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# the journal of population and sustainability

population matters

# Information

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## Submissions

The journal aims to publish papers exploring all aspects of the relationship between human numbers and environmental issues. It is truly interdisciplinary and invites contributions from the social sciences, humanities, environmental and natural sciences including those concerned with family planning and reproductive health. We also invite contributions from those working for NGOs with interests in population and environmental issues. It is intended that the journal act as an interdisciplinary hub facilitating collaboration and furthering the development of the field. We are interested in publishing original research papers, reviews of already published research and book reviews. For submission details please see our website (**www.populationmatters.org**) or contact the editor: **journal.editor@populationmatters.org**

The journal is available free of charge at **www.populationmatters.org** and is published by Population Matters, a membership charity that addresses population size and environmental sustainability. We believe population growth contributes to environmental degradation, resource depletion and other problems. We conduct research, inform the public and advocate improved family planning and sex education, women's empowerment, smaller families and moderate consumption. We are a company limited by guarantee (3019081) and a registered charity (1114109).

## Sustainability Insights

Population Matters has prepared a set of short papers on various subjects relating to the overall issue of population and sustainability. The index page **https://www.populationmatters.org/resources/sustainability-insights/** together with links between the papers can be used to navigate between topics to show how the various pieces of the jigsaw fit together. Whereas these papers are intended to be accessible to readers without specialist knowledge of the topics, we hope they will also prompt dialogue between experts in different specialisms, thereby furthering development of the integrated subject as a discipline in its own right.

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# The Journal of Population and Sustainability

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# Contents

Introduction 5
DAVID SAMWAYS – EDITOR

Solving the Human Sustainability Problem
in Short-Termist Societies 11
GRAEME MAXTON AND JORGEN RANDERS

Population, Climate Change, and Global Justice:
A Moral Framework for Debate 23
ELIZABETH CRIPPS

Prospects for Accelerated Fertility Decline in Africa 37
JOHN CLELAND

A Call for Conservation Scientists to Empirically Study the Effects
of Human Population Policies on Biodiversity Loss 53
NIKI RUST AND LAURA KEHOE

Saving Living Diversity in the Face of the Unstoppable
6th Mass Extinction: A Call for Urgent International Action 67
FRED NAGGS

# Introduction

DAVID SAMWAYS – EDITOR

While the primary focus of this journal is upon the connection between human numbers and environmental sustainability, it is impossible to explore this relationship without considering a number of other interdependent factors. The environmental movement has always encompassed a wide range of concerns. Arguably, the publication of Rachel Carson's *Silent Spring* in 1962 initiated popular environmental concern around the issue of pollution as the side-effect of "progress". However, and perhaps more importantly, Carson made accessible the idea that the human beings are part of and dependant upon the ecosystem. Her critique of modern science found fertile ground in the counterculture of the 1960s which would foster the genesis of the environmental movement as we know it with a broad spectrum of concerns ranging from littering through to a fundamental questioning of the benefits of "technological society". Somewhat ironically the greatest scientific and technical achievement of the age, the Apollo space missions, furnished the environmental movement with one of its most powerful symbols. Photographs of the Earth alone in space conveyed not only its beauty but also a sense of finitude and vulnerability, adding allegorical weight to the ideas of writers like Barbara Ward, Kenneth Boulding and E.F. Schumacher. Indeed, both Ward (1966) and Boulding (1966) would employ the concept of "Spaceship Earth" to convey the finite nature of the planet.

Ward, Boulding and Schumacher shared the view that human beings were outstripping the planet's ability to sustain humankind. Continuous economic growth based upon the consumption of the Earth's natural capital was creating environmental degradation and human misery. Moreover, while the impact of human beings on the environment was once localised, it had become global. A pioneer of sustainable development, Barbara Ward emphasised that the distribution of wealth, global justice and poverty reduction were central to any

discussion about how to deal with the issue of the survival of humankind on an ecologically finite planet.

The future prospects for humanity on a finite planet were examined in probably the best-selling environmental book of all time[1], The Club of Rome's *Limits to Growth* (1972). Authors, Donella Meadows, Dennis Meadows, Jorgen Randers, and William Behrens developed a ground-breaking computer-model of the future growth of human activities including: industrialisation; resource depletion; pollution; food production; and population. Extrapolating from trends between 1900 and 1970, under various permutations the model showed that continuing material and population growth would probably lead to overshoot and collapse sometime before the year 2100. The model stressed the dynamic interdependence of the constituents of the system: addressing one area led to a shift in another. Most importantly, the report argued that there are natural limits to the planet's ability to support human population, provide resources and absorb pollution. Meadows et al concluded that exponential material and population growth is not sustainable and unless a managed transition to equilibrium is implemented at a global level ecological collapse will, at some point, be unavoidable.

*Limits to Growth* initially received a positive response from the political establishment. However, a backlash soon developed, driven by short-termist thinking on the part of the business establishment with profitability in mind, and voters fearing the effect on jobs and affluence. Accepting that evidence and data regarding longer-term issues are insufficiently motivating, in their new book, *Reinventing Prosperity* (2016), Club of Rome General Secretary Graeme Maxton and one of the original authors of *Limits to Growth*, Jorgen Randers, propose 13 policy solutions to the principle environmental problem: climate change. They argue that these policies are politically feasible in western democracies since they confer immediate benefits to the majority of voters and simultaneously address persistent unemployment and widening inequality.

In this issue's first article, *Solving the Human Sustainability Problem in Short-Termist Societies*, Maxton and Randers examine three of their proposals: green stimulus packages to encourage renewable electricity generation, electrification

1. Over 30 million copies sold in 30 languages (Norgard and Ragnarsdottir 2010).

of transport and energy efficiency measures; heavy taxation of fossil fuel production at source with revenues given directly to citizens; and increasing the number of paid holidays to offset productivity increases with leisure time whilst simultaneously decreasing unemployment. However the "elephant in the room" as they put it, is human population. While acknowledging that population growth in less developed countries (LDCs) must be tackled, Maxton and Randers address the problem of population levels in the rich world where per capita impact is many times greater than in poor countries by proposing direct payments to women on their 50th birthdays who have had one child or none.

In *Population, Climate Change, and Global Justice: A Moral Framework for Debate*, Elizabeth Cripps explores the interdependence of multiple ethical factors in the debate about sustainability. She argues that questions of population and sustainability pivot around issues of global, gender and intergenerational justice. Critical to understanding these relationships is the observation that increasing any one factor in the right side of the IPAT[2] identity leads, other things being equal, to an increase in environmental impact. The people of less developed countries should be able to improve their standard of living, inevitably resulting in some increase in consumption which cannot be sustainable in combination with a rapidly growing population. This needs to be tackled, preferably through the use of choice-providing policies including family planning, health care and education. Moreover, Cripps argues, because current global consumption levels are already unsustainable, considerations of global justice also support the case both for transfer of resources and technology to the LDCs *and* for lowering consumption in the developed world. Significantly, Cripps points out that the complexities and interdependencies of the issues are such that already the collective action required for a sustainable outcome will not be possible without facing up to some morally hard choices including whether to introduce incentive changing procreative policies.

While, as Maxton and Randers observe, the environmental impact of each new individual born into the developed world is up to 30 times greater than those in developing countries, absolute population increases in the LDCs is an issue for both environmental sustainability and, importantly, the quality of life experienced in those countries. The greatest increase in population is anticipated in Sub-Saharan Africa – a 120% rise between 2015 and 2050. This compares with

2. I=PAT: Impact = Population x Affluence x Technology.

a 20% increase in Asia – the same as the expected rise in North America. "The future size of world population", John Cleland observes, "depends critically on what happens in sub-Saharan Africa": his paper focuses on the prospects for fertility change in the region.

Like many commentators on population growth in the LDCs, Cleland notes that socio-economic development, education and the availability of contraception have a positive effect. However, rates of fertility for African countries with the same level of development as those on other continents are about one birth higher. One critical factor which distinguishes sub-Saharan Africa from the rest of the developing world is the stated desire, by men and women alike, to have large families. Identifying the unique historical, cultural, political and economic factors which may explain attitudes to childbearing, Cleland is nonetheless cautiously optimistic about the possibility of attenuating the rate of population growth – especially in east Africa. A reinvigoration of international interest in family planning programmes and a shift in the attitudes of African political leaders are possible sources of hope. The examples of Rwanda and Ethiopia which have both had rapid declines in their birth rate due to determined government initiatives show that a deviation from the UN projections is possible.

Many have argued that the impact and domination of our planet by Homo sapiens should be described as the Anthropocene or "the age of humans". However, the distinguished biologist E.O. Wilson (2013) has put it more strongly describing the current level of species extinction as potentially leading to what he terms the Eremocene: "the era of loneliness". While, in the interests of clarity, Liz Cripps' paper restricts itself to the impact of population growth on human interests, our final two papers explore issues relating to species extinction caused by pressure of human numbers.

Niki Rust and Laura Kehoe's paper is a call for action on the part of conservation researchers to study the empirical effects of population dynamics on species diversity. While the rapid pace of species extinction is widely acknowledged by conservation scientists, the causes cited are usually proximate rather than the ultimate drivers of global change: human numbers and resource consumption. Rust and Kehoe postulate that conservationists' lack of direct engagement with the population issue is possibly due to the subject being seen as controversial.

They argue that a multidisciplinary approach is required where conservation researchers work with NGOs to study the effect on biodiversity of programmes addressing female education and improved access to contraception.

Fred Naggs sees no possibility of averting the human-caused 6th mass extinction. While in the longer run a reduction in the human population will undoubtedly occur, by that time the devastation of biodiversity will already be so great that the era of loneliness will be upon us. Naggs tempers this by outlining methods that allow the creation of a 21st Century Noah's Ark to preserve viable cells of species in order to repopulate the natural world at a point when human numbers have been reduced. He calls for the establishment of a coordinated international project to collect and store living diversity as a means of escaping the species solitude that awaits us.

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# Solving the Human Sustainability Problem in Short-Termist Societies

GRAEME MAXTON AND JORGEN RANDERS

*Graeme Maxton and Jorgen Randers are the authors of* Reinventing Prosperity, *published by Greystone, October 2016. Graeme is also the Secretary General of the Club of Rome while Jorgen is professor emeritus at BI Norwegian Business School and member of the Club's Executive Committee.*

## Abstract

Society has so far failed to create a sustainable economic system because all conventional attempts to change the current paradigm lead to a short-term decline in the rate economic growth, resulting in higher inequality and unemployment, outcomes which are politically unacceptable. This article shows how to overcome this hurdle, by adopting 13 unconventional policies which reduce unemployment and inequality while cutting greenhouse-gas emissions, regardless of what happens to economic growth, and so allow for a gradual transition to a sustainable system in short-termist societies.

**Keywords:** Economic Growth, Climate Change, Population, Unconventional Policy Options, Inequality, Sustainability, Green Growth, Limits to Growth, Short-termism.

The Club of Rome has been searching for a solution to the sustainability problem – that of fitting a big and materially rich human population onto small planet – for more than 45 years. The problem was first defined in its famous first "Report to the Club of Rome", *The Limits to Growth*, published in 1972, and co-authored by one of us.

The crux of the problem is comparatively simple. If there is continuing growth – in population, resource use or pollution – on a finite planet, the likely outcome is

overshoot of the physical limits of the planet. Such overshoot will be followed by collapse, back to sustainable levels, unless there is genuinely extraordinary action to organise a managed decline. Pitted against the ambitions of humanity, in other words, the laws of physics are unlikely to yield.

Collapse would not happen overnight, of course, but rather over several decades, and it is our belief that the fraying of the environmental and economic threads that hold human society together has already begun. Climate change is the most obvious sign, though rising levels of air and water pollution, the loss of numerous species, and humanity's rising migration problems are all indicators of a failing system too.

The biggest problem however, is climate change. Unless there is a very significant change in human behaviour over the next 20 years, global temperatures will reach a level that is +2°C above the pre-industrial average by 2050. This will intensify the already observable damage from extreme weather, increase human migration flows, cause much unnecessary suffering to many life-forms, and threaten the stability of many human institutions. In the long run, after the year 2100, the +2°C rise will be enough to start a gradual and unstoppable melting of the northern permafrost. This will take several centuries but will be accompanied by continually rising sea levels – from one metre this century to another half a metre each following century.

If we do not dramatically reduce the level of damaging emissions in the next few decades then, the subsequent warming will kick off a chain-reaction which humanity will be powerless to stop, with serious negative consequences for the vast majority of living things on the planet.

In the first few decades following the publication of *The Limits to Growth*, the Club of Rome directed its efforts towards informing the political establishment about the sustainability problem, reasoning that politicians were elected to protect the well-being of voters – and ensure their survival – and that they would act accordingly. The results of this approach were positive at first, but then suffered from a steady backlash from those parts of the business establishment which wanted to stick to the current path, because it is easier and more profitable, regardless of the long term consequences for humanity and the planet. The views

of these businesses were, sadly, also supported by many voters who feared losing their jobs during the transition to a more sustainable system.

## Evidence and data are not enough

Our conclusion from this experience is that it is not sufficient to present solid scientific data and then expect the political establishment to act. Creating the necessary momentum for a transition requires something else.

Recently, we have been working on specific solutions to the climate challenge – knowing that it will now require genuinely extraordinary action to stop global warming before it is too late. The main problem, in a short-termist world, is that the obvious steps needed are way beyond what will be profitable or cost-effective and, most critically, far beyond that which is conventionally possible in a free-market democratic society. Solving the problem requires significant government intervention – in the form of well designed restrictions and subsidies – yet this seems politically impossible in much of the rich world, certainly for now.

Faced with this conundrum, it is only mildly comforting to know that it is actually quite simple – in principle – to solve the climate problem. All it takes is a ban on the use of coal, oil and gas to reduce greenhouse gas emissions by 70-80 %. Sadly, this seems to be politically infeasible as well, because voters are unwilling to pay more for electricity, gasoline and heating or cooling. Even for the proponents of such a ban the rewards would be elusive unfortunately, because the climate problem will continue to worsen for decades no matter what society now does.

So politicians will not do what is necessary to stop planetary warming because this will not be popular with voters.

So what to do?

## Unconventional solutions are needed

Our new book *Reinventing Prosperity* (the German title *One Percent is Enough* offers a better summary of what we are proposing) provides the answer. It lists 13 extraordinary and unconventional policy measures that, if implemented, would make solving the climate problem much easier.

Our proposals differ from other climate solutions because we restrict ourselves to policies that should be politically feasible in rich-world free-market democracies. We have limited ourselves to proposals that will provide an immediate advantage to a majority of voters, in other words, and which will go a long way towards solving the climate problem.

Importantly, our proposals are designed in such a way as to avoid any increase in unemployment or any widening of inequality during the transition from a fossil-based energy world to a more sustainable one. This is crucial, because it is a sad fact that conventional climate solutions cut the number of jobs in dirty industries (those producing or using coal, oil, and gas) without providing a safety net for those who lose their jobs. It is therefore unsurprising that there is so much opposition from those who stand to lose.

A central objective of our 13 proposals is to ensure that those who lose their jobs during the transition continue to receive a steady income until they have been trained for, and obtained, a new job in cleaner industries. As well as work in the production and use of renewable energy (solar, wind, hydro and biomass) these new jobs will typically be in services, care, culture or research.

As the transition only affects around one percent of all jobs in the rich world – which is one of the reasons for the title of the German version of our book – it should be politically manageable to provide this safety net. (We deal with the poor world separately, because the steps required in the poor world are different. For decades, the poor world has been advised to follow the economic policies of the rich world, and these have generally been to the poor world's disadvantage. We believe that the economic policies of the rich and poor world need to be different, especially in the future.)

The transition from dirty to clean still needs to be financed however, and the simplest way to do this is for governments to impose slightly higher taxes. But charging any sort of new taxes – to make the understatement of the year – is unlikely to be welcome in some countries. Few people would favour a tax rise in the US, Australia and the UK, for example, because the majority of people in these countries seem unwilling to pay for a shift from fossil to the low-carbon energy, despite the long term environmental rewards that would accrue to all.

We have pondered long and deep to find a way around this problem. Our solution, as described in our book, is a basket of policy changes that – together – provide income and job security to those affected by the transition without any increase in taxes. By raising the number of annual vacation days (we use the example of two additional days each year) for example, without any reduction in pay, the number of jobs available in an economy gradually increases, creating new work opportunities (because the available work is more evenly shared). This idea should be supported by the majority of people too, because it offers more leisure time without any reduction in pay. The cost is a mild rise in inflation, and so is paid equitably by all. Shortening the work year also slows output growth and the growth in greenhouse gas emissions.

We understand, of course, that it will take a lot of explaining to demonstrate that our 13 proposals lead to increased income security and so eliminate the resistance to strong climate action. Yet they actually offer much more, because they would boost average well-being throughout the rich world too.

We also acknowledge that our proposals do not further the economic interests of the rich, and hence will be resisted intensely by business owners and many business people. But even in rich nations these people constitute a tiny minority and their special interests should not win the day if there is truly democratic decision-making.

The 13 proposals are listed at the end of the article in a table. In our view, three of the most innovative and promising are:

### 1. Accelerate the emergence of clean business sectors through the use of green stimulus packages.

In simple terms, this means printing money to pay for whatever is needed to cut greenhouse gas emissions. If governments can print trillions of dollars to prop up the financial system, they can logically print money to stop climate change.

To drastically slow climate change, humanity must stop burning fossil fuels and find replacements for the three major uses of such energy; the production of electricity, transport, and heating/cooling of buildings. This requires:

1. a rapid expansion of renewable electricity capacity (solar panels, windmills, hydroelectric plants, (some will argue nuclear)),

2. the electrification of the transport sector (replacing all fossil-fuelled cars and trucks, as well as many boats and trains, with electric ones, and establish the charging infrastructure), and
3. a vast increase in the energy efficiency of buildings (that is, to insulate them better) before they are converted to electric heating/cooling.

These three steps would reduce greenhouse gas emissions by as much as 70 – 80 % and are the core elements of the much discussed, and generally misunderstood, "green shift".

Our printing money proposal accelerates the electrification of the economy by using today's existing stimulus packages for an unconventional purpose. (Interestingly, President Trump has already suggested using stimulus packages to create jobs in the US by improving the highways though he could actually create the same number of jobs in the production of windmills, electric cars and installing building insulation while reducing his country's ecological footprint.)

Such green stimulus packages should be welcomed by the majority of people because they create jobs without any short-term cost to voters. In reality, and in the long-term, there should be a small cost, through a small hike in inflation (though, interestingly, this has not happened when the policy has been used to bail out the banking sector).

South Korea used green stimulus packages – paying people to create a cleaner country – as a central part of its macroeconomic response to the financial crisis in 2008-09. China is adopting a similar approach in its effort to clean the air of its mega-cities – by paying millions of workers to clean the air using newly printed money.

### 2. Tax coal, oil and gas heavily and divide the revenue among all citizens equally.

This proposal is to introduce a high tax on coal, oil, and gas – levied at the coal face, oil well, or gas pipeline entry point (or at the port of import) – and give the revenue to adult citizens equally in monthly pay cheque. It would make coal, oil and gas more expensive, and accelerate the transition to renewable energy. As the dividend cheque received by the majority of people would be larger than

the extra cost they have to pay for energy, since most people use less energy than the average, the policy would benefit most people. It is also redistributive, shifting income from the rich to the poor. The majority would have an immediate short-term advantage and everyone would have an incentive to use less dirty fuel.

Iran used this method to remove its huge subsidies on fossil fuels. To gain popular support, the government started by sending cheques to all households one month before it eliminated the subsidies.

### 3. Increase the number of annual paid vacation days – for example adding two more vacation days every year – without any reduction in annual pay.

In purely economic terms, this proposal offsets productivity increases with more leisure time. Two fewer working days a year is less than 1% of a normal work year – yet another interpretation of our book title – and can be compensated for by increased productivity, which has been around 2% a year in recent decades in the rich world. If productivity improvements are lower, then longer vacation time will simply increase the inflation rate slightly and so will be paid for by all citizens equally.

For this proposal to work best, vacation time should be compulsory and self-employment discouraged.

Norway, Germany and other European countries have already applied this policy since 1960 to great effect. The citizens of these countries have a work year (1,600 hours a year) that is much shorter than that of US workers (2,000 hours), yet incomes remain high, vacations are longer, and average subjective well-being has improved.

## The elephant in the room

As this is a journal about population as well as sustainability, we should add some comments on the population issue, as it is a central theme of our book too. While the world has improved its energy and resource efficiency dramatically in the last 30 years, these gains have been more than offset by a near-doubling in the number of people on the planet, with the result that the total human ecological footprint has continued to rise. Humanity lives today as if there were 1.6 planet

Earths (Global Foot Print Network 2003), something which is only feasible for a limited period of time.

Fixing this problem is, of course, extremely hard. Without some sort of famine, war or pestilence on a near global scale, the human population will continue to grow for many years, and with it the pace of ecological damage. The only proven way to reduce the rate of population growth, other than a one-child policy, is through improved levels of education, especially of women, better healthcare, especially of children, and, of course, through more easily available contraception.

In our book we have made one additional proposal, which we believe will lower birth rates further, and, at the same time, offer moral support to those many hundreds of million of women who have already made the decision to limit their family size.

In making this proposal we have two objectives. First, we want to help a wide audience understand that the human population is too large. We want to shine a light onto a subject which has been insufficiently addressed for decades and encourage debate. Second, we want to highlight the fact that the problem is not only in Africa, south-east Asia and the rest of the poor world, as many people seem to believe. Despite low and falling birth rates, it is a problem of the rich world too, because the average child born in the OECD creates up to 30x more environmental havoc than one in the poor world (Global Foot Print Network, 2017).

Our proposal is to reward women who have one child only, or none, through the payment of a generous financial bonus on their 50$^{th}$ birthdays. We do not advocate removing the existing incentives that encourage people in the rich world to have more children (maternity and paternity leave, income support, and free kindergartens, for example), because they have many other advantages. We advocate instead the use of incentives that encourage fewer children, partly because this will encourage a change in thinking.

Our proposal also helps strengthen the status of women and further increase their influence over the crucial decision of family size. It represents a shift from the oft-heard view that families without children are not doing their bit to create the workforce of the future.

Why give the payment to women only? Because they are the ones who actually carry and give birth to a child. This puts a pressure on women that men do not experience, and we see our proposal as a way to recognize this.

We do not pretend that our idea will be easy to implement, or indeed easy to get accepted. We admit too that there are all sorts of practical problems, such as how societies should reward singles, same-sex couples, the infertile, those who adopt children, and couples who have twins, triplets, or more when they plan for just one child.

What we are trying to encourage is a change in thinking – and for the rich world to lead by example.

Humanity needs to understand that the problem of overpopulation will eventually be fixed whether people like it or not. It will either be fixed by nature, through some sort of ecological or societal collapse, or it can be fixed by choice – by having ever fewer people living peacefully within nature's bounds.

We want to show that it is better for humanity to choose the way, and to make it as positive an experience as possible.

# One Percent is Enough

## THIRTEEN PROPOSALS TO BOOST AVERAGE WELL-BEING IN THE RICH WORLD

1. **Shorten the length of the work year** to give everyone more leisure time.

2. **Raise the retirement age** to help the elderly provide for themselves for as long as they want.

3. **Redefine "paid work"** to cover those who care for others at home.

4. **Increase unemployment benefits** to maintain demand during the transition.

5. **Increase the taxation of corporations and the rich** to redistribute profits, especially from robotisation.

6. **Expand the use of green stimulus packages by printing money or raising taxes** to help governments respond to climate change and the need for redistribution.

7. **Tax fossil fuels and return the proceeds in equal amounts to all citizens** to make low-carbon energy more competitive.

8. **Shift taxes from employment to emissions and resource use** to reduce the ecological footprint, protect jobs and cut raw materials use.

9. **Increase death taxes** to reduce inequality and philanthropy while boosting government income.

10. **Encourage unionisation** to boost worker incomes and reduce exploitation.

11. **Restrict trade where necessary** to protect jobs, improve well-being, and help the environment.

12. **Celebrate women who have one child or none** when they pass the age of 50 to reduce the pressure of humanity on the planet.

13. **Introduce a guaranteed livable income for those who need it most** and give everyone peace of mind.

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# Population, Climate Change, and Global Justice: A Moral Framework for Debate[1]

ELIZABETH CRIPPS

*Elizabeth Cripps is a Senior Lecturer in Political Theory at the University of Edinburgh. She is the author of* Climate Change and the Moral Agent: Individual Duties in an Interdependent World *(2013) and has published research papers on climate change ethics, collective responsibility, justice to non-human animals, parental duties, and population and justice.*

## Abstract

This paper outlines a moral framework for the debate on global population policy. Questions of population, climate justice and global justice are morally inseparable and failure to address them as such has dangerous implications. Considerations of population lend additional urgency to existing collective duties to act on global poverty and climate change. Choice-providing procreative policies are a key part of that. However, even were we collectively to fulfil these duties, we would face morally hard choices over whether to introduce incentive-changing procreative policies. Thus, there is now no possible collective course of action which is not morally problematic.

**Key words:** Population policy, climate justice, global justice, tragic choices, hard choices, procreative rights.

1. This paper draws extensively on material originally published in *Global Justice: Theory, Practice, Rhetoric* (Cripps, 2016a) and the *Oxford Handbook of Environmental Ethics* (Cripps, 2016b). I gratefully acknowledge the permission of Oxford University Press to reproduce arguments from the *Handbook*. The earlier articles benefited from the critical input of numerous colleagues, including the editors of both publications. This version has benefited from written comments from Harry Cripps, as well as discussion at the Cumberland Lodge Colloquium on Population Ethics and with the Edinburgh Politics and International Relations Research Group.

The United Nations Population Division predicts that there will be 9.7bn humans by 2050 and 11.2bn by the turn of the century (UNDESA, 2015b). That's on the medium variant, but it may err on the low side (O'Sullivan, 2016). The IPAT equation makes it clear that population, along with affluence and the limits of technology, is a factor determining our collective impact on the environment (Ehrlich and Holdren, 1972). That deleterious impact includes climate change, which threatens human lives, health, and community (IPCC, 2014).

Given this, it is unsurprising that increasing (though still limited) airspace is being given to the question of limiting global population growth. The topic is gaining some traction among some academics and campaign organisations, although still generally eschewed by policymakers. This paper will outline a much-needed moral framework for this debate, in two ways. Firstly, it is morally crucial that we address the population question but equally crucial that this be done in the right way. I will argue that considerations of global and particularly gender justice must remain centre stage in any policy proposals. Secondly, the paper will clarify the morally deplorable situation in which, as a generation, we find ourselves. To avoid morally terrible policies or outcomes, we must make morally hard choices. The global affluent must face up to their obligation to make these choices, as well as their responsibility for bringing the situation about.

Let me begin with a few clarificatory remarks. Firstly, my normative starting point is a basic view of justice: one so minimal that I hope few would deny that we human beings owe each other this much. The basic requirement is that everyone be given a genuine opportunity to secure central human interests such as life, health, and some form of community. In other words, it is unjust for anyone to be denied the opportunity for a basically decent human life. Basic global justice demands this for everyone now living; basic intergenerational justice requires that the opportunity be preserved for future generations. Securing the latter requires, but is not limited to, effective action on climate change mitigation and adaptation.

Secondly, I will refer to morally hard options and to hard or tragic choices. A morally hard option involves doing something against which, other things being equal, there is a significant moral presumption. Although not morally terrible or outrageous, it should provoke significant moral concern. The distinction might be

brought out at the individual level by the difference between breaking a promise and killing somebody. A choice is tragic if all options are morally terrible; it is morally hard if, although not all options are terrible, there is none which is not at least morally hard.

Thirdly, this paper focuses on the impact of population growth and climate change on central *human* interests. I do not deny moral significance to the interests or survival of non-humans. However, enough hard questions are raised without extending the moral sphere in this way.

Fourthly, I will often refer to collective policy options. These, in practice, would almost certainly have to be implemented at state level. Moreover, as will become clear, the case for permissible introduction of some policies will depend on background circumstances which are often state-specific. However, the collective challenge is ultimately a global one and is addressed here as such.

Finally, population – or more specifically procreative – policies can be categorised as follows. *Choice-providing* policies include education and empowerment of women, and provision of family planning and reproductive health. As will become apparent, they also include provision of basic social security and health care to minimise infant mortality. *Incentive-changing* policies are designed to influence the procreative decisions of individuals and couples by changing their pay-offs. 'Harder' options within these are negative financial incentives (fines, taxes) or modifications to the ways in which many societies externalise the cost of child-rearing. For example, child benefit might be cut or limited to one or two children. 'Softer' options include small positive financial or economic incentives for small families, or educational and campaigning initiatives to cultivate a social norm of small families. *Directly coercive* measures, such as forced sterilisation or forced abortions, constitute abuses of central human rights. As such, they are not considered here except as a morally terrible alternative to be avoided.

## How not to talk about population…

It is morally crucial to discuss population in the right way. One 'wrong way' is to limit the scope of debate to population and environment or population and climate change, ignoring considerations of global justice. Given rising population

figures in less developed countries (LDCs) and often below-replacement birth rates in more developed countries (MDCs) (UNDESA, 2015b), there is an apparently straightforward temptation to put the onus for action (and impose the *costs* of so acting) on LDCs and their citizens.[2] However, this is morally pernicious: it is not only highly unfair but also very dangerous.

This inference is unfair because human numbers do not bring about climate change or other environmental damage on their own. As the IPAT equation spells out, they do so in combination with per capita carbon footprint (or other ecological impact) and the limitations of technology. Many areas where human numbers are growing fastest are also those where per capita emissions are lowest (UNDESA, 2015b, WWF, 2014). To quote Stephen Gardiner: 'The raw numbers suggest that the climate problem would not be much affected by many more Indians, Bangladeshis, and Africans living as they currently do' (2011). Nor should the correlation between high population growth and other indicators of environmental destruction – such as plummeting biodiversity – be taken as reason to push responsibility onto LDCs. Again, population is only part of the equation: comparatively high biodiversity rates in more developed world countries are also the result of MDCs 'outsourcing' environmentally destructive production and waste disposal to poorer parts of the world (WWF, 2012).

Shifting responsibility to LDCs and their citizens also has dangerous implications for basic justice. Consider what it means to say that the global poor 'ought' to have fewer children? If couples lack access to and information about family planning, they may not have that option. Women in some traditional societies, uneducated and subject to the will of their husbands, may be deprived of choice even if contraception is in principle available. In some cases, a large family may be a woman's only route to social status. Where adult children are one's only means of security in old age and infant mortality is high, a large family can be necessary to protect against destitution.

2. The most morally outrageous conclusion – now fortunately widely discredited – is the 'lifeboat ethics' view that it would be justifiable to cut off aid to the global poor to put an end to this growth (Hardin, 1974). A more recent argument turns the fact that developed states are outstripping their resources into an environmental case for curbing immigration (Cafaro and Staples, 2009). I also find this morally problematic but will not address it in this paper.

Nor can the onus for action simply be shifted to state level. Without considerable resource transfers, the poorest states may be unable to provide the family planning, education, and social security without which individual change would be either impossible or involve extreme sacrifice. Moreover, international policies which incentivise states to reduce population growth could, against the current status quo, have terrifying human rights implications: they could incentivise coercion. Consider the catalogue of abuses already seen in many parts of the world: forcing, bribing, intimidating or humiliating men or women to be sterilised, pressuring women to have late abortions, and mass-level contraceptive injections carried out by the military (Nair et al., 2004).

The full moral force of these observations comes when we combine them. Many in LDCs lack female empowerment, family planning, education and basic security for old age. These, *which earlier effective action on global justice by the global affluent might have secured*, leave many in the global poor unable to have smaller families, or to do so without huge personal sacrifice. In addition to other per capita-resource level problems, the resulting population growth has negative environmental impacts. The global affluent often outsource the environmental costs of their own luxury lifestyles to LDCs, further exacerbating these local environmental problems. This in turn makes life tougher for the local population, pushing them still further from the level of affluence and empowerment at which women are genuinely free to choose to have fewer children. Given this, it would be morally outrageous for the policy and academic elite – in which MDCs dominate – to talk of the 'irresponsibility' of the global poor in having larger families.

## … and why we must not ignore it altogether

Basic justice must stay centre stage in any debate on population. So much, I hope, is clear. However, that debate must take place. For precisely those who *are* motivated to tackle climate change and secure ongoing basic justice, population must be part of the equation. To assume that population growth among the global poor can continue to be ignored because of their low per capita emissions is, effectively, to assume that these emissions will continue to be negligible. This means either assuming continued severe poverty or that it is possible to end such poverty, for increasing numbers, without worsening environmental impact. The former is incompatible with basic global justice. The latter, as I will come back to, is a gamble with a terrible legacy at stake.

There is a real danger that population growth over the next few generations will make it impossible to do both basic global and basic intergenerational justice: that our children's, grandchildren's or great-grandchildren's generation will no longer even have the option of securing a basically decent human life for all without undermining the ability of future generations to do the same. Since it would be morally terrible to sacrifice the basic interests of either current or future humans, they would face a tragic choice at the collective level.

The point isn't simply that current resource use and emissions are unsustainable. It is that the more people there are the lower the average per capita lifestyle must be for sustainability. Even if those now living more affluently reduced their consumption to the average, at some point the sustainable lifestyle would fall below what is needed for basic justice. For the 2010 population (a 'mere' 6.9bn) the per capita biocapacity was 1.7 global hectares (gha) (WWF, 2014). Other things being equal, this would mean a per capita biocapacity of only 1gha for a population of 11.2bn (predicted for 2100). I make no claim to draw precisely the line at which a given global per capita footprint is compatible with a decent human life, but would be willing to hazard that this is dangerous territory. Countries with 2010 footprints as low as this also tend to rank 'low' on the Human Development Index (UN Development Programme, 2014, WWF, 2014).

There are two related responses to this argument. The first acknowledges the danger of reaching a point where sustainability and basic justice become impossible but denies that this justifies any specific *population* policy. The argument goes like this: birth rates drop with development, so all we (collectively) need do is secure global justice by boosting development in LDCs.[3] Of course, development also worsens climate change, so this must be accompanied by extra efforts on mitigation and adaptation. Yes, all this is a 'big ask' but if we (collectively) can pull it off, then no anti-natalist policies will be required.

A more nuanced second response picks up on my reference, above, to 'other things being equal'. It argues that I have overlooked the crucial role played by technological development in achieving sustainability. On this view, even if global justice fails to stabilise population at a level that could be sustainably maintained

3. For a fuller discussion of the *population-scepticism* discourse, driven by demographic transition theory, see Coole (2013).

on current resources, any 'gap' can – and must – be plugged by technology. So the case is made for massive upscaling of technological investment but not for anti-natalist policies (Heyward, 2012).

Both these arguments have true and important elements. The danger of bequeathing our grandchildren a tragic choice between their own generation and the next adds further urgency to the already compelling moral case for urgent, effective action to challenge global injustice whilst also mitigating and enabling adaptation to climate change. This requires MDCs, and the global affluent in general, to make emissions cuts, invest in 'green' technology, transfer such technology to LDCs, and make the further resource transfers needed for basic global justice. It also requires action *by* LDC governments to use those resources to secure basic justice, including gender justice, for their citizens. So much is morally clear-cut, although (alas) very far from happening.

Moreover, some policies are not only morally required for basic justice but will also impact directly on birth rates. These include provision of family planning and reproductive health care, basic security for old age, education and empowerment of women. They are, in fact, exactly what I categorised above as 'choice-providing' population policies. In 2015, at least 10 per cent of married or in-union women globally wanted to avoid or delay childbearing but were not using contraception. In sub-Saharan Africa, this figure was 24 per cent (UNDESA, 2015a).

However, the UN medium projections already factor in considerable family planning improvements (UNDESA, 2015b). Moreover, the triple challenge - securing basic global justice and reversing population growth through development, whilst also reversing our collective negative impact on the environment – would be extremely demanding even given the political will. Even for 2010 population levels, countries with a sustainable average per capita footprint tend to score medium to low on human development and to have birth rates above (sometimes well above) replacement rate (UNDESA, 2015b, UN Development Programme, 2014). Thus, even assuming dramatic lifestyle and emissions cuts by the global affluent, it may not be possible to *increase* living standards elsewhere sufficiently to reduce birth rates to below replacement rate by that alone, whilst keeping the global average footprint sufficiently *low* to remain within biocapacity limits.

Equally, it would be a mistake to assume static technology levels. However, a massive upscaling of technological development and transfer is *already* essential for securing basic global justice without worsening climate change. Technology is not some 'magic bullet' on which we can automatically rely to accommodate larger and larger populations at the same time. Although 2015 was a record year for investment in renewables, they still only accounted for 10 per cent of global electricity generation (excluding large hydro-electric projects) (Frankfurt School of Finance and Management, 2016). Moreover, technological change is uncertain by its very nature, it carries heavy infrastructure costs, and the time required for previous technological revolutions (70 to 100 years) simply isn't available now (UNDESA, 2011).

Where, then, does this leave the argument that current generations should focus on tackling climate change and global poverty, invest heavily in technology, but eschew any population-specific policy? Such a policy – although morally many times better than what we are currently doing – amounts to taking a gamble. The hope is that this would be enough to avoid bequeathing a tragic choice to one of the next few generations. However, it is only a hope. There is a clear moral presumption against such gambles, especially when the severe suffering associated with losing them would be borne by others. The precautionary principle dictates, at the very least, not taking them unless there are no less morally problematic alternatives (Shue, 2010).

There is a further reason against eschewing all population-specific policies: one which makes it, again, a morally hard option. It is a widely shared moral view that institutional arrangements should not impose additional costs on some people as a result of the free choices of others. If I neglect to repair my fence and it falls onto my vegetable garden, destroying the crop, that's my look out; if my neighbour fells his tree carelessly and *it* crushes my vegetables, fairness dictates that he should compensate me. Population growth will, at the very least, increase the costs of securing basic global and intergenerational justice. If these costs go up for everyone then those who have small families are, in effect, landed with additional burdens because others have had bigger ones. Such fairness considerations make a case for internalising the environmental and global justice costs of children (or above replacement rate children) by, as far as possible,

assigning them to parents.[4] Such a policy would be likely to overlap with the 'harder' end of the incentive-changing policy spectrum.

However, this argument has two important caveats. Firstly, it applies on the assumption that the environmental costs of other lifestyle choices (flights for holidays, for example, or eating meat) are also internalised as part of a just policy of climate change mitigation. Otherwise, it could be unfair to pick out the decision to have many children in this way. Secondly, the reference to a 'free' choice, above, is crucial. The case for internalising assumes that the decision to have a large family is genuinely free and informed. As we have seen, this is not the case in many parts of the world, especially for women. The point is not that policies to internalise the environmental and basic justice costs of large families could be justified globally under anything like current circumstances. Rather, it is that against a background of basic justice, *including genuine choice-provision*, internalisation could avoid one specific kind of institutional unfairness.

## Incentive-changing policies and hard moral choices

We have seen that, where basic justice is already in place, there are moral reasons to pay serious attention to incentive-changing policies, including those which go some way towards internalising the environmental and global justice costs of large families. Failure to do so would amount to choosing a morally hard option. Unfortunately, however, such policies *also* represent morally tough options. They all have implications against which, other things being equal, there are significant moral presumptions. Harder incentive-changing policies – including fully internalising policies – give rise to greater moral concerns. However, hard moral choices are faced even with the softer policy options.

This is because children are usually brought up by their own parents. We generally regard this as a very good thing. In practice and in political philosophy the family is treated as a unit important in itself and worthy of protection. However,

4. This is at odds with the view that children are a public good at the national level, a claim used to offer a moral defence of policies which externalise the costs of child-rearing. The idea is that parents deserve extra support for producing the next generation which will pay our pensions, provide public services, and care for us in old age. I will make only two quick points on this. Firstly, it is perfectly possible that children could be a public good nationally, at least in the short term, and a 'public bad' globally (Casal, 1999). Secondly, there is difference between having some children – at the collective level, bringing a next generation into being *at all* – and having many of them.

this way of doing things makes children's prospects contingent on the resources and inclinations of their parents. Thus, any policy designed to change parents' incentives by changing their pay-offs runs the risk of penalising children, or rewarding some relative to others. This is problematic because if anything in this emotive and perplexing field can be agreed on it is, I hope, that the children themselves are not to blame. They are entitled to the same moral consideration however many siblings they have.

At the extreme, this danger could rule out some incentive-changing policies. Suppose that the effect of introducing harder incentive-changing policies was to force a collective-level choice between removing children from otherwise good parents and making those families so badly off that the basic interests of the children were threatened. This could happen if parents had large families despite the policies and were heavily penalised for it. Both options are morally terrible and this choice would be a tragic one.

Even assuming this could be avoided – whether by eschewing harder incentive-changing policies altogether or by developing nuanced versions – a morally uncomfortable choice would remain. Other things being equal, softer incentive-changing policies would make children in smaller families better off relative to those in larger ones. For an institutional scheme to influence children's relative resources and opportunities in this way would be unfair. The unfairness might be mitigated – by providing many goods directly to children – but only by taking away elements of childcare from parents, and so interfering within families. Given the moral presumption against either of these outcomes, states or other collective institutions would face hard moral choices in introducing soft incentive changing policies. Even educational and campaigning alternatives run the risk of leaving third or fourth children feeling like second class citizens.

A further moral presumption against incentive-changing policies, especially any negative ones, results from their implications for gender equality. Even if such policies are introduced only where there is already both choice provision and basic justice, unless there is *full* gender equality in terms of pay, parental leave, and social childcare norms, many negative incentive-changing policies will have a disproportionately negative effect on mothers. This would apply particularly to cuts to current benefits such as maternity pay, child benefit, or childcare tax credits.

This, then, is the moral predicament. Even given effective, immediate collective action on climate change and basic global justice, with extensive investment in 'green' technology – even if, as basic justice demands, family planning, reproductive health and other choice-providing policies are an integral part of this – morally hard choices on population would remain. Incentive-changing procreative policies force (at best) a choice between unfairly rendering some children better off than others and interfering with the family. *Not* introducing such policies means accepting institutional unfairness across adults. It also means taking a gamble which, if it comes up tails, will leave our children or grandchildren facing a tragic choice between their own generation and the next.

## Population and the 'right' to decide family size

Before closing, one objection must be anticipated: that this paper has ignored an absolute moral right to determine family size which would overrule even incentive-changing anti-natalist policies. My response is as follows. It is true that a right to 'decide freely and responsibly the number and spacing of [one's] children' was upheld at the 1994 Cairo International Conference on Population and Development (United Nations, 1994). However, the moral philosophical case for an *absolute, unlimited* right to have as many children as one chooses is not compelling (Conly, 2015, Kates, 2004, Overall, 2012, Robeyns, Unpublished).

Parenting is an extraordinarily rewarding activity and a central part of a full life for many of us. This interest is so fundamental that it is plausible that the opportunity to be a parent should be protected by basic justice or, to put it another way, that this is a human right. However, it is not clear that this extends to a right to have many children of sufficient force to override all costs to others. Why should the aim of having a large family, important as it is to some, be treated differently from other aims and ambitions? Why should this goal be ring-fenced in a way that (say) the goal of climbing the world's highest mountains should not? Most accounts of justice accept that some of the costs of such ambitions should be borne by the individuals concerned. It is also accepted that it can be legitimate to limit the extent to which individuals can pursue their own ambitions if this is necessary to protect the basic rights of others (at least so long as individuals retain *some* scope to follow their own plan of life). Incentive-changing policies are thus not automatically ruled out, so long as they apply after one child.

However, context is everything. There are decisive human rights objections to many of the means that might – and have – been used to sway procreative decision-making. As indicated earlier in this paper, there are circumstances under which almost any incentive-changing policies are effectively coercive either for both potential parents or for mothers. An example of the former would be financial incentives for the extremely poor; the latter can too easily result given unequal power relations within the family. Misinformation or lack of information also undermines the idea of a genuine, free informed choice. Feminists rightly cite the frightening example of effectively coercive policies in in India or south America (Nair et al., 2004). Such cases reinforce the crucial importance of choice-provision and basic justice, including education and empowerment of women, as a prerequisite for the morally permissible introduction of incentive-changing policies.

To conclude, this paper has argued that questions of population, climate justice and global justice are morally inseparable. It has pointed out that considerations of population lend further urgency to some existing duties of global justice: duties to act immediately and effectively to tackle both global poverty and climate change. It has stressed that choice-providing population policies must be part of that. Finally, it has pointed out that hard moral choices would remain *even were we collectively to fulfil these morally clear-cut duties*.

I have not attempted to make these hard choices. For my part, I think a case can be made for adopting some incentive-changing procreative policies, where choice-provision is already established, rather than gamble on development and yet-to-be-developed technology to spare our immediate descendants a tragic choice. Morally uncomfortable though they are, trade-offs between maintaining equal opportunities for children and fully respecting the integrity of the family are already accepted in other contexts. However, I have not defended this view. Indeed, given how depressingly far the global affluent are even from doing what *is* morally clear cut, it is all too probable that the situation will be still starker – and the choices will have become truly tragic – before we face up to it.

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# Prospects for Accelerated Fertility Decline in Africa

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## Abstract

The future size of world population depends critically on what happens in sub-Saharan Africa, the one remaining region with high fertility and rapid population growth. The United Nations envisages a continuing slow pace of fertility change, from five births per woman today to three by mid-century, in which case the population of the region will increase by over one billion. However, an accelerated decline is feasible, particularly in east Africa. The main grounds for optimism include rising international concern and funding for family planning (after fifteen years of neglect), and favourable shifts in the attitudes of political leaders in Africa. The examples of Ethiopia and Rwanda show political will and efficient programmes can stimulate rapid reproductive change.

**Keywords:** Africa, population projections, fertility, desired family sizes, population policies.

## Introduction

The future of the world's population depends on many factors that are impossible to predict with certainty. A devastating pandemic is a distinct risk. The 1918 flu pandemic is estimated to have killed about 4% of the world's population. A repetition today would imply the death of 280 million, a huge number but one that represents only about four years of growth at current rates. Another possibility

that would have a profound impact on future population growth is a substantial rise in China's low birth rate in response to the ending of the One-Child policy. But the biggest uncertainty is the future of fertility in sub-Saharan Africa, the one remaining region with high birth rates and rapid population growth. Compared with projections based on an assumption of a continued gentle decline, an accelerated decline in fertility would reduce Africa's projected population size by 200 million by mid-century, rising to 800 million by the end of the century (Gerland, Biddlecom and Kantorova 2016).

The central aim of this paper is to analyse the prospects for future fertility change in sub-Saharan Africa. This will require an examination of past trends, an attempt to understand the factors underlying the persistence of high fertility and the conditions favourable to decline, and identification of policies and programmes that can most effectively change the future course of childbearing.

## Projected population growth, 2015–2050

Table 1 shows the most recent medium (ie most likely) population projections up until mid-century published in 2015 by the United Nations Population Division. Longer-term projections exist but are highly speculative because they have to make assumptions about the childbearing of individuals not yet born. Over a horizon of a few decades, UN projections have a good record of predictive validity at global and regional levels. While by no means immutable, they deserve to be taken seriously.

Table 1 shows an expected increase in global population of 2.4 billion between 2015 and 2050. The growth comes very largely from two regions, Asia with an extra 870 million and sub-Saharan Africa with 1.2 billion. The proportionate increases in these two regions, however, are very different. In Asia, the projected increase is a mere 20%, about the same as expected in northern America, largely because of assumptions of continuing in-migration, and lower than in Latin America or north Africa. The large increment of 870 million in Asia is mainly a reflection of that region's huge base population size. By contrast, the population of sub-Saharan Africa is projected to more than double in size, an increase of 120%. Whatever happens in regions other than Asia and sub-Saharan Africa will make precious little difference to the global total in mid-century. Differential growth has had and will continue to have a profound effect on the regional balance of population.

In 1950, sub-Saharan Africa accounted for only 7% of world population. By 2050, this fraction will likely rise to 22%. Over the same 100 years, Europe's contribution is the exact mirror opposite, a decline from 22% to 7%.

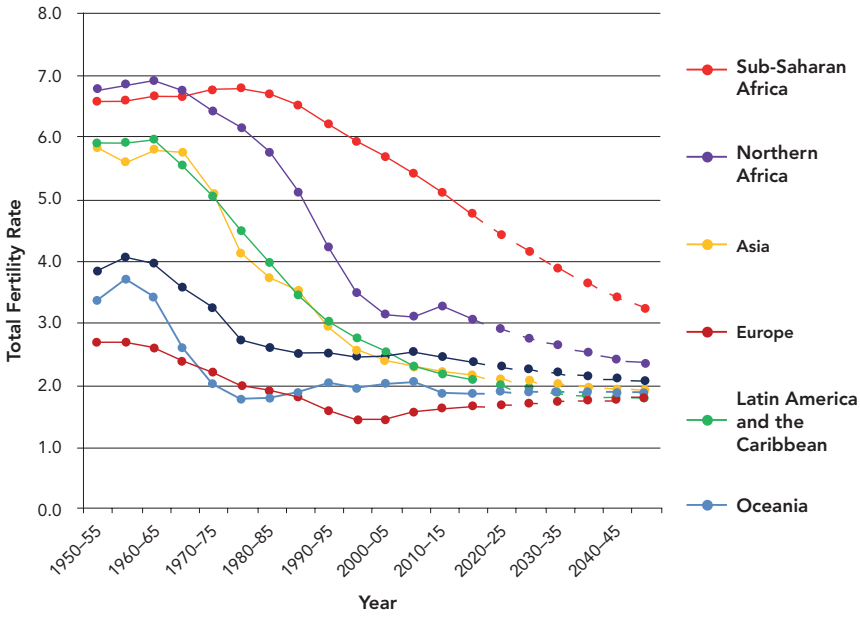
**Table 1: Population Growth, 2015–2050, by region**

| | Population size (millions) | | Absolute change (millions) | Percent change |
|---|---|---|---|---|
| Region | 2015 | 2050 | 2015–2050 | 2015–2050 |
| Europe | 738 | 707 | -31 | -4 |
| Northern America | 358 | 433 | 75 | 21 |
| Asia | 4393 | 5267 | 874 | 20 |
| Latin America/Caribbean | 634 | 784 | 150 | 24 |
| Oceania | 39 | 57 | 18 | 46 |
| North Africa | 224 | 354 | 131 | 58 |
| **Sub-Saharan Africa** | **962** | **2123** | **1161** | **121** |
| World | 7349 | 9725 | 2376 | 32 |

SOURCE: UNITED NATIONS.2015 WORLD POPULATION PROSPECTS: THE 2015 REVISION

The main drivers of population growth are fertility and age structure: the higher the proportion of population in the reproductive age span, the higher will be the birth rate at the same level of childbearing per woman. Figure 1 shows past and projected fertility for the same seven regions as in Table 1. In the 1950s, fertility in the four poorer regions was similar, in the range of six to seven births per woman. In Asia and Latin America, sharp declines started in the 1960s and fertility is now close to two births per woman, the replacement level that in the long term ensures population stability. Population growth continues mainly because of a conducive age structure. In its projections the United Nations assumes a continuing fall in fertility to below replacement. In the Arab states of north Africa the drop in childbearing also started in the 1960s and the United Nations assumes a continuing fertility decline, from a little over three births today to close to replacement by mid-century. In sub-Saharan Africa, decline started later and proceeded at a slower pace than elsewhere. The UN assumes that the gentle decline will continue from the current level of about five to about three births by 2050.

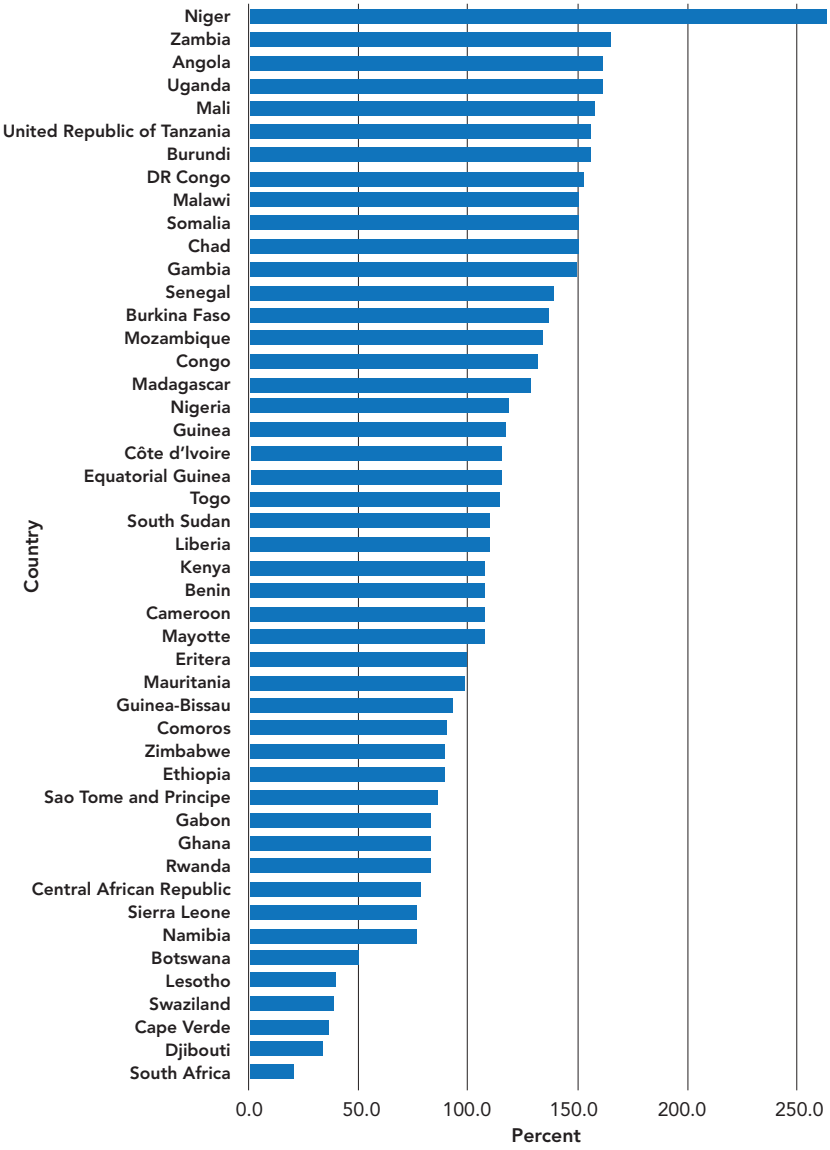
**Figure 1: Trend of total fertility rate by world region, 1950–2050**




SOURCE: UNITED NATIONS.2015 WORLD POPULATION PROSPECTS: THE 2015 REVISION

Of course, these regional averages disguise country variations. In Asia, the main exceptions to prevailing low fertility and population growth are Afghanistan, Iraq and Yemen where the child-bearing level is still around four births. Fertility also remains above three in Pakistan's substantial population. In sub-Saharan Africa, fertility ranges from close to replacement in the Republic of South Africa to over seven births per woman in Niger. This variability is expressed in Figure 2 in terms of projected percent increase in population between 2015 and 2050. Figure 2 makes clear that most countries in Africa are expected to experience a doubling of population, or more, in the next 35 years. Only 11 of the 46 countries are projected to grow by appreciably less than 100%.

## Figure 2: Percent increase in population between 2015 and 2050




SOURCE: UNITED NATIONS.2015 WORLD POPULATION PROSPECTS: THE 2015 REVISION

Niger with a projected increase of 250%, from 20 million to 72 million demands special consideration. This is a relatively rare example of a projection that makes no sense. Niger has a very fragile environment, highly susceptible to climate change, and suffers periodic food crises. It is impossible to envisage that the country can support such a growth in population, even at the most basic standards, or that international food relief can come indefinitely to the rescue on such a massive scale. The inevitable resolution will be mass migration, mostly to neighbouring countries. Whether this can happen without major strife is one of the great uncertainties but the topic is so politically sensitive that it is ignored in international discourse. Niger is only an extreme example of a Malthusian crisis that will affect the whole of the Sahel, the strip of arid and semi-arid land stretching from the Atlantic to the Horn of Africa (Potts, Henderson and Campbell 2013). As shown in Figure 2, population projections for Mali and Chad are also very high.

## Explanations for the slow fertility decline in sub-Saharan Africa

What distinguishes African reproductive systems most clearly from those in other parts of the world is the stated desire for many children, expressed by both women and men in countless surveys. The earliest surveys in Asia and Latin America, conducted in the late 1950s and 1960s typically showed that most couples wanted to have two to four children; many women in their 30s wanted to stop childbearing altogether. In sub-Saharan Africa, desired family sizes were (and remain) much larger and fewer women wanted to stop. For instance, World Fertility Surveys, conducted in the 1970s and early 1980s, show that desired sizes among young women in seven African countries ranged from 5.2 in Ghana to 8.3 in Senegal. By contrast, in only one (Syria) of 14 Asian and Pacific countries did the mean desired size exceed five children. In 13 Latin American and Caribbean countries, the highest desired size was 3.8 in Mexico (Lightbourne 1987).

What accounts for this huge difference in attitudes towards childbearing? Answers can be sought in evolutionary history. *Homo sapiens* evolved in Africa, facilitating the co-evolution of a uniquely wide range of parasitic diseases, leading to exceptionally high mortality. Africa's population is characterised by a mosaic of different ethnicities with rather little historical evidence of large empires that could impose eras of peaceful co-existence. Mortality was thus further raised by incessant raiding and warfare between different tribes. These two factors go a long way to explaining Africa's small population size until recently. They may also

account for reproductive attitudes. Survival of the group depended on a high birth rate and, in particular, on the ready availability of young men to protect against aggressive neighbours.

The speculations in the preceding paragraph are consistent with more commonly expressed explanations. John Caldwell has argued forcefully that features of social organisation, underpinned by traditional African religion, served to engender and sustain pronatalism (Caldwell and Caldwell 1987; Caldwell, Orubuloye, and Caldwell 1992). Drawing on anthropology and his own extensive field studies in Nigeria, Caldwell viewed the extended lineage, rather than the nuclear family, as the key feature of social organisation. The lineage includes both the living and the dead. The dead retain their individuality for as long as they are specifically remembered and may be reborn into the lineage. The imperative for both living and dead is survival of the lineage. Reproduction is enforced with spiritual power and reproductive failure is interpreted as ancestral disapproval.

The dominance of the lineage also has more prosaic economic implications. Mortality decline invariably precedes drops in fertility and, as a consequence, the number of children who survive to adulthood rises. Whereas in Asia, the burden of rearing an increasing number of surviving children fell directly on the nuclear parents, in Africa the burden is diffused among relatives. More affluent lineage members are under an obligation to help those less fortunate with, for example, school fees. Child fostering is common. A related factor concerns land tenure in much of Africa, which is controlled by communities and allocated to individuals according to need. These features are likely to delay a fertility response to improving survival.

Other commentators have sought to account for the slow decline in fertility more straightforwardly in terms of low socio-economic development. All the familiar indicators – life expectancy, GDP per head, percent urban and educational level – are less favourable in Africa than elsewhere. A recent examination suggest that the level of development at the start of the African fertility transition in the 1990s was lower than in other developing regions at the start of their transition in the 1970s (Bongaarts 2016). Nevertheless, at the same level of development, fertility in African countries is about one birth higher than elsewhere. In other words, there is a unique "Africa" effect on childbearing.

Yet a further explanation is the relative lack of firm policies and programmes to reduce rapid population growth by promotion of contraception. Opinion is divided about the effectiveness of family planning programmes to reduce fertility. Most economists are sceptical and view demand for smaller families stemming from modernisation as the overridingly important factor. But they ignore the fact that contraceptive practice represents a radical innovation that concerns core features of human life, sex and procreation. Like most such innovations, contraception is often greeted with deep suspicion and anxiety and sometimes with outright hostility. Information and educational efforts, together with family planning services, organised by governments or large non-governmental organisations, can allay suspicion and subdue opposition and thereby hasten mass adoption of contraception and fertility decline. Strong government actions were a major influence on fertility transition in Asia, though less so in Latin America where initiatives were spearheaded by non-government organisations such as Profamilia in Colombia and Bemfam in Brazil.

Until recently, the attitude of African political leaders to the idea of fertility reduction and curbing population growth has been lukewarm or hostile, no doubt in part because of the perception by leaders that most citizens wanted large families (May 2016). Few governments have launched major family planning initiatives. The main exceptions have been South Africa under the Apartheid regime, Rhodesia (now Zimbabwe) under the illegal Smith regime and Kenya in the 1980s under President Moi; it is no coincidence that these three countries have been at the forefront of reproductive change in Africa.

## Prospects for accelerated fertility declines

The UN medium projections, thus far, have been used to portray the most likely future for Africa's fertility trend and population growth. But, as already mentioned, they are not set in stone. In this section, future fertility prospects are assessed in three very different ways: trends in the desire to stop childbearing; the reproduction of the best educated; and the lessons from two countries that have achieved recent rapid declines.

### *Desire to stop childbearing*

In Asia, Latin America, and north Africa, the fall in childbearing was dominated by family size limitation. Couples, typically in their early 30s, having had a few children, decided that they wanted no more and adopted contraception to

achieve this desire. Some evidence suggests that the African fertility transition is taking, and will continue to take, a very different form. Rather than contemplating a permanent cessation of childbearing, it is suggested that couples will postpone births and reduce ultimate family size by very long inter-birth intervals (Moultrie, Sayi and Timaeus 2012). Such behaviour is consistent with a large and convincing body of evidence that wide birth spacing has long been valued in Africa and indeed has an important role in enhancing child growth and survival. Historically it was achieved by prolonged postnatal sexual abstinence.

Nevertheless, it seems unlikely that low fertility will be achieved in Africa solely by postponement and spacing. Women start families at an early age and, even with average inter-birth intervals of 48 months, five children can be achieved with ease. It is also telling that prospective studies in Nigeria, Ghana, Malawi and work in progress in Kenya show that women or couples who state at baseline that they want no more children do indeed achieve lower fertility in the subsequent two or three years than those who state a desire for more children at some time in the future. In rural North Malawi, for instance, 33% of women who stated that they wanted no more children gave birth or became pregnant within the next three years compared with 55% of those who wished to delay the next child by three or more years and 63% of those who wanted a child within three years (Machiyama et al. 2015). The proportion of those wishing to stop who nevertheless became pregnant may seem large but similar results have been obtained in Asia and north Africa and many possible explanations can be found: change of preference; contrary desires of the husband; and contraceptive failure, discontinuation or avoidance. The significance of the Malawi results is that the family size limitation appears to provide a more compelling motive for pregnancy-avoidance than postponement. Perhaps, after all, the pattern of African reproductive decline will not be so different from that in other regions.

To the extent that the spread of family size limitation is essential for the goal of low fertility, it becomes relevant to examine trends in the desire to stop having any more children. Table 2 shows these trends for women who already have three surviving children. The choice of three children is in part arbitrary but also justifiable on the grounds that low fertility is unlikely until a large fraction of couples are content to have a small family of three or fewer offspring. Countries with at least four Demographic and Health Surveys have been chosen for this analysis.

**Table 2: Among women with three living children, percentage who want no more**

| | PERIOD | | | | |
|---|---|---|---|---|---|
| | 1990–4 | 1995–9 | 2000–4 | 2005–9 | 2010 |
| **REGION/COUNTRY** | | | | | |
| West/Central Africa | | | | | |
| Benin | – | 15 | 15 | 19 | 23 |
| Burkina Faso | 12 | 11 | 14 | – | 14 |
| Cameroon | 8 | 10 | 16 | – | 20 |
| Ghana | 31 | 36 | 36 | 36 | 35 |
| Mali | – | 11 | 10 | 11 | 12 |
| Niger | 6 | 5 | – | 4 | 4 |
| Nigeria | 9 | 11 | 8 | 13 | 13 |
| Senegal | 9 | 9 | – | 12 | 12 |
| East/Southern Africa | | | | | |
| Kenya | 47 | 52 | 50 | 58 | 60 |
| Namibia | 35 | – | 65 | 68 | 61 |
| Rwanda | 25 | – | 24 | 57 | 57 |
| Tanzania | 12 | 24 | 25 | – | 21 |
| Uganda | – | 25 | 29 | 24 | 30 |
| Zambia | 11 | 23 | 28 | 24 | 28 |
| Zimbabwe | 31 | 45 | – | 53 | 50 |

SOURCE: UNITED NATIONS.2015 WORLD POPULATION PROSPECTS: THE 2015 REVISION

The trends for west and central Africa are depressing in terms of prospects for decline. In most countries, only a small minority of women wish to stop childbearing after three children and trends over the past 20 years are modest. Cameroon is a partial exception, with an increase from 8% to 20% between the early 1990s and recent years. Ghana, the forerunner of fertility decline in this sub-region, has a much larger proportion wishing to cease childbearing though little change has occurred in the past two decades.

In east and southern Africa, the impression is very different. In four of the seven countries, half or more of women with three children express contentment with this number. The exceptions are Tanzania, Uganda and Zambia. In both Tanzania

and Zambia, a sharp rise from around 12 to 24% is apparent in the 1990s but there has been little further change since then.

Kenya is a particularly interesting case. In the World Fertility Survey of 1979-80, only 16% of all married women wanted no more children but within a decade this proportion had swelled to 49%. This decade saw the implementation of a vigorous family planning programme, with a strong informational and educational component, led by President Moi and Vice-President Kibaki, and a surge in contraceptive adoption. This sequence suggests that reproductive aspirations can be abruptly de-stabilised by the advent of reproductive choice. Something similar may have occurred in Rwanda. In this country the dramatic rise in the percent wishing to stop at three children in the first decade of this century coincided with a major re-invigoration of family planning under the auspices of President Kagame. However, puzzles remain. In Zambia, use of a modern contraceptive method rose sharply from about 20% in 2000 to 45% in 2013, about the same level of use as in Rwanda, but without the revolution in reproductive attitudes.

The broad conclusion from this examination of reproductive preferences is that the idea of family size limitation has taken root in much of east and southern Africa and the prospects of further declines look bright. The opposite applies to west and central Africa.

*Fertility among well educated women*

The reason for attempting to discern the future by examining current levels of childbearing among well educated women is that they are usually in the vanguard of change. Contraceptive adoption and a fall in fertility usually starts in privileged strata before diffusing more widely. Thus the reproduction of women with secondary or higher schooling in Africa may be a guide to behaviour in the total population in the next couple of decades.

A total of 13 west or central Africa countries have conducted Demographic and Health Surveys, or similar, in 2010 or more recently. The percent of women aged 15-49 years with some secondary or higher education ranges from 9% in Niger to 63% in Ghana, with a mean of 29%. Among this group, the lowest fertility is recorded in Cote d'Ivoire at 2.8 births. Fertility of over 4.0 is apparent in Niger (5.0), Mali (4.6), Nigeria (4.5) and Gambia (4.5). The mean for all 13 countries is 3.8.

In east and southern Africa the percent of well educated women ranges from 11% in Ethiopia to 73% in Zimbabwe, with a mean among 11 countries of 31%. In this group the highest fertility is found in Burundi (4.6) and Uganda (4.5) and the lowest in Ethiopia (1.9). Mean fertility is 3.5 births.

Several observations may be made on the basis of this simple exploration. First, achievement of secondary schooling does not automatically translate into low fertility as evidenced in seven of these 24 countries. Second, the large east-west divide seen in Table 2 largely disappears when attention is focussed on behaviour of the well educated. The level of women's education is similar and, while fertility, on average, is lower in the east than the west, the difference is small. Third, the indications for future fertility decline tend to be positive. Close to one-third of women of reproductive age have received secondary or higher schooling and their fertility is currently not much above three births, compared with about five for all women. Secondary school enrolments are destined to increase in the future and, more importantly, the less well educated are likely to follow the reproductive path of their better educated counterparts.

*The lessons of success*

Two countries, Ethiopia and Rwanda, have experienced remarkably sharp recent fertility declines. What can be learnt from these successes?

Ethiopia's population is estimated to be about 100 million, the second most populous country in sub-Saharan Africa. Despite rapid growth in GDP in the past 10 years, it remains one of the world's poorest countries and is the world's largest recipient of international food aid. School enrolments have improved but adult educational levels are low. Half of women of reproductive age have received no schooling and, as shown above, the percentage with secondary schooling is exceptionally low.

Despite these disadvantages, the country has achieved an impressive degree of demographic modernisation. For instance, life expectancy improved by close to 16 years between 1990 and 2013, whereas the gain for Africa as a whole was only about six years. Similarly, fertility fell from seven births per woman in the early 1990s to 4.6 births in 2010–15, a drop of 35% compared with a drop over the same period of 18% for the entire region.

Strong policies and programmes can take much of the credit for these stunning achievements (Halperin 2014). The 1993 population policy set explicitly demographic goals of reducing fertility to four births and raising contraceptive use to 44% by 2015. In 2004, the abortion law was liberalised. A cadre of over 30,000 mainly female community-based health and family planning workers was trained for one year and posted back to their own localities. One lesson from Ethiopia, like that of Bangladesh in the 1980s, is that major progress towards low mortality and fertility can be made in the absence of broad socio-economic development given political will and programmatic efficiency.

Rwanda, a much smaller and more densely populated country than Ethiopia, is placed at position 163 out of 188 on the human development index, the same as Uganda but slightly higher than Ethiopia at position 174. The country adopted a pronatalist stance in the aftermath of the genocide but in 2003, the policy changed to the goal of reducing population growth and, as in Ethiopia, a strong emphasis was given to outreach family planning services. Between 2005 and 2014/5, the percent of married women using a modern contraceptive method rose from 10 to 48% and fertility fell from six to a little over four births per woman, an astonishingly rapid transformation.

The key lesson from Ethiopia and Rwanda appears to be that determined government initiatives can bring about rapid reproductive change as part of a wider agenda of health improvements, educational expansion and economic vibrancy. Both political regimes run relatively efficient administrations that are capable of mass mobilisation and implementation of effective nationwide programmes. Both are autocratic, with little tolerance for opposition, and it remains uncertain whether political evolution towards greater inclusiveness and freedom of expression will occur. The civil insurrection in Ethiopia in October 2016 is certainly a warning sign that a more inclusive approach is needed. Nevertheless, the experience of these two countries is relevant to the more secure and competent regimes in Africa.

## Discussion

As stated at the outset of this paper the future size of the world's population depends largely on what happens to fertility in sub-Saharan Africa. The skilled and experienced team of demographers at the UN Population Division think

that the pace of decline will continue to be as gentle as in the past. They may well be correct, particularly for west Africa. Some of the evidence reviewed here, however, suggests that sharper declines could be achieved. In addition, rapid urbanisation is expected in Africa. Though this will result in a proliferation of slum populations, fertility is markedly lower in urban slums than in rural areas and thus rural-urban migration will favour drops in childbearing. Further expansion of secondary schooling will also accelerate the pace of change, as will increased exposure to mass media.

Developments in the application of birth control technologies are a further relevant factor. Hitherto, injectable contraception has been dominant. Though highly effective, this type of method requires re-supply every two or three months. Discontinuation because of side effects and health concerns is common and switching to an alternative method is low. The link between contraception and pregnancy-avoidance is thus weakened. In response, there is a new emphasis on the promotion of long-acting reversible methods, intra-uterine devices and implants, which have much lower rates of discontinuation than injectables, perhaps because stopping requires a conscious decision to remove the device. Use of implants, but not IUDs, is now rising rapidly in many countries. The proliferation of medical abortion products, often available illegally across the counter in medical stores, may already be having an effect on childbearing, particularly among sexually active single young women for whom the stigma of abortion is less than the shame and threat to prospects of motherhood (Johnson-Hanks 2002).

The most compelling grounds for optimism concerns politics, both international and domestic. Just as the fertility transition was starting in Africa in the early 1990s, international concerns about high fertility and rapid population growth waned. At the 1994 Cairo conference on population and development, the agenda of population control was swept aside and replaced by a broader vision of women's reproductive health, rights and empowerment. Subsequently, the desirability of curbing population growth, and even the word "contraception" disappeared from international discourse. In Africa, family planning funding was diverted to a new emergency, HIV. As high fertility and rapid population growth jeopardises employment prospects, food security, improvement of human capital and the environment, Africa's long term prospects were severely damaged by the new international consensus.

The pendulum of international opinion has now swung back. The worst of the HIV pandemic is over, new concerns have arisen about the world's ability to feed a growing population without further severe environmental damage, and the huge surge in Africa's population has raised alarms about mass migration from poverty and hunger. In 2012, the London Family Planning Summit pledged to reach an extra 120 million women with affordable contraception by 2020. Funding has increased and the reluctance to talk openly about the subject has abated.

This change at the international level will achieve little without changes at national governmental level. Here also, positive developments are apparent. The concept of a "demographic dividend" has traction among African politicians and economists. This dividend, or boost to living standards, arises when the falling fertility brings in its wake a rise in the ratio of adult workers to dependent infants and children. Econometric evidence suggest that this change in age structure made a large contribution to rapid improvements in income per head in east Asia. This prospect is appealing to African elites. Poverty reduction is a universal goal and the narrative of the demographic dividend neatly circumvents explicit mention of curbing population growth, though, of course, it will have exactly this effect. President Museveni of Uganda, historically an opponent of family planning promotion, has been convinced and other leaders are showing similar signs, spurred on by endorsements from the World Bank and IMF (May 2016). We are entering an era when political will and (hopefully) international funding may act in concert to accelerate reproductive change. The re-imposition by President Trump in January 2017 of the global GAG rule that prevents US funding of any non-government organisation that in any way promotes or facilitates access to abortion is a backward step but in the past this restriction has not made a decisive difference to overall funding for family planning, in part because other donors made good the deficit.

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# A Call for Conservation Scientists to Empirically Study the Effects of Human Population Policies on Biodiversity Loss

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## Abstract

The world is changing more quickly now than it ever has before, predominantly due to our large consumption rates and population size. Despite this epoch being well-accepted as the "Anthropocene", it is surprising that there is still a lack of willingness by many conservation scientists to engage with the consequences of human population dynamics on biodiversity. We highlight the importance of addressing the effects of our population abundance, density and growth rate on conservation and note that environmental organisations are beginning to embrace this problem but the take-up amongst conservation researchers to empirically study their effect on biodiversity is slow. We argue that the lack of published research may partly be because the topic is still considered taboo. We therefore urge conservation scientists to direct more of their research efforts on this issue, particularly to examples that highlight the effects of Population, Health and Environment (PHE) projects and female education initiatives on biodiversity.

**Keywords:** family planning, fertility, overconsumption, overpopulation, population growth, population health and environment

Earth has entered a new era dominated by humans, the "Anthropocene" (Crutzen and Stoermer, 2000; Steffen, Crutzen, and McNeill, 2007; Corlett, 2015). It is estimated that over three-quarters of the world's ice-free land has now been altered in some way by people (Ellis and Ramankutty 2008; Caro et al. 2012), we are already overstepping our planetary boundaries – which are defined as a safe operating space for humanity (Steffen et al. 2015), and our actions are causing climate change (Huber and Knutti 2012; Intergovernmental Panel on Climate Change 2014) and the sixth mass extinction (Barnosky et al., 2011). Current projections indicate that the number of threatened bird and mammal species will rise 14% by 2050 due to human population growth alone (McKee et al. 2013), this is on top of the 52% of vertebrate population abundance that has already been lost only in the last four decades (WWF 2014).

Conservation scientists studying the drivers of biodiversity loss are aware of the oft-cited reasons for human-influenced species declines: habitat loss and fragmentation (Tilman et al. 1994), climate change (Cahill et al. 2013), overharvesting (Price and Gittleman 2007), alien species (Dextrase and Mandrak 2006), disease (Rödder et al. 2009) and pollution (Bobbink et al. 1998). But these are proximate rather than ultimate drivers of global change; our consumption and population size, density and growth underlie these all.

## Lack of research on the effects of human population dynamics on biodiversity loss

Only 13 years ago, the human population size was 6 billion (Lutz et al. 2001); just 7 years later, it reached 7 billion and, if predictions are correct, by 2100 it could be as high as 12.3 billion (Gerland et al. 2014). The absolute size of the human population greatly influences our environment (Ehrlich and Ehrlich, 1990), as does our density (Stallings 2009; Brewer et al. 2013; Thompson and Jones 1999) and population growth rate (Jha and Bawa 2006). High human population density and size are linked with increased numbers of threatened and introduced species, species extinctions, reduced areas under protection and a lower abundance of individual species (Luck 2007; Brashares et al. 2001; McKinney 2001; Parks and Harcourt 2002). We also now know that the average American woman increases

her carbon emissions by almost 6-fold with each child she produces (Murtaugh and Schlax 2009) and that fertility rates decline the longer females spend in education (Rindfuss et al. 1980). It is estimated that improved female education has the potential to decrease the birth rate by 1 billion people by 2050 (Lutz et al. 2014). However, despite this evidence, there is still a dearth of research on the effects of improved female education levels and reduced fertility rates on biodiversity degradation by conservation scientists.

There have been some exceptions to this rule, particularly during the 1990s–2000s in the journal Conservation Biology (e.g. Gehrt, 1996; Kay, 1997; Meffe, Ehrlich, and Ehrenfeld, 1993; Meffe, 1994; Pletscher and Schwartz, 2000; Sieving et al., 1994). However, these articles were not empirical research papers detailing novel scientific findings, but were instead opinion pieces on the topic. Addressing this topic is rare in our discipline: for example, we searched the 5 highest-ranking conservation journals listed in Google Scholar Metrics between January 1989 and September 2014 (using the keywords "overpopulation" OR "human population" OR "population growth" AND "human"), we retrieved only 18 articles, which equated to 0.00077% of all articles published in this time period for these journals. While it is necessary that we, as conservation scientists, engage in this conversation, particularly in the public forum, there is a dire need for further quantitative research in this field.

For instance, although we can estimate the effects of human population size, growth, migration and density (hereafter called "human population dynamics") on the planet, it is less clear what are the most effective interventions to reduce our impact on the planet. Available knowledge on how population policies affect biodiversity is very limited and we are equally naïve, for example, to the effects of cultural shifts in contraceptive use on conservation. Furthermore, with a few notable exceptions (e.g. Chown and Rensburg 2003; Dietz et al. 2007; Limburg et al. 2011), the empirical articles that have considered the effects of human population dynamics on the planet do not make any recommendations to change social norms about large families, nor to recommend providing access to affordable family planning and/or female education to those in need (e.g. Burgess et al. 2007; Wittemyer et al. 2008; Cinner et al. 2009; Estes et al. 2012; Mackenzie and Hartter 2013; Brewer et al. 2013; Bulte and Horan 2015).

It is not just conservation academics that have shied away from this topic. International conservation policies too, such as the Convention on Biological Diversity (CBD Secretariat, 2013), do not address human population dynamics in their manifesto despite indicating clear links between overconsumption and biodiversity loss. This is in stark contrast to the Millennium Development Goals (MDGs) for which nearly all of the targets set for 2015 were associated in some way to reducing human population growth (World Health Organization, 2008).

Why do conservation researchers ignore this topic? It could be that they believe that the topic is still taboo (King and Elliott 1997; Butler 2004; Maher 1997) or that some believe that even talking about human population could lead people to associate them with coercive population policies similar to those used in China (All Party Parliamentary Group on Population Development and Reproductive Health 2007). Another possible non-mutually exclusive reason for the lack of research could also be that the effects of human population dynamics on the planet are difficult to understand because of the many variables that must be taken into consideration, such as socio-economic and environmental factors that influence biodiversity loss and make it difficult to prove direct causation. Regardless of the challenges, we must not be dissuaded from trying to unravel this complex web of interactions.

## A call for research

We therefore call for urgent further research into this topic with specific reference to empirical studies on the effects of altered human population dynamics on biodiversity. Emphasis could, for example, be placed on studies that test the effect of the accessibility of family planning and female education on conservation outcomes. We do not have to wait long to see the benefits of directing our focus towards family planning: payoffs can materialise within a generation. For example, between 1960-2000, use of contraceptives in married women in developing nations increased from 10% to 60% and reduced the average number of children per woman from six to three (United Nations 2004). The time is now to embrace this area of conservation research.

## Action is already taking place amongst conservation NGOs

Although it is important to raise awareness to the effects of human population dynamics on biodiversity (Holl, Daily, Daily, Ehrlich, and Bassin, 1999; Meffe, 1994),

research must be coupled with action, particularly by conservation practitioners. For instance, a small but growing number of NGOs around the world are beginning to embrace the challenge of integrating biodiversity conservation with family planning. Similarly, The Wildlife Society, American Fisheries Society and The Audubon Society are some of the few environmental organisations with position statements on human population. Other NGOs are taking it a step further: Blue Ventures, a marine conservation organisation in Madagascar, has trained local women to provide contraception in rural villages close to protected areas. In three years, the project reduced the community's ecological footprint by 267 global hectares purely by providing access to family planning (Harris et al. 2012). A slightly different approach was taken by The Center for Biological Diversity, which distributed condoms wrapped in packaging depicting endangered species with catchy slogans such as "Wrap with care, save the polar bear" (Bernstein 2014). Whilst this may have been considered a publicity stunt during the World Population Day on July 11th 2014, the organisation handed out 40,000 of these condoms to areas in the United States. It is unclear whether this type of approach has any effect on human behaviour, but the emphasis on providing contraception to a developed country with a high consumption rate is commendable, given the typical focus on stemming population growth only in developing countries.

A more holistic avenue taken by the Population, Health and Environment (PHE) initiative appreciates the intertwined links between human population abundance, health and the effects we have on the environment. This combines family planning provision and other healthcare services along with alternative livelihood options and has been implemented in some key areas high in biodiversity and with an unmet need for contraception and healthcare. In one case study in Nepal, the program led to an increased uptake in condom use coupled with a reduction in wood fuel equivalent to saving nearly 9,000 trees annually (Hahn 2011). Understanding the effectiveness of projects like PHE schemes on biodiversity is essential to gain new insights on the potential of interventions such as family planning access for biodiversity conservation.

## Challenges to overcome

The effects of human populations on the planet are complex areas to understand and act upon, involving complicated religious, cultural and economic barriers. For instance, 20% of women worldwide have an unmet need for modern

contraception – with this as high as 60% in developing countries (Darroch and Singh 2013) and there is an increasing gap between support for provision and demand for contraception (Ross and Bulatao 2001). Furthermore, fulfilling the unmet need for family planning across developing countries would cost US $8.1 billion annually (Susheela Singh and Darroch 2012); finding this amount of money will clearly be challenging.

Female education and family planning are not only complex to address financially but also socially. For example, use of contraceptives (Srikanthan and Reid 2008) and female access to education (King and Hill 1993) are both affected by strong cultural and religious factors. Thus we cannot simply advocate for more access to family planning and education without addressing the barriers to their access (Cleland et al. 2006).

It would therefore be advisable to take a multidisciplinary approach to tackling this problem, where conservation scientists and practitioners form alliances with other sectors of society (All Party Parliamentary Group on Population Development and Reproductive Health 2007), such as reproductive choice and women's rights groups (Johns 2003). As NGOs often integrate educational aspects into their programs, it would not be difficult to direct further educational materials towards women and girls. However, funding interdisciplinary projects may also prove difficult (D. Johnson, personal communication) but it is worth noting that some grants are available from organizations such as USAID and Comic Relief.

We cannot pretend that these challenges will be easy to overcome. We therefore suggest that conservation researchers work closely with conservation NGOs to empirically study the effects of projects like PHE schemes on biodiversity. Findings from this type of research are essential to understand whether the above examples, showing that family planning access and provision of female education reduces environmental degradation, are exceptions or the norm. This will be important information for conservation practitioners to understand as it may highlight areas that should be focused on in future interventions. The outcomes will also be essential for policymakers to determine whether PHE schemes and others like this provide cost-effective win-win scenarios for people and biodiversity. If this is the case, they may prove essential for reaching MDGs and other national and international sustainability policies.

## Conclusions

In summary, we now have evidence to show the links between human population size, growth and density on the environment, but we need to increase our research efforts on how population and female education policies affect biodiversity conservation. Conservation scientists cannot dismiss the direct effect of human consumption on natural resources, but likewise, we also cannot disregard the effect our sheer population size and growth has on the environment. We argue that a combination of effective social, political, technological and population changes are needed to overcome environmental problems effectively. Among these interventions, tackling unsustainable human population growth may be a relatively fast and cheap remedy for conservation, which concurrently reduces consumption and brings us closer to meeting the MDGs (Chown and Rensburg 2003; Cleland et al. 2006; Wire 2009; Allen 2007).

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# Saving Living Diversity in the Face of the Unstoppable 6th Mass Extinction: A Call for Urgent International Action

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## Abstract

The global scale and impact of current and increasing human population size is incompatible with the survival of biological diversity and the 6th mass extinction cannot be stopped. For the vast majority of species we have neither the knowledge of when they will go extinct nor the capacity to find out. Conventional conservation measures can only amount to token damage limitation. Advances in molecular biology allow low cost options for storing the genetic diversity of numerous species and maximising future options for restoring species.

**Keywords:** mass extinction, conservation, cryobanking, land snails, international collaboration

## Introduction

We are witnessing a biodiversity crisis: the loss of a large proportion of living diversity resulting from a wide range of events that can all be ultimately attributed to human population growth and human activity. Nothing else is involved. The scale and speed of extinction is widely thought to be unprecedented since the

mass extinction event that occurred 65 million years ago, which marked the transition from the Mesozoic to the Cainozoic era of geological time (Ceballos et al. 2010; Barnosky et al. 2011; Laurance et al., 2014; Ceballos et al., 2015). Clearly there is an urgent need to enact conservation measures that will seek to safeguard remaining natural habitats, to evaluate the relative conservation value of transformed habitats and to restore habitat connectivity. However, barring a catastrophic human population reduction, the process of massive extinctions cannot be stopped and can only be moderated to a very limited extent (Naggs and Raheem, 2014). We are shielded from this stark reality by a lack of honesty and willingness to admit collective human culpability. It is not possible to control this situation in the short or medium term and we cannot know how this calamity will play out, other than the fact that there is no happy ending in prospect. The long-term hope must be that at some point in the future mankind will exist in reduced numbers with improved stewardship that will allow a sustainable existence in relative harmony with the natural world. The problem with this scenario is that unless we act with urgency and purpose, there won't be much of a natural world left to live in harmony with.

Perhaps more shocking than widespread apathy is that organisations entrusted with responsibility for recording and understanding biodiversity offer only the pretence of responding to the biodiversity crisis. Almost without exception, international museums with the remit of recording and understanding the natural world exhibit a lamentable failure to address the biodiversity crisis let alone act in a relevant way, although they have the capacity to do so. The international Convention on Biodiversity (CBD) has largely been diverted to a completely different agenda, epitomised by Britain's Darwin Initiative's shift to poverty alleviation as a core objective, driven in part by the way in which government funding is channelled *(Darwin Initiative Secretariat 2014)*. This seemingly worthy objective might appear to be beyond criticism but it represents a hijacking of its supposedly biodiversity conservation intent. A CBD target to halt extinctions by 2020 (Hochkirch, 2016) is out of touch with reality. There is a prevailing lack of honesty about the extent to which, by the scale of our existence, human utilisation of the planet to satisfy human needs and voracity is driving extinctions, and about our inability to control the process. While conservation as a scientific discipline has flourished, it has failed to halt the process of massive habitat loss and consequent extinctions (Whitten, et al., 2001; Wunder, 2001). Having witnessed the ongoing and appalling scale of rainforest loss

and degradation in large areas of south-east Asia over the past few decades, I am under no illusion as to the magnitude and reality of the biodiversity crisis.

Although human driven species extinction often gains media coverage and arouses episodes of anguish, attention is almost invariably drawn to an iconic vertebrate and usually a mammal species. Just occasionally an invertebrate makes the headlines. It is often overlooked that over 99% of multicellular animals are invertebrates (Lunney and Ponder, 1999), many of which have disappeared and continue to disappear without our having known of their existence (Lydeard et al. 2004; Régnier et al. 2015; Hochkirch, 2016). Here I draw on my knowledge of land snails, a major invertebrate group, to illustrate some key issues in the biodiversity crisis. Snails serve to demonstrate that although extinctions are happening on a massive scale it is more or less a waste of time to attempt to critically evaluate ever more data on current extinctions. The ultimate scale of the current mass extinction will be recognised long after the damage is done but we will have little idea of what has been lost. Research is absolutely necessary for furthering our understanding of the natural world but the broad picture on extinction is clear; we need to focus our efforts on delivering solutions.

More in the realm of science fiction than reality, when faced with mortality, some human beings seek a solution by having their bodies cryogenically preserved in the hope that they can be woken in a future, advanced world, where they can be restored to life. However, the cryogenic storage of viable cells of living organisms has moved beyond the realm of science fiction. Advances in molecular biology allow us to store the genetic diversity of species and potentially restore species should they become extinct (Lerman et al., 2009). This is the new reality that allows us the only route for storing living diversity on a scale that is commensurate with its current levels of loss. It offers a long-term strategy that extends way beyond a human lifetime but as a course of action it is entirely doable and fundable, if the will to do so can be summoned. This is about maximising future options. We may not be able to preserve all living diversity, but we can aim to do so and the sooner we act the greater the chance of preserving as many species as possible before they disappear.

## Islands and disappearing snails

Oceanic islands have a special significance for evolutionary biologists as natural laboratories that model events in the wider world. Islands also represent the

delicate canary in the coal mine of the world's natural environments. As an outstanding observer of the natural world and armed with a copy of Charles Lyell's newly published *Principles of Geology*, Charles Darwin was well equipped to read landscapes and interpret their history. From the first landing on the voyage of the Beagle at the Cape Verde Islands, Darwin had immediately recognised the impact of human activity on natural habitats. "When the island was discovered, the immediate neighbourhood of Porto Praya was clothed with trees, the reckless destruction of which has caused here, as at St. Helena, and at some of the Canary islands, almost entire sterility" (1845 [1839], p 2). On 8th July 1836, towards the end of Darwin's voyage on the Beagle, a brief stop of a few days was made at the isolated island of St Helena in the Atlantic Ocean. With his notable powers of perception Darwin recognised that the island had been transformed by human occupation and that this had led to the loss of its native forest and numerous species of invertebrates:

> On the higher parts of the island, considerable numbers of a shell, long thought to be a marine species, occur embedded in the soil. It proves to be a Cochlogena, or land-shell of a very peculiar form; with it I found six other kinds; and in another spot an eighth species. It is remarkable that none of them are now found living. Their extinction has probably been caused by the entire destruction of the woods, and the consequent loss of food and shelter, which occurred during the early part of the last century…. There can be little doubt that this great change in the vegetation affected not only the land-shells, causing eight species to become extinct, but likewise a multitude of insects. (Ibid. pp 469 – 471) (figure 1).

Recorded extinctions of land snails are disproportionately high and there is clear evidence for snail extinctions over the past few hundred years that exceed recorded extinctions for all other animal groups combined. From the Hawaiian Islands alone Cowie et al., (1995) estimated that some 570 of the 763 species listed in their catalogue are probably extinct and this does not take account of the approximately 200 species of 'known' but undescribed species of now extinct Hawaiian charopid snails in the Bishop Museum (Naggs et al., 2006). Compare this with the total of 484 human induced extinctions cited by Groombridge (1992) for all animal groups, which includes a mere 191 molluscs. The IUCN Red List



Figure 1: Chilonopsis nonpareil (Perry, 1811) [*Chilonopsis = Cochlogena sensu* Darwin]. There can be little doubt that this medium sized snail had been extinct for many years prior to Darwin's observations of subfossil shells on St Helena in 1836. Nevertheless, some of the shells look as fresh as those of a living snail and they are found with what are likely to be their eggs. Using a shell and preserved eggs this image reconstruction shows what a living example might have looked like. Image prepared by Harold Taylor.

(2015) includes 832 species listed as extinct since 1600 and there are regular calls for more research into establishing detailed information for current extinction levels (Hayward, 2009). Although it is widely recognised that the level of evidence and how it is interpreted vary enormously (Regan et al., 2005), efforts continue to be made to refine and justify hard data. Several commendable and critical studies have attempted to establish reliable, evidence-based assessments of land snail extinctions (Lydeard et al., 2004; Régnier et al., 2009, Régnier et al., 2015). They come up with alarming figures but we should be mindful of Darwin's observation that extinctions of land snails are a visible example of a multitude of other extinctions that do not leave shells as a record of their passing. The 394 insect species recorded as being extinct by the IUCN Red List of Threatened Species bears absolutely no relation to reality (Hochkirch, 2016) and is meaningless. It might seem reasonable to ask, as these researchers do, what detailed evidence is available for current extinction levels. But is this missing the point? Firm figures are often cited but I contend that very few invertebrate risk status evaluations

survive close inspection; we simply do not know. A more promising approach is to estimate species loss by extrapolating from known habitat loss, but such model-based studies (e.g. Beck, 2011) do not take us beyond the self-evident reality that such approaches can only provide broad approximations. If we have little idea of how many species there are (Caley et al., 2014; Giller, 2014), how can we begin to know the rate of extinction? Because of massive habitat loss and degradation, we can confidently infer that extinctions are happening on a massive scale but geographical species turnover varies enormously from one area to another, often for no discernible reason, and there is no simple way of linking extinction to habitat loss. When it comes to specifics relating to small animals and invertebrates in particular we are profoundly ignorant. Anyone who is familiar with large reference collections of invertebrates will be aware that many species have not been recorded again since they were first described. Attempts, such as the IUCN Red List system applied to invertebrates are well meaning but illusory. The transition from critically endangered to extinct is indeed a profound and currently irretrievable step and we want to know about when it happens but it is important not to compromise our credibility with unwarranted certainty of the particular when it is the general picture that is of paramount importance. To establish the status of a single invertebrate species could take years of research and still be wrong. Asserting that a particular tiny snail has just become extinct simply exposes researchers to ridicule if just one example should later be found surviving in a remote valley.

## Unintended consequences: a global pest, transmitter of human pathogens, wave of extinctions and a vision for saving biodiversity

In 1847 William Benson, a civilian administrator in the service of the East India Company and pioneer in the study of land snails in India (Naggs, 1997), brought two Giant African Snails back with him from Mauritius to India. Released in a Chowringhee garden after Benson left India, the snails slowly spread across Calcutta (Benson, 1858; Blanford, 1868; Godwin-Austen, 1908) and have since been recorded in every continent except for Antarctica. The species has since become a serious agricultural pest and vector for a sometimes fatal disease in humans (Alicata, 1966). Vast sums of money are spent on its control and local eradication but its large size, extended distribution range and the high densities populations often reach render it likely to have the highest biomass of any species of snail (Budha and Naggs, 2005). Following their introduction to a new area,

*L. fulica* often reach plague proportions and this is what happened when they were released in Tahiti in 1967. They soon spread throughout the archipelago, including the island of Moorea.

An ill-conceived but widely advocated biological control method for *L. fulica*, based on setting a snail to catch a snail, was initiated with the release of several species of predatory snail in areas where *L. fulica* had become established. The most 'successful' of these introductions was of the voracious predatory species *Euglandina rosea*. There was no evidence that *E. rosea* would be an effective control agent of *L. fulica* and it proved not to be but it was very successful in killing local endemic species. *E. rosea* has caused devastation to the endemic land snail faunas on Indian Ocean and Pacific Ocean islands. Early and thorough evidence of this came to the notice of the scientific community (Tillier and Clarke, 1983; Clarke et al. 1984) because the land snails of Moorea, their abundance and distribution, were known in great detail, most notably the endemic genus *Partula*. The genetics and distribution of *Partula* had been studied for decades as a model system for investigating speciation and evolution (Crampton, 1932; Murray and Clarke, 1980; Murray et al., 1982).

Bryan Clarke was a pioneer of ecological genetics and a central figure in the study of *Partula* (Jones, 2014). After years of studying *Partula* Bryan was deeply shocked to find that *Partula* species were rapidly becoming extinct and this personal experience of extinction drove him to seek, if not a solution, a strategy for addressing the issue of extinction. Bryan was instrumental in setting up an international project for the captive breeding of *Partula* that is coordinated by Paul Pearce Kelly at the Zoological Society of London[1]. Captive breeding of *Partula* was successfully established and *Partula* species that became extinct in the wild remain in captive breeding projects with a long-term aim to return them to their natural homes[2]. The *Partula* story is a flagship example of how zoos can perform an important role in conserving species on the brink of extinction but something far more ambitious was needed to be of any relevance to the scale of extinctions and this led to Bryan, his wife Ann and Anne McLaren setting up the Frozen Ark in 1996[3].

1. See https://www.zsl.org/conservation/regions/oceania/partula-snail-conservation-programme
2. See https://www.zsl.org/zsl-london-zoo/news/release-the-snails
3. See https://frozenark.org/

The initial objectives of the Frozen Ark were to establish repositories of frozen tissue of endangered animals and to at least have a genetic record of animals that might become extinct. The idea was to set up a global consortium of partners in this venture, which currently includes 22 zoos and other research institutions in eight countries. Bryan and Ann soon realised that the prospect of restoring species from viable cells had moved from the realms of science fiction to scientific reality and rather than simply store DNA the cryogenic storage of viable cells became a Frozen Ark objective. The value of biobanking or cryobanking as a conservation tool is recognised in some academic circles (Lerman et al., 2009) but to date the only serious development of cryogenic storage of species viable cells is undertaken at the San Diego Zoo, Institute for Conservation Research, Frozen Zoo project[4]. However, valuable as these initiatives are they do not yet begin to approach the scale that is needed.

## Priorities for action and how they can be delivered

Either new institutions are required or existing institutions need to respond to the challenge of establishing a worldwide programme to undertake surveys and store viable cells of the whole range of living diversity. The institutional requirements can be identified as:

1. Secure long-term funding.
2. Teams of appropriate scientific personnel.
3. Expertise in data management
4. Capacity to store cryogenic and conventionally preserved biological collections.
5. The capacity to undertake large-scale collection based surveys.
6. An institutionally shared vision and commitment to utilise these skills and resources to build cryogenic collections as a means of species conservation.

Hochkirch (2016) advocates the establishment of new institutions for invertebrate conservation but, apart from item 6, it would seem that the world's major international museums that encompass life sciences meet all of these criteria. However, in lacking both leadership on this issue and a relevant culture it may

4. See http://institute.sandiegozoo.org/resources/frozen-zoo%C2%AE

be that these institutions cannot respond to the challenge[5,6,7]. Across the world only the Muséum national d'Histoire naturelle (MNHN), Paris, is a major museum that has an ambitious collections programme attempting to make twenty-first century collections to record living diversity, rather than being preoccupied with historical collections that date mostly from the nineteenth century. The MNHN programme[8] is entirely due to the vision, energy and drive of one man, Philippe Bouchet. In 2009 Philippe Bouchet with colleagues at the MNHN and the NGO Pro-Natura International launched ambitious plans to amass enormous collections of reference specimens. They focussed on rich but poorly-known biotas under the programme 'La Planète Revisitée' ('Planet Reviewed') a vast program of surveys planned over 10 years. This massive undertaking is the most praiseworthy of any of the world's collection-based research institutions' initiatives. It has demonstrated that large-scale collecting is still achievable in a bio-politicised world and that traditional morphological collections can be integrated with DNA collections and molecular bar coding on a large scale (Puillandre, et al., 2012). Hopefully, viable cell preparations and storage will be added to their collection protocols. However, commendable as the Planet Reviewed programme is, it is almost entirely directed at marine surveys. The criteria for identifying priorities include areas of highest diversity, endemism and threat. So far, the current wave of extinctions has occurred almost entirely in non-marine environments. This has been most visible on oceanic islands but is occurring largely unrecorded on continental land masses, most notably in tropical rainforests.

Undertaking large-scale collection surveys in tropical forests is far less expensive than the major expenditure involved with marine surveys but it can be more problematic. Until the mid-twentieth century it was possible to collect specimens throughout much of the world with few restrictions. Collecting of invertebrates in particular was perceived as an obscure obsession pursued by a few eccentrics that very few cared about. However, in the past seventy years or so there has been an ever-growing reluctance to allow specimen collections to be made, particularly by non-nationals, and international collecting has become increasingly difficult. The 1992 international Convention on Biological Diversity (CBD) pushed biodiversity

5. https://www.si.edu/Museums

6. http://www.nhm.ac.uk/about-us/our-vision-strategy.html

7. http://www.nhm.ac.uk/research-curation/about-science/science-directorate/science-strategy/

8. See https://www.mnhn.fr/en/research-expertise/scientific-expeditions/our-planet-reviewed

higher up the political agenda of nations and reaffirmed that states have sovereign rights over their biological resources. Whatever the intent of the CBD, the reality has been biodiversity nationalism and barriers to international collaboration. Having run collection-based survey programmes throughout south and much of tropical southeast Asia over the past two decades I have been privileged to work with international colleagues in various productive ways but our collaborations have been significantly hampered by such constraints.

The first step in establishing optimal collaboration is to set up international agreements based on a common vision and shared objectives. Following five years of collaborative projects with colleagues in Vietnam, I established an agreement with the Vietnamese National Museum of Nature (VNMN) in 2010 that allows international partners to work effectively. The key element is to share survey material and allow for duplicate centres for the cryogenic preservation of viable cells in addition to conventional voucher specimens and frozen tissue samples. Supported by the Natural History Museum, the Zoological Society of London and the Frozen Ark, I led a team with UK and Vietnamese colleagues in 2013 with the objective of undertaking a survey project that included viable cell preparations. We successfully carried out a traditional survey, sampling and preserving morphological voucher specimens and, in addition to preserving tissue samples for molecular research, followed with the additional stage of making viable cell preparations. This proved to be relatively straightforward and was a procedure easily incorporated into our existing methodology for processing specimens and transferring frozen samples to cryogenic storage facilities at the Natural History Museum, London. Clearly such surveys need to be integrated with research that refines and assesses the viability of cell preparations. In many instances, it may prove possible to preserve viable zygotes or gametes, obviating the need for cloning to restore species.

The programme in Vietnam serves as a model system, demonstrating that large scale biotic surveys and routine preparation of viable cells in the field are relatively straightforward. The VNMN is committed to the process: it is establishing a new museum with ambitious biobanking facilities, embarking on nationwide biotic surveys and actively pursuing collaborations with international partners. Similar schemes urgently need to be taken up by the international scientific community and government agencies. It is our best hope for maximising options for restoring a biodiverse world (figure 2).

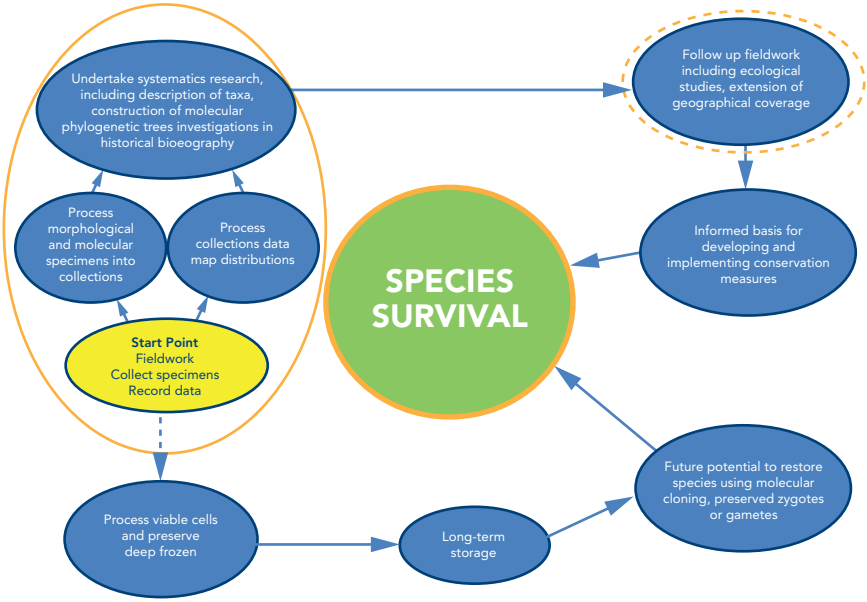


Figure 2: International museums' historical specimen collections are priceless and provide the foundation for naming the world's biota. However, they do not begin to meet the needs of current and future research, which requires state of the art collection methods of preservation, georeferenced localities and habitat data. The rate of extinctions imposes an urgent need for recording the current extent of living diversity and establishing a global inventory. It is a small additional step to include the preservation of viable cells. In addition to providing optimal material for research, preservation of viable cells provides a mechanism for safeguarding genetic diversity and allows for the possibility of restoring species should they become extinct. This offers a long-term option and alternative route for conserving living diversity that complements traditional conservation measures.

Calls for prioritising the description of new species are misplaced in the context of viable cell conservation and the assertion that we can only preserve what we know (Hochkirch, 2016) does not apply to broad-based survey collections: you collect what you find. Obviously, it is desirable to name new species as soon as possible and molecular tools can facilitate this but if viable cells and morphological voucher specimens are preserved, we have a very long time at our disposal to describe them. If they are gone, we have nothing.

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