Climate ethics and population policy

Philip Cafaro

According to the Intergovernmental Panel on Climate Change, human population growth is one of the two primary causes of increased greenhouse gas emissions and accelerating global climate change. Slowing or ending population growth could be a cost effective, environmentally advantageous means to mitigate climate change, providing important benefits to both human and natural communities. Yet population policy has attracted relatively little attention from ethicists, policy analysts, or policy makers dealing with this issue. In part, this is because addressing population matters means wading into a host of contentious ethical issues, including family planning, abortion, and immigration. This article reviews the scientific literature regarding voluntary population control’s potential contribution to climate change mitigation. It considers possible reasons for the failure of climate ethicists, analysts, and policy makers to adequately assess that contribution or implement policies that take advantage of it, with particular reference to the resistance to accepting limits to growth. It explores some of the ethical issues at stake, considering arguments for and against noncoercive population control and asking whether coercive population policies are ever morally justified. It also argues that three consensus positions in the climate ethics literature regarding acceptable levels of risk, unacceptable harms, and a putative right to economic development, necessarily imply support for voluntary population control.

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INTRODUCTION

The scientific literature, as summarized in such massive efforts as the Millennium Ecosystem Assessment1 and the twice-a-decade reports from the Intergovernmental Panel on Climate Change (IPCC), states unequivocally that the world’s environmental problems—including climate disruption, excessive nitrogen deposition in the oceans, and mass species extinctions—are driven primarily by human economic and demographic growth. More people consuming more goods and services per capita generate more pollution. We use more land, more water and other resources, leaving less suitable habitat and fewer resources for other species.2,3 Ever increasing demands tend to degrade the key ecosystem services that human and natural communities need to flourish.

Severe global ecological problems show that humanity as a whole is bumping up against limits regarding how much we can take from and dump on the earth. Despite this, most policymakers and commentators appear to assume that an ever-growing human presence can be squared with successfully dealing with global climate change, provided that we develop and deploy safer technologies and manage our economic activities a little more carefully.4 The likely falsity of this assumption renders much of what is written about climate change misleading, or even positively harmful, in its uncritical support for a political economy that has caused these problems and that continues to make them worse.

Humanity’s failure to grapple with ecological limits is ubiquitous; this article explores this failure with regard to global climate change and overpopulation. It describes how ethical analyses, policy studies, and policy initiatives to date have largely neglected climate mitigation and adaptation options focused on...
slowing or reversing population growth. It also considers how climate ethics and policy making might look different if we took human numbers not as a given, but as a variable subject to conscious choice and management.

**POPULATION GROWTH AND CLIMATE CHANGE**

Human population growth is not just an important cause of global climate change: it is one of its two primary causes. As the IPCC’s 4th Assessment Report succinctly puts the matter: ‘GDP/per capita and population growth were the main drivers of the increase in global emissions during the last three decades of the 20th century ... At the global scale, declining carbon and energy intensities have been unable to offset income effects and population growth and, consequently, carbon emissions have risen’ (Ref 5, p. 107)

Climate scientists speak of the ‘Kaya Identity’: the four primary factors which determine overall greenhouse gas emissions. They are economic output/per capita, total population, energy used to generate each unit of GDP, and greenhouse gases emitted per unit of energy. Over the past three and a half decades, improvements in energy and carbon efficiency have been overwhelmed by increases in population and wealth. Again according to the IPCC: ‘the global average growth rate of CO2 emissions between 1970 and 2004 of 1.9% per year is the result of the following annual growth rates:

- population + 1.6 percent,
- GDP/per capita + 1.8 percent,
- energy-intensity (total primary energy supply (TPES) per unit of GDP) −1.2 percent,
- and carbon-intensity (CO2 emissions per unit of TPES) −0.2 percent.’

Greenhouse gas emissions account for about three-quarters of anthropogenic climate forcing; the other quarter comes from deforestation and the conversion of wild lands to agriculture. Here too, population growth is a key factor driving the problem, as governments encourage new settlements and the conversion of forests to agriculture, in order to feed and accommodate burgeoning human numbers.

Crucially, the IPCC’s projections for the next several decades see a continuation of these trends. More people living more affluent mean that despite expected technical efficiency improvements, under ‘business as usual’, greenhouse gas emissions will increase 25–90% between 2000 and 2030 (Ref 5, p. 111) (Figure 1). If we allow this to occur, it will almost surely lock in global temperature increases of more than 2°C beyond preindustrial levels, exceeding the threshold beyond which scientists speak of potentially catastrophic climate change. Following this path would represent a moral catastrophe as well: the selfish overappropriation and degradation of key environmental services by the current generation to the detriment of future ones, by rich people to the detriment of the poor, and by human beings to the great detriment of the rest of the living world.

Just as population growth is an important cause of global climate change, slowing or ending population growth could play a big part in mitigating the problem. Recent evidence suggests that merely providing modern, inexpensive contraception to the

![Figure 1](https://wires.wiley.com/climatechange) | Decomposition of global energy-related CO2 emission changes at the global scale for three past and three future decades (Ref 5, p. 30, Figure 1.6).

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hundreds of millions of women and couples around the world who want it could shift future population numbers significantly downward, from the likely U.N. ‘middle projection’ of 9.3 billion toward the ‘low projection’ of 8.1 billion by 2050, and from a middle projection of 10.1 billion toward a low projection of 6.2 billion by 2100.⁷,⁸

Finding that noncoercive measures could achieve large reductions in population growth, one recent study concluded that ‘reduced population growth could make a significant contribution to global emissions reductions.’ It continued:

Several analyses have estimated how much emissions would have to be reduced by 2050 to meet long-term policy goals such as avoiding warming of more than 2° C or preventing a doubling of CO2 concentrations through implementation of a portfolio of mitigation measures characterized as ‘stabilization wedges’. Our estimate that following a lower population path could reduce emissions 1.4–2.5 GtC/y by 2050 is equivalent to 16–29 percent of the emission reductions necessary to achieve these goals … By the end of the century, the effect of slower population growth would be even more significant, reducing total emissions from fossil fuel use by 37–41 percent across the two scenarios. (Ref 9, p. 17525)

Another way to state this last point is that about 40% of the excessive greenhouse gas emissions projected over the rest of this century under ‘business as usual’ will come from population growth.

Note that population control’s contributions to climate change mitigation increase over time, as smaller global populations in one generation lead to smaller populations in the next generation, and the next, and the emissions reductions continue to cumulate (Ref 10, p. 21). This contrasts with the energy efficiency improvements touted by many political leaders and environmentalists as climate change panaceas, whose early contributions often decrease over time, due to the Jevons paradox: the counterintuitive result by which aggregate resource consumption increases as efficiency improves.⁹ Because higher efficiency reduces the relative cost of using energy and resources, it often stimulates demand for them, thus offsetting potential savings. Moreover, increased efficiency typically encourages economic growth, further increasing demand for energy and other resources. This is precisely the pattern that fossil fuel use followed in the decades after World War II: increased efficiency and increased overall use.

In contrast, less people is the environmental gift that keeps on giving. Those people are not there, and need not show any foresight or discipline in order to make their contributions to decreased resource use. They and their nonexistent nondescendants just do the right environmental thing—nothing—and the Earth’s existing inhabitants benefit.

The key point is that the potential emissions reductions from population stabilization or reduction are immense. Under one likely scenario, noncoercive population measures could reduce greenhouse gas emissions by 5.1 billion tons per year by 2100.⁹ For comparison, total current emissions are approximately 8 billion tons per year. 5.1 billion tons per year is more than five times the annual emissions savings we would achieve in 50 years by doubling the fuel efficiency of the world auto fleet, or by halving the average kilometers traveled per car, or by tripling the number of nuclear reactors currently providing electricity around the world, or by increasing current wind energy capacity 50 times, or by halting all deforestation everywhere around the world.¹¹ Reducing population growth could provide more emissions reductions than all five of these other measures put together.

‘Population control’ tends to bring to mind coercive measures, such as forced abortions or sterilizations.¹² So it should be emphasized that such measures are anathema to most population control advocates. Serious proposals to end global population growth focus on effective, noncoercive policies that enable people to ‘control’ their own reproductive lives.¹⁰ First, providing free or low-cost birth control, and accessible, appropriate information about how to use it, has proven very effective in lowering birth rates in many countries in recent decades.¹²,¹³ Providing inexpensive birth control allows those who want to have fewer children to do so, increasing reproductive freedom while decreasing population growth. Second, making abortion safe, legal and easily available has helped reduce birth rates in many countries. Third, policies which improve the lives of women have been shown to reduce fertility rates in many developing countries.¹⁴ These include guaranteeing girls the same educational opportunities as boys, promoting female literacy, and improving women’s economic opportunities. Fourth, radio and TV soap operas (telenovelas) promoting teenage pregnancy prevention, respect for women, and the economic benefits of small families, have proven effective in changing attitudes and increasing contraception use in areas of the world where large families remain the cultural norm.¹⁵,¹⁶

All these measures can directly improve people’s lives at the same time that they help end population growth. Some of the most effective policies to reduce fertility rates, such as providing cheap, reliable contraception, improving maternal health, and keeping girls in school longer, have also been singled out as keys
to helping poor countries achieve the U.N.’s Millennium Development Goals. Slowing demographic growth, done correctly, can increase women’s freedom and opportunities. It can secure children better access to food and other essential resources. It can help young adults face less glutted labor markets. It can buy time for the sprawling cities of an increasingly urbanized world to set up the infrastructure that makes urban life healthy and bearable. As countries around the world struggle to adapt to climate change—in some cases, perhaps, adjusting to less available food or water—one of the simplest, most effective adaptations may be having fewer people to support (Refs 10, pp. 29–35 and 21).

FAILURE AND ITS CONSEQUENCES

Ending human population growth is almost certainly a necessary (but not sufficient) condition for preventing catastrophic global climate change. Indeed, significantly reducing current human numbers may be necessary in order to do so. Leading climate scientists tell us we need to drive down total annual worldwide greenhouse gas emissions by 60 to 80% over the next 40 to 50 years, in order to keep average global warming below 2°C. We have little reason to believe we can limit greenhouse gas emissions this much, while ignoring the main causes of growing emissions. Technological improvements and efficiency gains will likely be necessary to achieve drastically lower emissions, but only in combination with limits to growth, not instead of them.

By and large, however, those making or commenting on climate change policy reject or ignore such limits. The goal, always, seems to be to accommodate more people and more economic activity with fewer carbon emissions; population issues, in particular, are seemingly taboo. At recent international meetings on climate change in Copenhagen, Cancun, and Durban, population issues were not up for debate. The websites of activist groups like 350.org or Al Gore’s Alliance for Climate Protection fail to mention population growth, when explaining the causes or possible solutions to global climate change. So do the websites and magazines of more established environmental organizations, such as the National Audubon Society (USA) and Greenpeace International. Recent scholarly anthologies on climate change ethics contain no sustained discussions of the population/climate change connection, with the exception of a contribution of my own.

While one recent anthology on climate change policy does include a good stand-alone article on the topic, population matters are barely mentioned by the other 48 contributors.

As further evidence of this silence, consider the most extensive discussion of population growth in the IPCC’s 4th Assessment Report, given below in its entirety:

‘The challenge—an absolute reduction of global GHG emissions—is daunting. It presupposes a reduction of energy and carbon intensities at a faster rate than income and population growth taken together. Admittedly, there are many possible combinations of the four Kaya identity components, but with the scope and legitimacy of population control subject to ongoing debate, the remaining two technology-oriented factors, energy and carbon intensities, have to bear the main burden’ (Ref 5, p. 109; emphasis added).

The IPCC’s position seems to be that population control is too controversial to discuss. But the premise that efficiency improvements on the scale necessary to actually deal with the problem are less controversial than population control, is belied by the past 20 years of fierce debate on climate change policy. Furthermore, the report’s authors do not consider whether sufficient mitigation or adaptation is possible without addressing population issues. This silence leaves an immense hole in their analysis.

At least the 4th Assessment Report’s authors mention population control in this passage, before summarily dismissing it. When they come to consider policy options for mitigating global climate change, limiting population growth is not considered. Within the 4th Assessment Report, you may find hundreds of pages of detailed discussions of alternative agricultural practices, alternative building techniques, alternative airplane, train and automobile technologies—and no discussion of how to limit the number of people whose need for food, shelter and transportation is largely driving global climate change (Ref 35, p. 249). Similarly, in the chapters on adaptation, there are detailed discussions of how societies might prepare for the climate change that we know is coming—but no mention that limiting the number of people clamoring for potentially diminished resources might help countries adapt to a warming world.

By defining ‘the challenge’ of global climate change as reducing greenhouse gas emissions (and deforestation), while still accommodating endless growth, policymakers and the environmental community render an immensely difficult problem even harder, and quite likely unsolvable (Ref 39, pp. 61–76). In addition, the failure to address population issues distorts our judgments regarding just what we should do to mitigate and adapt to climate change, and what constitutes a fair international
division of labor regarding these efforts. Consider that a recent study from the London School of Economics found that reducing population growth is cheaper than most other mitigation alternatives under consideration, as shown in the following table (Ref 40, p. 23, Table 5.0.1):

<table>
<thead>
<tr>
<th>Carbon Reducing Technology or Proposal</th>
<th>Cost-Effectiveness, in $ Spent per Ton of CO₂ Equivalent Prevented ($/ tCO₂e)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugarcane ethanol</td>
<td>6</td>
</tr>
<tr>
<td>Family planning</td>
<td>7</td>
</tr>
<tr>
<td>Reduced deforestation</td>
<td>13</td>
</tr>
<tr>
<td>Switch-grass biofuels</td>
<td>18</td>
</tr>
<tr>
<td>Wind-powered electricity</td>
<td>24</td>
</tr>
<tr>
<td>Solar-powered electricity</td>
<td>51</td>
</tr>
<tr>
<td>Carbon capture and sequestration for coal-fired electricity (new construction)</td>
<td>57</td>
</tr>
<tr>
<td>Carbon capture and sequestration for coal-fired electricity (retrofits)</td>
<td>83</td>
</tr>
<tr>
<td>Plug-in hybrid vehicles</td>
<td>92</td>
</tr>
<tr>
<td>Electric vehicles</td>
<td>131</td>
</tr>
</tbody>
</table>

Consider that measures to reduce population growth provide environmental benefits across the board, not just regarding carbon emissions, in contrast to common alternatives such as nuclear power or hydropower, which threaten human health and degrade wild rivers. Consider that because family planning programs can utilize simple, proven contraceptive technologies, they have a greater likelihood of success than unproven, high-tech mitigation efforts such as carbon capture and sequestration at coal-fired power plants, or futuristic geo-engineering schemes.41

Given such facts regarding cost, environmental impacts, and likelihood of success, previous discussions of ‘what to do’ and ‘who should do it’ must be recognized as incomplete, at best. Just as we may doubt our ability to successfully deal with global climate change, absent a full statement of the problem, so we may doubt that we correctly understand our moral obligations regarding climate change, for the same reason.

THE CAUSES OF THE FAILURE

One likely reason that population control gets ignored in most climate change discussions is that the topic offends many people’s religious sensibilities. For decades, the Catholic Church has been in the forefront of efforts to quash international family planning efforts42 and other conservative religious denominations have also fought to discourage contraception, keep abortion illegal, and defend traditional, subservient female roles within society. For example, Catholic bishops have led recent efforts in the Philippines to legally prohibit or discourage all ‘artificial’ birth control (the ‘rhythm method’ remains morally acceptable, however; probably because it does not work).43,44 True, despite this opposition, many predominantly Catholic countries, such as Mexico, have instituted effective family planning programs, while a conservative Islamic clergy supported efforts to reduce fertility rates in Iran, preaching the values of family planning and women’s education from the pulpit.45 Religious views regarding population control are hardly monolithic. Still, given the sensitivity of these topics, it is understandable that policy makers concerned to develop a consensus around fighting climate change often chose to avoid them.

Even from a secular perspective, population control is contentious.46 Regarding the failure to deal with population issues at the Copenhagen meetings in 2010, the U.N.’s top climate official, Yvo de Boer, remarked: ‘A lot of people say population pressure is a major driving force behind the increase in emissions, and that’s absolutely true; but to then say ‘OK, that means that we need to have a population policy that reduces emissions,’’ takes you onto shaky ground morally’.28 Perhaps to a ‘shaky’ place where you say, or just consider the possible truth of the following statements:

‘There can be too many people in the world’.
‘There are too many people in the world’.
‘Birth control is morally acceptable’.
‘Abortion is morally acceptable’.
‘Birth control and abortion are in many cases morally desirable’.
‘Immigration from poor countries (with low per capita greenhouse gas emissions) into wealthy countries (with high per capita emissions) should be reduced’.d
‘Couples should be encouraged to have only one or two children’.
‘Couples should be discouraged from having more than one or two children’.

Contraception. Abortion. Limiting immigration. Discouraging procreation. Conservatives may see some
of this as ‘baby killing’, encouraging promiscuity, or breaking down the traditional family. Liberals may see some of it as blaming the poor for a problem, global climate change, that they did not cause, or unfairly limiting their opportunities in an attempt to solve it. Why engage these difficult, contentious issues, if it is not necessary to do so? Perhaps because the stakes are so high, and we probably cannot successfully deal with climate change without population control.

Start with the undeniable fact that population growth is currently a major driver of climate change. Next consider the strong unwillingness of most governments to even consider reining in the other main driver: increased per capita wealth. Now add the fact that every additional human being makes some demands on the environment and some contribution to global climate change, and that this contribution cannot be driven down to zero. Finally, recall that human beings have proven selfish and short-sighted in this matter, dithering for several decades now in the face of clear evidence of climate change; that there is every reason to think that our response will continue to be insufficient to address the problem; and that every extra human being makes the problem worse.

It is true, as Yvo de Boer noted, that considering population control forces us to confront difficult moral issues. But those issues do not disappear when we ignore the possibility of population control. Countries still must decide whether or not to provide affordable, accessible contraception to their citizens; whether or not abortion should be legal; how many immigrants to allow in annually; whether tax codes will encourage couples to have fewer or more children; and whether to appropriate all available habitat and resources for people, or instead to reserve some for other species. Their citizens, present and future, then have to live with the consequences of these decisions. Failure to consider all this in terms of a comprehensive population policy and in terms of global climate change and other ecological challenges simply means that such decisions will be made piecemeal, in ecological ignorance, and thus that they will be less likely to further human happiness or the well being of Earth’s many other inhabitants. Given the stakes, continuing to ignore population’s contribution to climate change seems like the real ‘shaky moral ground’.

**WHAT ABOUT COERCION?**

A reasonable argument against using population control to fight climate change is that interfering with people’s reproductive decisions is too intrusive, and an unjustified infringement on their freedom. One answer to this argument is that such intrusion is sometimes justified, when societal well being demands it. Onora O’Neill claims: ‘coercive population policies can be justified only by the threat of major harm, the threat of the destruction of people and of standards of life, and not by lesser inconveniences and impoverishments’. She suggests that such harms might include ‘threats of war, famine, disease, poverty, pollution or overcrowding’ (Ref 48, pp. 38, 36). In On Liberty, John Stuart Mill makes a similar argument to justify coercive population policies, focused on economics rather than ecology:

The fact itself, of causing the existence of a human being, is one of the most responsible actions in the range of human life … And in a country either overpeopled, or threatened with being so, to produce children, beyond a very small number, with the effect of reducing the reward of labor by their competition, is a serious offense against all who live by the remuneration of their labor. The laws which, in many countries on the Continent, forbid marriage unless the parties can show that they have the means of supporting a family, do not exceed the legitimate powers of the State: and whether such laws be expedient or not (a question mainly dependent on local circumstances and feelings), they are not objectionable as violations of liberty. Such laws are interferences of the State to prohibit a mischievous act—an act injurious to others, which ought to be a subject of reprobation, and social stigma, even when it is not deemed expedient to superadd legal punishment (Ref 49, p. 110).

Coming from one of history’s greatest proponents of individual freedom, these words often surprise readers today. But Mill, unlike many contemporary human rights advocates, never loses sight of the importance of individual responsibility, as freedom’s necessary complement. His rights-holders are conceived of as citizens, who live in a world of limited resources and necessary trade-offs, with the expectation that they will sometimes sacrifice for the common good.

The essential idea behind O’Neill’s and Mill’s positions seems to be that rights are justified by their contributions to human flourishing. When the exercise of a right undermines the conditions for that flourishing, it sometimes should be curtailed. As Steve Vanderheiden puts it, in an account updating Millian liberty for the present age: ‘given ecological limits, aggregate ecological space is finite and threatened by current patterns of overappropriation, yielding imperatives to fairly allocate that space among various claimants, present and future.'
Uninhibited autonomy... is not sustainable, justifying significant limits on both personal space and acceptable conceptions of the good life if one person’s exercise of liberty is to be prevented from diminishing another’s opportunity to do the same (Ref 53, pp. 257–258). All this seems plausible, in theory. In practice, however, as an attempt to justify coercive population control, it is hotly contested.

The example of Garrett Hardin’s work is instructive here. In several influential articles and books, Hardin argued that ecological necessity justified coercive population policies. He typically maintained that such policies were justified in order to avoid the even more objectionable or coercive impacts of further population growth; as he put it in Living Within Limits: ‘the real point of population control—a point that critics often miss—is not to reduce population per se, but to reduce misery among the living’ (Ref 56, p. 262). In sharpening this argument, however, Hardin sometimes unhelpfully downplayed the great potential of noncoercive measures to reduce birth rates. Time has clearly proven him mistaken in this. His detractors, meanwhile, often focused on Hardin’s more extreme suggestions, using them as an excuse to avoid asking difficult questions regarding when coercion might really be justified (Ref 47, pp. 15–16), or what the most reasonable alternatives to coercion might be. In the process, those critics often lost sight of the need to limit human populations somehow if we hope to deal successfully with our environmental problems.

Given all this, a second answer to the argument against population control might prove more widely palatable. It is that we may promote policies that put the ‘control’ of their reproductive lives in the hands of individual women and couples. By helping people choose when and whether to have children, such policies will increase, not decrease, their freedom. At the same time, these policies have already proven their effectiveness in many countries by driving down fertility rates and slowing population growth. In this case, it makes sense to implement simpler, less contentious, ‘win win’ solutions and promote voluntary family planning and women’s empowerment. If necessary, such measures might be supplemented with noncoercive incentives for smaller families and noncoercive disincentives for larger ones: for example, tax exemptions could be provided for a first child, but not for additional ones; or, people who have more than two children might be fined. The question of when and whether actual government coercion might be justified—which, after all, is a question that cuts across a whole range of issues, not just reproductive decisions—might be deferred to a later time, or even permanently avoided.

Making noncoercive population control a success now could be the key to avoiding coercion in the future. Meanwhile, it should be remembered that most coercion in reproductive matters today, as in the past, involves forcing women to have more children than they want. According to Babatunde Osotimehin, executive director of the U.N. Population Fund, ‘some 215 million women in developing countries lack access to family planning and therefore cannot fully exercise their reproductive rights’.

CLIMATE CHANGE ETHICS AS IF LIMITS EXISTED

The failure to address limits to growth in the climate change debate has deep roots and will not be corrected easily. Politicians and intellectuals on both the left and the right have fetishized economic growth and are disinclined to ask key questions, such as whether increased wealth will improve human well being or whether more economic activity is ecologically sustainable. Population growth has been less fetishized than ignored. Thus questions regarding the proper scale of the human presence on Earth remain largely unasked. Answering them would help clarify what is at stake in climate change policy.

A short story by Leo Tolstoy famously asked: ‘How Much Land Does a Man Need?’ Climate change suggests that today we need to ask: how much land can Man take? Also: how much land should humanity take, as a matter both of prudence and morality? After all, we are not the only species living on Earth (yet). These questions deserve much fuller exploration by ethicists. I will not attempt to review previous answers here; for good initial discussions (see Refs 67, pp. 228–234 and 68, pp. 60–204). Instead, in the second half of this survey article, I consider how taking limits seriously might make a difference to climate change policy.

In the following sections, I set out three widely accepted positions in climate change ethics and argue that each implies support for strong noncoercive population control measures—provided we add the premise that climate change shows that humanity is bumping up against ecological limits. For the purposes of the argument, I follow convention and define such limits anthropocentrically, as the current human generation making demands that cannot be met without degrading ecological conditions for generations to come.
ACCEPTABLE RISK

One of the more robust conclusions among those studying climate change ethics is that atmospheric carbon and other greenhouse gases should not be allowed to exceed levels that might precipitate catastrophic climate change and cause serious harms to many innocent people. As an important White Paper on the Ethical Dimensions of Climate Change summarized the matter:

All people have a right to be protected from threats to their life, safety, and security caused by others, and [...] existing levels of GHG emissions threaten these rights. [...] so long as atmospheric GHG levels threaten basic human rights, [we] cannot find any respected ethical system that would justify allowing atmospheric levels of GHGs to rise thereby additionally jeopardizing human rights [...] various ethical systems converge in the conclusion that atmospheric levels of GHGs should be stabilized at the lowest possible levels above existing atmospheric GHG concentrations.

(Ref 6, p. 18)

Some climate ethicists and policy analysts might reject stabilization at ‘the lowest possible levels’ as too demanding. But despite some divergence regarding the exact amount of acceptable climate change, a broad consensus appears to hold among climate ethicists that the nations of the world should take aggressive steps to limit greenhouse gas emissions, so as to avoid causing grave harms to fall on large numbers of people.

This consensus also appears to hold among policymakers, at least when we focus on their words, rather than their actions. Article 2 of the United Nations Framework Convention on Climate Change, accepted by most of the world’s governments, states that humanity should ‘stabilize GHG concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system’. Since 1992, this has often been interpreted to mean that greenhouse gases should be limited to levels that prevent an increase greater than 2°C in global average temperatures, relative to an historical baseline—although some analysts have argued that temperature increases should be limited even further. Even the parties at the 2009 Copenhagen Climate Change Conference, in the course of doing nothing to actually help reduce greenhouse gas emissions, verbally restated the 2°C commitment.

My first substantive assertion in the second half of this paper is as follows: the consensus regarding acceptable limits to global climate change demands, at a minimum, that we take steps to end human population growth. Indeed, taking such limits seriously probably supports significantly reducing the size of the current global human population. Given the role population growth has played and will play in accelerating climate change under business as usual, no less cautious policy would appear to pass ethical muster. We should support policies that limit human numbers, not just in the poor countries that are conventionally understood to be overpopulated, but in rich ones, where each additional person generates much larger amounts of greenhouse gases. Just as measures to increase solar and wind power, decrease automobile use, or reduce deforestation should be embraced wherever they are achieved, as helping meet the global challenge of climate change, so measures that reduce human numbers in a humane manner are welcome wherever they occur, and should be encouraged universally.

This conclusion will seem too radical, or appear to follow too quickly, for some readers. Certainly the argument could be set forth in greater detail and with more attention to potential supporting premises: the proven difficulty of getting humanity to work on the other causal levers at our disposal, for example; or the overwhelming evidence, at both national and global scales, that population growth typically translates into increased emissions and deforestation, which in turn drive climate change. Such supplemental argumentation would be required for a full brief for action to stabilize the global population, but I remind the reader that is not what I propose to provide here. My claim is simply that the consensus view on how much climate change risk is morally acceptable, should lead to support for ending human population growth. It should do so obviously and without a lot of heavy lifting, among all those who support significant efforts to mitigate global climate change. To reject this is equivalent to choosing a future in which we try to support ever more people in comfort and security while generating ever fewer greenhouse gas emissions. We need not establish just how unlikely such a future is; it is sufficiently unlikely, that one cannot consistently endorse it while still endorsing any reasonably cautious principle regarding morally acceptable levels of climate change.

UNACCEPTABLE HARM

Another important principle on which all climate change ethicists seem to agree, is that we should not harm the poorest of the world’s poor: either by allowing too much climate change, or by unfairly burdening them in the attempt to mitigate climate change. Simon Caney expresses this consensus view clearly, in the language of human rights. According to Caney, ‘human rights specify minimum moral
thresholds to which all individuals are entitled, simply by virtue of their humanity, and which override all other moral [and other] values’ Ref (71, p. 73). Among the most essential and inviolate human rights are the right to life, the right to health (understood as a right not to have one’s health undermined by the preventable actions of others) and the right to subsistence. But as climate change accelerates, it threatens the life, health and subsistence of many people globally, particularly among the poor. For this reason, individual actions and governmental policies today which contribute to climate change, or which undermine efforts to meet the challenge, are morally objectionable, as contributing to human rights violations.71

Although not all ethicists would state this consensus position in the language of rights, I believe Caney is right to do so. The concept of rights well expresses the moral demand that treating one another decently should trump all our other goals, particularly the pursuit of personal wealth or corporate profits. This point is perennially in danger of being obscured, as the rich and powerful make climate policy. In any case, even among those ethicists who eschew the language of rights, almost all would agree that preventing significant harms to innocent people is a necessary moral obligation as we deal with global climate change.

Now for a second substantive assertion. This moral consensus regarding the need to avoid the massive human rights violations threatened by catastrophic climate change necessarily demands serious efforts to reverse human population growth. If the rights to life, health and subsistence justify telling individuals not to drive gas-guzzling automobiles, take unnecessary plane trips, build and heat immense houses, or otherwise generate excessive greenhouse gas emissions, they also justify telling individuals not to have six children—wherever they live, in the developed or the developing worlds. If these rights allow us to state confidently that governments should institute carbon taxes, fund alternative energy research, or take other steps to reduce excessive energy consumption or make it less carbon intensive. Such a course seems an exercise in futility, as improvements can increase moderately, while their per capita emissions should substantially contract, poor nations’ consumption or make it less carbon intensive. Such a course seems an exercise in futility, as improvements can increase moderately, while their per capita emissions should substantially contract, poor nations’ emissions reductions. More recently, ‘Contraction & Convergence’—the position that wealthy nations’ emissions should substantially contract, poor nations’ emissions can increase moderately, while their per capita emissions converge on a similar average—has garnered wide support. Thus climate ethicists who tackle ‘the allocation problem’ have almost all assigned the lion’s share of emissions reductions to the wealthier, higher emitting countries, who

Another way to put this point is that people who are overprocreating, wherever they live, are threatening the human rights of future people. In Bangladesh and Niger, overpro creators are creating people who are likely to suffer from extreme weather events, droughts, and lack of food in the decades to come. Nor can this problem be laid solely at the door of Western overconsumption; given their available resources, Bangladesh and Niger are overpopulated right now, even before they double or quadruple their populations over the next 50 years, as they are respectively on track to do, and even before many impacts of climate change kick in.8 Meanwhile, each child born in the United States, Britain, or Japan starts life with a surprisingly large carbon footprint, which only grows larger as they mature. Earth cannot accommodate too many of them.72

Having one or two children to fulfill the strong psychobiological urge to procreate seems reasonable, but more seems excessive, even unjust, in a world that is ‘full up’. And there does not appear to be a good argument for giving overly enthusiastic parents a pass, while ramping up efforts to reduce per capita consumption or make it less carbon intensive. Such a course seems an exercise in futility, as improvements which decrease per capita carbon emissions are cancelled out by more ‘capitas’.73 If we take seriously the notion that today’s carbon emissions may lead to tomorrow’s massive harms and human rights violations, we cannot ignore population matters.1

A RIGHT TO DEVELOP

Paul Baer notes that ‘there is a fairly broad consensus among both the philosophers who write about climate change and the majority of the climate-policy community that efforts to reduce greenhouse-gas emissions should not harm the ability of poor countries to grow economically and to reduce as rapidly as possible the widespread poverty their citizens suffer’ (Refs 74, p. 215 and 75). The 1992 United Nations Framework Convention on Climate Change (UNFCCC) spoke of ‘differentiated responsibilities’ to mitigate climate change and assigned wealthy nations the role of initiating emissions reductions. More recently, ‘Contraction & Convergence’—the position that wealthy nations’ emissions should substantially contract, poor nations’ emissions can increase moderately, while their per capita emissions converge on a similar average—has garnered wide support. Thus climate ethicists who tackle ‘the allocation problem’ have almost all assigned the lion’s share of emissions reductions to the wealthier, higher emitting countries, who
have done the most to cause the problem and who have the greatest ability to rectify it.\textsuperscript{76} Since effectively mitigating global warming will demand action from poor countries as well as rich ones, these ethicists typically add that wealthy nations should largely underwrite poor countries’ emissions reduction efforts, through technology transfers and outright subsidies.

A clear statement of this consensus position comes from Baer and his colleagues, who have developed the concept of ‘Greenhouse Development Rights’. Baer et al. argue that ‘there is no road to development, however conceived, that does not greatly improve access to energy services’ and hence that does not increase poor people’s energy use (Ref 77, p. 35). This is bad news from the point of view of reducing global greenhouse gas emissions, but it would be wrong to forestall poor people’s development to deal with the problem (at least so long as rich people continue to generate large amounts of unnecessary emissions). Therefore, they claim that up to a certain threshold of wealth—set at $7500 annual household income, in one recent iteration (Ref 74, p. 222)—individuals bear no moral responsibility to help mitigate climate change. They should not be asked to reduce consumption in order to do so, and any costs associated with making their consumption less environmentally harmful should be fully subsidized by those who are wealthier. Poor people have a right to develop their way out of poverty.\textsuperscript{77}

Now for a third substantive assertion. \textit{Those committed to ‘greenhouse development rights’—or more generally, those who support a universal right to develop, or a universal right against poverty—must reject a right to unlimited procreation and support humane measures to reduce the global human population.} This is so both because actualizing such a right demands a certain amount of ecological space, which global climate change suggests we are running out of, and because continued population growth is itself a serious obstacle to the alleviation of poverty, even leaving its ecological impacts aside. At a minimum, we are more likely to achieve a decent future for the world’s poor if we end global population growth as quickly as possible. In fact, reducing the human population may be necessary in order to achieve such a future. There is no guarantee that Earth can support 7 billion human beings indefinitely in comfort and security, and considerable evidence that it cannot, in the form of dying forests, bleached coral reefs, dwindling fisheries, disappearing wildlife, encroaching deserts, and growing ‘dead zones’ at the mouths of many of the world’s major rivers.

We cannot ask poor people to forego development, or some reasonable increase in energy use, while wealthy people continue to hog limited carbon emissions space. Agreed. But if ‘greenhouse development rights’ exist, or we want to assume them as part of a fair international climate regime, then it is wrong for people today to have lots of children, because this will make it harder to secure such rights universally in the future. If alleviating poverty really is a moral imperative, as rights talk implies, then proponents of a ‘right to develop’ cannot balk at the need for population control.\textsuperscript{78}

Consider the latest U.S. Census Bureau population projections for seven nations that are likely to be hit hard by global climate change and for the two most populous countries in the world\textsuperscript{79}

<table>
<thead>
<tr>
<th>Country</th>
<th>Population in 2005, in Millions (Actual)</th>
<th>Population in 2050, in Millions (Projected)</th>
<th>Percent Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bangladesh</td>
<td>144</td>
<td>250</td>
<td>74</td>
</tr>
<tr>
<td>Bolivia</td>
<td>9</td>
<td>16</td>
<td>78</td>
</tr>
<tr>
<td>Brazil</td>
<td>189</td>
<td>261</td>
<td>38</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>75</td>
<td>278</td>
<td>270</td>
</tr>
<tr>
<td>Indonesia</td>
<td>229</td>
<td>313</td>
<td>37</td>
</tr>
<tr>
<td>Niger</td>
<td>13</td>
<td>55</td>
<td>323</td>
</tr>
<tr>
<td>Pakistan</td>
<td>169</td>
<td>291</td>
<td>72</td>
</tr>
<tr>
<td>China</td>
<td>1298</td>
<td>1304</td>
<td>0</td>
</tr>
<tr>
<td>India</td>
<td>1090</td>
<td>1657</td>
<td>52</td>
</tr>
</tbody>
</table>

Which among these first seven countries have the better chance to develop economically in ways that share wealth widely and limit environmental damage: those set to grow 30\%, or 300\%? Among the two giants, China and India, which is better positioned to provide economic opportunities for the next two generations of young adults, without choking on its own effluents? Numbers matter.\textsuperscript{80} We might even sharpen the point, and ask which is the greater threat to poor people in Bangladesh, Ethiopia, Niger, Pakistan, or India: \textit{global climate change or national population growth?} While the increased possibility of drought due to climate change may cause water shortages in Pakistan or Niger, having two to four times as many thirsty people seems certain to cause such shortages. But perhaps we need not rank these two threats, since, as the example suggests, they magnify one another’s potential harms. More people consuming water + longer, more frequent droughts = water shortages in Niger and Pakistan. More people living on marginal lands + harsher, more frequent storms = more deaths and environmental refugees.
from Bangladesh and Indonesia. Those worried about alleviating human suffering in the developing world cannot avoid population issues.1

RIGHTS, RESPONSIBILITIES AND SUSTAINABILITY

Some may see the arguments in the previous three sections, for action to end population growth, as convenient rationalizations for inaction on overconsumption. That would be a mistake. A reasonable approach to environmental risk and a decent respect for human rights argue just as strongly for reining in harmful consumption as they do for avoiding overpopulation—and for exactly the same reasons.81 A preferential concern for the poor does indeed demand that wealthy people rein in overconsumption and share resources (including available carbon sinks) more fairly with the poor. Nothing in the preceding discussion supports denying the rights of the poor to their fair share of the world’s resources. But it takes seriously the fact that rights are justified claims to limited resources82; that rights come with concomitant responsibilities83; and that the ultimate purpose of rights is to enable people to live flourishing lives.49 Because rights are claims to limited resources, future individuals’ ‘fair share’ of those resources may be driven down to uncomfortable or even unbearable levels, if those resources are degraded or the number of rights-bearers grows too high. In such situations, even a perfectly just distribution of resources could be insufficient to allow future individuals to live decent lives.84

Contraction and Convergence policies ask us to create a world in which greenhouse gas emissions, and relatedly wealth and consumption, are more equal than they are today; thus, a world in which adding another African or South Asian is roughly comparable to adding another European or American. As we have seen, most climate ethicists ask citizens in the developed world to show restraint, by limiting their consumption and helping pay for the rest of the world to develop in more ecologically sustainable ways.85 Essentially, these are proposals that the rights of modern democracies and the material benefits of modern industrial economies, well established in the developed world, be extended to the residents of the developing world.86 But if we take such goals seriously, they seem to generate at least as strong demands on citizens in developing nations as on wealthy westerners. If it makes sense to demand, as a matter of right, that Belgians or Italians devote significant resources to secure the well being of future generations in the developing world, then it makes sense to demand that Nigerians and Bangladeshis refrain from having more children than they can reasonably expect to feed, house, and educate.

With rights come responsibilities, including the need to make responsible decisions regarding consumption and procreation. Both are important. If it is irresponsible, in a warming world, for an individual to drive a Hummer that gets six miles per gallon of gasoline, it is irresponsible for him to father six children—each of whom will generate much more greenhouse gas emissions during the course of his or her lifetime than the car.

A recent study by researchers at Oregon State University showed that for Americans, having a child typically generates more carbon emissions, by two to three orders of magnitude, than can be saved in a full lifetime of taking many common energy efficiency steps, such as buying a more fuel efficient car, driving less frequently, improving home insulation, or upgrading major appliances (Ref 87, p. 18, Table 3). As they outline their findings: ‘the summed emissions of a person’s descendants, weighted by their relatedness to him, may far exceed the lifetime emissions produced by the original parent. Under current conditions in the United States, for example, each child adds about 9441 metric tons of carbon dioxide to the carbon legacy of an average female, which is 5.7 times her lifetime emissions’ (Ref 87, p. 14) This means that an American couple who have two children cannot reduce their total greenhouse gas footprint down to the level of another couple who only have one, no matter how radically they change their consumption patterns (this is particularly striking, given how wastefully the average American uses energy). Furthermore, the importance of reproductive decisions in generating greenhouse gas emissions appears to hold throughout the world, in both developing and developed countries. Having a child increases the carbon legacy of the average inhabitant of China 4.4 times, the average Indian 2.4 times, the average Pakistani 4.1 times, the average Mexican 4.3 times, and the average Brazilian 4.9 times (Ref 87, p. 18, Table 2).

The same logic that applies to individuals would appear to hold at the national level. If it is irresponsible for a nation to follow economic policies that are likely to double its per capita energy consumption over the next five decades, it seems equally irresponsible for it to set demographic policies that are likely to double its population during that same period. And it seems even worse to undertake both at once, as the United States, Canada and Australia are currently doing. When such policies threaten to harm others, either citizens of other nations, future generations, or
other species, they arguably need to be reversed. New policies designed to discourage procreation or limit consumption may need to be instituted in their place. True, for many people, telling them what kind of car to drive or how many children to have will seem an intolerable infringement of their rights. But then we should move expeditiously to put noncoercive or less coercive incentives in place that achieve the desired ends. If these prove insufficient, then we may have to accept stricter limits on our freedom to consume or to have children.\textsuperscript{k}

In a crowded, warming world, the onus is on all of us to find ways to mesh an expansive complement of rights, which we want, with maintenance of the ecological services that we need, in order to live flourishing lives. Climate change should have put this issue squarely on the political agenda; surprisingly, it has not. For their part, climate ethicists and policy analysts have mostly just assumed sufficient ecological space to accommodate their preferred ethical claims or allocation schemes.\textsuperscript{l} All things considered, we appear no closer to thinking intelligently about ecological limits to growth than we were 40 years ago, when the term first became current, even though there is good evidence that we are closer to the limits themselves, and even though protecting human rights in the future may depend upon facing this issue rather than avoiding it.

**CONCLUSION**

While most commentators on climate change have ignored population issues, recently some seem to be waking up to their importance. Kathleen Dean Moore and Michael Nelson, editors of the excellent recent climate ethics anthology *Moral Ground: Ethical Action for a Planet in Peril*, note the need to address population. ‘Think hard about the most important personal decision you will make’, they ask their readers:

\begin{quote}
whether to bring children into the world. It’s easy to think of overpopulation as a moral failing of other people, other religions, other continents. But if you have more than one or two children, overpopulation is a moral problem in your household. No one ‘deserves’ more children than anyone else; in fact, affluent Americans may have difficulty claiming even equal rights to children, given the global impacts of our lifestyles and life spans. Overpopulation in a time of climate crisis creates terrible problems of distributive justice; overpopulation coupled with overconsumption creates injustice that is exponentially worse (Ref 88, pp. 327–328).
\end{quote}

Similarly, in his recently published *A Perfect Moral Storm: The Ethical Tragedy of Climate Change*, Stephen Gardiner makes the necessary connections between climate change, ecological harms, and population matters. ‘Population is a problem mainly because both the increased absolute number of people and the rate of increase itself are likely to have a severe impact on the planet’, he writes. ‘Extra people place extra demands on food, water, and energy supply, and their activities cause environmental damage’ (Ref 89, pp. 444–445).

As we have seen, a strong case can be made that limiting population must be part of responsibly dealing with climate change, and more generally, with achieving global justice and genuine sustainability. Thankfully, the necessary conversations regarding human numbers and ecological limits seem to have begun.

**NOTES**

\textsuperscript{1}The Jevons paradox is named for the English economist William Stanley Jevons, who first commented on this phenomenon in 1863. Jevons had observed that technological improvements in the efficiency of coal use in various industries actually increased overall coal consumption, rather than reducing it, as one might expect.\textsuperscript{90}

\textsuperscript{2}Readers might wonder why, given these negative connotations, I do not follow the current fashion (Ref 91, p. 387) and avoid the term ‘population control’. The answer is that I believe that humanity does indeed need to control its population in order to deal effectively with global climate change, and I want to emphasize that fact.

\textsuperscript{3}In the index to one anthology, one looks between ‘pollution’ and ‘poverty’ for the word ‘population’ and a long list of citations, and finds instead “Portugal, 189” (Ref 29, p. 343).

\textsuperscript{4}This position is defended in Refs 72 and 92; for an opposing view, see Ref 93.

\textsuperscript{5}One complication for this approach is that ‘empowering’ women and poor people can lead to their using more power Refs (89, pp. 454–455 and 94). As people get wealthier, they tend to have fewer children, but their wealth supports greater per capita energy use. Fortunately, the idea that countries must first become wealthy in order to transition to smaller families has been debunked over the past three decades, as many developing nations have drastically cut average fertility rates.\textsuperscript{95,96}

\textsuperscript{6}However, the question of coercion may not be avoidable forever. It is an article of faith among many progressive writers in this area that voluntary methods are sufficient to limit populations to acceptable levels, but that probably does not hold true for all times and
places, and it may not hold true for the world as a whole in the 21st or 22nd centuries. We will see. The temptation toward wishful thinking is strong here. For example, Clark Wolf writes that non-coercive methods of population control are “arguably far more effective than the harsh measures adopted by China” (Ref 97, p. 273). Wolf seems to forget that China’s policies have largely stabilized its population, while some nations that rely solely on non-coercive measures, like India, continue to balloon. The U.S. Census Bureau predicts no increase (0%) in China’s population between 2005 and 2050 and a 52% increase in India’s population over the same period (79). Other nations, however, have stabilized or greatly reduced their population growth through voluntary means. There is room for cautious optimism here—but we should avoid the temptation to tie the subject up in a neat little bow.

However, speaking for myself, I believe global climate change should cause us to rethink and reject anthropocentrism. According to the IPCC’s 4th Assessment Report, under business as usual, as global average temperature increase exceeds 3.5°C, between 40 and 70% of all Earth’s species may be extinguished by the end of this century (Ref 23, p. 52). Scientists now speak of humanity’s increased demands and impacts on the globe as ushering in a new geological epoch: the Anthropocene. Such selfish and destructive appropriation of the resources of the Earth can only be described as interspecies genocide. It is past time to acknowledge the immense injustice toward other species represented by climate change and other human assaults on the biosphere, and to reform our environmental ethics and behavior accordingly (Refs 100, pp. 41–68; 101–103).

Caney quotes several studies which make this very point, although he does not draw the obvious conclusions regarding population growth:

In southern Africa, the area having water shortages will have increased by 29% by 2050, the countries most affected being Mozambique, Tanzania, and South Africa [all countries with high rates of population growth].

In the 2080s, 5–6 billion people would be at risk of dengue [fever] as a result of climate change and population increase, compared with 3.5 billion people if the climate remained unchanged [and even fewer, if populations remained stable].

Recent research suggests that there will be 45–55 million extra people at risk of hunger by the 2080s for 2.5°C warming, which rises to 65–75 million for 3°C warming [but which falls back below 50 million if we avoid further population growth] (Ref 69, pp. 80–82).

‘Claims such as Caney’s regarding the justice of global resource use necessarily engage questions regarding overall human numbers. In effect, these claims entail further empirical claims that a certain number of people can be provided with particular resources, and further moral claims that other people and other species should limit their own resource use. The fact that most commentators on climate change and global justice ignore these implications weakens any substantive claims they may make.

The preceding three sections have focused on mitigation issues, but their general line of reasoning also applies to adaptation. So far, unfortunately, climate ethicists and policymakers concerned with adaptation issues have failed to consider them in conjunction with population policies. Consider, for example, Dale Jamieson’s assertion that ‘those of us who are rich by global standards and benefit from excess emissions have strenuous duties in our roles as citizens, consumers, producers and so on to reduce our emissions and to finance adaptation’ in the developing world (Ref 85, p. 217). Does it not lose plausibility, absent any complementary demand that citizens and leaders in developing nations work to secure the social, political, and ecological conditions necessary for their own future adaptation to climate change—including limiting their population growth? It hardly seems possible that I and my neighbors in Fort Collins, Colorado, are under a ‘strenuous duty’ to pay to dig deeper wells in Chad or build higher storm levees in Bangladesh, while the inhabitants of those countries are under no duty to help ensure that those wells and levees remain adequate to their tasks. Demands for adaptation funding cannot amount to a blank check for ecological suicide, or the continued overloading of Earth with ever more people. For a good initial discussion of population and adaptation, see Ref 21.

If limiting either childbearing or personal consumption is anathema, for whatever reason, that increases the need to accept limits on the other. As a matter of logic and as a precondition for actually dealing with our environmental problems, the unwillingness to accept demographic limits should lead to a greater willingness to accept limits on per capita wealth and consumption, and vice versa. But in practice, the desire to avoid facing limits to growth in one area has worked to suppress attention to limits to growth in others. Thus a conspiracy of silence has prevailed, and wishful thinking has taken the place of serious attempts to deal with our environmental problems.

Tim Hayward is one philosopher who does try to consider how limits to ecological space might inform climate change ethics, and matters of global justice
more generally. His discussion of these matters is far-reaching and valuable. However, Hayward does not appear to integrate population issues into his approach. Sam Adelman grapples with limits, but in the end, his brief for socialism and a more egalitarian global distribution of wealth supplants a forthright discussion of ecological limits. In any case, Adelman, too, does not consider population matters. Baer et al. recognize the potential for limited ecological space to undermine attempts to effectuate their preferred allocation scheme; their answer is to demand even more greenhouse gas reductions from the wealthy and to engage overly optimistic hopes for ‘decarbonized development pathways’ in the future. These moves allow Baer et al. to avoid a hard question that they tiptoe up to in their work: what would our climate change responsibilities be in a world with insufficient ecological space to provide the resources to alleviate world poverty? Depending on how we define poverty—Baer et al. set the threshold quite high—we might live in such a world already. ‘What kind of a climate regime can allow us to bring global emissions rapidly under control, even while the developing world vastly scales up energy services in its ongoing fight against endemic poverty and for human development?’ they ask (Ref 77, p. 15). The answer may be: none.

REFERENCES


FURTHER READINGS


