissions

Introduction

According to the United Nations Climate Change (UNCC), the world is facing the triple planetary crisis of climate change, loss of biodiversity and waste and pollution (UNFCCC, 2022). Land degradation is another major global problem, affecting over 40% of the world's land (UNEP, n.d.). All of these crises are related to human activity, and have serious consequences for human and planetary health. Everyone is harmed by the effects of climate change, though the severity of the effects varies depending on the ability of individuals and countries to adapt. The World Health Organization estimates that the effects of climate change will account for 250,000 additional deaths per year between 2030 and 2050, and that millions of people across the world are already suffering as a result of extreme temperatures, drought, flooding and air pollution (WHO, 2023). Under the Paris Agreement, nations of the world are committed to putting in place measures to limit the rise in global temperatures to less than 2 °C below pre-industrial levels, preferably to levels as close to 1.5 °C as possible. Eminent scientists have already sounded the alarm that the world will

✉ Nyovani J. Madise, Nyovani.Madise@afidep.org
[1] African Institute for Development Policy, Lilongwe, Malawi

miss the 1.5 °C target (Independent Group of Scientists, 2023; Stallard and Rowlatt, 2023). According to NASA, 2023 was the warmest year on record. During that year, Earth was about 1.4 °C warmer than the late 19th-century average, when modern record-keeping began (NASA, 2024). Indeed, it is estimated that close to 50% of days in 2023 were more than 1.5 °C warmer than the 1850–1900 level, and two days in November were, for the first time, more than 2 °C warmer (European Commission's Copernicus Climate Change Service Centre, 2024). Greenhouse gas (GHG) emissions mainly driven by human activity and El Niño are thought to be the main drivers of these temperature extremes.

The world population reached eight billion in 2022, and is predicted to exceed 9.5 billion by 2050 (UN, 2022). Approximately two-thirds of this growth will occur because of past growth (population momentum), with sub-Saharan Africa contributing 54% and Central and Southern Asia contributing 29% of this growth (Eastwood and Lipton, 2011). By 2050, the pressure on land, water and other resources will be significant, and a 50% increase in GHG emissions is expected as the world economy quadruples in size (OECD, 2012). It is tempting to attribute the increase in GHG to population growth in sub-Saharan Africa and Asia, but such conclusions can be misleading since they ignore the complexity in the relationship between population variables and climate change. The population variables relevant to this debate include the size, growth rate, age structure and socioeconomic composition of a population. In this paper, we argue that the relationship between population and climate change should be seen from many angles and using temporal scales. We further argue that climate mitigation strategies should be adopted by all nations, even those currently perceived as being low emitters, because low-emitting countries that are growing fast have the potential to become high emitters depending on the economic growth policies they adopt.

Population and GHG emissions

It is widely acknowledged that countries with large populations such as China (1.4 billion), India (1.4 billion), the United States of America (332 million), Russia (144 million), Brazil (214 million), Indonesia (274 million) and Japan (126 million) are also among the top emitters of GHG, contributing more than 60% of global emissions (see Table 1) (WHO, 2023). Large numbers of people put pressure on natural resources because of increased demand for land, food, water, transport and energy. As a result, countries extract from ecosystems more than they can replenish, leading to overconsumption of resources and increases in GHG emissions. However, when we look at population growth rates, we see that, on average, the countries with the highest rates are among the lowest emitters of GHG. While sub-Saharan Africa's population of 1.2 billion is growing at an annual rate of 2.5% and is expected to keep growing throughout this century, the region emits less than 3% of global GHG, according to Climate Watch. At the same time, sub-Saharan Africa is highly vulnerable to climate change-induced droughts, flooding and food insecurity. Climate adaptation measures are promoted in the region to minimize the effects of climate change.

https://doi.org/10.1553/p-624f-7c9a

Table 1. Population and emission characteristics of countries with the highest and the lowest CO_2 emissions

Highest emitters of CO_2				
Country	**Population size in 2022 (million)**	**Population growth rate in 2022 (%)**	**CO_2 (million tons)**	**CO_2 per capita**
China	1412.0	0.0	11396.8	8.0
United States	338.0	0.4	5057.3	15.0
India	1417.0	0.7	2829.6	2.0
Russia	144.0	0.1	1652.2	11.4
Japan	125.1	−0.4	1053.8	8.5

Highest emitters by CO_2 per capita				
Country	**Population size in 2022 (million)**	**Population growth rate in 2022 (%)**	**CO_2 (million tons)**	**CO_2 per capita**
Qatar	2.7	0.3	101.3	37.6
United Arab Emirates	9.4	0.8	243.9	25.8
Bahrain	1.5	0.6	37.8	25.7
Kuwait	4.3	0.4	109.2	25.6
Brunei	0.4	0.8	10.8	24.0

Lowest emitters of CO_2 in Africa				
Country	**Population size in 2022 (million)**	**Population growth rate in 2022 (%)**	**CO_2 (million tons)**	**CO_2 per capita**
Central African Republic	5.6	2.2	0.2	0.0
Comoros	0.8	1.8	0.4	0.5
Djibouti	1.1	1.4	0.5	0.4
Cape Verde	0.6	0.9	0.6	1.0
Somalia	17.6	3.1	0.6	0.0

Lowest emitters by CO_2 per capita				
Country	**Population size in 2022 (million)**	**Population growth rate in 2022 (%)**	**CO_2 (million tons)**	**CO_2 per capita**
Democratic Republic of Congo	99.0	3.2	3.6	0.0
Somalia	17.6	3.1	0.6	0.0
Central African Republic	5.6	2.2	0.2	0.0
Burundi	12.9	2.7	0.8	0.1
Malawi	20.4	2.6	2.1	0.1

Source: Global Carbon Budget (Friedlingstein et al., 2023), UN (2022) – with major processing by Our World in Data (Ritchie et al., 2023).

https://doi.org/10.1553/p-624f-7c9a

Meanwhile, Asia's population is growing at 0.4%, and Europe and North America have a zero natural population growth rate (UN, 2022).

The evidence from the literature on the relationship between population growth and climate change is mixed (Kuruc et al., 2023). In 2003, Shi published findings using pooled cross-country data relating to the period between 1975 and 1996 that showed that a 1% increase in population was associated with a 1% increase in carbon dioxide emissions, and that the effect was more pronounced in low-income countries (a 1.2% increase in emissions for every 1% increase in population) (Shi, 2003). In contrast, Satterthwaite, using data from 1980 to 2005, found that low-income countries contributed more than 52% of world population growth but only 12.8% of carbon dioxide emissions growth, while high-income countries contributed 7% of world population growth and 29% of growth in carbon dioxide emissions (Satterthwaite, 2009). Sohag, using World Bank data from 1980 to 2010, found that middle-income countries contributed the most to the growth in carbon dioxide emissions (approximately 43%), primarily due to rapid industrialization rather than population growth (Sohag et al., 2017). The earlier study used cross-sectional data, and thus did not capture temporal effects.

We argue that time is an important factor, and that fast population growth led to the large (Satterthwaite, 2009) populations of countries that are among the biggest emitters. Presently, the only African country among the 10 most populous countries in the world is Nigeria. However, by 2050, the Democratic Republic of Congo and Ethiopia will join Nigeria on this list, and by 2100, five of the 10 most populous countries will be in Africa. These countries will not stand still in terms of their economic development, and we should expect to observe rapid land use changes to accommodate food and housing production, and increased demand for energy and other resources. Thus, these countries are likely to follow the historically unsustainable paths of Western countries (Herrmann et al., 2020). Nonetheless, fertility levels in many regions of Africa have started falling through the voluntary use of contraception. Development aid should support poor nations in reducing population growth by helping couples achieve their fertility preferences, while also focusing on education, environmental protection and the eradication of extreme poverty.

Age structure is another population variable that impacts GHG emissions. Older people, as a sub-group, are low emitters but their per capita energy consumption is higher than that of the average adult, and they are less likely to alter their behavior (Deuster et al., 2023; Jiang and Hardee, 2011). On the other hand, youthful populations are associated with lower GHG emissions, and are more likely to take climate change into account in their fertility intentions (Arnocky et al., 2012; Lim et al., 2020). Harnessing the vitality of younger populations can facilitate a transition to more sustainable consumption and production patterns.

When GHG emissions are viewed from the angle of per capita emissions, a different tableau unfolds. From this perspective, the small Gulf states with populations of less than five million, such as Qatar, United Arab Emirates, Bahrain and Kuwait, emerge as top emitters (see Table 1). Meanwhile, the positions of the population giants vary, with China in 40th place, the United States in 12th place and India trailing behind at 142nd place. It would thus

https://doi.org/10.1553/p-624f-7c9a

appear that associations between population growth and GHG emissions are spurious, or are, at best, dependent on the measures used.

Economic development and GHG emissions

It has been argued that it is not population growth that leads to increases in GHG emissions, but rather growth in the number of consumers and their consumption patterns (Satterthwaite, 2009). The argument that economic growth gives rise to overconsumption and increases in GHG emissions underpins demands that high-income countries pay for global climate mitigation actions while low-income countries are allowed to increase consumption for the purposes of economic growth and are entitled to receive compensation for damages and losses caused by climate change (Thomas, 2023). Indeed, at many global conferences on climate change, the dichotomy between the high-income and the least-developed countries is very clear, with the negotiations involving the latter group focused on "loss and damages". In these arguments, the role of population growth is largely ignored because fast-growing but poor African nations are seen as victims of climate disasters caused by the greed of high-income countries.

Climate mitigation strategies

One climate mitigation strategy that has been floated by some researchers is population engineering, i.e., implementing fertility policies to intentionally alter the size and structure of a population (Hickey et al., 2016). These researchers have suggested policies focused on "enhancing choice", "preference adjustment" and "incentivization"; and argue that reducing childbearing is an easier strategy for lowering GHG emissions than reducing consumption (Cook Michael, 2016). However, such experiments have been tried previously but were halted due to their coercive nature, unintended consequences and ethical problems (Ramsden, 2004).

More than 100 countries have signed up to climate mitigation actions that include reducing their GHG emissions by 45% by 2030 and reaching net zero[1] by 2050 (UN, n.d.). This will require a major shift away from fossil fuels and toward renewable energy sources such as solar, wind, hydropower and geothermal, as well as carbon sequestration. Even the biggest polluters have made these commitments, but the trend is going in the wrong direction, with GHG emissions projected to increase 9% by 2030 compared to 2010 levels (UN, n.d.). Meanwhile, smaller countries such as Bhutan, Suriname and Panama have already reached net zero. Whether it is reasonable to expect poorer nations that are hoping to achieve economic growth and poverty alleviation to reach net zero when richer nations are failing to do so is a question that remains unresolved. The least-developed countries must have the policy space to prosper and to lift millions of their citizens out of poverty. However, we argue that

1 Net zero means that all greenhouse gas emissions that are produced are counterbalanced by the elimination of an equal amount of emissions.

https://doi.org/10.1553/p-624f-7c9a

if the world is truly concerned with population growth and climate change, then development aid must be available to ensure that poor countries can address their food security and energy needs with sustainable means. Unfortunately, financial sources for up-front investments in sustainable agriculture and renewable technologies for the least-developed nations have not yet materialized.

Conclusion

Population has many facets that affect climate change in different ways. Thus, we must move beyond a simplistic discourse on the role of population in climate change. While there is no doubt that large populous countries are the biggest contributors to GHG emissions, the evidence on the role of population growth in GHG emissions is mixed. While the obvious and immediate call is for mitigating the effects of climate change by reducing GHG emissions in rich countries through decarbonization and greening the world economy, countries with very high population growth must also do their part, given that they will likely need more energy and transportation resources and more land for food production as their populations double or quadruple. The dichotomy of climate mitigation for high-income countries and climate adaptation for poor, low-emitting countries makes sense when considering short- and medium-term measures, but is insufficient for the future. Forward-looking investments should target fast-growing, poorer populations to prevent them from following historically unsustainable pathways and engaging in overconsumption.

ORCID iDs

Nyovani J. Madise https://orcid.org/0000-0002-2813-5295

Naa Dodua Dodoo https://orcid.org/0000-0002-4811-9823

John A. Mushomi https://orcid.org/0000-0002-0001-2031

Chifuniro S. Mankhwala https://orcid.org/0009-0000-5712-4627

References

Arnocky, S., Dupuis, D., and Stroink, M. L. (2012). Environmental concern and fertility intentions among Canadian university students. *Population and Environment: A Journal of Interdisciplinary Studies*, *34*(2), 279–292. https://doi.org/10.1007/s11111-011-0164-y

Cook Michael. (2016). *Let's fight climate change with population engineering*. BioEdge. https://bioedge.org/medical-practice/lets-fight-climate-change-with-population-engineering/

Eastwood, R., and Lipton, M. (2011). Demographic transition in sub-Saharan Africa: How big will the economic dividend be? *Population Studies*, *65*(1), 9–35. https://doi.org/10.1080/00324728.2010.547946

European Commission's Copernicus Climate Change Service Centre. (2024). *Copernicus: 2023 is the hottest year on record, with global temperatures close to the 1.5 °C limit*. 9 January 2024. https://climate.copernicus.eu/copernicus-2023-hottest-year-record

Friedlingstein, P., O'Sullivan, M., Jones, M. W., Andrew, R. M., Bakker, D. C. E., Hauck, J., Landschützer, P., Le Quéré, C., Luijkx, I. T., Peters, G. P., Peters, W., Pongratz, J., Schwingshackl, C., Sitch, S., Canadell, J. G.,

Ciais, P., Jackson, R. B., Alin, S. R., Anthoni, P., . . . and Zheng, B. (2023). Global Carbon Budget 2023, *Earth System Science Data*, *15*, 5301–5369. https://doi.org/10.5194/essd-15-5301-2023

Herrmann, S. M., Brandt, M., Rasmussen, K., and Fensholt, R. (2020). Accelerating land cover change in West Africa over four decades as population pressure increased. *Communications Earth & Environment*, *1*(1), 53. https://doi.org/10.1038/s43247-020-00053-y

Hickey, C., Rieder, T. N., and Earl, J. (2016). Population engineering and the fight against climate change. *Social Theory and Practice*, *42*(4), 845–870. https://doi.org/10.5840/soctheorpract201642430

Independent Group of Scientists. (2023). *Global Sustainable Development Goals Report 2023: Times of crisis, times of change: Science for accelerating transformations to sustainable Development*. United Nations, New York. https://sdgs.un.org/gsdr/gsdr2023

Jiang, L., and Hardee, K. (2011). How do recent population trends matter to climate change? *Population Research and Policy Review*, *30*(2), 287–312. https://doi.org/10.1007/s11113-010-9189-7

Kuruc, K., Vyas, S., Budolfson, M., Geruso, M., and Spears, D. (2023). Population decline: Too small and too slow to influence climate change. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.4535022

Lim, H., Kim, J., and Jo, H.-H. (2020). Population age structure and greenhouse gas emissions from road transportation: A panel cointegration analysis of 21 OECD countries. *International Journal of Environmental Research and Public Health*, *17*(21). https://doi.org/10.3390/ijerph17217734

NASA. (2024). *NASA Analysis Confirms 2023 as Warmest Year on Record*. 12 January 2024. https://www.nasa.gov/news-release/nasa-analysis-confirms-2023-as-warmest-year-on-record/

Deuster, C., Kajander, N., Muench, S., Natale, F., Nedee, A., Scapolo, F., Ueffing, P. and Vesnic Alujevic, L. (2023). *Demography and climate change*. European Commission, Joint Research Centre. *https://doi.org/10.2760/26411*

OECD. (2012). *OECD Environmental outlook to 2050: The consequences of inaction*. OECD Publishing. https://doi.org/10.1787/1999155X

Ramsden, E. (2004). Frank W. Notestein, Frederick H. Osborn, and the development of demography in the United States. *The Princeton University Library Chronicle*, *65*(2), 282–316. https://doi.org/10.25290/prinunivlibrchro.65.2.0282

Ritchie, H., Roser, M., Mathieu, E., Macdonald, B. and Rosado, P. (2023). CO_2 and greenhouse gas emissions. Our World in Data. https://ourworldindata.org/co2-and-greenhouse-gas-emissions

Satterthwaite, D. (2009). The implications of population growth and urbanization for climate change. *Environment and Urbanization*, *21*(2), 545–567. https://doi.org/10.1177/0956247809344361

Shi, A. (2003). The impact of population pressure on global carbon dioxide emissions, 1975–1996: evidence from pooled cross-country data. *Ecological Economics*, *44*(1), 29–42. https://doi.org/10.1016/S0921-8009(02)00223-9

Sohag, K., Al Mamun, M., Uddin, G. S., and Ahmed, A. M. (2017). Sectoral output, energy use, and CO_2 emission in middle-income countries. *Environmental Science and Pollution Research*, *24*(10), 9754–9764. https://doi.org/10.1007/s11356-017-8599-z

Stallard, E., and Rowlatt, J. (2023). World will miss 1.5C warming limit - top UK expert. *BBC*, 20 July 2023. https://www.bbc.com/news/science-environment-66256101

Thomas, V. (2023). The truth about climate action versus economic growth. *Brookings*, 3 May 2023. https://www.brookings.edu/articles/the-truth-about-climate-action-versus-economic-growth/

UN. (n.d.). For a livable climate: Net-zero commitments must be backed by credible action. United Nations. Retrieved 15 April 2024, from https://www.un.org/en/climatechange/net-zero-coalition

UN. (2022). *World Population Prospects 2022*. United Nations Department of Economic and Social Affairs, Population Division. https://population.un.org/wpp/

UNEP. (n.d.). *Facts about the nature crisis*. UN Environment Programme. Retrieved 15 April 2024, from https://www.unep.org/facts-about-nature-crisis

UNFCCC. (2022). *What is the triple planetary crisis?* 13 April 2022. https://unfccc.int/news/what-is-the-triple-planetary-crisis

WHO. (2023). *Climate change*. 12 October 2023. https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health

https://doi.org/10.1553/p-624f-7c9a