

# ‘Any size population will do?’: The fallacy of aiming for stabilization of human numbers

Human population growth is slowing down, but there is no end in sight: we are due to reach 11 billion towards the end of this century, and to continue expanding our numbers well into the next. This article discusses why focusing on the rate of population growth as the central problem amounts to a mistaken and misleading approach to thinking about the issue, as does the suggestion that we should aim to ‘stabilize’ population size. Our current population size is already unsustainable, which poses great risks to human beings and wildlife alike. The aim must be to reverse human population growth rather than merely to slow it down or lock it in at some arbitrary, unsustainable size. High fertility rates are largely a product of social norms. But social norms can change, and this is a powerful argument for active and honest dialogue about the problem of unsustainable human population growth.

Human numbers were relatively stable during thousands of years, slowly edging up until reaching our first billion around 1804 (see <https://is.gd/hziWqH>). After this, growth accelerated, then exploded. By 1927, when beloved naturalist Sir David Attenborough was a baby, humanity had already notched up the second billion. By the time Attenborough narrated the first *Life on Earth* series in the late 1970s, our numbers had more than doubled again. We are now on course to reach our third doubling by 2023; there will be 8 billion of us then. Population growth is slowing down, but there is no end in sight: we are due to reach 11 billion towards the end of this century and to continue expanding our numbers well into the next (United Nations, 2015). The number of people added to this planet every year (approximately 80 million) has not changed much since the late 1970s, but it translates into an ever-smaller rate of growth because our absolute numbers are getting larger and larger. For many, this means there is no problem left to solve.

In this article, I briefly discuss why focusing on the rate of population growth as the central problem amounts to a mistaken and misleading approach to thinking about the issue, as does the suggestion that we should aim to stabilize population size (whether at the national or global level).

Population size is not a neutral factor and poses great risks to human beings and wildlife alike. The aim must be to reverse population growth rather than merely to slow it down or lock it in at some arbitrary, unsustainable size. High fertility rates are largely a product of social norms. But social norms can change, and this is a powerful argument for active and honest engagement with the problem of population growth by scientists, activists and policy-makers.

First, a clarification. In this paper I criticize arguments about the problem of population growth which are frequently put forward by economists, futurists and policy-makers, but sometimes also by natural scientists and even population concern activists. Any of these actors might be motivated by political expediency, ideological commitment or a sincere belief that their positions are empirically and logically sound. Whether or not they are genuinely endorsed by those who proffer them, the arguments I attack are *commonly* presented to the public as though they represent sound reasons for dismissing concerns about population growth. This is a problem, for, as I attempt to demonstrate, even a fairly cursory examination shows these arguments to be fallacious. I make no claim that my criticisms or counter-arguments are novel. On the contrary, I take the fallacies I identify as evident to anyone

## Karin Kuhlemann

### About the author

Karin is a population ethicist and lawyer based in London, UK.

### Citation

Kuhlemann K (2018) ‘Any size population will do?’: The fallacy of aiming for stabilization of human numbers. *The Ecological Citizen* 1: 181–9.

### Keywords

Anthropocentrism; overpopulation; sixth mass extinction

who has given serious thought to the subject of population and sustainability.

The future of population growth is not set in stone. But if we get the problem wrong, we are bound to misunderstand our options about what can or should to be done to mitigate the risks to all life on this planet.

### Too fast, or too much growth?

Concerns about population growth are often articulated in terms of the growth being *too fast*. Supposedly, we should aim at *slowing down* growth or *stabilizing* our numbers. In its most intellectually reprehensible incarnation, this framing of the problem translates into the argument that there is nothing to worry about because the rate of population growth is already slowing down. The easiest way to ‘solve’ a complex ethical and practical problem is, as ever, to deny that it exists.

Current declines in fertility rates are neither irreversible nor inevitable, which is why multiple United Nations (UN) population projections have had to be adjusted upwards in recent years. But more importantly, the rhetoric of ‘slower growth’ or ‘stable population size’ erroneously and misleadingly implies that population size is a neutral factor. If a ‘stable’ population, or at least a population that is not growing as fast, is an ideal outcome then it must follow that any population size is fine; the problem is merely that there is change, or that the change is too fast. But this is not the case, however much it may suit one’s ideological inclinations or political aims.

From an environmental sustainability perspective, what matters is the current and cumulative effect of *absolute population size*, not the *rate* at which our numbers grow. It makes a great deal of difference to the prospects for human security and well-being, and for wildlife survival, if our population is 2 billion, 7 billion, 11 billion or, indeed, 16 billion. Whether a population is sustainable turns on how many consumers there are, consuming as they can be realistically expected to consume.<sup>1</sup> If there are more consumers than can be sustained, the risks will turn principally on how many more and for how long there is an imbalance.

The risks from an unsustainable pattern of resource use do not crystallize overnight. Consider a situation where your one and only source of livelihood is withdrawals from a bank account into which someone placed a large deposit (precise amount unknown to you). Even if you repeatedly withdraw from the account more than it is earning in interest, it may take a long time to empty the account completely; you may come to think it will never happen, even though it is the logical end point of your trajectory. You may be a very optimistic person who is counting on interest rates going up in future, or on finding a way to diminish your withdrawals before the capital is completely gone. (Another way of looking at it, of course, is that you are being reckless with your finances.) But for the time being, your withdrawals are unsustainable. They do not stop being unsustainable because *things might change in the future*. The longer the unsustainable withdrawals go on for, the harder it becomes for you to mitigate the risk that you will run out of money. In particular, the longer you keep up your unsustainable withdrawals, the less leeway you will have to deal with unexpected expenses, falling interest rates or simply misjudgements about how much there is left in the account. As with our planet’s resources, there is no safety net in this thought experiment.

I am quite willing to concede that, from the perspective of provision of public services, the speed of population growth is indeed an independent problem. Rapid population growth can create something of a ‘Red Queen’ race for societies, where continuously increased public expenditure is needed simply to keep up with growing demand for school places, hospital beds, housing, sanitation, public transport and so forth.

But insofar as one accepts that at least some needful resources are finite and prone to depletion – that is, insofar as one accepts that sustainability is or can be an issue independently of the capacity of social structures to adapt to population growth – then it simply cannot be logically supposed that the solution lies in ensuring growth eventually stops, yielding a stable population size. To repeat the core point:

“From an environmental sustainability perspective, what matters is the current and cumulative effect of absolute population size, not the rate at which our numbers grow.”

that a population's size is stable in no way entails sustainability. It may be sustainable, or it may be far too large. This turns on a range of factors, most notably on how big that 'stable' population is and on the state of the resource base on which it depends.

Framing population stabilization as a policy goal – independently of any sustainability assessment – is bound to mislead the public about the nature of the problem. It reflects an unthinking acceptance of the premise that populations must not shrink; that whatever arbitrary size a population grows to must be locked in and accommodated somehow. The fear of population 'decline' or 'ageing' is primal and tribal, reflecting anxieties of a bygone era where survival depended upon how many young men one could round up for waging war or fighting off invasions. It makes no sense in today's world, where the main threats to the long-term viability of human societies are ultimately rooted in there being too many of us – men and women, young and old – doing damage simply by peacefully leading our own lives.

### Population, affluence and technology

It is trivially true that the environmental impact of any given population size is modulated by affluence and by the technology available (in addition to cultural and institutional particularities). This broadly corresponds to the familiar 'IPAT identity' formula (Ehrlich and Ehrlich, 1990):  $\text{impact} = \text{population} \times \text{affluence} \times \text{technology}$ . However, it is often mistakenly assumed that more advanced technology translates into a reduced impact, or that people living in poverty have next to no environmental impact or will remain poor for ever.

Technology can be used to increase efficiency in resource use, allowing us to make more with less. But it can also be used to extract resources faster and more cheaply, masking their scarcity, encouraging overuse or otherwise accelerating resource depletion. As Aldo Leopold put it nearly 70 years ago (1949: 223), "few educated people realize that the marvellous advances in technique made during recent decades are improvements in

the pump, rather than the well." There is mounting evidence that the predominant relationship between technology and resource use is one of improvements to the pump – that is, facilitating their extraction rather than creating more resources. A related phenomenon is described in economics as Jevons' paradox (Magee and Devezas, 2016), where greater technological efficiency in the use of a resource ultimately increases its overall consumption. In addition, technology can also be used to *convert* one environmental problem into another, for example where freshwater scarcity is 'resolved' via desalination plants that consume vast amounts of fossil fuels, decimate marine life or generate serious pollution.

Affluence is a similarly multivalent factor. A wealthier population will typically consume much more than a poorer population of the same size, but will also be better able to invest in the development of new technologies that may reduce their impact on resources – or amplify it. But there is nothing inherently 'environmentally friendly' about poverty. In much of the world, those who are struggling to find opportunities in the formal economy will turn to extractivist activities to make a living for themselves and their families (e.g. Harrison, 2011; Duffy and St John, 2013), often with devastating results: empty forests where most wildlife has been hunted down (e.g. Kerr *et al.*, 2004; Nellemann, 2014); rampant deforestation for wood fuel and growing food (e.g. McCarthy, 2011; Hosonuma *et al.*, 2012); and overfished rivers and bays (e.g. Stobutzki *et al.*, 2006; Keskar *et al.*, 2017). In addition, it is clear that some environments are better able to support larger human populations than others. Poverty-stricken, rapidly growing populations are too often found in drought-prone, resource-poor, fragile environments such as the Sahel and the Horn of Africa. In such areas, mere subsistence activities are enough to overexploit natural resources, driving desertification and worsening the already chronic food insecurity (United Nations Economic Commission for Africa, 2007; Lifland, 2012).

The contribution of population size to our environmental impact is comparatively

---

“The main threats to the long-term viability of human societies are ultimately rooted in there being too many of us – men and women, young and old – doing damage simply by peacefully leading our own lives.”

---

“Even if it were possible to secure food and decent livelihoods for 11 billion people, our population may keep on growing well past that already enormous size.”

unambiguous. For any given level of affluence, technology use or environmental constraints, and regardless of which way these factors pull, a smaller population size will mean a smaller environmental impact, slower resource depletion and a greater range of alternatives for coping with resource scarcity (for example, relocating elsewhere). Conversely, a bigger population will have a greater environmental impact, a faster rate of resource depletion, fewer alternatives for coping with scarcity owing to the concatenation of multiple scarcities and to greater competition for resources, and a greater number of human lives at risk than would otherwise be the case.

Population size *always* matters, and in today’s world, a smaller population is a more resilient one.

### The irrelevance of current food production

It is often suggested that we ought not to worry about population growth because we already produce enough food to feed 10 billion people. Supposedly we can, or should, let population growth run its course, whatever it may prove to be, because we are safe on the food front. There are at least three reasons why this reasoning is fallacious.

First, answering the question of how much food is produced now is not answering the question of how much food we can expect to produce over the foreseeable future. Current resource use in agriculture is unsustainable (Government Office for Science, 2011; International Food Policy Research Institute, 2016), and this is without taking into account the potentially devastating impact of climate change. Discussions about food waste and expansion of the agricultural frontier typically ignore the reality that not all waste can be prevented, that most productive land worldwide is already in use for agriculture (e.g. Tilman *et al.*, 2002) and that what is left is natural habitat that supports important ecosystem services and provides critical sanctuary for what remains of the world’s wildlife.

Secondly, even if it were possible to sustainably produce enough food to feed a population of 10 or even 11 billion – and

we have no reason to be confident it will be (Schade and Pimentel, 2010) – food production is not the only issue. People’s ability to earn a livelihood matters to their ability to secure enough food and other basic resources for themselves and their families, to their ability to live lives of dignity, and to the fiscal sustainability of their societies. The International Labour Office has been chronicling a global trend towards higher unemployment and underemployment for years, due to job creation not keeping up with growth in the number of new labour market entrants. This has particularly affected younger workers (International Labour Office, 2017), reflecting the morally problematic asymmetry of all population growth externalities: the costs and risks of population growth are typically worse for younger generations than for the older generations who have made the choices that created or added to the risks. As if these population growth-driven trends were not enough of a threat to the livelihoods of younger generations, in recent years there has been growing concern about the scope for developments in artificial intelligence to cause unprecedented levels of unemployment without concomitant creation of new jobs for those displaced (e.g. Frey and Osborne, 2013), potentially vastly aggravating fiscal non-sustainability problems that are already widespread.<sup>2</sup>

And thirdly, even if it were possible to secure food and decent livelihoods for 11 billion people, our population may keep on growing well past that already enormous size. The expectation of a global population of 11 billion circa 2100 is based on the two latest UN population projections (United Nations, 2015; 2017), but it could prove to be an optimistic underestimate. Population projections for countries experiencing high fertility are particularly uncertain; these are the countries which are projected to drive the bulk of global population growth from 2050 onwards. Even slightly slower-than-anticipated fertility declines could result in a much larger population size. The UN’s ‘high’ variant projection assumes fertility rates will remain half a child higher, on average, than the ‘medium’ variant. This yields a

2100 population of over 16 billion. It may be thought that the high variant assumes an increase in fertility; on the contrary, it still builds in a substantial reduction in fertility rates relative to today's levels. A straightforward extrapolation of current fertility rates would yield a population of well over 25 billion by 2100.<sup>3</sup>

While many remain steadfastly optimistic about the prospects for producing enough food to feed 11 billion in a climate-changed world with damaged soils and not enough water, I am not aware of any credible proposals for feeding a world of 16 billion or more.

### Already unsustainable

Our current population's impact on the natural resources on which we depend suggests 7 billion is already an unsustainable population size. Further population growth will increase systemic risks to food security and livelihoods, in particular climate change, mounting unemployment and sub-employment, degradation of agricultural soils, overfishing and freshwater scarcity.

The Intergovernmental Panel for Climate Change (IPCC) recognizes population growth as a primary driver of climate change (Pachauri *et al.*, 2015), along with economic growth. The IPCC warns that climate change may have severe impacts on food security via higher temperatures, precipitation changes, increased frequency of extreme weather events, the spread of new pests and ocean acidification. Estimates suggest that some 200 million people could be displaced by climate change over the next 40 years (Laczko and International Organization for Migration, 2009). Food production is a major contributor to greenhouse gas emissions and a dominant force behind diversity loss, degradation of land and depletion of freshwater sources, among other serious environmental impacts. Simultaneously, agriculture is the most weather-dependent of all human activities and is extensively reliant on the same natural resources and ecosystem services it is degrading (Daily, 1997).

The Food and Agricultural Organization of the UN (FAO) identifies population growth and economic growth as the primary

drivers of the ongoing loss and degradation of agricultural soils, which in turn is a major threat to food security (FAO, 2015). Global marine fisheries landings have been declining since the late 1980s owing to overfishing (Mora *et al.*, 2009). The FAO's analysis of assessed stocks has found a downward trend in biologically sustainable fish stocks since 1974; some 30% of fisheries are already overfished and a further 60% are 'fully fished' (FAO, 2016), with pressures on fish stocks largely driven by population growth (but also economic growth). Around 1.4 billion people live in areas where ground water is being drawn at a faster rate than it can be replenished (FAO, 2009; 2012). The UN projects that almost half the world's population will be living in areas of high water stress by 2030, potentially displacing as many as 700 million people (Secretariat of the United Nations Convention to Combat Desertification, 2014). Water scarcity is driven principally by population growth and economic growth, is set to be worsened by climate change and is thought to be a major driver of armed conflict, particularly in Africa. Some of the most water-stressed countries are also experiencing very high population growth rates (United Nations Development Programme, 2006). The UN estimates that nearly 80% of the jobs constituting the global workforce depend on access to an adequate water supply (United Nations World Water Assessment Programme, 2016).

Population growth contributes to and amplifies every one of these risks while increasing the number of people exposed to them. In addition, by expanding the reach and intensity of human pressures on the natural environment, human population growth poses an existential threat to countless other species.

The most recent doubling of our numbers was accompanied by a loss of over half of wildlife numbers, driven by destruction of natural habitats and harvesting of wildlife to meet human needs and aggravated by environmental fouling from human activities (WWF, 2016). This involves a combination of thinning of wildlife populations and eradication of thousands of other species.

---

“The most recent doubling of our numbers was accompanied by a loss of over half of wildlife numbers, driven by destruction of natural habitats and harvesting of wildlife to meet human needs and aggravated by environmental fouling from human activities.”

---

A sixth mass extinction event is ongoing, the worst spate of species loss since the Cretaceous–Tertiary extinction event that saw the end of non-avian dinosaurs and many other lineages of life (e.g. Ceballos et al., 2015). Even if our human population eventually stops growing and shrinks back to a sustainable size, the species pushed to extinction along the way will be lost forever.

Those of a particularly extreme speciesist or anthropocentric moral outlook may believe that there is no inherent wrong in causing other species to go extinct. Let us assume, for the sake of argument, that the interests of human beings are the only moral considerations that count. Even then, humanity's impact on the natural world is a serious moral wrong of reckless risking of livelihoods and safety nets. Many millions of people in Africa, Asia and Latin America rely on wildlife resources for their livelihoods and as a buffer to see them through times of hardship, such as unemployment and crop failures (e.g. Nasi et al., 2008; Ntuli and Muchapondwa, 2015). More generally, the world's poor are often highly dependent on natural resources for their livelihoods and are the most vulnerable to the effects of defaunation and environmental degradation (Organisation for Economic Co-operation and Development, 2008).

For those of us who reject the anthropocentric worldview, or at least do not endorse such an extreme version of it, the permanent loss of biodiversity is a profound moral wrong to the species being annihilated by humanity's reckless expansionist project. It is also a moral wrong to future generations, condemned to live in a biologically impoverished world where such iconic fauna as elephants, sea turtles, snow leopards, orangutans, rhinos, gorillas and tigers no longer exist in the wild, or at all.

### Ideas, values and behaviours

When we accept a large risk, we must have in mind an even greater benefit that justifies taking that risk, or else we are behaving irrationally and recklessly. Most people should be able to recognize that it is wrong to expose younger and future generations to enormous risks, and bring entire lineages

of life to an end, for as trivial a reason as our reluctance to adjust our own behaviour and attitudes in response to changing circumstances, or as disreputable a reason as treating children and wildlife as means to the ends of today's parents and consumers. We are supposedly a rational species. We have been aware of population growth for decades, and reliable and inexpensive birth control methods have been available for more than 50 years. And yet we hold on to the idea that cultural and individual preferences about family size should be left to drift along, as if the future of humanity and of countless other creatures was not sufficiently important to warrant conscious effort to mitigate population growth.

Where population growth is acknowledged to be a problem, it is commonly suggested that the way to address it is by educating girls, tackling gender discrimination or lifting people out of poverty. Ensuring women and girls are treated with equal respect and afforded the same educational and economic opportunities as men and boys is a matter of justice and basic human decency. The same applies to efforts to secure for everyone at least the minimum material resources needed for lives free from fear and want. However, it is important to note that tackling gender inequality and absolute poverty are neither preconditions to fertility declines nor reliable ways to achieve declines that are as deep and fast as they need to be to adequately mitigate unsustainable population trajectories.<sup>4</sup> Conversely, high fertility rates pose a formidable obstacle to securing improvements to gender equality and to economic and educational opportunities.<sup>5</sup>

Women who are unable to control their bodies can be confidently predicted to bear more children than those who can, and education tends to make larger families less appealing. But it would be a mistake to surmise that women having large families necessarily do so out of ignorance or because they have no choice. It seems more likely that ideas about the role of women and the (instrumental versus intrinsic) value of children spring from the same socio-cultural fountain as preferences about family size.

---

“The permanent loss of biodiversity is a profound moral wrong to the species being annihilated by humanity's reckless expansionist project.”

---

The weight of the evidence suggests that the most important factors driving population growth today are persistent preferences for larger family sizes (e.g. Westoff, 2010; Bongaarts, 2011) and unintended births resulting from non-use of contraception even where it is available, often due to cultural or religious objections.<sup>6</sup> Both factors are amenable to changes in values and social norms that have a tremendous bearing on individual attitudes and reproductive behaviour, as exemplified by the many successful ideational change campaigns employing entertaining television and radio shows (e.g. Westoff and Koffman, 2011).

But the case for changes in values and social norms is undermined whenever and wherever those best placed to understand and explain the risks that are driven or aggravated by population growth stay silent on it, and even more so if the only voices speaking on population are pro-natalist ideologues representing capitalist, patriarchal or religious interests. An unconscionable taboo has developed whereby scientists, activists and policy makers ‘talk around’ population growth and gloss over or omit reference to the need for smaller family sizes when discussing climate change, food or livelihood insecurity, loss of biodiversity and environmental degradation (e.g. Campbell and Bedford, 2009; Coole, 2013; Mora, 2014). In doing so, these actors are complicit in creating an environmentally impoverished world in which many millions, possibly billions, of people may starve, become displaced or have no hope of securing decent livelihoods. This needs to change.

### What can be done?

Fundamentally, we must foster a shared sense of responsibility for the size of our human population and adjust our behaviours and ways of thinking. In the oft-quoted words of Stanisław Jerzy Lec, no snowflake in an avalanche ever feels responsible. But we all are. Even the childless by choice are still consumers, and as social beings we all make a contribution, however small, to what ideas live or die.

The logical and ethical response to unsustainable population growth is to

reject the primitive rhetoric of irrational fears about population degrowth and ageing and of unthinking acceptance of speculative gambles with our collective futures. It calls for us to confront those who promote population growth on the ethically repugnant premises that human beings exist to serve the needs of a supposedly ever-growing capitalist economy, or the political goals of religious leaders. It asks that we embrace, rather than fear, sub-replacement fertility levels.

In order for younger and future generations to have a chance at decent lives in a world that is not an environmental wasteland, there needs to be change to social ideas about what a normal family looks like. A one-child family ideal is a very small family indeed, but one that prioritizes the life chances of children and future generations, the long-term stability of human societies, and the survival of the world’s wildlife over the immediate preferences and desires of prospective parents. This is what makes sense, and how it should be. ■

### Notes

- 1 In the original (and rather more eloquent) words of Paul and Anne Ehrlich (1990: 37–40): “Overpopulation is defined by the animals that occupy the turf, behaving as they normally behave, not by a hypothetical group that might be substituted for them.”
- 2 See for example the World Economic Forum (2017) report on global risks, which (as with previous reports) ranks fiscal non-sustainability and unemployment or underemployment, along with a host of anthropogenic environmental and humanitarian crises, as high-impact, high-likelihood risks.
- 3 There was no ‘business as usual’ (constant fertility) graph in the UN’s 2015 or 2017 projections, perhaps because the business as usual graph in the 2012 projections was thought to be alarmist. It is fair to say that a human population of over 25 billion is improbable.
- 4 Campbell and Bedford (2009) provide a useful summary. See also Garenne (2012) and Grant (2015) for sobering data on the limited impact of education on fertility rates in Sub-Saharan Africa, and Myrskylä *et al.* (2009) on how advanced levels of socio-economic development can reverse fertility declines.
- 5 The population of many Sub-Saharan African countries is set to at least quintuple over this century (United Nations, 2015), greatly depressing

“The case for changes in values and social norms is undermined whenever and wherever those best placed to understand and explain the risks that are driven or aggravated by population growth stay silent on it.”

“An unconscionable taboo has developed whereby scientists, activists and policy makers ‘talk around’ population growth and gloss over or omit reference to the need for smaller family sizes when discussing climate change, food or livelihood insecurity, loss of biodiversity and environmental degradation.”

the scope for those societies to provide decent education and livelihood opportunities for rapidly enlarging cohorts of young people. See for example McNay (2005) and Grant (2015). See also Recoules (2011) and Anderson and Kohler (2015) on how low fertility may boost gender equality and how gender equality may in turn boost fertility rates. The relationship between fertility and gender equality appears to be far more complex than is commonly assumed.

6 This reflects the difference between unmet demand and unmet need for contraception. Where a woman would like to avoid pregnancy but does not intend to use contraception, there is unmet need but no unmet demand. For example, 65% of people in Pakistan, 54% of people in Nigeria and 52% of people in Ghana personally believe that using contraceptives is morally unacceptable; it does not necessarily follow that very large families are wanted (see Poushter [2014] and Pew Research Center [2014]).

## References

- Anderson T and Kohler H (2015) Low fertility, socioeconomic development, and gender equity. *Population and Development Review* **41**: 381–407.
- Bongaarts J (2011) Can family planning programs reduce high desired family size in Sub-Saharan Africa? *International Perspectives on Sexual and Reproductive Health* **37**: 209–16.
- Campbell M and Bedford K (2009) The theoretical and political framing of the population factor in development. *Philosophical Transactions of the Royal Society B: Biological Sciences* **364**: 3101–13.
- Ceballos G, Ehrlich PE, Barnosky AD *et al.* (2015) Accelerated modern human-induced species losses: entering the sixth mass extinction. *Science Advances* **1**: e1400253.
- Coole D (2013) Too many bodies? The return and disavowal of the population question. *Environmental Politics* **22**: 195–215.
- Daily GC (1997) What are ecosystem services? In Daily GC, ed. *Nature's Services: Societal dependence on natural ecosystems*. Island Press, Washington, DC: 1–10.
- Duffy R and St John F (2013) Poverty, poaching and trafficking: What are the links? *Evidence on Demand*. Available at <https://is.gd/DEr8PV> (accessed October 2017).
- Ehrlich PR and Ehrlich AH (1990) *The Population Explosion*. Simon and Schuster, New York, NY, USA.
- FAO (2009) *How to Feed the World in 2050: Issue brief*. FAO, Rome, Italy. Available at <https://is.gd/d8Zj51> (accessed October 2017).
- FAO (2012) *Coping with Water Scarcity: An action framework for agriculture and food security* (FAO Water Reports). FAO, Rome, Italy. Available at <https://is.gd/7WmSkH> (accessed October 2017).
- FAO (2015) *Status of the World's Soil Resources: Technical summary*. FAO, Rome, Italy. Available at <https://is.gd/SDrnTF> (accessed October 2017).
- FAO (2016) *The State of the World's Fisheries and Aquaculture*. FAO, Rome, Italy. Available at <https://is.gd/lafm7V> (accessed October 2017).
- Frey CB and Osborne MA (2013) *The Future of Employment: How susceptible are jobs to computerisation?* Oxford Martin School, Oxford, UK.
- Garenne M (2012) *Education and fertility in Sub-Saharan Africa: A longitudinal perspective* (DHS Analytical Studies 33). United States Agency for International Development, Calverton, MD, USA.
- Government Office for Science (2011) *Foresight – the Future of Food and Farming: Final project report*. Government Office for Science, London, UK. Available at <https://is.gd/E5fnLR> (accessed October 2017).
- Grant MJ (2015) The demographic promise of expanded female education: Trends in the age at first birth in Malawi. *Population and Development Review* **41**: 409–38.
- Harrison RD (2011) Emptying the forest: Hunting and the extirpation of wildlife from tropical nature reserves. *BioScience* **61**: 919–24.
- Hosonuma N, Herold M, De Sy V *et al.* (2012) An assessment of deforestation and forest degradation drivers in developing countries. *Environmental Research Letters* **7**(4): 8 October.
- International Food Policy Research Institute (2016) *Global Food Policy Report 2016*. International Food Policy Research Institute, Washington, DC, USA.
- International Labour Office (2017) *World Employment and Social Outlook: Trends 2017*. International Labour Office, Geneva, Switzerland. Available at <https://is.gd/nMdSwb> (accessed October 2017).
- Kerr S, Pfaff A, Cavatassi R *et al.* (2004) *Effects of Poverty on Deforestation: Distinguishing behaviour from location* (ESA Working Paper No 04–19). FAO, Rome, Italy.
- Keskar A, Raghavan R, Kumkar P *et al.* (2017) Assessing the sustainability of subsistence fisheries of small indigenous fish species: Fishing mortality and exploitation of hill stream loaches in India. *Aquatic Living Resources* **30**: article 13.
- Laczko F and International Organization for Migration (2009) *Migration, Environment and Climate Change: Assessing the evidence*. International Organization for Migration, Geneva, Switzerland.
- Leopold A (1949) *A Sand County Almanac: With other essays on conservation from Round River*. Random House, New York, NY, USA.
- Lifland A (2012) Starvation in the Sahel. *Harvard International Review* **34**: 7 July 2012.
- McCarthy M (2011) Exhausted, deforested landscapes show the truth about over-population. *The Independent*. Available at <https://is.gd/WDz8HW> (accessed October 2017).

- McNay K (2005) The implications of the demographic transition for women, girls and gender equality: A review of developing country evidence. *Progress in Development Studies* **5**: 115–34.
- Magee CL and Devezas TC (2016) A simple extension of dematerialization theory: Incorporation of technical progress and the rebound effect. *Technological Forecasting and Social Change* **117**: 196–205.
- Mora C (2014) Revisiting the environmental and socioeconomic effects of population growth: A fundamental but fading issue in modern scientific, public, and political circles. *Ecology and Society* **19**: article 38.
- Mora C, Myers RA, Coll M *et al.* (2009) Management effectiveness of the world's marine fisheries. *PLoS Biology* **7**: 1000131.
- Myrskylä M, Kohler HP and Billari FC (2009) Advances in development reverse fertility declines. *Nature* **460**: 741–3.
- Nasi R, Brown D, Wilkie D *et al.* (2008) *Conservation and Use of Wildlife-Based Resources: The bushmeat crisis* (Technical Series 50). Secretariat of the Convention on Biological Diversity, Montreal, QC, Canada, and Center for International Forestry Research, Bogor, Indonesia. Available at <https://is.gd/31ElaH> (accessed October 2017).
- Nellemann C, ed (2014) *The Environmental Crime Crisis: Threats to sustainable development from illegal exploitation and trade in wildlife and forest resources* (UNEP Rapid Response Assessment). GRID Arendal, Arendal, Norway.
- Ntuli H and Muchapondwa E (2015) *Effects of Wildlife Resources on Community Welfare* (Discussion Paper EFD DP 15–21). Environment for Development, Nairobi, Kenya. Available at <https://is.gd/l4rBct> (accessed October 2017).
- Organisation for Economic Co-operation and Development (2008) *Natural Resources and Pro-Poor Growth: The economics and politics*. OECD Publishing, Paris, France.
- Pachauri RK, Mayer L and Intergovernmental Panel on Climate Change (2015) *Climate Change 2014: Synthesis report*. Intergovernmental Panel on Climate Change, Geneva, Switzerland.
- Pew Research Center (2014) *Morality Interactive Topline Results: Spring 2013 and Winter 2013–2014 surveys*. Available at <https://is.gd/gyLJ5l> (accessed October 2017).
- Poushter J (2014) *What's Morally Acceptable? It depends on where in the world you live*. Pew Research Center, Washington, DC, USA. Available at <https://is.gd/hoEj3b> (accessed October 2017).
- Recoules M (2011) How can gender discrimination explain fertility behaviours and family-friendly policies? *Review of Economics of the Household* **9**: 505–21.
- Schade C and Pimentel D (2010) Population crash: prospects for famine in the twenty-first century. *Environment, Development and Sustainability* **12**: 245–62.
- Secretariat of the United Nations Convention to Combat Desertification (2014) *Desertification: The invisible frontline*. Available at <https://is.gd/ZXEDKO> (accessed October 2017).
- Stobutzki I, Silvestre GT, Garces LR (2006) Key issues in coastal fisheries in South and Southeast Asia: Outcomes of a regional initiative. *Fisheries Research* **78**: 109–18.
- Tilman D, Cassman KG, Matson PA *et al.* (2002) Agricultural sustainability and intensive production practices. *Nature* **418**: 671–77.
- United Nations (2015) *World Population Prospects, 2015 Revision: Key findings and advance tables* (ESA/P/WP.241). United Nations, New York, NY, USA. Available at <https://is.gd/jObjdU> (accessed October 2017).
- United Nations (2017) *World Population Prospects, 2017 Revision: Key findings and advance tables* (ESA/P/WP.248). United Nations, New York, NY, USA. Available at <https://is.gd/HFoLot> (accessed November 2017).
- United Nations Development Programme (2006) *Beyond Scarcity: Power, poverty and the global water crisis*. United Nations Development Programme, New York, NY, USA. Available at <https://is.gd/Nq1fKL> (accessed October 2017).
- United Nations Economic Commission for Africa (2007) *Africa Review Report on Drought and Desertification* (E/ECA/ACSD/5/3). United Nations Economic Commission for Africa, Addis Ababa, Ethiopia. Available at <https://is.gd/j46WzG> (accessed October 2017).
- United Nations World Water Assessment Programme (2016) *Water and Jobs*. UNESCO, Paris, France. Available at <https://is.gd/Nm4VUr> (accessed October 2017).
- Westoff CF (2010) *Desired Number of Children: 2000–2008*. United States Agency for International Development, Washington, DC, USA.
- Westoff CF and Koffman DA (2011) The association of TV and radio with reproductive behaviour. *Population and Development Review* **37**: 749–59.
- World Economic Forum (2017) *Insight Report: Global risks 2017*. World Economic Forum, Geneva, Switzerland. Available at <https://is.gd/P8NDjg> (accessed October 2017).
- WWF (2016) *Living Planet Report 2016: Risk and resilience in a new era*. WWF International, Gland, Switzerland. Available at <https://is.gd/rcbOx9> (accessed October 2017).

“A one-child family ideal is a very small family indeed, but one that prioritizes the life chances of children and future generations, the long-term stability of human societies, and the survival of the world's wildlife over the immediate preferences and desires of prospective parents.”

Discuss a range of Earth-centred issues: [www.ecocentricalliance.org/#ju](http://www.ecocentricalliance.org/#ju)