Sustainable Population Australia

DISCUSSION PAPER

Population and Climate Change

Ian Lowe, Jane O'Sullivan and Peter Cook

www.population.org.au

Sustainable Population Australia

Sustainable Population Australia (SPA) is an independent not-for-profit environmental advocacy organisation established in 1988. SPA seeks to protect the environment and quality of life by ending population growth in Australia and globally, while rejecting racism and involuntary population control. SPA works on many fronts to inform public awareness about population issues from ecological, social and economic viewpoints, and to advocate for how Australia and the world can achieve an ecologically sustainable population.

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Key Points

1

Human activities are releasing greenhouse gases and causing climate change. The quantity of greenhouse gases is the product of emissions per person multiplied by the population. Hence climate change can't be 'blamed' on either consumption patterns or population but both together: each multiplies the other and both must be part of action to avoid catastrophic outcomes.

2

Population growth increases people's vulnerability to climate change in many ways. Globally, water and food insecurity are already increasing due to population pressure. More people mean more housing vulnerable to floods, bushfires and storm damage; rapid growth leads to inadequate infrastructure; larger and denser cities raise the urban heat-island effect and increase disease transmission.

3

The future challenges of climate change, including emissions reduction and adaptation, can be lessened by minimising further population growth. In developed countries like Australia, having fewer children is the most impactful lifestyle choice available to individuals to lessen their environmental impact. High immigration also increases emissions, since most migrants to Australia shift to more carbon-intensive lifestyles.

4

High population growth in low-income countries can cause environmental impacts such as deforestation and soil degradation. These not only accelerate climate change by reducing carbon stores in forests and soils, but also reduce the capacity of the local food production system to adapt to the changing climate. Lower population growth in low-income countries will help increase their standard of living, while minimising the growth of total emissions as their per capita emissions rise.

5

In high-fertility countries, voluntary family planning services are severely underfunded and under-promoted, leaving many women without the means to avoid pregnancies they don't want. Providing these services, empowering women and promoting small families would have multiple benefits for communities coping with climate change. Family planning programs are a 'best buy' for development, environment and climate adaptation.

6

Climate mitigation models show that sufficient emissions reduction cannot be achieved unless the model scenarios assume a rapid peak and decline in global population. Population stabilisation alone can't solve climate change, but ignoring population will ensure we fail.

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Summary

The relationship between population and climate change is complex. At a basic level, for a given lifestyle (consumption pattern), emissions of the greenhouse gases that cause climate change are directly proportional to the size of the population. For example, if Australia's recent population growth rate of about 1.5% per year were to continue, in less than 50 years we would double our demands for energy, food, water and all natural resources. All else being equal, we would double our carbon footprint also. On the other hand, in a hypothetical world where we achieve lifestyles entirely free from greenhouse gas generation, how many of us there were would make no difference to the climate. But even if this were achievable, which is questionable, we could decarbonise our lifestyles more rapidly if population growth was not constantly adding to the demand for energy and resources. Hence, the rate of population growth will make a considerable difference to the cumulative emissions generated during the transition. Furthermore, population growth greatly increases our vulnerability to the impacts of climate change.

The population issue has had a controversial history which has led to the development of a 'taboo' against talking about population as a policy-relevant factor. This paper calls for a new level of maturity in discussing the population issue. It should no longer be acceptable for unfounded accusations of racism to be used to silence respectful and thoughtful discussions about population growth. It should no longer be acceptable – at an epochal moment of existential risk for human civilisation – for climate policy prescriptions to conspicuously exclude population-related actions in the face of abundant evidence (as reported in this paper) that such measures are feasible, effective and consistent with human rights and democratic values. Ending global population growth more swiftly and at a lower peak is a necessary but not sufficient condition for overcoming the climate crisis.

Population and consumption work together

The Intergovernmental Panel on Climate Change (IPCC) says 'Globally, economic and population growth continue to be the most important drivers of increases in CO_2 emissions from fossil fuel combustion.' But these are not independent contributors to emissions; they multiply each other. Most emissions are attributable to the richest billion people, but their economic growth since 1970 has not increased their average emissions per person. The growth in emissions has come from lifting multitudes of poor people to a modest middle-class lifestyle in places like China and India.

It is futile to 'blame' past emissions on either population or consumption patterns when they are the product of both. What should be of more interest to us is the extent to which the future challenges of climate change, including emissions reduction and adaptation, can be lessened by giving due attention to population growth. This paper argues that our climate change response can't afford to ignore the potential to minimise further population growth.

Slow-response actions are no less urgent

Nobody expects addressing population growth alone to solve climate change. There is no intention to deflect attention from high-emissions consumption patterns, nor to blame the poor for the excesses of the rich. Demographic inertia means that even concerted efforts to slow population growth are unlikely to have significant impact on the timescale demanded by the climate crisis. Measures to decarbonise our energy system and reverse the loss of vegetation and biodiversity are needed urgently in this decade, if we are to avoid catastrophic impacts of climate change. Measures to reduce childbirth will take decades to make an appreciable difference to greenhouse gas emissions and human demands on nature.

Nevertheless, how well we do in the second half of this century will depend more on what we do about population growth this decade than on any actions that will remain available to us in 2050. If the successful efforts to promote voluntary family planning adoption in the 1970s and '80s had not been abandoned in the 1990s, the global population might now be on track to peak below 9 billion. Because of decisions made in the 1990s, we're heading for 11 billion or more. But if we renew family planning efforts now, a peak below 10 billion is possible and we could end this century with fewer than 8 billion people. If we wait until 2050, 11+ billion would be locked in.

A slow fruition does not make population action any less urgent. As the proverb says, 'The best time to plant a tree is 20 years ago. The second-best time is now.' So it is with addressing global population. The climate crisis is largely a product of the short-sightedness of political responses decades ago. Those who say that reducing birthrates is too slow to be relevant to the climate change response are suffering the same short-sightedness that created the problem they seek to fix.

In rich countries, fewer people means lower emissions and fewer vulnerabilities

Any increase of population in the more affluent countries will add to those countries' use of resources and their greenhouse gas emissions. In a rich country, having fewer children does more to slow climate change than any of the other actions often advocated, such as eating less meat, avoiding air travel or using only renewable energy. If immigration is high enough to cause population growth, it also increases a country's emissions, but some people argue that it makes no difference globally. This is untrue: the average migrant to Australia increases their carbon footprint fourfold by adopting Australian lifestyles. While Australians have recently reduced their per capita emissions a little, Australia's total emissions from energy have risen 49% since 1990 due entirely to population growth of 8.3 million people.

Australia is not only one of the world's largest per capita emitters of greenhouse gases, it is also among the countries likely to be most affected, in terms of negative impacts on agriculture, water supply, bushfire threat and extreme weather events. All these threats are intensified by the threat-multiplier of population growth.

The current Australian government policy of encouraging high levels of migration could see the 2060 population approaching 40 million and continuing to grow rapidly. That scale of increase would significantly magnify the task of producing enough clean energy to meet our material needs within a responsible carbon budget. Australian agriculture is unlikely to feed that number during increasingly frequent and severe droughts, and water security will depend on costly and energy-intensive desalination or recycling. These serious vulnerabilities are entirely avoidable if we choose population stabilisation.

In poor countries, smaller families are essential for adaptation

Population growth heightens vulnerability to climate change to a much greater extent in poor, high-fertility countries. For most of these countries, population growth itself is a greater threat to security and wellbeing than climate change is. Saying this does not in any way diminish the serious impacts of climate change. However, if a projected 11–25% reduction in crop yields this century due to climate change is considered a crisis, it is absurd to claim, as many people do, that population growth in high-fertility countries is not important when it will diminish the available water and agricultural land per person by a factor of three or more, while ensuring high levels of unemployment and poor infrastructure provision. While family size should be considered part of emissions reduction efforts in rich countries, it should be integral to adaptation efforts in poor countries. Nevertheless, the emissions caused by growing numbers of the poor are not insignificant. Deforestation is particularly vulnerable to population pressure.

Currently, family planning services are badly underfunded, denying many women access to safe and reliable contraception. As a result, the fall in birthrates has been much slower than was anticipated a generation ago, unemployment is rampant and hunger is once more on the rise.

Many of the beneficial impacts of lower birthrates are enjoyed much more rapidly than their effect on carbon emissions. These benefits include greater autonomy of women, health of infants, food security of families, protection of biodiversity, employment prospects for youth and economic development of nations. If climate adaptation is dominating the agenda for international aid, it makes sense that family planning should be included as an adaptation measure.

Climate change will affect world population

The other side of the coin is the impact climate change is projected to have on population, through greater loss of life. The frequency of extreme heat events, floods and crop-destroying droughts is projected to increase substantially. Some Pacific islands and low-lying coastal areas will become uninhabitable, causing either loss of life or relocation of whole populations. Mass migrations could possibly in turn lead to conflict between the displaced people and those whose traditional lands they enter. However, responses to climate change can have some beneficial health impacts. Urban air pollution and indoor smoke exposure are both major causes of premature deaths, and might be substantially reduced by electrification of energy systems. It is difficult to anticipate the net effect on population trends.

Only low-population scenarios can keep warming below 2°C

The most compelling reason to include population in the climate change response is that climate mitigation models are only able to achieve sufficient emissions reduction if their scenarios assume a rapid peak and decline in global population. These assumptions are not readily visible: they are hidden under the labelling of scenarios such as ‘SSP1’ or ‘SSP2’. Without making these assumptions explicit, and discussing the actions that could help achieve the required birth reductions in a way that elevates people’s rights and freedoms, these scenarios can’t become reality.

Addressing population growth alone can’t solve climate change, but not addressing it will ensure we fail.

Introduction

It shouldn't be contentious that human population growth is an important driver of greenhouse gas emissions and hence of climate change. The IPCC confirms this fact:

> Globally, economic and population growth continue to be the most important drivers of increases in CO_2 emissions from fossil fuel combustion. The contribution of population growth between 2000 and 2010 remained roughly identical to the previous three decades, while the contribution of economic growth has risen sharply (high confidence). Between 2000 and 2010, both drivers outpaced emission reductions from improvements in energy intensity … Without additional efforts to reduce GHG emissions beyond those in place today, emissions growth is expected to persist driven by growth in global population and economic activities.[1]

Yet looking at the recommended actions and policies to reduce greenhouse gas emissions, both globally and in Australia, we are hard-pressed to find any mention of actions to stop population growth.[2] One of the few exceptions is the World Scientists' Warning of a Climate Emergency, which includes strong recommendations to minimise population growth.[3] For much of the remainder of both official and scientific discourse on climate policy, mention of population appears to be studiously avoided. The extraordinary scope of the interventions that *are* proposed range from as-yet unproven technologies such as carbon capture and storage and geoengineering through to degrowth strategies and radical social transformation on a global scale. The degrees of difficulty, cost and risk of all of these should not be underestimated. Yet their proponents repeatedly overlook population policy despite it offering a relatively simple and low-cost suite of actions with many co-benefits in addition to emissions reduction and climate adaptation.[4]

In Australia there is no mention of the population question in Commonwealth government climate policies or by opposition parties, nor by reputable think tanks such as the Grattan Institute or the Climate Institute, nor by leading environmental advocacy organisations such as the Australian Conservation Foundation. This is despite the sobering findings of a 2016 research paper on the implications of Australia's population policy for future greenhouse gas emissions targets, which concluded that:

> Based on current population policies, the projected growth in the Australian population will make its already challenging future emissions-reduction goals even more difficult to achieve. In addition to the rising pressure of Australia's population on its ecosystems, the country's future greenhouse gas emissions are also partially tied to its immigration policy.
>
> … More population growth driven by immigration will hamper Australia's ability to meet its future climate change mitigation commitments and worsen its already stressed ecosystems … [5]

How can it be that population is recognised as a driver of climate change, but there is no policy response, no attempt to steer towards lower population growth? The short answer, we argue,

that this is a kind of wilful blindness, driven partly by theoretical and ideological preconceptions, and partly by misunderstandings about the drivers of population growth and fertility reductions over the past fifty years.

The population debate has been going for decades, if not centuries. Do we treat population growth as 'just something that is happening',[6] over which we have no control, and accept the consequences whatever they may be? Or do we look at ways to influence the rate of population growth so that we are more likely to get the outcomes we desire? The latter approach, which we advocate in this paper, is what we will call 'population policy'. This is a way to treat population growth as a policy-relevant variable which, to some extent, is amenable to conscious influence at the societal level even while enhancing individual choice and autonomy.

To minimise the existential risk posed by climate change and the various other interlinked ecological crises – to the future of advanced human civilisation if not to the human species – we need to use all the feasible policy levers at our disposal. Why would we not include the population lever? As we shall discuss later in this paper, the IPCC's own scenario modelling shows that ending population growth is an essential part of the suite of actions needed to avoid the worst-case outcomes. Of course, the population factor in itself is not a panacea. A multi-pronged, comprehensive and integrated approach for both emissions reduction and adaptation to climate risks is needed. We should reject mono-causal explanations that single out population or any other sole factor, such as 'technology' or 'capitalism', as the cause or the way out of the climate crisis. Similarly, we should reject policy prescriptions that conspicuously *exclude* population-related actions in the face of abundant evidence (as reported in this paper) that such measures are feasible, effective and consistent with human rights and democratic values. Ending global population growth more swiftly and at a lower peak is a necessary but not sufficient condition for overcoming the climate crisis.

Procreation and immigration, as the drivers of population growth, each have their unique moral and political challenges. For procreation these centre around questions of individual choice and autonomy. For immigration they centre around questions of political sovereignty and how best to mitigate the extremes of global inequality. Undoubtedly each issue poses difficult questions that require considered judgement and ongoing open conversation. There is no reason, however, to think these difficulties are any greater than those posed by other prescriptions for emissions reduction, such as forgoing meat or air travel.

Ending global population growth more swiftly and at a lower peak is a necessary but not sufficient condition for overcoming the climate crisis.

The population issue has had a controversial history which has led to the development of a 'taboo' against talking about population as a policy-relevant factor. This taboo is a kind of 'population denial', similar to the climate change denial with which we have become familiar. Any talk about population policy, as we have defined it here, routinely faces attempts to vilify, trivialise or shut down the potential conversation. This taboo has proven useful cover for those narrow sectoral interests which do in fact reap most of the benefits of population growth through, for example, land speculation, property development and the availability of cheap labour. Spokespeople for these interests positively reinforce the taboo and promote various narratives in favour of perpetual population growth, such as the panic myths surrounding population ageing.[7] Operating in this pincer-like movement, the taboo and pro-growth tropes have largely succeeded in undermining effective population policy in recent decades – meaning that women's reproductive rights have been neglected and valuable time has been lost in the task of curbing population growth.

Although some objections to population policy do come from a position of deeply held religious or philosophical convictions (which nonetheless should always be open to critical exploration and re-assessment), there are many instances where these objectors are simply ill-informed about the arguments and evidence to which they imagine they are responding. An amalgam of anti-Malthusian clichés, stereotypes and straw men are typically trotted out. Among them, responses like 'who are you going to cull first?',[8] or 'this is racist and targeted against the people of the Global South', or 'this is blaming the poor for the excesses of the rich',[9] are among the more common. The former accusation is frankly ridiculous. The latter imply that voluntary family planning programs were imposed by outsiders against the interests of recipients, a gross misrepresentation. These programs were a product of humanitarianism, not racism, and were highly successful in promoting gender equity and economic development. A former head of UNICEF said, 'Family planning could bring more benefit to more people at less cost than any other single technology now available to the human race.'[10] In contrast, those who deny the relevance of population policy measures such as family planning stand in the way of people achieving their 'basic human right to decide freely and responsibly the number and spacing of their children' (established in the 1968 Tehran Conference on Human Rights)[11] and, in doing so, condemn high-fertility countries to deepening poverty.

It should go without saying (but it must be said) that any policy prescriptions based on racism must be unequivocally condemned and opposed. Conversely, it should no longer be acceptable for unfounded accusations of racism to be used to silence respectful and thoughtful discussions about population growth.[12]

More substantive concerns refer to the regrettable instances where governments seeking to reduce population growth did abuse human rights, resorting to forced sterilisations and abortions, or various penalties for childbearing. China's one-child policy is the most notorious, but instances occurred in India, Peru and elsewhere. Coercive measures were always unnecessary and probably always counterproductive. It is a mistake to think that such measures were ever condoned, let alone intended, by the international family planning movement, which always saw addressing women's reproductive health and rights as essential and synergistic with slowing population growth to reduce poverty and food insecurity. To say we should not have programs intended to lower birthrates for fear of coercive measures is like saying we should not have schools for fear of child sexual abuse. Vigilance is necessary, but we should not shun such an effective force for good to avoid a manageable risk.

It should no longer be acceptable for unfounded accusations of racism to be used to silence respectful and thoughtful discussions about population growth.

Some of those who intentionally dismiss the population question do so in the belief that the necessary slowing of population growth is already happening and will continue to do so with more education of women and poverty reduction in poorer countries. Accordingly, it is assumed there is no need to talk about population as such; it will take care of itself, and hence some uncomfortable conversations may be avoided. As we discuss below, this belief is based on a poor understanding of the causal dynamics and has contributed to more population growth.

In this paper we will reflect on the recent history of the climate crisis, and analyse the ways it has been, and continues to be, exacerbated by population growth. We will also outline how a changing climate will itself have feedback effects on populations and their capability to adapt to these changes. Along the way we will demonstrate how population policy can significantly increase the chances of averting catastrophic climate change, and highlight a number of misunderstandings which have, in recent decades, prevented effective population policy.

Energy and climate change: a personal and historical reflection by Ian Lowe

For over forty years, I have been researching Australia's future energy alternatives. I began when the 1970s 'energy crisis' demonstrated energy's critical importance to our modern lifestyle. Energy enables us to light our homes, cook our food, move people and goods, produce raw materials and manufactured products, communicate and so on. It also enables us to overcome some limitations. Energy-intensive agriculture allows us to produce more food from the shrinking area of productive land. As we depleted rich mineral deposits, we have used more energy to process poorer grades of ore. Desalination plants use energy to produce fresh water from the sea. Without useable energy, our society would literally grind to a halt. When I began my research, there were already significant environmental issues associated with energy supply and use: acid rain, urban air quality and the direct pollution associated with mining and burning coal. I gave public lectures and published newspaper columns in the 1970s, arguing for an energy policy that would assure our future. A coherent approach would take account of limited oil resources as well as the economic, environmental and social issues involved in energy supply and use.

Climate change only became an issue outside the small community of relevant scientists after a 1985 international conference in the Austrian town of Villach. The conference statement suggested a possible relationship between human activity and the changing climate.[13] Within a few years, it became clear climate change would demand a new approach to energy supply and use. The 1987 report of the World Council on Environment and Development, *Our Common Future*, concluded that new energy systems were needed to power human development, but noted that the changes would require 'new dimensions of political will and institutional cooperation.'[14] CSIRO scientists, led by Professor Graeme Pearman, organised a national conference in 1987 to examine potential impacts of climate change. As Minister for Science in the Hawke government, Dr Barry Jones had established the Commission for the Future to work on long-term issues that would be significant for Australia. I was the Commission's Acting Director

in 1988, when we worked with CSIRO on a national project to educate the community about climate change and its implications.

There was a huge demand for information about the problem. During 1988 and 1989 I spoke to an average of two gatherings a week, in venues ranging from schoolrooms to luxury hotels. Most of the communication started with the basics. The Swedish scientist Svente Arrhenius had coined the phrase 'the greenhouse effect' in the 1890s when he recognised that trace gases in the atmosphere behave like glass in a greenhouse, allowing light to warm the interior but preventing heat from flowing out. The effect makes the average temperature of the Earth about 33°C warmer than it would be if, like our moon, we had no atmosphere. It also moderates the difference between day and night temperatures, typically about 10 to 15°C on Earth compared with about 250°C on our moon. Arrhenius warned that burning fossil fuels might eventually increase the levels of carbon dioxide (CO_2) in the atmosphere and so change our climate. I explained the science, which was well established, and the measurements showing that the levels of greenhouse gases were indeed increasing significantly. I observed that climate changes were becoming apparent: increasing average temperatures, more very hot days, fewer very cold nights, changes in rainfall patterns and so on, as well as outlining the consequences projected by climate scientists. Although patterns were emerging, at that time, scientists could not say with confidence that individual weather events were influenced by climate change. Sceptics used this uncertainty to claim that scientists had no sound evidence of climate change, which was untrue.

There is no serious doubt in the scientific community that we are seeing climate change that is driven by human activity increasing the atmospheric levels of greenhouse gases.

Scientists agreed that increasing levels of greenhouse gases would inevitably change the global climate, but there were different views about the likely rate and scale of change. Some people were uncomfortable with the uncertainty and wondered whether we should act. Giving his view as an elected politician and government minister, Dr Barry Jones wisely said that prudent decision-makers should weigh up the consequences of being wrong. If the climate scientists were wrong and we listened to them, he said, the worst that could happen is that we would use cleaner but more expensive energy. That might not be economically optimal, he said, but it would not be a serious problem. If the science was right and we didn't listen, he continued, the results could be catastrophic. So, he invoked the precautionary principle to argue it would be prudent to develop responses, despite the uncertainty at that time. State governments agreed and began planning for cleaner energy supply and more efficient use. There were only a few dissenting voices, like the Queensland Chamber of Mines, which claimed that the concern about climate change was unjustified hysteria caused by misinformation from wild-eyed environmentalists. Even the Murdoch press, less ideologically blinkered then than it has been in subsequent decades, reported the science and published columns written by me and by other scientists.

The science advanced rapidly. In 1992, the Rio Earth Summit concluded the problem was urgent and developed the Framework Convention on Climate Change (UNFCCC). Our government set up the National Greenhouse Advisory Panel. As a member of that body, I continued to address public meetings and write columns for various publications. By 1997, the science was convincing enough for the global community to negotiate the Kyoto Protocol to reduce greenhouse gas emissions from developed countries. That agreement was reached despite concerted opposition from energy-intensive industries, the commercial world generally and governments of a few recalcitrant nations like Saudi Arabia and Australia. One business sector supported action: the

insurance industry, which said in 1997 that they could read the red ink on their accounts, being unable to increase premiums to keep pace with the rapidly increasing cost of property damage from extreme events.

The Australian delegation eventually voted for the protocol and Prime Minister John Howard claimed it was a great deal for Australia. It may have been, but it was a bad deal for the planet, as our delegation had held out for a uniquely generous target. Despite that favourable treatment, Howard joined the Bush administration in refusing to ratify the Kyoto Protocol, so the treaty did not become legally binding until Kevin Rudd ratified it ten years later in 2007. The Howard government also disbanded the National Greenhouse Advisory Panel and did little to rein in Australia's rapidly increasing production of greenhouse gases.

The late 1990s had seen the beginning of a well-funded campaign by the fossil fuel industry and others with vested interests to muddy the waters, leading many to believe to this day that the science is still uncertain. That is an amazing achievement, given there is no credible challenge to the science. The more recent 2016 Paris Agreement was recognition by political leaders from all around the world that we face a serious collective problem, demanding concerted global action to slow climate change. A small group still say the science is uncertain, but a recent review pointed out the obvious fact that there is no coherent alternative theory. As it concluded:

> Some blame global warming on the sun, others on orbital cycles of other planets, others on ocean cycles, and so on. There is a 97% expert consensus on a cohesive theory that's overwhelmingly supported by the scientific evidence, but the 2–3% of papers that reject that consensus are all over the map, even contradicting each other. The one thing they seem to have in common is methodological flaws like cherry picking, curve fitting, ignoring inconvenient data, and disregarding known physics.[15]

As one journalist said, if one person says it is raining and another says it is fine, the task of the media is not to report the two views but to look out the window and see who is telling the truth! We have seen a prolonged and determined campaign of climate misinformation by the Murdoch press, which only now seems to be coming to an end. At one level, it consisted of putting forward amateur contrary views as if they hold equal weight with the science. *The Australian* featured on its front page a sun-tanned Bondi surfer who said he had not noticed any rise in sea level, as if this anecdote cancelled out decades of careful analysis of about 10,000 tide gauges around the world.[16] At another level, it was blatant deliberate misrepresentation. When I was interviewed on ABC Radio and asked if cyclone Yasi was a sign of climate change, I gave a careful reply reflecting the science: no one event is by itself a demonstration of climate change, but the overall pattern of more frequent and severe extreme events is what the science has been predicting for decades. The next day I was deliberately misrepresented by two Murdoch columnists, each taking half of the reply out of context. One said that even an alarmist like me had to admit that an extreme event like the Category 5 cyclone was not a sign of climate change. The second seized on the other part of my reply and said that alarmists like me blamed climate change for everything, whether it was a cyclone or a bushfire, a flood or a drought.

Books have been published with the obvious aim of muddying the waters, claiming the science is not sufficiently robust to justify action to reduce the release of greenhouse gases into the atmosphere. One recently argued that the science is 'not settled', as if this justified continuing inaction. At a basic level, that claim is true but essentially trivial because science is never settled, it is always a work in progress, the continuing attempt to explain natural phenomena by coherent theories. We keep doing research and justify public funding for it because our understanding of the natural world, and our impacts on it, is still far from complete. Any credible scientist will

concede that new data or new theoretical insights can demand revision of what was accepted science. So, it is important to be clear about what is known with certainty, what is agreed sufficiently broadly to guide policies and investments, and which areas are still uncertain and require further research.

It has been known for well over a hundred years that trace gases such as CO_2, methane and water vapour act as greenhouse gases, keeping the Earth warmer than it would otherwise be. It was proposed late in the nineteenth century that burning coal could increase the amount of CO_2 in the air sufficiently to change the global climate. Measurements of the atmospheric concentrations of greenhouse gases began in the northern hemisphere in the 1950s and in the southern hemisphere in the 1980s; since then analysis of air bubbles trapped in polar ice cores has made it possible to reconstruct levels for the last million years. We know that the level of CO_2 in the atmosphere has varied naturally between about 180 and 280 parts per million over that period, but has increased rapidly since the Industrial Revolution to the current figure of 419 ppm.[17] Methane levels have increased even more and are now about 2.5 times the pre-industrial level.

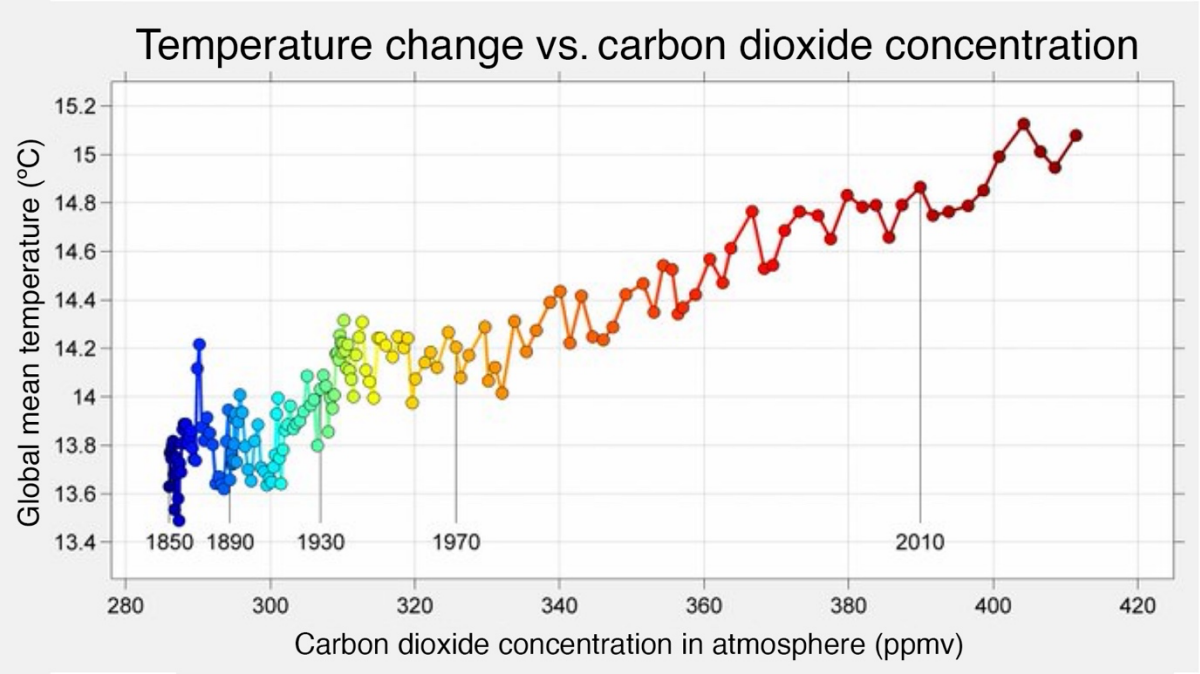

Figure 1: Historical record of global mean temperature and atmospheric CO_2 concentration. The chart shows that the global mean temperature has increased in proportion to CO_2 concentration (the trend being roughly a straight line) and that the warming has accelerated (each 40-year interval has seen a greater increase in both CO_2 and temperature than the last). Source: Berkeley Earth [18]

Our understanding of atmospheric physics leads to the expectation that increasing the concentrations of greenhouse gases will increase average temperatures and cause a range of other changes to the climate. Those changes are clearly observable. Figure 1 shows the simple correlation between increasing CO_2 levels and global temperatures.

The first Australian national scientific conference on climate change, Greenhouse '87, explored the other changes we could expect to see if the emerging science was correct. Various papers presented at that conference projected that we would see increasing average temperatures, more very hot days, fewer very cold nights, changes in rainfall patterns with the south of Australia,

especially the south-west, becoming drier. They also projected the north, particularly the north-west, becoming wetter, longer dry periods and more intense rainfall events, stronger tropical cyclones, extended fire seasons, changes to growing seasons, rising sea levels and changes to the distribution of plants, animals, birds and fish as the climate changed. All of those trends have now been observed. There is no serious doubt in the scientific community that we are seeing climate change that is driven by human activity increasing the atmospheric levels of greenhouse gases.

Where there is uncertainty is attempting to model the future scale and rate of change. We are now in uncharted territory, with greenhouse gas levels higher than at any time since humans have existed as an identifiably separate species. We know there are long time lags in the atmosphere; on average, the extra CO2 we are putting into the atmosphere will be there for a hundred years. So, the climate will continue to change for the foreseeable future, even if there is remarkable success in the effort to reduce emissions of greenhouse gases.

There is a reasonable degree of confidence in models that have shown agreement with the changes observed in the last hundred years. Extending those models for different future levels of greenhouse gas concentrations gives estimates of likely future changes to the global climate. There is less confidence about the ability of models to show what changes will happen at regional or local levels. More fundamentally, there is concern that our science does not indicate when tipping points could occur that would accelerate change, such as destabilisation of large ice sheets, release of methane from Arctic tundra, drying and subsequent burning of large forests, and shrinking of polar ice caps. In that sense, the science is certainly not settled, but the uncertainty is cause for heightened concern rather than justifying complacency and inaction.

The 2016 Paris conference of parties to the climate change treaty agreed that we should attempt to keep the increase in average global temperature below 2°C, with an aspirational goal of restricting the increase to 1.5°C. However, the pledges by individual nations would most likely cause at least 2.4°C of warming, if fully implemented. Strengthening of pledges in mid-2021 by the USA, Europe, China and Japan have helped bring this prognosis down from a disastrous 2.9°C.[19] This outlook has not substantially changed following the 2021 climate summit COP26 in Glasgow.[20] Australia was not among the countries that strengthened pledges. But most countries so far lack the policies needed to achieve their pledges. Without implementing emergency-level scale-up of renewable energy systems, emissions regulation and forest protection, we are on track for 3 or 4°C.[21]

Throughout my journey in climate policy and research over the decades, the importance of population in climate mitigation and adaptation has always been clear. But, far from calling governments to account for their hypocrisy in supporting action on climate change while boosting population growth, environmental organisations have tended to ignore or deny the connection. All governments have the option to use population policy to help reduce greenhouse gas emissions, either by minimising further population growth or supporting its gradual decline. This lever is more accessible to Australia than to most other countries.

1. The massive challenge of replacing fossil fuels

Australia remains one of the highest emitters of greenhouse gases per person. Almost 80% of our energy comes from fossil fuels, mainly coal for electricity and oil for transport fuels. However, Tasmania has traditionally relied heavily on hydro-electricity and the Australian Capital Territory now gets all of its power from renewable sources: solar, wind and hydro. For the year of 2020, South Australia got the majority of its electricity from solar and wind, with days where it used no fossil fuel electricity at all and even exported its surplus clean energy to Victoria. New South Wales now has a plan to transform its electricity system, expecting to get 90% of its power from solar, wind and hydro by 2030. There are also concrete plans for a power supply inter-connector between NSW and SA, which will allow SA to export wind energy to NSW.

By 2021, it had become clear that there is no longer a financial penalty for using clean energy. A detailed study of electricity prices, GenCost, was conducted jointly by CSIRO and the electricity market operator in 2018 and has been updated annually since. In round figures, the latest report shows that power from solar farms and large wind turbines now comes at an average price of about $40 per Megawatt-hour (to relate this to your retail price, it is 4 cents per kilowatt-hour).[22] Adding enough storage to make this what the industry calls 'firm capacity' temporarily increases the price to about $60. By comparison, the average wholesale price in 2021 was $84. Estimates of the likely price of electricity if new gas or coal-fired power stations were to be built are around $80 and $110 respectively. So, there is no economic case for new fossil fuel capacity, although the Morrison government was at the time of writing still talking about using public funds to develop new gas fields and to build a gas-fired power station.

> Although renewables made up over 80% of the new capacity added in 2020, they still only supply about 5% of world electricity.

While politics may be obstructing change in the Australian electricity industry, sheer economics is driving the transformation globally. The investments in new generating capacity for the year 2020 tell a compelling story. In that year the world installed 127 Gigawatts (GW) of new solar energy, 111 GW of wind, 20 GW of hydro and 2.5 GW of bio-energy, adding up to 261 GW of new renewables.[23] About 40 GW of new gas-fired power came on line,[24] but the amount of new coal-

fired electricity was almost fully offset by the amount of old capacity decommissioned.[25] The average price of power from new solar farms is 3.7 cents per kilowatt-hour, wind 4.1, gas about 8, coal over 11 and nuclear more than 16. However, the huge amount of capital invested in coal and gas means some of those facilities will continue to be used, even when the operating costs mean they are running at a loss. As one financial analyst pointed out, while the old power stations are still operating, they appear on the company's balance sheet as an asset.[26] Once they close, they disappear from the asset column and become a liability which incurs the cost of decommissioning and cleaning up the site.

Although renewables made up over 80% of the new capacity added in 2020, they still only supply about 5% of world electricity. Similar figures apply in Australia: for 2018–19, the last full year for which figures were available at the time of writing, 6.4% of energy used in Australia came from renewable sources, with 39% from oil, 29% from coal and 26% from gas.[27] Those figures are a stark reminder of the enormity of the task of moving to net zero emissions by 2050. While it is relatively straightforward, at least in principle, to replace all the coal-fired electricity with renewables and storage, that only tackles about 30% of our energy use. The Australian transport system is overwhelmingly fuelled by oil, while huge amounts of gas are used for cooking, heating and industrial processing. As Dr Alan Finkel's 2021 Quarterly Essay *Getting to Zero* made clear, reducing all our fossil fuel use to near zero is a huge challenge, even on a thirty-year time scale.[28]

Renewables are not a magic pudding for infinite energy.[29] Every extra megawatt comes with environmental impacts of its own, and the sites for the most efficient energy harvesting and storage will be rapidly exhausted. The quantities of minerals such as copper, lithium and rare earth metals required to scale up renewable technology raise issues of scarcity of available ores, geopolitical constraints and environmental impacts of mining. The energy required in mining, manufacture, installation and maintenance of energy infrastructure is not insignificant. Anything we can do to minimise our aggregate energy demand is going to make the transition more feasible and ecologically sustainable. As a multiplier of energy demand, the scale of the future human population is a crucial factor for ensuring a world powered by renewables can deliver enough energy per person. Also, we shouldn't neglect non-energy-related emissions, including deforestation and soil degradation, in which population also plays a crucial role.

2. Contribution of population to emissions

At a basic level, there is an obvious link between population and use of fuel energy. In the absence of significant changes in lifestyle, the energy demand is directly proportional to the number of us using the energy. For most developed countries, greenhouse gas emissions per person peaked in the 1970s (see Figure 2). Where population growth was sufficiently low, such as in Europe, total emissions also declined thereafter. Most of the growth in emissions has been in emerging economies, particularly China and India, due to their large and growing populations steadily improving in wealth. But even in sub-Saharan Africa, where per capita fossil fuel use has fallen, emissions have grown 60% since 1990 due to population growth. If we include deforestation (referred to in emissions accounts as LULUCF, which stands for Land Use, Land Use Change and Forestry), Brazil and Indonesia make it into the top 10 countries for total emissions.[30]

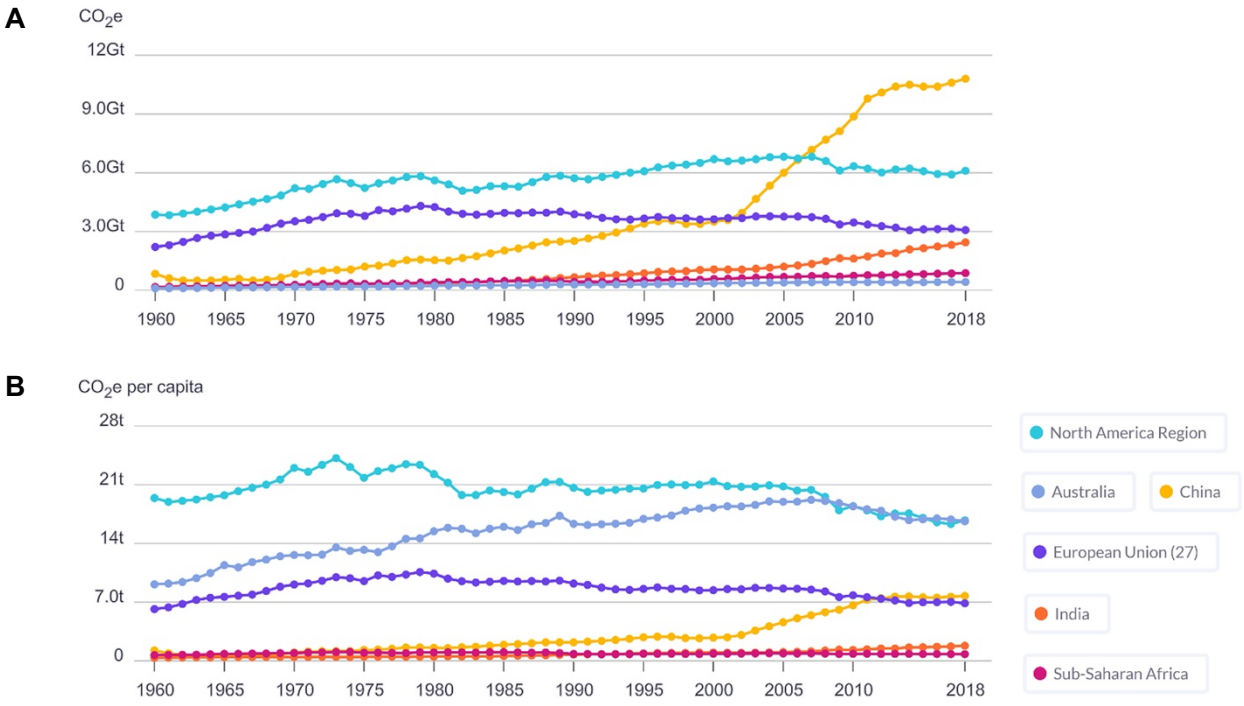

Figure 2: Historical greenhouse gas emissions (CO_2-equivalent) [31] excluding land use and land use change, for selected regions and countries, on a total territorial basis (A) and per person (B). Source: World Resources Institute [32]

However, the declining emissions in rich countries might be deceptive. The increasing role of international trade means that most rich countries consume increasing amounts of things made in other countries, so the emissions associated with making those things are not counted in the consuming country. Australia is unusual among developed countries, for a long time exporting more embedded emissions than we import, on account of the vast amount of energy used in mining and agriculture for export commodities. But in recent years, the import demands from our growing population have wiped out that credit and made us net importers of embedded emissions. That means our national figures underestimate the emissions due to our lifestyles.[33]

Australia is not typical of developed countries

Australia has seen little of the decline in per capita emissions that other rich countries have achieved. Our per capita energy use has stayed around 250 gigajoules a year, which is equivalent to about 8 kilowatts of continuous energy use, 24 hours a day. That figure is a graphic reminder of the extent to which our entire lifestyle is based on huge flows of energy. While you are sitting reading this discussion paper, your basal metabolic rate is about 100 watts, you might be using a similar amount of energy for light, perhaps a kilowatt or so of heating or cooling and your household is probably running a refrigerator and other appliances, but you would struggle to get your direct energy use above a couple of kilowatts. You could use energy at a rate of 8 kilowatts when you are driving a car, but you probably don't spend more than a small fraction of your day behind the wheel. That per capita total reflects the fact that energy is required to construct and operate the buildings in which we live, work and play, to grow, process and distribute our food, to supply drinking water, to remove and process our wastes, to operate our hospitals and so on. Almost every aspect of modern life depends on the availability of energy.

> Import demands from Australia's growing population have made us net importers of embedded emissions, meaning our national figures underestimate the emissions due to our lifestyles.

The fact that our lifestyle emissions have altered little in the last thirty years means that our energy use has increased in direct proportion to population growth. In 1990, there were 17 million Australians using 4000 petajoules of energy; by 2019, there were 25.2 million people using 6200 petajoules. In Figure 3A, we can see that Australia's total emissions have recorded some decline since 2007, but this is entirely due to reduced land clearing (LULUCF). It is convenient for the Australian government that emissions from land clearing happened to be higher in the base year used for commitments under both the Kyoto Protocol and the Paris Agreement.

Excluding land clearing, emissions rose as our population grew. On a per capita basis (Figure 3B), we are consuming as much fossil fuelled energy as in 1990. Only non-energy emissions (mostly land clearing, but also industrial process emissions) are lower now than 1990, according to the national accounts. Energy emissions per person grew until 2007. Their subsequent decline might have been influenced by higher petrol prices or the Global Financial Crisis, but the uptake of renewable energy contributed. The small decline in energy emissions per person was insufficient to stem the growth in emissions due to population growth.

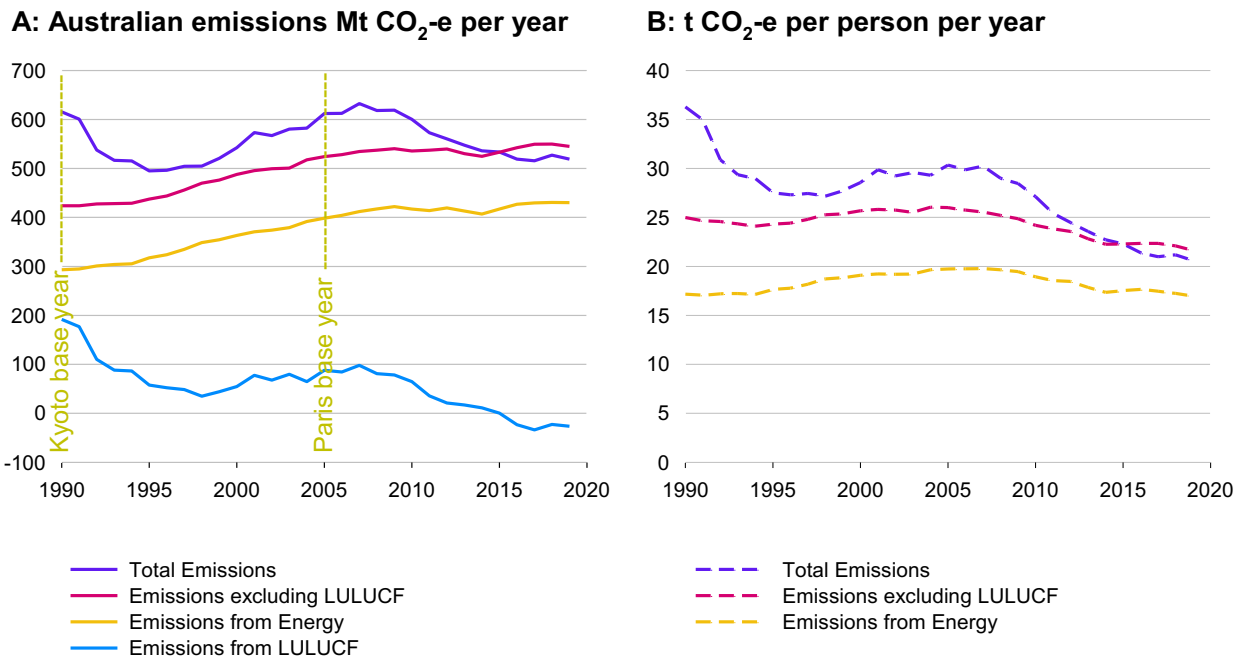

Figure 3: Australian greenhouse gas emissions from 1990 to 2019, (A) total national CO_2-e per year (millions of tonnes) and (B) tonnes per person per year. Source: OECD [34]

Deforestation remains a significant source of emissions in Australia, as well as a threat to wildlife species.

According to national carbon accounts, total LULUCF emissions recently went into negative territory due to continued growth in existing forests and some expansion of plantation forests. Ecologists are questioning this result, claiming that the national accounts are missing substantial areas of land clearing.[35] Queensland is the state with the greatest areas of land clearing, and the Queensland government's Statewide Landcover and Trees Study (SLATS),[36] published in late 2021, estimated that 680,688 hectares (ha) of woody vegetation were cleared in 2018–19, in contrast to the 370,000 ha estimated in the national carbon accounts.[37] It also implied a big jump in clearing since 2017–18 but the increased imaging resolution used in the latest estimate suggests that all earlier estimates might have been too low. In any case, deforestation remains a significant source of emissions in Australia, as well as a threat to wildlife species. According to the national accounts, emissions from tree clearing fell from around 136 million tonnes of carbon dioxide-equivalent (Mt CO_2-e) in 1990 to around 50 Mt in 2021.[38] Stronger land clearing regulations might have stemmed the loss of vegetation in the outback, but urban expansion, driven by population growth, continues to drive deforestation in moist coastal areas, where native vegetation contains high levels of carbon per hectare.

Population and consumption multiply each other

Whether population growth or economic growth matters more to climate change has been long argued. But these are not independent contributors, they are factors that multiply each other. China's rapid enrichment is significant for climate change because of its vast population. How much Africa's population growth will contribute to climate change will depend on how it develops economically. A commonly used breakdown of factors contributing to energy emissions is known as the Kaya Identity:

Emissions = Population x GDP/capita x Energy/GDP x Emissions/Energy

Hence, the impact is the product of population multiplied by wealth (GDP per capita) multiplied by the energy intensity of the economy (joules per $ of GDP) multiplied by the emissions intensity of energy (g CO_2 per joule). Figure 4 shows the change in each of these factors for Australia since 1990. Although economic growth has been a little higher than population growth, the declining energy intensity of the economy reflects the fact that much of that growth has been concentrated in sectors that don't increase the throughput of energy and resources, such as finance and property trading.

For Australia, although real GDP per capita grew 59% from 1990 to 2019, all the change in energy emissions was due to the change in population.

In a low-income country, GDP growth might increase emissions disproportionately, as people switch from biomass to fossil fuels. But in a developed country, much of the extra wealth affects the quality rather than quantity of consumption (air travel is an exception.) For Australia, although real GDP per capita grew 59% from 1990 to 2019, falling emissions intensity per dollar of GDP negated this increase so all the change in energy emissions was due to the change in population: an increase of 8.3 million people. Transitioning to renewable energy is now critically urgent, but we will make faster progress if we simultaneously use less energy per person and slow population growth.

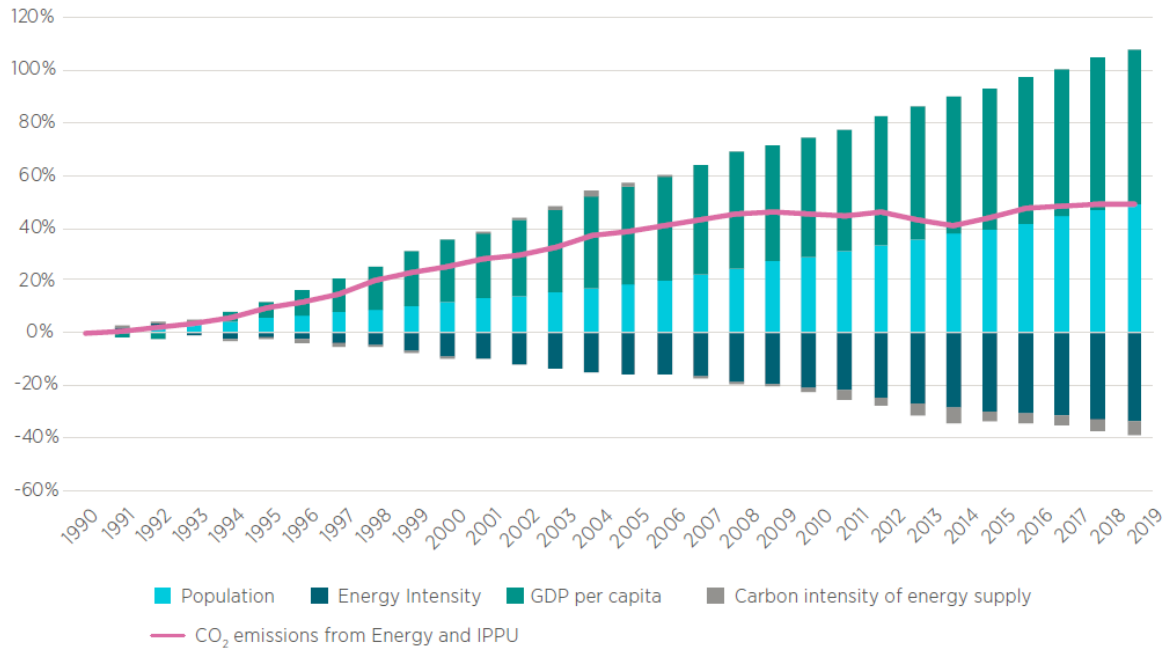

Figure 4: Growth in Australian CO_2 emissions from fuel combustion and industrial processes (purple line) and in the four factors that contribute to this change. (IPPU = industrial processes and product use.) Source: Australian Government [39]

The effect of family size on a person's emissions legacy

One recent study to identify the most effective way of reducing greenhouse gas emissions put the spotlight on population growth as a driving force.[40] The research team estimated the amount of CO_2 emissions that could be reduced by possible actions in the affluent world. Among the choices found to have most impact were living without a car, calculated to save 2.4 tonnes of CO_2 a year, or adopting a vegetarian diet, which would save 0.8 tonnes a year. Long flights produce significant emissions, with a return transatlantic flight between North America and Europe releasing about 1.6 tonnes of CO_2. But the savings that could be achieved by these sorts of actions

were dwarfed by the potential impact of having fewer children. The calculation recognised that a child will not just be a consumer for their lifetime but will probably in turn have children who will eventually have children of their own, and so on for future generations. By adding up the lifetime emissions of each child and their potential descendants, then dividing that total by the expected lifespan of the parents, with each parent assumed responsible for 50% of the child's emissions, 25% of each grandchild and so on, the remarkable conclusion was that having one less child would save the equivalent of 58.6 tonnes of CO_2 each year of the parent's remaining life. By this calculation, having one less child saves each parent more than 20 times as much as living without a car, or about 70 times as much as eliminating meat from the diet (Figure 5).

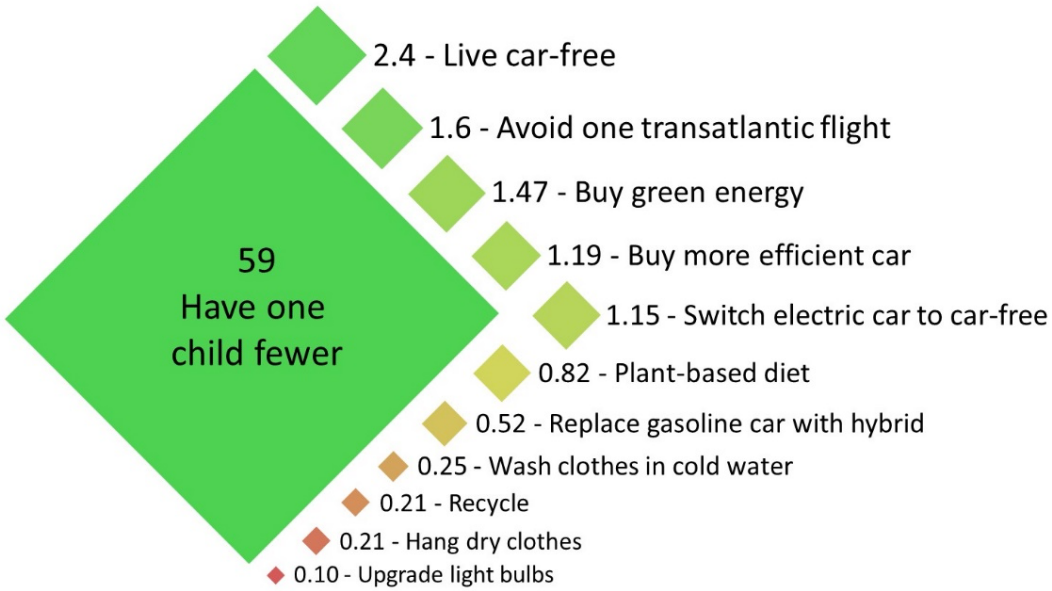

Figure 5: The emissions reduction (tonnes CO_2-e per year) achievable from various individual actions – the mean value of developed countries. Emissions avoided by having one child less assumes each parent is responsible for half the lifetime emissions of their child, a quarter of a grandchild etc., divided among the parent's remaining years of life. Data from Wynes and Nicholas [41]

Having one less child saves each parent more than 20 times as much emissions as living without a car, or about 70 times as much as eliminating meat from the diet.

Some people have challenged the validity of this calculation. They claim that it would count the same emissions multiple times: attributing responsibility to the individual and their parent and their grandparents etc.[42] This is a misunderstanding, however, since we are referring to emissions *reductions*, not emissions. If an emissions reduction is attributed to the parent for deciding not to have a child, there is no child in the next generation to attribute the missing emissions to, so no double counting. We should also avoid confusing the contentious issue of moral responsibility with the mathematical calculation of the impact of decisions. Of course, it is arguable that the children and grandchildren would have had smaller footprints than their parents, as we transition to renewable energy. Nevertheless, in accounting 'emissions reductions', what matters is the baseline. The baseline assumption is that current behaviours persist, including current fertility rates and current consumption behaviours. If a child has less impact than their parent, then those emissions reductions are attributable to the child, not the parent.

But if there are fewer children than the baseline, those avoided emissions are legitimately attributable to the potential parents for choosing not to have them.

Early emissions reductions are vital, but longer-term reductions matter too

The issue of timing of the avoided emissions is a valid consideration: the single act today of choosing not to have a child spreads the avoided emissions over many decades, whereas choosing not to take a long-haul flight has a rapid effect (if we can assume that airlines respond quickly to falling demand by scheduling fewer flights). But many other actions also have delayed effects: installing solar panels initially causes additional emissions in their manufacture and installation, and spreads the avoided emissions over the next 30 years or so. Planting trees sequesters carbon with a similar time profile to not having a child: initially gradual, and peaking in the 20–100 year period, tapering off as tree generations turn over. None of these timing issues are used to discredit these mitigation actions, so should not be used to invalidate the impact of avoided births.

Most actions with delayed benefits have a limited period: the life of the solar panels, for instance. In contrast, decelerating and reversing population growth continues to magnify its impact into the future. A few decades after a change in population policy, it could become the biggest factor influencing demand for energy, construction materials, land clearing and emissions-intensive foods such as rice and meat. The fact that these big gains take decades makes it all the more urgent to choose a lower population path now.

That being said, some impacts of slowing population growth happen quickly. For example, the construction industry currently accounts for around 18% of Australian greenhouse gas emissions.[43] While Australia was growing at around 1.5% per year, at least 40% of this construction activity was attributable to population growth.[44] If we end that population growth, construction is limited to improving and replacing old facilities, not constantly expanding our stock. Straight away, 7% or more of Australia's emissions could be avoided. In contrast, maintaining our recent 1.5% population growth would lead to ever-escalating impacts, not only in total but per person. As cities get more dense, construction becomes more intensive of energy, concrete and steel.[45] Tunnels must be dug for roads and railways, buildings must be taller, water is pumped from further afield, recycled or desalinated. These changes progressively increase the emissions per person, without representing an increase in consumption or wellbeing. Indeed, often this extra resource-intensity is accompanied by reduced quality of life.

> If we end Australia's population growth, straight away 7% or more of Australia's emissions could be avoided in unneeded construction.

There are also political reasons why the climate impact of procreation has attracted little attention. Decision-makers are very wary of the possible political backlash if they try to take action to slow population growth.[46] Powerful vested interests who benefit from property development and cheap labour maintain a strong campaign of misinformation claiming economic calamity if population growth is slowed or even starts to decline. Political leaders also tend to focus on the short term and see more people as the easiest way to achieve the economic growth they desire. They don't seem concerned that this population-driven economic growth doesn't improve incomes per person.[47]

3. Drivers of population growth

Australia's population

Australia's population growth is the sum of two contributing fluxes: the so-called 'natural increase' (the difference between births and deaths) and the net level of migration (the difference between immigrants and emigrants).

There is often confused public debate about the birthrate in Australia. The widespread availability of reliable contraception has significantly reduced the average number of children each woman has, from about 3.5 in the post-war baby boom to a current figure around 1.6–1.7. That is less than the level regarded as the replacement rate of 2.1 children per woman. As a result, you will sometimes hear uninformed observers say that we aren't replacing ourselves and the population would be shrinking if we weren't bringing migrants into the country. Whether such shrinkage would be a good or bad thing is another subject, but the point here is that the argument simply is not true. Although Australian women are on average having fewer children, the 'natural increase' is still about 130,000 per year.[48] The reason is that each year we have more women in the reproductive age range, partly because of the past birthrate and partly because of migration to Australia, since most of the migrants who come to Australia are in the child-bearing age group. If net migration immediately ceased, as during the COVID-19 pandemic, the population would still increase by about 130,000 a year, or a million more every 7–8 years, due to natural increase. But in the longer term, if low immigration levels were sustained, this growth would tail off as the biggest generations reach the end of their life, increasing the number of deaths until it overtakes the number of births, so that within a few decades Australia's population would be able to stabilise.

> The average migrant to Australia increases their carbon footprint fourfold by adopting Australian lifestyles.

Between 1990 and 2020, Australia's population grew from 17 million to over 25 million, 8 million in 30 years or about 270,000 a year. The rate of increase has actually been greater in the most recent decade: 3.5 million in 10 years or 350,000 a year. This change in pace was the result of Howard and Rudd government policies to increase both births (through the 'baby bonus' and other encouragements) and immigration (by expanding a range of different visa categories).

High immigration that leads to population growth will also increase Australia's resource use and our emissions of greenhouse gases. It also is likely to increase global emissions, since many migrants come from countries using less energy and emitting less CO_2, and they change their

lifestyle when they build their life in Australia. In most cases, that is part of the reason they come to Australia, seeking a higher material standard of living. One study calculated that the average migrant to Australia in 2010 would have emitted 5.35 tonnes of CO_2-e per annum in their home country.[49] When they move to Australia, that amount is likely to gradually move upwards to the Australian cultural 'norm', in this case 20.4 tonnes per person in 2019, an increase of 15 tonnes per migrant per year.

Global population

The global picture is more complicated. In overall terms, the countries with the highest rates of population growth are generally those where tradition and poverty reinforce each other. Misogynist and pronatalist traditions lead to large families, which result in resource scarcity and an inability to expand job opportunities, education and health services fast enough, leaving people poor and with neither access to family planning nor the motivation to use it. In affluent countries, children are a significant financial burden. People are inclined to defer childbearing to establish their career and home, and limit births to ensure they can provide well for their children. In relatively poor countries, children are often seen as both extra workers and a source of security for parents in old age. That the children themselves might be better off with fewer siblings wasn't traditionally considered because family size was not a choice, it was merely fate. Women who are permitted no other role in life than raising children also gain prestige from a larger brood, particularly of sons. But logical reasons are only a small part of the picture, since attitudes to ideal family size are influenced more by social norms than reason.[50]

Better education, changing attitudes to women's roles and rights, and urbanisation all contribute to changing these traditional attitudes. But in countries that were most successful in reducing birth rates, the active promotion of small families and contraception methods greatly accelerated the change in attitudes. By reducing population growth, these countries were able to develop economically much faster than those where birthrates remain high. Emphasis is often placed on the role of education and development in driving lower birthrates, but a stronger case can be made for influence in the opposite direction: that family planning programs, with consequently lower birth rates led to more rapid gains in education and development.[51]

Emphasis is often placed on the role of education and development in driving lower birthrates, but a stronger case can be made for influence in the opposite direction.

Voluntary family planning programs thus have a proven track-record for priming a virtuous cycle, in which smaller families lead to better household finances and education, leading to smaller family preferences in the next generation. They are also much less costly than making significant direct impacts on poverty and education, and each dollar spent on family planning saves around three dollars in avoided health care for mothers and infants.[52] The economic stimulus from slowing population growth repays the investment more than a hundred-fold within a few years.[53] The same investment in family planning avoids more greenhouse gas emissions per dollar than any renewable energy technology, even when the avoided births are in low-income countries.[54, 55] The same dollar liberates women from unwanted childbearing, saves lives of women and children, improves children's nutrition, education and employment prospects, enhances peace and security and eases pressure on natural resources and biodiversity. This makes family planning a 'best buy' for both development and the environment (Figure 6).

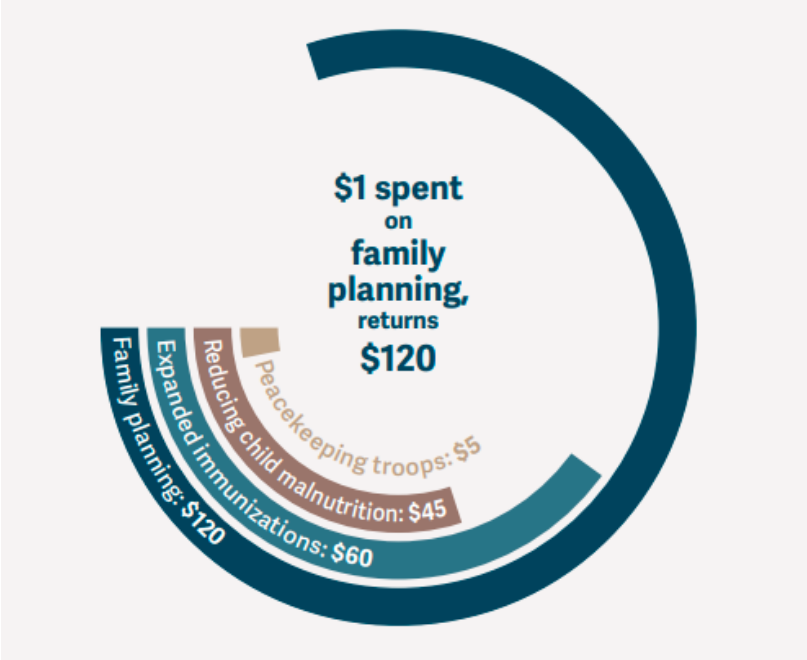

Figure 6: Benefits per dollar spent for various development interventions. Source: OASIS [56]

Despite these immense benefits, reproductive health and family planning activities are chronically underfunded,[57] and shunned as too controversial by many aid agencies. In 2010 family planning received only 0.3% of European international aid (Figure 7: 7% of 57% of 8% is 0.3%). Australian spending on family planning was only 0.1% of bilateral aid in 2017–18.[58]

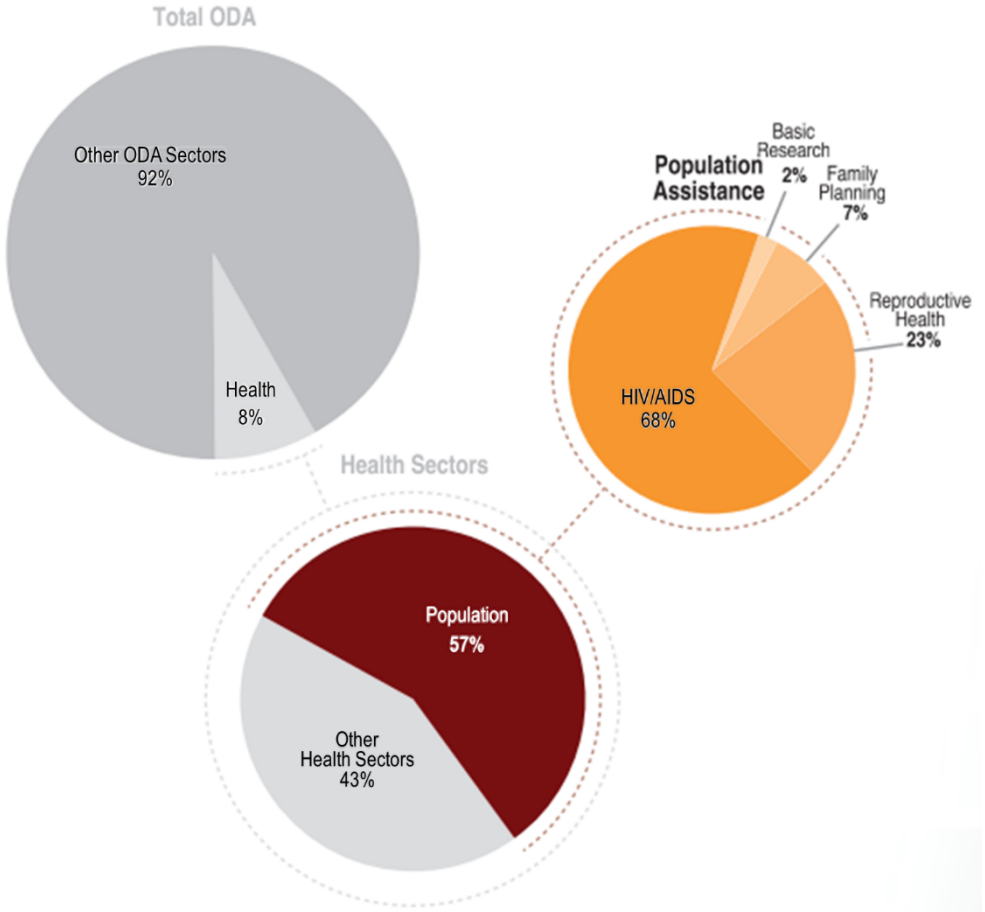

Figure 7: Distribution of European official development assistance to health sectors including family planning in 2010. In that year, the EU provided 63% of global development aid. Source: Pavao & Ongil (2011). [59]

In 2012, the UK government and the Bill and Melinda Gates Foundation launched a campaign to rekindle international support for family planning, initiated through the 2012 London Family Planning Summit. Attending countries committed to increased funding and cooperation. Australian Foreign Minister Bob Carr promised AUD $53 million per year, but the incoming Coalition government did not honour this pledge.[60] The campaign aimed to halve the number of women with an unmet need for family planning by 2020, anticipating an extra 120 million contraception users in poor countries. The organisation Family Planning 2020 was created to drive and monitor this agenda.[61] Some improvements in funding and service delivery were achieved, but by 2020 there were only 60 million additional contraception users, while the numbers of non-users increased due to population growth.

While never sufficiently funded to meet women's needs, the underfunding became dramatically worse after the 1994 United Nations Conference on Population and Development (ICPD).[62] Prior to 1994, the family planning agenda was regarded as an instrument enabling economic development. In most countries, services were entirely voluntary and focused on improving the health and rights of women and infants, but the focus was on persuading couples, in their own interests, to limit childbearing with the aim of limiting population growth, knowing this was essential for reducing poverty and ensuring food security. However, in some countries, coercive measures were taken, including forced vasectomies in India in the late 1970s, and China's 'one child policy' from 1979. A campaign leading up to the ICPD advanced the idea that any program explicitly aiming to reduce population growth would abet coercion and was incompatible with advancing women's rights. The campaign succeeded in reframing the UN's family planning agenda as serving women's reproductive health and rights exclusively, rather than ensuring (as the global family planning movement had always intended) women's rights and population goals should be simultaneously and synergistically pursued. Targets shifted from fertility rates to the percentage of women with unmet needs for contraception. While well-intentioned, this shift demoted family planning from a central component of national development strategies to a minor activity of health departments. Funding and political interest in the provision of family planning services shrank, and efforts to promote small family norms were abandoned.

> Investment in family planning is a 'best buy' for both development and the environment – but remains chronically underfunded.

Various myths were promoted to help embed this perspective, including that population growth does not harm economic development, that poverty reduction and girls' education (not family planning programs) are the most effective ways to reduce fertility, and that any attempt to link population growth with environmental damage is a cynical ploy to deflect blame from rich people onto the poor. Hence, it has become taboo to speak of population growth as a problem. Interest in the reasons for this taboo has generated a growing research literature.[63] Because of this taboo, the population issue has almost disappeared from development, environmental, climate change and food security literature.[64] Due to lower levels of funding and attention, this reframing has not had the intended effect of elevating women's reproductive health and rights; it has done the exact opposite.

4. Population as part of the climate change response

Three issues must be addressed in considering whether population should be part of the climate change response. One is the question of how much we can change future population numbers using acceptable methods. This generally means only voluntary methods that enhance individual rights and autonomy, but does not rule out active promotion of small families.[65] As discussed above, claims that 'population control' must mean draconian measures display ignorance of the many countries that implemented successful voluntary family planning programs that benefited women, families and national economies. The second issue is how much difference any achievable population change would make to climate change. Here discussion tends to focus on the small emissions per person in high fertility countries. But these small emissions add up, and addressing the demands of these people for better lives magnifies the trade-off between clean development and sufficiently fast expansion of energy and infrastructure. The third issue is often overlooked but is potentially the most compelling. It is the difference lower population size and growth rate would make to people's vulnerability and capacity to adapt to climate change.

Demographers John Bongaarts and Brian O'Neill set out what they identify as the four crucial misperceptions about the role of population as a driver of climate change:[66]

> *That population growth is no longer a problem*, 'the belief that fertility declines already under way in Asia and Latin America would soon occur in Africa'.
>
> *That population does not matter much for climate,* the view that climate change is largely driven by consumption patterns in high-income countries which generally have low rates of population growth.
>
> *That population policies are not effective*, a view they argue is just wrong because 'family planning programs to assist women in achieving their reproductive goals...have been successful in a number of countries'.
>
> *That population policy is too controversial to succeed*, the view that family planning attracts criticism from religious zealots, has been associated in the past with coercive measures or could be seen as blaming poor countries for the problem created by consumption patterns in the affluent world.

The last of these misperceptions often underlies the others: if people believe it is inappropriate to respond to population growth, they will seek justifications for not doing so, clinging to beliefs that any such responses would be unethical, ineffective and unnecessary. This position presents voluntary family planning programs as an imposition on poor, high-fertility communities – making them pay for the excesses of the rich – rather than as a duty of care, both to address their own desires to avoid pregnancies, and to improve their economic prospects and security.

Population and climate are both security threats

If climate change did not exist, reducing birthrates would still be a key factor for avoiding food insecurity,[67] mass unemployment and violent conflicts in coming decades.[68] The risk of civil conflict is particularly elevated when land and water scarcity coincides with a youth bulge (a high proportion of those aged 15 to 29 in the adult population) and high rates of urban population growth – the 'high-fertility triumvirate'.[69]

Adding climate change to this mix makes it all the more volatile.[70] This was exemplified in Syria where a severe drought coincided with groundwater depletion, sending many farmers off the land and into towns where competition for employment was intense.[71] At the same time, Syria's declining oil revenues were overtaken by its growing oil import needs, leaving a shortfall for importing staple foods. Similar collapses in oil revenue preceded conflict in Egypt and Yemen. All the Middle East oil states have funded increasing food-import dependence from oil revenue, but all face collapse of this revenue when oil runs out.[72] The Sahel region of West and Central Africa, which lacks even this temporary solution, is already experiencing chronic hunger, malnutrition and escalating violence. By 2050, however, it will likely double its population while suffering a climate 3°C hotter than in 1950.[73]

Family planning promotion, not indirect drivers, best slows population growth

Even acknowledging the above benefits of lower birthrates, many people insist that the best way to hasten the end of population growth is by not talking about it and instead focusing on economic development and education, particularly for girls. It is true that these factors correlate with lower birthrates, but it is not true that investments in these areas have been responsible for rapid fertility declines. Overwhelmingly, family planning effort is the biggest determinant of the rate of decline in birthrates.[74] In fact, a major reason that high-fertility countries have generally failed to gain any economic ground is because of the debilitating burden of rapid population growth.[75] (Middle East oil states are the main exception, but a precarious one as we have noted). Countries that prioritised family planning, like South Korea, Thailand, Bangladesh and Indonesia, managed to reduce birthrates while still very poor and with low levels of women's education. Only after the birthrate fell did their economies improve. Generally, girls have greater access to education when they have fewer siblings, are not married off too young, and have access to contraception. The idea that we should focus on development and education instead of directly tackling population is a case of correlation leading people to assume causation in the wrong direction. Both directions can have an effect: wealthier households and better educated women are likely to choose smaller families, but in countries struggling with rapid population growth, investments in family planning are likely to improve wealth and education more than spending the same amount on development and education.

Family planning effort, rather than economic development or education, is the biggest determinant of the rate of decline in birthrates.

Limiting population growth is essential for avoiding dangerous climate change

If all countries instantly moved to 'replacement rate' fertility (2.1 children per woman), this would only reduce the global population in 2050 by about 10%, and that reduction would mostly be in countries with low emissions per person. Some people use this to argue population policy is irrelevant to climate change.[76] However, nobody is suggesting that addressing population growth would be a solution for climate change on its own. Moreover, we should also be thinking in the longer term. Although the period between now and 2050 is the crucial time for decarbonising the energy system and ending deforestation, whether people will have enough food and water and infrastructure to adapt to climate change in the decades beyond 2050 will be enormously affected by the population path we choose now. Strong support for family planning could mean 30% fewer people in 2100 than the United Nations currently projects.

Whether people will have enough food and water and infrastructure to adapt to climate change in the decades beyond 2050 will be enormously affected by the population path we choose now.

A more pertinent question is, can we limit global warming to less than 2°C *without* accelerating the transition to low fertility? Here we note that climate mitigation (i.e., emissions reduction) modellers usually use a set of socioeconomic scenarios adopted by the IPCC to represent possible futures, with varying levels of international cooperation, inequality and pursuit of energy intensive or green technologies. The five shared socioeconomic pathway scenarios (SSP1 – SSP5) have different assumptions about global population (Figure 8).

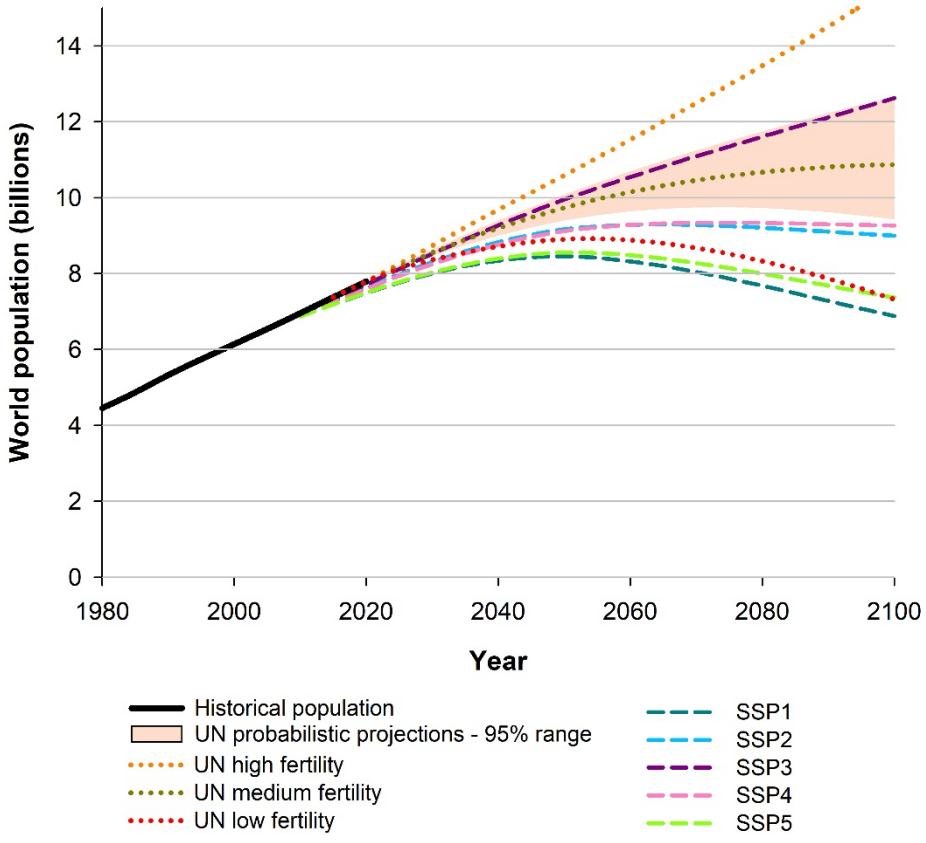

Figure 8. The population projections applied in the IPCC's Shared Socioeconomic Scenarios (SSPs) in comparison with the United Nations (2019). Source: Wittgenstein Centre (2018)[77] and UN (2019).[78]

SSP1 and SSP5 assume a rapid reduction in fertility in Africa and elsewhere, to extremely low levels (1.3 children per woman). Even the 'middle of the road' scenario, SSP2, has a population path below the range that the UN thinks is likely.[79] Only SSP3 is within the UN's probable range, with a population a little higher than the UN's 'medium fertility' projection. According to climate modellers, SSP3 is the worst-case scenario in many respects, a divided world in which poor countries remain poor and international cooperation is weak. But SSP3 is closer to a 'business as usual' pathway for global population, since even the UN's medium projection depends on increased family planning efforts.[80] As the UN says:

> If the international community does not follow through on its commitment to ensure that all men and women are informed and have access to safe, effective, affordable and acceptable methods of family planning of their choice, then future fertility declines may occur more slowly, and future population growth may be faster than what is depicted in the medium variant.[81]

Unfortunately, the SSPs neglect any initiative directed at reducing fertility, and depend solely on improvements in education and poverty reduction to drive fertility decline. There is no historical precedent for such rapid fertility declines occurring without concerted efforts to deliver and promote family planning.[82] As discussed above, this is a case of correlation assuming causation in the wrong direction. Without greatly increased resourcing for voluntary family planning, a world approximating SSP3 seems almost inevitable.

Climate mitigation models show that sufficient emissions reduction cannot be achieved unless the model scenarios assume a rapid peak and decline in global population.

A synthesis of results from several climate mitigation modelling groups concluded that it is not feasible to limit global warming to less than 2°C using the SSP3 scenario.[83] None of the independent modelling approaches achieved it, no matter how rapid the renewable energy transition or how high the carbon price. This is despite per capita GDP and consumption being far lower in SSP3 than in other scenarios. One reason for this failure was the infeasibility of ending and reversing deforestation due to the ongoing demand for land to feed an ever-growing population. We might be able to decarbonise the luxuries of life, but the land and water to meet humanity's fundamental needs are unavoidably a function of population.

Limiting population growth is essential for successful adaptation to climate change

Just as important as the impacts of population stabilisation on greenhouse gas emissions is the potential for it to improve the resilience of communities against climate change and weather extremes.[84] A recent paper by Maja and Ayano (2021) argued that population growth is significantly affecting the ability of farmers in low-income countries to respond to climate change.[85] They concluded that rapid population growth 'continues to be a major underlying force of environmental degradation', leading to scarcity of arable land, declining soil fertility and encroachment on natural areas such as forests. Perhaps more importantly, they found that these pressures would reduce average farm incomes and make it more difficult for farmers to adapt to climate change. Meanwhile, good farmland and water access are lost to urban sprawl, forests are cut for fuel and land, and soil carbon is lost through intensive use. They showed that rapid population growth was not just accelerating climate change by reducing the carbon stores in forests and soils, but compounding the problem by reducing the capacity of the food production system to adapt to the changing climate.

The regions most vulnerable to critical shortages of food and water tend to be those with high population densities and growth rates. In these regions, population growth is a much greater driver of water and food insufficiency than is climate change. A recent study estimated that climate change could reduce global crop yields by 3–12% by mid-century and 11–25% by 2100.[86] Such reports are deserving of the media attention they get, but none is given to the fact that projected population growth will diminish the land and water available per person by 56% in the Middle East, 66% in North Africa and 83% in sub-Saharan Africa over the course of the 21st century.[87] Modelling by Gunasekara and co-workers concluded that small reductions in population growth could have large effects on the numbers of people exposed to acute water stress.[88] Carter and Parker evaluated threats to groundwater access in Africa, concluding,

> The climate change impacts [on groundwater] are likely to be significant, though uncertain in direction and magnitude, while the direct and indirect impacts of demographic change on both water resources and water demand are not only known with far greater certainty, but are also likely to be much larger. The combined effects of urban population growth, rising food demands and energy costs, and consequent demand for fresh water represent real cause for alarm, and these dwarf the likely impacts of climate change on groundwater resources, at least over the first half of the 21st century.[89]

Modelling drivers of future food insufficiency, Hall and co-workers concluded,

> Very little to no difference in undernourishment projections were found when we examined future scenarios with and without the effects of climate change, suggesting population growth is the dominant driver of change.[90]

In 2012, Moreland and Smith found that even a modest increase in the rate of fertility decline in Ethiopia would negate the anticipated impacts of climate change on food insecurity in that country.[91] Thankfully, Ethiopia has since made considerable progress in extending and promoting family planning, as have Rwanda and Malawi, but most other tropical African countries are progressing more slowly.

Population growth affects the ability of farmers in low-income countries to respond to climate change.

The 2021 famine in southern Madagascar is salient. The famine is claimed to be triggered by a severe drought, which is most likely exacerbated by climate change. But it is surely relevant that there are now seven Madagascans for every one present in 1950. All of the agricultural development that has happened in the past three generations could have enriched farmers and improved the country's capacity to cope with bad seasons. Instead, it served only to accommodate more people, each generation living more precariously than the last.

It is not surprising that the global media attribute events such as the Madagascar famine to climate change. Highlighting this link might hopefully increase political will for urgent action to curb greenhouse gas emissions. It is also unsurprising that people are reluctant to mention population growth as a contributing factor. It might give the impression of trying to deflect blame from heavy fossil fuel users in the developed world onto the victims in poor countries. But attribution is not the same as blame. If we don't accurately attribute the causes of problems, we won't fix them. Stopping climate change tomorrow would not avoid deepening food insecurity in Madagascar. Only ending and reversing population growth can do that. This will take decades, and in the meantime we need a great deal of international cooperation to ensure that food aid is provided to those in need, not only in Madagascar but across much of sub-Saharan Africa. The likelihood of achieving this Herculean feat will be much greater if the global population peaks below 9 billion than if it continues to grow past 11 billion.

5. Implications of Australia's population policy for climate change mitigation and adaptation

As we have seen in section 4, up until the COVID-19 pandemic, population growth cancelled out all the progress we had made in reducing greenhouse gas emissions per person in Australia. But the contribution of this growth to our emissions is routinely ignored. Beyond Zero Emissions' Stationary Energy Plan to achieve renewable energy in 10 years anticipated no growth in energy demand, implying that each Australian would need to reduce energy demand by 1.5% per year to compensate for population growth.[92] An extra $6 billion per year would have been needed on account of population growth to achieve the transition while maintaining energy supply per person. Population growth itself costs tens of billions per year in additional infrastructure, and as mentioned earlier, this population-related construction accounts for at least 7% of Australia's greenhouse gases. All this adds to the challenge of reaching net zero emissions.

Population growth must not be used as an excuse for low ambition

Successive Australian governments have recognised the challenge of reducing Australia's emissions in the face of population growth. One of the authors of this paper (Ian Lowe) was at three conferences of the parties (COP) to the climate change treaty (1996, 1997 and 2009). On each occasion, the Australian government delegation argued that Australia needed a more generous emissions reduction target than other affluent countries because of our comparatively high rate of population growth. Delegations from other nations were not sympathetic to this claim, pointing out that the growth rate was not imposed on Australia by other countries or Martians, but was the direct and entirely predictable result of the immigration targets set by the government.

Population growth heightens Australia's vulnerability to climate change

Australia is not only one of the world's largest per capita emitters of greenhouse gases, it is also among the countries likely to be most affected, in terms of negative impacts on agriculture, water supply, bushfire threat and extreme weather events. All these threats are intensified by population growth.

Most Australians would not believe we could become food-insecure, but this is a real threat if our population continues on the path currently projected by the government.[93] The Australian grain harvest is enough for around 60 million people in an average year. Despite being a fairly small contributor to global grain production, Australia contributes significantly to globally traded grain, on which an increasing number of countries depend.[94] The IPCC Sixth Assessment Report anticipates considerable declines in farm profitability across much of Australia.[95] This means that production might be reduced more than yields, since farmers will not plant crops where they are not profitable in most years.

As climate change progresses, Australia could become chronically food-insecure.

If Australia's agricultural output is reduced by climate change, as scientists anticipate,[96] this is likely to contribute to increases in global food prices, threatening food security for the urban poor in many countries. Moreover, if Australia resumes its pre-pandemic population growth, the increasing domestic demand is likely to reduce our grain exports more rapidly than climate change. In a bad drought year, Australia produces only enough grain for 30 million people. Such years are usually associated with El Niño events, when other major grain exporters also have lower-than-average yields. We could exceed 30 million Australian residents in little more than a decade, rendering Australia food-insecure in the years when global prices are highest. As climate change progresses, and if population growth continues, Australia could become chronically food-insecure.

Australia's population growth is controlled by the federal government

Unlike high-fertility countries, Australia's population growth is directly controlled by the federal government, through immigration quotas. As recognised explicitly by the Productivity Commission in its landmark 2016 report *Migrant intake into Australia:*

> With low and stable rates of natural population growth, decisions about the size of the permanent and temporary immigration intake amount to a de facto population policy.[97]

The government could immediately set Australia on a path to population stabilisation simply by not restoring immigration to its pre-COVID-19 levels. A policy of setting net migration levels below 60,000 a year would see the future population stabilise by 2050 at a level in the range of 30–35 million. The current policy of encouraging much higher levels of migration could see the 2060 population approaching 40 million and continuing to grow rapidly. That scale of increase would significantly magnify the task of producing enough clean energy to meet our material needs within a responsible carbon budget. It would also burden many Australian towns and cities with energy-intensive solutions to water scarcity, such as recycling and desalination.

If the government also welcomed lower birthrates instead of fretting over them, the sustainable level of immigration would be a little higher. For instance, the most effective, long-acting

contraceptive options (IUDs and injectables) are little used in Australia because they are quite costly. If they were provided free, it would save the health system money while improving women's lives and avoiding at least a little child poverty. Such a scheme in Colorado saved the health system around $5.85 in perinatal care for every $1 invested, while greatly reducing teen pregnancy and abortion rates.[98] France has recently extended free contraception to women up to the age of twenty-four.[99] But such a win-win solution would not get on the agenda in Australia for the unwarranted fear of lowering fertility.

High immigration does more harm than good globally

Ethical objections to lower immigration quotas often point to massive global inequalities attributed to colonialism and historical injustices. It is said that Australia bears some responsibility to rectify these. To imagine inequalities can be rectified by means of returning to Australia's pre-COVID-19 levels of immigration, or even much higher levels under an imagined open borders scenario, is misguided.[100] Since Federation, Australia has never had an open border policy, such that it would allow anyone who can reach our shores to settle here. No country has such a policy. The demand for migration is simply too great to make this feasible. Around 3% of people globally are migrants, and only about 1% moved from a poor country to a rich one.[101] According to Gallup polls, some 750 million adults (15% of all adults, including one in three sub-Saharan Africans) aspire to migrate and have taken steps to prepare or apply, including more than 25 million who name Australia as their first preference.[102] Clearly we could not satisfy this demand.

> The government could immediately set Australia on a path to population stabilisation simply by not restoring immigration to its pre-COVID-19 levels.

There can be no moral case that Australia has a duty to accept everyone who would improve their life by moving here, because we physically could not accommodate them. Whether we disappoint 99% of potential applicants (under current immigration settings) or 99.7% (under a sustainable immigration quota) makes little difference from the perspective of prospective migrants. Instead, Australia's immigration policies have always been explicitly self-interested, even if the interests served were actually those of politically influential minorities such as property developers and large employers, rather than the wider Australian public.[103] The humanitarian (refugee) intake is the exception, but has typically been only 5–10% of Australia's immigration and could be maintained or even expanded within an immigration cap of 60,000 per year. If Australia really were serious about helping rectify global injustice, then the best policy option would be a major increase in funding for well-targeted foreign aid – thereby making good use of the tens of billions of dollars saved from the infrastructure expansion that would otherwise be required by continuing population growth.

The Big Australia rhetoric can be very damaging to the prospects of people in poor, high-fertility countries. Governments have supported family planning services adequately only when they thought it was important for economic advancement. Some have argued that family planning should only be promoted for the sake of women's reproductive health and rights, and that no population focus is needed because birthrates would fall if women's needs were met.[104] But this strategy has not worked because governments don't prioritise women's rights. Resources plummeted in the 1990s when the economic role of lower birthrates was downplayed in favour of an exclusive focus on women's interests.[105] As a result, fertility reduction stalled in many countries.[106] It is still true that population growth impedes economic advancement, but that message has been suppressed for political reasons. Instead, a manufactured paranoia about population ageing has set in, and countries are being told they'll be better off the faster and

> If Australia really were serious about helping rectify global injustice, then the best policy option would be a major increase in funding for well-targeted foreign aid.

bigger their population grows. Despite the economic claims about ageing populations being ill-founded and population growth providing no lasting solution to ageing,[107] the Big Australia advocates champion this false message. This is a direct discouragement to high-fertility countries, dissuading them from investing in family planning and women's reproductive health and rights. Several developing countries, including Iran and Turkey, have already moved to limit women's access to contraception based on ageing fears espoused by growth-proponents in developed countries.[108] The late president of Tanzania, John Magufuli, did not want Tanzania to suffer Europe's fate (imagine that!) and said women who used contraception were lazy for not wanting to raise many children.[109] Iran, formerly an exemplar of successful rights-based family planning, back-flipped spectacularly with its 2015 Comprehensive Population and Exaltation of Family Bill stripping women of reproductive rights and contraception access.[110] In this way, arguing that we need population growth for the economy does more to exacerbate poverty than the good done by bringing a small fraction of the least-disadvantaged members of other countries to Australia.

6. The impact of climate change on population growth

Climate change could affect the size and distribution of the global population by affecting the birthrate, increasing premature deaths, or stimulating mass migrations. The extent of impacts is uncertain and depends greatly on how communities and governments respond.

The effect of climate change on births

Among the three determinants of population, births are least likely to be directly affected by climate change. Heat stress can marginally increase the risk of miscarriage or stillbirth, but losing a pregnancy does not necessarily change the size of families couples ultimately achieve. The places with the highest fertility on Earth also tend to be places where women are frequently subjected to heat stress during agricultural work. More concerning is the risk of socio-economic disruptions linked to climate change reducing women's access to contraceptive methods. The COVID-19 pandemic illustrated how such disruptions can affect access to reproductive health services.[111] Natural disasters and refugee situations also tend to take girls out of school and increase child marriage, potentially raising fertility rates.

On the other hand, in developed nations, climate change is contributing to the decision of many young people to remain childless, or to reduce the number of children they have. This could be because they fear for the quality of life that the future will afford for their children,[112] or that they want to avoid the environmental impacts that their child would inevitably make.[113] Usually both reasons contribute to the decision.[114] Even in low-income countries like Ethiopia, there is some evidence that communities see smaller families as a means of adapting to worsening environmental conditions.[115] However, to date such sentiments are too rare to alter national fertility appreciably. Indeed, other cultural influences are operating in the opposite direction, including government promotion of births as a misconceived attempt to avoid population ageing,[116] and positive media focus on celebrities who have large families.[117]

Displacement and migration

Many commentators anticipate that large numbers of people might be displaced by the effects of climate change. Most attention has been given to the potential loss of coastal land and small islands due to sea level rise and greater storm surges. These trends have the potential to depopulate affected areas more due to evacuation than to deaths. But such movements of people

are likely to contribute to the indirect drivers of mortality discussed below. A recent US report couched the problem in these terms:

> Many U.S. Pacific islands are atolls fringed with coral reefs and have maximum elevations of 3–5 meters, with mean elevations of 1–2 meters. Sea level in the western Pacific Ocean has been increasing at a rate 2–3 times the global average, resulting in almost 0.3 meters of net rise since 1990. The 2012 US National Climate Assessment provided global sea level rise scenarios that ranged from 0.2 to 2.0 meters by 2100. Regional scenarios are needed. A high surf event in December 2008 overwashed numerous atolls in Micronesia, ruining freshwater supplies and destroying agriculture on approximately 60% of the inhabited islands. Sea-level rise will exacerbate the hazards posed by climate change (storms, waves, temperatures, precipitation, etc.) to infrastructure, freshwater supplies, agriculture, and habitats for threatened and endangered species on U.S. and U.S.-affiliated atoll islands.[118]

Similar concerns have been expressed in other Pacific island communities such as Kiribati and the Marshall Islands: increases in average sea level of about 30 cm in the last three decades have combined with more severe storm events to flood productive land, disrupt agriculture and threaten supplies of fresh water. Of direct relevance within Australia, some of the lower-lying islands in the Torres Strait are already reporting similar problems. The long time-lags in the climate system mean these effects will inevitably worsen in coming decades.

Kirezci and co-workers modelled the impact of climate change and sea level rise on land area exposed to coastal flooding events.[119] Only some of these areas would require permanent evacuation. They estimated that by 2100 under the worst-case climate scenario, the population exposed to such flooding events would increase by 52%, from 148 million currently to around 225 million, based on current population distribution (not allowing for population growth). They emphasise that these figures could be lowered by the construction of protective infrastructure such as sea walls. Again, population growth on the most vulnerable islands and river deltas, particularly in South and South-East Asia, will increase the number of people exposed to this hazard more than climate change will. Although coastal lowlands (less than 10 metres above sea level) occupy only 2% of global land area, they contain 10% of global population, and over 20% of the urban population of least developed countries – cities whose populations are doubling every few decades.[120]

Climate change as a direct cause of mortality

Of greater concern is the prospect of large numbers of people being killed. This could be through heat stress, or impacts of storms, floods and other weather-related disasters, or it could be indirectly as a result of famines or conflicts triggered by climate change. The latter have potential to affect far greater numbers of people, but we should be mindful that climate change would be only one of the contributing factors. Population pressure is usually a greater underlying contributor to food insecurity and civil unrest.

Heat stress is perhaps the most widely studied potential impact of climate change. Climate change causes a disproportionate increase in the frequency of very high temperatures in locations where they were previously very rare. This is often referred to as ‘shifting the bell-curve’. Although the rise in average temperature might be small compared with the usual range of variation, the frequency of extreme heat events at the tail of the curve becomes many times its previous level (Figure 9). The effect is exacerbated because hot locations are experiencing disproportionate amounts of population growth, increasing the number of people likely to be exposed to future heatwaves.

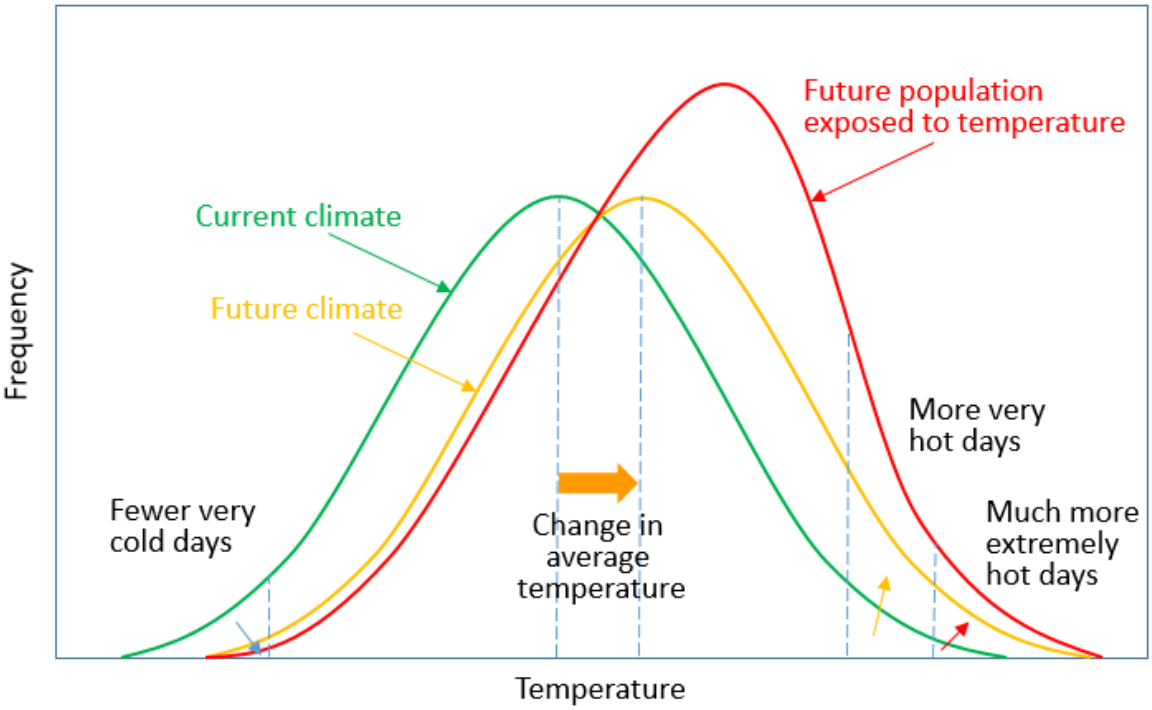

Figure 9: Diagrammatic illustration of the effect of climate change shifting the 'bell curve' of the frequency of temperature events. In addition, population growth is occurring more in hot, humid regions, so that the shift in human exposure to extreme heat (green to red line) is greater than the shift in incidence of extreme heat (green to yellow line).

'Lethal' heatwaves are variously defined in the literature, such as 'a three-day period with maximum daily wet-bulb temperatures exceeding 34°C.'[121] Climate modellers found that 'the most intense hazard from extreme future heatwaves is concentrated around densely populated agricultural regions of the Ganges and Indus river basins'.[122] But heatwaves defined in this way target temperatures deemed to be unsurvivable by healthy adults. Much lower levels of heat stress can contribute to deaths of vulnerable people, such as the elderly, ill or obese. It has been argued that heat is a much more common contributor to deaths than is currently reported on death certificates.[123] In the 2005 European heatwave, some 15,000 people died in Paris alone, mainly elderly people who were living alone. Mora and co-workers analysed reported incidents of excess human mortality associated with heatwaves between 1980 and 2014, to determine a weather threshold for lethality.[124] They estimated that 30% of the world population is already exposed to such events, and this could rise to 74% without climate change mitigation, but possibly as low as 48% if greenhouse gas emissions are rapidly reduced.

> Regions with greatest risk of lethal heatwaves are those with high population density, high population growth rate and high rates of poverty.

The lethality of heatwaves can be mitigated by changes in building design, human behaviours and availability of air conditioning. Because of this, estimates of the death toll are highly speculative. However, it does not bode well that the regions with greatest risk of lethal heatwaves are those with high population density, high population growth rate and high rates of poverty, making it less likely that they will have appropriate infrastructure and access to air conditioning to avoid heat stress. The urban heat island effect, due to heat-absorbing hard surfaces, lack of vegetation and the blanketing effect of smog, can raise the night-time temperature in large cities like

Mumbai by several degrees above the rural surrounds.[125] Population growth makes cities larger, denser and, particularly in poor countries, less green. This makes population growth and intensifying heatwaves a lethal combination.

Other studies have considered the extent to which climate change will extend the range of vector-borne diseases, which will be an issue in affluent areas as well as poor countries.[126] In the Australian context, Liehne argued that the projected climate change will increase the incidence of epidemic polyarthritis caused by Ross River virus, extend the geographical area affected by Murray Valley encephalitis, increase vulnerability to malaria and possibly increase the risk of dengue fever outbreaks.[127]

Mortality attributable directly to climate change is unlikely to affect local and global populations greatly. Most of these extra deaths are likely to be among the old and frail. This does not make them less tragic, but does mean that they have less impact on populations, since few life-years are lost and the number of potential parents is barely affected. Between 2030 and 2050, the WHO estimates that climate change will cause approximately 250,000 additional deaths per year from malnutrition, malaria, diarrhoea and heat stress.[128] This represents around 0.3% of all deaths.

Mortality avoided through the climate change response

The climate change response could reduce mortality associated with air pollutants, which kill over 7 million people per year: the largest environmental cause of ill-health globally, and the second leading cause of deaths from non-communicable diseases.[129] Indoor smoke affects respiratory health of roughly 3 billion users of biomass-fuel cooking in developing nations. Cooking smoke is estimated to lead to between 1.6 million and 4.3 million premature deaths per year, particularly of women and small children.[130] Efforts to introduce improved stoves to reduce smoke exposure have been given a boost by climate finance, since they also reduce emissions of black carbon, which is a potent, if short-lived, climate forcing.[131] Smog (comprising ozone, nitrogen oxides and fine particulate matter), a rapidly increasing health hazard in burgeoning Asian cities, will also be eased by the electrification of transport. To maximise the benefit, however, the source of electricity must transition away from coal.[132] Replacement of coal-fired electricity with renewables substantially reduces fine particulate pollution. Downwind of coal-fired power stations, fine particulates (<2.5 micrometres) have been associated with a range of health impacts, including an estimated 1.37 million cases of lung cancer per year.[133] It seems clear that these climate change mitigation measures will have direct health benefits as well as reducing the risks of intensified weather events.

Mortality to which climate change contributes indirectly

A cataclysmic escalation of deaths this century is a real risk, but climate change would be only an exacerbating factor in a complex combination of stresses generated principally by population pressure. For global population growth to be reversed through more deaths rather than fewer births, premature deaths would need to increase by more than 80 million per year – around 30 times the death rate experienced due to the COVID-19 pandemic, sustained for many years. Clearly, policies should aim to avoid such a catastrophic outcome. Since an infinitely large population is not possible, avoiding this outcome depends on population growth ending through fewer births before environmental strains cause system collapse. Climate change adds to these strains, and hence increases the urgency to minimise further population growth.

Food security is at the centre of this existential risk. Much has been written about potential impacts of climate change on food production. The IPCC's 2019 special report on climate change

and land included an entire chapter on the subject of food security.[134] The executive summary said, in part:

> **Observed climate change is already affecting food security through increasing temperatures, changing precipitation patterns, and greater frequency of some extreme events *(high confidence)*.** Studies that separate out climate change from other factors affecting crop yields have shown that yields of some crops (e.g., maize and wheat) in many lower-latitude regions have been affected negatively by observed climate changes, while in many higher-latitude regions, yields of some crops (e.g., maize, wheat, and sugar beets) have been affected positively over recent decades. Warming compounded by drying has caused large negative effects on yields in parts of the Mediterranean. Based on indigenous and local knowledge (ILK), climate change is affecting food security in drylands, particularly those in Africa, and high mountain regions of Asia and South America.
>
> **Food security will be increasingly affected by projected future climate change *(high confidence)*.** … global crop and economic models projected a 1–29% cereal price increase in 2050 due to climate change (RCP 6.0), which would impact consumers globally through higher food prices; regional effects will vary *(high confidence)*. Low-income consumers are particularly at risk, with models projecting increases of 1–183 million additional people at risk of hunger … compared to a no climate change scenario (high confidence). While increased CO_2 is projected to be beneficial for crop productivity at lower temperature increases, it is projected to lower nutritional quality (high confidence) (e.g., wheat grown at 546–586 ppm CO_2 has 5.9–12.7% less protein, 3.7–6.5% less zinc, and 5.2–7.5% less iron). Distributions of pests and diseases will change, affecting production negatively in many regions (high confidence). Given increasing extreme events and interconnectedness, risks of food system disruptions are growing (high confidence).
>
> **Vulnerability of pastoral systems to climate change is very high *(high confidence)*.** Pastoralism is practiced in more than 75% of countries by between 200 and 500 million people, including nomadic communities, transhumant herders, and agropastoralists. Impacts in pastoral systems in Africa include lower pasture and animal productivity, damaged reproductive function, and biodiversity loss. Pastoral system vulnerability is exacerbated by non-climate factors (land tenure, sedentarisation, changes in traditional institutions, invasive species, lack of markets, and conflicts).
>
> **Fruit and vegetable production, a key component of healthy diets, is also vulnerable to climate change *(medium evidence, high agreement)*.** Declines in yields and crop suitability are projected under higher temperatures, especially in tropical and semi-tropical regions. Heat stress reduces fruit set and speeds up development of annual vegetables, resulting in yield losses, impaired product quality, and increasing food loss and waste. Longer growing seasons enable a greater number of plantings to be cultivated and can contribute to greater annual yields. However, some fruits and vegetables need a period of cold accumulation to produce a viable harvest, and warmer winters may constitute a risk. (emphases in original)

Some of the detail in the IPCC report is particularly concerning. In Asia, much of the food production is dependent on water from melting of ice in Himalayan glaciers, yet that source is already being impacted by climate change. Grain production is projected to increase in regions which are now temperature-limited such as Canada and Russia, but to decrease in regions where

production is limited by water availability, particularly Latin America, sub-Saharan Africa and Australia.[135] Unfortunately, the countries anticipated to lose most production are those with high population growth rates, both trends increasing the burden of food imports in these poor countries. The urban poor are most vulnerable to shifts in global food prices. Historically, spikes in food prices have been associated with uprisings of civil unrest and conflict, such as during the Arab Spring.[136] While the IPCC does not quantify the scale of the problem, it is clear food security would be an increasing problem even if populations had now stabilised. It is difficult to imagine how food production could be scaled up to meet the needs of the projected quadrupling of the African population, when it is already proving difficult to meet current needs. The IPCC report cites UN data estimating that more than 800 million people are under-nourished, more than 150 million children under the age of 5 are stunted by malnutrition, while more than 600 million young women suffer iron deficiency.

The countries anticipated to lose most food production due to climate change are those with high population growth rates. Both trends will increase the burden of food imports in these poor countries.

The overall conclusion is a stark one. Climate change is already affecting our ability to support the current global population, with extreme weather events already taking a toll and food security being reduced by changes in growing patterns. The climatic changes to which we are already committed by emissions to date will make it more difficult to support the current population and are likely to preclude the level of population growth which has been projected for Africa.

Jeffrey Sachs, director of The Earth Institute at Columbia University, made the following comments in a 2017 article:[137]

> Africa's demographic trajectory is deeply worrisome because it is built on an extremely high fertility rate that will hinder its own sustainable development. In Sub-Saharan Africa, the average fertility rate remains more than five children per woman, and the resulting population trajectory is roughly a quadrupling of the continent's population by the end of this century. That means about four billion people in Sub-Saharan Africa, compared to a European population that might be around 500 million at the end of the century. One can only imagine what kind of pressures – perhaps completely irresistible – this would generate. And there's almost no public discussion about it, because you can see how incredibly sensitive this topic is. It can be misconstrued as racist to talk about it, so the left doesn't, religious groups won't, and politicians – facing an issue that will ripen only long after they're out of power – steer clear. Yet the first point is that Africa's own economic, social, and environmental health depend on achieving a rapid and voluntary reduction of fertility rates, mainly by enabling Africa's girls and boys to remain in school.
>
> ... [We need] to recognize that these demographic changes are in nobody's interest, and that they really should be a matter of direct policy attention. I say that at the risk of serious misunderstanding. But the bottom line is that Africa will never achieve successful development if it reaches four billion people at the end of this century. That trajectory would lead to unbearable environmental stress, hunger, war, water depletion, and destruction of remaining biodiversity. It would be a disaster first and foremost for Africa.
>
> But it's possible to promote a rapid demographic change by simple and utterly decent means ... and all in a wholly voluntary manner. I raise this point all the time with African and European leaders, but there's a great difficulty and reluctance to grapple now with a reality that's 20 or 40 or 60 years ahead.

7. Conclusion

If we are serious about our stated goal of living sustainably, stabilising the future population is an essential requirement. This is true about climate change as it is about other environmental issues such as biodiversity loss and habitat conservation, as well as ensuring future sufficiency of food, water and energy supplies. Population should be woven into the policy responses for all these issues. Reaching a global population peak at the earliest date and lowest level achievable will greatly enhance the feasibility of limiting global warming to less than 2°C, and simultaneously reduce the vulnerability of future people to the impacts of climate change.

Because population levels take decades to respond to changes in birthrate or the scale of migration, other mitigation strategies have potential to be much more effective in reducing greenhouse gas emissions in the short term. However, the long lead-time for making significant changes to populations only increases the urgency to put appropriate policies and measures in place now.

The reasons for omitting population measures from the climate change response are political and ideological, not scientific. The reticence stems from the myth that measures to limit population growth require abuses of human rights. On the contrary, measures to provide and promote voluntary family planning *enhance* rights, particularly of women and children, while evading population issues *erodes* rights to sufficient sustenance and physical security, and perpetuates the toll that high fertility takes on women's health and economic freedom. As the political philosopher Diana Coole wrote,

> On a globalised planet on the verge of environmental catastrophe, it seems anachronistic and unnecessary to maintain that the reproductive interests of women are antithetical to their interests in genuinely sustainable development.[138]

Food insecurity is already a resurgent issue due to population growth outpacing growth in food production in many countries. Climate change will make it more difficult to support existing populations, so any population increase will exacerbate the problem. Climate change poses a range of other health threats including heat stress, traumatic injury in extreme weather events and the risks from water-borne diseases during floods, all exacerbated by population density. If we do not consciously choose to stabilise population in socially acceptable ways, it is likely to be curbed by forces we cannot control. Hence, moral jeopardy lies not in action to curb population growth but in the failure to act.

Just as each country has a responsibility to minimise its future greenhouse gas emissions, each country should take responsibility to minimise its future population through voluntary, rights-

based means. In the remaining high-fertility countries (especially in sub-Saharan Africa but also in Australia's Pacific and Asian neighbourhood), family planning services are severely underfunded and promotion of birth control is almost absent. The international community should restore generous support for national family planning programs in these countries, with an emphasis on voluntary, culturally sensitive interventions but without shirking from explicit promotion of small family norms – a component of family planning programs that has been neglected in recent decades but must be reinstated as both necessary and deeply humanitarian. Continuing to claim that population is best addressed through economic development or girls' education is irresponsible when the data show clearly that family planning effort has had the greatest influence on birthrates. Development and education were enhanced as a *consequence* of smaller families relieving the burden on families and government services.

If we are serious about our stated goal of living sustainably, stabilising the future population is an essential requirement.

Relatively low birthrates have essentially stabilised population numbers in many affluent countries. But even in these countries, choosing to have fewer children and allowing the population to contract would make decarbonising the energy and food systems much more feasible. The long-term greenhouse gas impact of having fewer children is much greater than other options available to individuals, such as eating less meat or abandoning car travel. Even affluent countries fail to provide affordable access to birth control to ensure women's reproductive rights, and in some countries the desire to raise fertility rates contributes to the barriers women face. Additionally, some affluent countries such as the Australia, USA, Canada and the UK, still have relatively rapid population growth due to high levels of immigration, contributing significantly to the emissions from those countries.

Affluent countries should desist from promoting population growth, both through pronatalism and high economic immigration. The claims that this growth is needed to combat population ageing are either misguided or insincere – the negative consequences of ageing are exaggerated, and the positives neglected. The much greater chance of avoiding catastrophic climate change is certainly one positive of declining populations that should be widely acknowledged.

While the COVID-19 pandemic has slowed migration rates, most decision-makers in Australia, as in other countries, envisage a return to 2019 policies of high population growth in the relatively near future. Such a resumption would squander the opportunity to speed up Australia's climate change response. Australia would have greater capacity to accommodate genuine climate change refugees in the future if not already straining to accommodate 'economic' migration. An annual net migration cap around 60,000, in contrast to pre-COVID levels around 230,000, would allow Australia's population growth to taper off.

It is not possible for the global population growth to continue forever. Its continued growth is driving us ever closer to the brink of environmental crisis. Climate change, as one result of too much human impact on the environment, is simultaneously driving the brink of environmental crisis toward us. To avert catastrophic collision of these two forces, we must urgently implement policies and actions to decelerate both population and greenhouse gas emissions.

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- How has population growth contributed to Australia's greenhouse gas emissions?
- What are the implications of population growth for climate change mitigation and adaptation in poorer countries, compared to the more affluent countries?
- How does the greenhouse gas impact of having fewer children compare with other climate-friendly actions such as eating less meat or avoiding air travel?
- How can population policy be used as part of the actions to avoid catastrophic climate change?
- How will climate change affect the health, safety and growth of populations?
- Why has population been so often ignored in the policy prescriptions for combatting climate change?

This paper includes unique insights by lead author Ian Lowe, who has been deeply involved in climate policy and research in Australia from its very beginning in the 1980s.