

# The Sahel: A Malthusian Challenge?

Malcolm Potts · Courtney Henderson ·  
Martha Campbell

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**Abstract** The population of the least developed countries of the Sahel will more than triple from 100 million to 340 million by 2050, and new research projects that today's extreme temperatures will become the norm by mid-century. The region is characterized by poverty, illiteracy, weak infrastructure, failed states, widespread conflict, and an abysmal status of women. Scenarios beyond 2050 demonstrate that, without urgent and significant action today, the Sahel could become the first part of planet earth that suffers large-scale starvation and escalating conflict as a growing human population outruns diminishing natural resources. National governments and the international community can do a great deal to ameliorate this unfolding disaster if they put in place immediate policies and investments to help communities adapt to climate change, make family planning realistically available, and improve the status of girls and women. Implementing evidence-based action now will be an order of magnitude more humane and cost-effective than confronting disaster later. However, action will challenge some long held development paradigms of economists, demographers, and humanitarian organizations. If the crisis unfolding in the Sahel can help bridge the current intellectual chasm between the economic commitment to seemingly endless growth and the threat seen by some biologists and ecologists that human activity is bringing about irreversible damage to the biosphere, then it may be possible also to begin to solve this same formidable problem at a global level.

## 1 Introduction

In 1798 Thomas Malthus famously said,

“I think I may fairly make two postulata

First, that food is necessary to the existence of man.

Secondly, that the passion between the sexes is necessary and will remain nearly in its present state” (Malthus 1798).

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M. Potts (✉) · C. Henderson · M. Campbell  
Bixby Center for Population, Health & Sustainability, University of California, Berkeley, USA  
e-mail: potts@berkeley.edu

Since the end of World War II, the human population has tripled in less than a single human lifetime—something that has never happened before and will never happen again. Over the same period, industrial production has increased eightfold. The world as a whole has been remarkably successful in keeping up with this unprecedented pace of change (Potts 2009). But continuing rapid population growth in certain parts of the world, especially in regions likely to suffer from severe climate change, and where food supplies will diminish, could force us to look again at the conclusion Malthus reached in 1798,

“The power of population is so superior to the power of the earth to produce subsistence for man, that premature death must in some shape or other visit the human race” (Malthus 1798).

Most scientists use past history as a foundation for projecting future events, although they sometimes come to opposite conclusions. Building on past patterns, many demographers see population as stabilizing. Most economists and practically all politicians, building on the past 60 years of economic history, assume that the global economy will, and should, continue to grow. The global economy is estimated to have been \$38 trillion in 2000 and it is suggested it could reach \$206 trillion in 2050 (Vision 2050 Report, 2013). David Lam, an economist who gave the 2011 Population Association of America address, concluded, “I expect that [the world] will have improved in many ways, including lower poverty, higher levels of education, and plenty of food to go around” (Lam 2011). Many biologists, climatologists and ecologists hold the opposite view, expecting current levels of human consumption, particularly of energy, to exceed the capacity of the biosphere to supply enough food or absorb carbon dioxide waste (Millennium Ecosystem Assessment 2005). Many biologists see insurmountable barriers to continued economic growth and judge a \$206 trillion global economy as unequivocally unsustainable (The Royal Society 2012).

In 1972, *The Limits of Growth* stated, “The basic behavior mode of the world system is exponential growth population and capital, followed by collapse” (Meadows et al. 1972). Forty years later, with more data and after considerable additional growth in population and industry, Paul and Anne Ehrlich returned to the same theme suggesting “global collapse seems likely” (Ehrlich and Ehrlich 2013). The next 60 years, according to biologists, will be somewhat different from the past. This chasm between the intellectual paradigm of economists and many demographers, and the ecologists, biologists, and some physical scientists, is surprising and dangerous. Analyses of projections and possible evidence-based solutions to population and climate change in the Sahel over the rest of this century will test whether this chasm can be bridged.

## 2 The Challenge

The 2012 Working Group of the Royal Society, *People and the Planet*, recommended “Population and the environment should not be considered as two separate issues” (The Royal Society 2012). It is a particularly apt recommendation for the Sahel, where the uniquely high population growth rate is going to collide with the impacts of climate change, threatening a major humanitarian disaster.

The Sahel is sometimes equated with the Francophone countries that comprise West Africa. In our analysis, however, we are using an ecological definition encompassing over one million square miles of arid and semi-arid land stretching from the Atlantic coast to the Red Sea.

In 1950, the population of the countries in this region totaled 30 million. Today, the Sahel is home to approximately 100 million of the poorest, most disempowered and forgotten people in the world. Pastoralists and subsistence farmers live in a drought stricken and famine prone area. The countries of the region are on the bottom rungs of the Human Development Index. Illiteracy and poverty are pervasive, child marriages are common, and the status of women is particularly low. Some countries, such as Chad, are amongst the most corrupt in the world (World Bank 2012). Already today, 12–18 million people in this region are hungry (OXFAM 2012). In 2012, jihadists, such as *Ansar Din* and al-Qaeda clones took over half of Mali, an area equal to the size of France. Although the jihadist groups have been driven from most cities, violence remains near the surface (Oumar 2013).

## 2.1 Climate

The Western Sahara has a monsoon climate that carries moisture from the Atlantic eastward across the African continent. Since 1950, the climate of the region has experienced increasing variability, probably driven in part by the increase in atmospheric particulates drifting across the Atlantic from the industrialized regions in North America. After 1950, there was an overall increase in precipitation, but between 1970 and the early-1990s, there were severe droughts. Since 1993, there have been further changes, including some very wet years and very dry years (Ward 1998). New studies predict that the Sahel will be 3–5°C warmer by 2050 (Potts et al. 2013). To give a sense of scale, it is estimated that a rise of 5°C is all that separates today's world from the last Ice Age. Extreme weather events are predicted to become more common. Precipitation may increase, but it could be so hot that the water will evaporate before it reaches plant roots. The rain that does occur is increasingly likely to come as flash floods that wash crops away. By 2100, it is projected that the mean temperatures in countries such as Niger could increase by 5–8°C (Potts et al. 2013).

Based on the history of the past two decades, the possibility of the Sahel feeding itself or providing alternative employment for another 100 million people by mid-century is remote. The 2007 *Inter-governmental Panel on Climate Change* pointed out that in much of Africa, food production will "be severely compromised" by climate change and will "further adversely affect food security and exacerbate malnutrition" (IPCC 2007).

## 2.2 Population

The 1994 International Conference on Population and Development (ICPD) in Cairo set out two complementary goals: an emphasis on individual rights and choice in family planning, and the obligation to invest in family planning with the objective of slowing rapid population growth, especially in Africa. Unfortunately, instead of following the agreed Programme of Action (PoA), some advocacy groups framed attention to population in pejorative terms and the subject was pushed off the international agenda for 20 years (Campbell 2007). Budgetary support for international family planning collapsed (Spiedel et al. 2009). Between 1997 and 2007, the World Bank devoted only four percent of its funds to family planning. An independent evaluation group concluded that, "support for population nearly disappeared" (World Bank 2009). International organizations such as the United Nations Population Fund (UNFPA) and International Planned Parenthood Federation (IPPF) embraced a wide range of goals that were considerably different from their own origins. For example, in 2011 with a total income of just over \$120 million, IPPF spent \$47 million on "non-contraceptive services," including \$15.1 million on HIV/AIDS (IPPF 2012). Unfortunately, in low-resource settings, adopting too many goals can dilute efforts to make family planning choices easily accessible.

As a result of the loss of focus on family planning since the ICPD, the decline in birth rates, which had begun in parts of Africa before 1994, stalled (Ezeh et al. 2009). This led to the development of a great deal of demographic momentum and undermined the powerful contribution that the adoption of family planning could have led to reducing maternal and infant mortality (Diamond-Smith and Potts 2011; Rutstein 2005).

The UN Population Division's medium variant projections show that the population of the Sahel will reach 340 million by 2050 and 600 million by 2100 (UN Population Division 2012). The 2050 figure is likely to be unsustainable; the 2100 projection is certain to be unsustainable. There is a possibility that if vigorous efforts are made immediately, the unmet need for family planning in the area could be filled. The international community will also need to keep pace with the escalating need for humanitarian assistance in this region. With such activities, it may be possible to reduce the threat of rising death rates and increasing political instability posed by such a high rate of population growth. However, adapting to massive population growth and climate change at the same time seems extremely unlikely.

In 2009, Adair Turner stated, "... how Niger is going to feed a population growing from 11 million today to 50 million in 2050 in a semi-arid country which may face adverse climate change is unclear" (Turner 2009). Four years later, the population of this one country has grown to over 17 million (Potts et al. 2011). The new Demographic and Health Survey (DHS) found that the Total Fertility Rate (TFR), defined as the average number of children 1,000 women will have in a fertile lifetime, was 7.6 children per woman, the highest birth rate in the world. An earlier estimate of 7.1 children proved unduly optimistic. Despite some recent changes in the commitments to family planning by the government of Niger, the Contraceptive Prevalence Rate (CPR), defined as the proportion of women of reproductive age who are using (or whose partner is using) a contraceptive method at a given point in time, is only 11 % for modern contraceptives. The CPR has increased by just over two points per year since the last DHS in 2006. The new goal of the Nigerien government is to reach the unprecedented goal of a 25 % CPR by 2015. In Chad, the CPR is increasing by a mere 0.05 additional points each year (Guengant 2012). Significant policy changes and considerable investment will be needed to shift the population projections of the Sahel to a trajectory that might permit sustainable growth in the population. Unfortunately, the threat of climate change makes a difficult problem doubly difficult to solve.

### 2.3 After 2050

Climate and population projections to the second half of the twenty-first century entail more uncertainty than near term forecasts, but they are still scientifically possible and useful. Demographic changes take place over generations. Some of those who will still be in their fertile years in mid-century are already born. The demographic momentum that has been built up in the past 20 years cannot be reversed—unless, of course, death rates rise. The uncertainties that exist are not so much whether serious adverse population and climate changes will occur, but exactly when these adverse changes will take place. Crops that are exposed to temperatures of 29°C or more for any length of time see yields plummet dramatically (Schlenker and Roberts 2009). What is certain is that under 'business as usual' scenarios for population growth in the Sahel, and for continued levels of greenhouse gas emissions from industrialized nations, climate change will destroy crops and kill livestock.

Under these circumstances, the region is likely to see massive migration and possibly more conflict. The combination of rapid population growth and a particularly severe impact of climate change imply pain and misery for many tens of millions of people, resulting in a burden on neighboring countries of an increasing number of ecological refugees. This

situation is likely to escalate political instability that will prove costly far outside the region. Even in 2011, long before the huge increases in population and temperature that scientific analysis projects, food aid to the Sahel cost over \$900 million. Considering Somali piracy as an increased cost of trade translates into an estimated US \$18 billion yearly loss to the world economy (The World Bank 2013). Al-Qaeda leaders call Mali, Chad, Mauritania, Libya and Niger, "The Great Islamic Desert." European researchers in the Monitoring Centre for Organised Crime estimate that there are between 8,000 and 14,000 members of al-Qaeda in training camps, and these represent a greater threat than the al-Qaeda presence in Afghanistan (European Monitoring Center for Organised Crime 2013). In the mid-twenty-first century and beyond, when there are two or even four times as many uneducated, unemployed, volatile young men in the region, the situation will be even more challenging.

### 3 Are There Solutions?

Can scientific innovation avert what analysis suggests in an inevitable and large-scale disaster? Almost 200 years ago, Friedrich Engels refuted Malthus' dismal prognostications by maintaining that scientific "progress is as unlimited and at least as rapid as that of population" (Engels 1844). The progress of science-based industry and science-based agriculture has indeed gone a long way towards substantiating this criticism of *An Essay on the Principle of Population*. In the case of agriculture, a heavier use of fertilizer and pesticides and better quality seeds might triple crop yields. Modern irrigation methods could further increase output. In coming decades, genetic engineering might improve the yield and/or the resistance to plant pests of African staples, such as sorghum. But all these solutions take time and money, and neither is available in generous amounts in the Sahel. Moreover, the scale of climate change projected for the second half of this century seem likely to overwhelm any plausible improvements in crop yields.

Switching to large scale, mechanized agriculture might be more cost-effective, but it would have to be introduced carefully to avoid displacing small sharecroppers who comprise the majority of farmers. Real progress will be made if farmers are given access to more transparent, just markets and insurance against poor harvests is made available. Perhaps information about when to plant, and about market prices, can be disseminated over cell phones. Small irrigation projects to store sudden downpours and drip irrigation are appropriate technologies, and the Sahel is the best place in the world to develop small solar powered electrical systems. However, given the poor governance and increasing violence in the region, will such best practices get implemented?

No significant long-term progress in the Sahel will be possible without improving the status of women. Over considerable parts of the Sahel, women do much of the agricultural work, by providing labor in the fields and caring for animals. The Sahel has the disadvantage of child marriage, polygamy, and the brutality of widespread female genital mutilation—symbols of a patriarchal society where few women are empowered to make choices about marriage or managing their childbearing. Lack of investment in women's education, inappropriate medical policies, and an absence of comprehensive abortion care have made a difficult situation worse. Over the past 15 years in Northern Ghana, the Navrongo Project has explored the impact of offering modern family planning in a remote region with the culture and ecology of the Sahel. In one quasi-experimental area, where nurses distributed contraceptives and there were social mobilization activities for men, the TFR fell from 5 in 1995 to 3.6 in 2010 (Phillips et al. 2012). Unfortunately, the contraceptive distribution system was over-medicalised, following inappropriate protocols such as requiring nurses to take a

woman's blood pressure before using oral contraceptives. The three-month injectable contraceptive proved the most popular method among family planning clients, but distribution of this method was also limited to nurses, which unnecessarily constrained its availability.

Other countries in sub-Saharan Africa are making important progress and the Sahel could do better, provided the international community has the will to make needed investments and policy changes. Malawi made family planning illegal until 1984, but by 2010, 42.2 % of women were using modern contraception. Rwanda, through providing robust family planning programs, has gone from a CPR of 6 % in 2000 to 45 % in 2010 (Zulu 2012).

If the Sahel is to avoid a Malthusian disaster it will be made possible by adopting evidence-based solutions to slow population growth and give women more autonomy. To do so will require looking at old problems in new ways.

## 4 Paradigms, Ideology and Evidence

As observed earlier, when building future scenarios pertaining to complex issues, scientists are sometimes tempted to extrapolate from past experience stretching back 100 or 200 years. We suggest that in the case of demography and economics, the past may not always be a good predictor of the future.

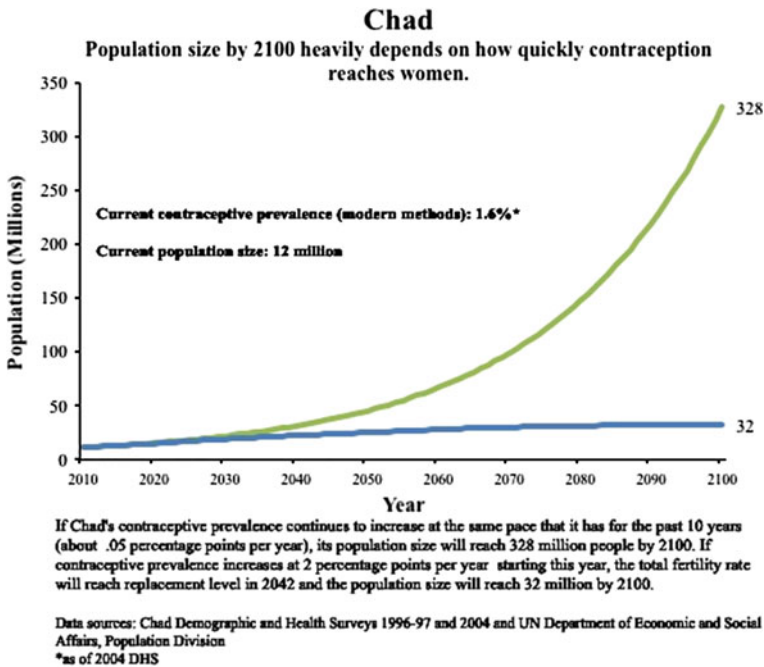
### 4.1 Demography

The classical theory of the demographic transition put forward by Frank Notestein, Kingsley Davis and others in the middle of the twentieth century has continued to have considerable influence on demographic and economic thinking, even though this paradigm, based on extrapolations from the European countries' demographic transition, has proved to have limited predictive value in today's world. The theory holds that death rates fall before birth rates, leading to a growth in population until a new equilibrium is established when low death rates are matched by low birth rates. It assumed that these changes were driven primarily by improvements in wealth and education. The classical theory was used to criticise the launch of family planning programs established in the second half of the twentieth century (Davis 1967). However, many of these programs ultimately proved highly successful. It did not predict or explain below replacement fertility in industrialized nations. In *Population and Development: the Demographic Transition*, Dyson sees a transition as, "self-contained and inexorable over the long run" (Dyson 2010). The US National Academy of Sciences panel in 2000 concluded, "fertility in countries that now have not completed the transition should eventually reach levels similar to those now observed in low fertility countries." (Bongaarts and Bulatao 2000) Wolfgang Lutz, editing a recent volume called *The End of World Population Growth in the twenty-first Century* writes,

"...the well founded, general notion of demographic transition is the basis of our expectation that world population growth will come to an end during the second half of the twenty-first century" (Lutz et al. 2001).

But, even taking the Lutz assumption that all countries will drift inexorably towards 2.1 children, the UN Population Division projects that the least developed countries (those with a current a TFR of 3 to over 7) will be the largest single population group in 2100—between 2.8 billion in the low population variant and 6.1 billion in the high variant.

We suggest that the classical demographic transition theory has outlived its usefulness (Campbell et al. 2013). As Szreter comments,



**Fig. 1** The rate at which contraceptive prevalence increases determines the final population size: the example of Chad

“the [demographic] model’s conceptual structure was allowed to become so general and the theoretical relations so flexible that, as a causal explanation of change, it became an empirically irrefutable theory” (Szreter 1993).

If we are correct in arguing that there is little or no empirical evidence to support the assumption on which the UN Population Division makes its predictions that the least developed countries will reach, or come close to, 2.1 children by 2100, then the situation in the Sahel becomes even more challenging. For example, only 1.6% of women in Chad use modern methods of contraception. The CPR increased by only an additional 0.05% per year between 1996–1997 and 2010 (Guengant 2012). Unless there are major changes, the population will reach unsustainable numbers and still be growing rapidly in 2100 (see Fig. 1). If, however, Chad increased the CPR by an additional 2% each year, then the population would still almost triple before it stabilized late in the century.

Population projections based on careless assumptions mislead policymakers. The recent efforts of the UN Population Division to publish probabilistic population projections using a Bayesian Hierarchical Model (BHM) is particularly deceptive if, as we suggest, assumptions such as Dyson’s that the demographic transition is, “self-contained and inexorable over the long run” are incorrect. For example, Niger’s upward revision from a TFR of 7.1 to 7.6 made in the 2012 DHS has already partly undermined the BHM projections published only a few months earlier. The UN Population Division country profile for Chad projects life expectancy at birth to rise from 50 years for women in 2000 to 77 years in 2100. As Chad’s under-5 mortality has actually risen in the early twenty-first century, and as Chad has no achievable way of supporting over 64 million people, let alone 290 million, the data coming out of countries such as Chad strongly suggests that death rates are likely to begin to rise

long before fertility declines substantially. The need is for projections based on the recent history of changes in the CPR—projections that might stimulate domestic leaders to place more emphasis on removing the non-evidence based barriers that often prevent women from using modern contraception (Campbell et al. 2006).

#### 4.2 Economics

Herb Stein, senior fellow at the American Enterprise Institute and economic advisor to Nixon and Ford, once said about trends that run into finite barriers, “If something cannot go on forever, it will stop” (Stein 1999). In general, economists discussing fertility decline have given greater weight to distal factors, such as wealth and education, than to the alternative hypotheses that access to family planning can drive fertility decline, even in poor, illiterate societies (Campbell et al. 2013). For example, in *The End of Poverty*, Jeffrey Sachs writes,

“One reason for the poverty trap is the demographic trap, where impoverished families choose to have lots of children.” “. . . Because the parents are risk averse, and want to assure with a high probability of the least one child. . . they overcompensate in a statistical sense” (Sachs 2005).

It might be useful to return to Malthus’s second postulate—that, “the passion between the sexes is necessary and will remain nearly in its present state.” The flaw in Sachs’ argument is not that “impoverished families” necessarily want “lots of children”, but that they do not have the knowledge or means to separate “the passion between the sexes” from another unintended pregnancy. In patriarchal societies, such as most of those in the Sahel, a wife cannot refuse her husband’s sexual demands, and a large family is the default situation. Malthus got it right: this reality is a simple concept but all too often overlooked.

The need is to understand the problems facing women in male dominated societies who want to separate child bearing from the “passion between the sexes.” In the Navrongo study in Ghana, which was quoted earlier, 56% of women surveyed wished to keep the use of contraception secret from their husbands and neighbours. The mistake in Navrongo was to force women to go to a nurse in order to receive an injectable contraceptive. The more productive approach is to train community volunteers over only a few days to dispense injectable contraceptives in the privacy of the woman or the volunteer’s home, as has been done safely and effectively in Ethiopia (Prata et al. 2011).

Finally, if the Sachs contention that, “impoverished families choose to have lots of children”, unless individuals get richer and better educated is correct, then another serious problem arises. According to May, no country, with the exception of some anomalous oil-rich states, with a TFR of 5 or over has developed (May 2012). If this is true, then the Sachs assumption implies that nothing is ever going to stop women in high fertility societies from having “lots of children.” It was this conundrum that seems to have forced Indian prime minister Indira Gandhi in 1975 to introduce financial incentives for adopting family planning—a policy that rapidly deteriorated into coercion. Gandhi’s policies caused the loss of her party’s 1977 election. It seems reasonable to suggest that, as a result of the classical explanation of the demographic transition she had inherited, she saw no alternative to the politically difficult path she chose. Gandhi was caught by the dilemma that arises when economists and demographers subscribe to the paradigm that improvements in socio-economic circumstances are a prerequisite to fertility decline. She wrote,

“It is clear that simply to wait for education and economic development to bring about a drop in fertility is not a practical solution. The very increase in population makes



economic development slow and more difficult of achievement. The time factor is pressing and the population so formidable, that we have to get out of this vicious circle through direct assault upon this problem . . . Where [an Indian] state legislature, in the exercise of its own powers, decides that the time is right and it is necessary to pass legislation for compulsory sterilization, it may do so” (Pearce 2010).

#### 4.3 A Human Rights Framework

The hypothesis we suggest is that if the unjustified barriers to family planning are removed, if family planning is demedicalised, if poor communities are empowered to help themselves, if needed investments in contraceptive delivery systems are made, if the widespread misinformation about modern contraceptives are corrected, and if in societies with child marriage an investment is made to keep girls in school and enable them to raise the age of their first births, then the TFR will fall. If these things were done, then Chad might be in a position to increase the CPR by an additional 2 percentage points every year over several decades (Fig. 1). Unfortunately, there are a lot of ‘ifs’ in such a policy. We worry that not all decision makers in countries with weak governance, little or no representation of women, and often high rates of corruption, will adopt the policies urgently needed. We also recognize that the international community, as represented by the World Bank and the African Development Bank, may not respond rapidly enough to the imperative to place family planning center stage. Humanitarian organizations such as UNICEF or UNHCR have either been timid in recognizing the centrality of family planning, or more commonly, they have avoided the subject all together.

Decision makers in large donor institutions such as USAID, DFID or the Bill and Melinda Gates Foundation often work in silos. So, for example, USAID’s Feed the Future Initiative makes no explicit reference to the simple fact that it is going to be impossible to feed 300 million people in the Sahel by 2050—and doubling again by 2100. The report published by the *Commission on Sustainable Agriculture and Climate Change*, chaired by the UK Chief Scientist Sir John Beddington, recognizes the challenge set by rapid population growth in some regions, but it fails to take the next step of recognizing that such rapid growth can be slowed within a human rights framework, and that investing in family planning should be an intrinsic and essential part of any realistic set of policies to achieve food security.

## 5 Conclusion

Eighty percent of the world’s population is at or within striking distance of replacement level fertility, and it is likely to remain at that level or below for the remainder of this century. The other 20 % has between three and more than seven children, and there is no compelling reason to assume that most of the least developed countries will reach replacement level fertility by 2100. These high fertility counties include nations such as those in the Sahel, Afghanistan, Yemen, and parts of Pakistan. Continued rapid population growth in these regions has three important geopolitical implications. First, the current global divide between rich and poor nations will get significantly worse. Second, much of this population growth will be in least developed countries which are highly vulnerable to climate change, potentially rolling back many of the public health achievements of the past 50 years. Third, we might expect to see these high fertility, least developed countries become even more politically unstable.

It needs to be understood that the rate at which population continues to grow in the least developed countries later in this century will be largely determined by decisions made before 2020. Population growth is rather like a super tanker—it takes a long time to slow down. A good illustration of demographic momentum is Iran, where the TFR has fallen to 1.9 but there are still one million more births than deaths each year.

*People and the Planet* concludes, “On a finite planet there are environmental constraints on human population growth.” Later it concludes,

“The combined effects of market forces and new technologies are not able to overcome planetary boundaries on the scale necessary to avoid unsustainable pressure on the planet and much human suffering.”

Those boundaries are being reached in the Sahel. This is the region where the fabric of civilization, weakened by rapid population growth and stretched by climate change driven by bloated northern consumption, is likely to fail first. This is where death rates could begin to rise again. If a ‘business as usual’ policy and lack of investment continues, then the Sahel could prove the first region where, as Thomas Malthus wrote in 1798, “The power of population is so superior to the power of the earth to produce subsistence for man, that premature death must in some shape or other visit the human race.”

It is difficult to estimate the overall ability to increase energy and food production, but recent analysis suggests that human consumption may be approaching a finite boundary (Neff et al. 2011). In the case of food, there is a limit to the net primary plant production (NPP), the maximum photosynthetic production, which is possible on the planet. As Running writes, “It is not whether humans will reach the global NPP boundary but when they will do so” (Running 2012). The emerging economies are likely to continue to eat more animal protein, and a larger slice of the world’s available grain will be diverted to feeding livestock, or to ethanol to drive automobiles.

Rapid population growth in the Sahel is not because women are having more children than they did previously, but because more children are surviving to reproduce in the next generation. Rapid and unprecedented declines in death rates have been brought about by the introduction of science-based technologies such as vaccines, almost entirely funded by international agencies supported by northern governments and philanthropic institutions. Restoring a sustainable rate of population growth based on a falling birth rate instead of a rising death rate and unparalleled migration, as seems likely if a ‘business as usual’ scenario continues, will largely depend, as it has in the case of death rate decline, on policies and investments made by the international donor community. Lack of resources, endemic corruption and cultural attitudes to polygamy, large families and lack of female autonomy make the generation and funding of domestic solutions improbable. Whether industrialized nations will take on the responsibility of limiting carbon production will depend to a considerable extent on whether the chasm between the economists and biologists can be bridged. If that chasm can be spanned, then perhaps global collapse can also be avoided. If huge numbers of thoughtful people with access to colossal amounts of data are unable to close this divide, then hundreds of millions of vulnerable people, most likely beginning in the Sahel, will suffer pain and misery. If this happens, it may also be that the possibility of solving even larger global problems will become even more remote.

The first determinant of the health, happiness and economic sustainability of the least developed countries—beginning with the Sahel—will be the timeliness with which the pledges that were made at the London Family Planning Summit held in July 2012 are followed up and implemented. Time is of the essence. Donors must learn to work in difficult,

sometimes dangerous regions in flexible, opportunistic ways. Carefully planned strategies that might work in a moderately stable country like Tanzania are unlikely to prove useful in Chad or Mali, where the infrastructure is weak, human capital is in short supply, and corruption widespread. The work that needs to be undertaken, especially the investment needed to improve the status of women will be in billions, not hundreds of millions, of dollars. But if this is not done, the cost of inaction will be much greater. The US federal government (2013) spends almost \$2 billion a day on defense, and bringing stability to a region such as the Sahel needs to be seen as a national security goal, as well as a humanitarian imperative. The second important determinant will be the ability—or lack of ability—of the industrialized nations and emerging economies to reign in the use of fossil fuels.

It would be satisfying to prove Malthus wrong once again, but the portents are not encouraging. It will take new thinking by economists, demographers, agriculturalists, many humanitarian organizations and a concerned public to avert a Malthusian catastrophe in the Sahel. If the unfolding crisis in the Sahel can help bridge the current intellectual chasm between the economic commitment to seemingly endless growth and the threat seen by some biologists and ecologists that human activity is bringing about irreversible damage to the biosphere, then it may be possible also to begin to solve this same formidable problem at a global level.

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## References

- Bongaarts J, Bulatao RA (2000) Beyond six billion. The National Academies Press, Washington, DC
- Campbell M (2007) Why the silence on population? *Popul Environ* 28(4):237–246
- Campbell M, Sahin-Hodoglugil NN, Potts M (2006) Barriers to fertility regulation: a review of the literature. *Stud Fam Plan* 37(2):87–98
- Campbell MN, Prata N, Potts M (2013) Impact of freedom on fertility decline. *J Fam Plan Reprod Health Care* 39(1):44–50
- European Monitoring Center for Organised Crime (2013) <http://www.al-monitor.com/pulse/security/01/12/study-sahel-greater-threat-to-europe-than-afghanistan.html>. Cited 3/23/13
- Davis K (1967) Population policies: will current programs succeed? Grounds for skepticism concerning the demographic effectiveness of family planning programs. *Science* 158(802):730
- Diamond-Smith N, Potts M (2011) A woman cannot die from a pregnancy she does not have. *Int Perspect Sex Reprod Health* 37(3):155–157
- Dyson T (2010) Population and development: the demographic transition. Zed Books, London
- Ehrlich PR, Ehrlich AH (2013) Can a collapse of global civilization be avoided? *Proc R Soc B Biol Sci* 280(1754):1–9
- Engels F (1844) Outlines of a critique of political economy. *Deutsch-Französische Jahrbücher*
- Ezeh AC, Mberu BU, Emina JO (2009) Stall in fertility decline in Eastern African countries: regional analysis of patterns, determinants and implications. *Philos Trans R Soc B Biol Sci* 364(1532):2991–3007
- IPCC (2007) In: Parry ML, Canziani OF, Palutikof JP, van der Linden PJ, Hanson CE (eds) *Climate change 2007: impacts, adaptation and vulnerability: Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge
- Guengant J (2012) *Population, development et dividend démographique au Tchad*. Paris: l'Agence Française de Développement (AFD). Available at: <http://www.afd.fr/webdav/site/afd/shared/PORTAILS/PAYS/TCHAD/PDF/Etude%20dividende%20d%C3%A9mographique%20finale.pdf>. Cited 23 March 2013
- International Planned Parenthood Federation (2012) *Annual performance report: 2011–2012*. IPPF, London
- Lam D (2011) How the world survived the population bomb: lessons from 50 years of extraordinary demographic history. *Demography* 48:1231–1262
- Lutz W, Sanderson W, Scherbov S (2001) The end of world population growth. *Nature* 412:543–545
- Malthus T (1798) *An essay on the principle of population*. Penguin books, London
- May J (2012) *World population policies: their origin, evolution and impact*. Springer, New York

- Meadows DH, Meadows DL, Randers J, Behrens WW (1972) Limits of growth. Potomac Associates, Washington
- Millennium Ecosystem Assessment (2005) Ecosystems and human well-being: biodiversity synthesis. World Resources Institute, Washington, DC
- Neff R, Parker C, Kirschenmann FL, Tinch J, Lawrence RS (2011) Peak oil, food systems and public health. *Am J Public Health* 101(9):1587–1597
- Oumar J (2013) Ansar al-Din threat stokes Sahel fears. Magharebia. Available at: [http://www.magharebia.com/cocoon/awi/xhtml1/en\\_GB/features/awi/features/2013/01/07/feature-02](http://www.magharebia.com/cocoon/awi/xhtml1/en_GB/features/awi/features/2013/01/07/feature-02). Cited 3 February 2013
- OXFAM (2012) Food Crisis in the Sahel: Five steps to break the hunger cycle in 2012. Available at: <http://www.oxfam.org/sites/www.oxfam.org/files/ib-food-crisis-sahel-31052012-en.pdf>. Cited 22 March 2013
- Pearce F (2010) The coming population crash and our planet's surprising future. Bacon Press, Boston
- Phillips JF, Jackson EE, Bawah AA, MacLeod B, Adongo P, Baynes C, Williams J (2012) The long-term impact of the Navrongo project in Northern Ghana. *Stud Fam Plan* 43(3):175–190
- Potts M (2009) Where next? *Philos Trans R Soc* 364:3115–3124
- Potts M, Gidi V, Campbell M, Zureick S (2011) Niger: too little, too late. *Int Perspect Sex Reprod Health* 37:95–101
- Potts M, Zulu E, Wehner M, Castillo F, Henderson C (2013) OASIS: organizing to advance solutions in the Sahel. Bixby Center for Population, Health & Sustainability, University of California, Berkeley, CA
- Prata N, Gessesew A, Cartwright A, Fraser A (2011) Provision of injectable contraceptives in Ethiopia through community-based reproductive health agents. *Bull World Health Organ* 89(8):556–564
- Running SW (2012) A measurable planetary boundary for the biosphere. *Science* 337(6101):1458–1459
- Rutstein SO (2005) Effects of preceding birth intervals on neonatal, infant and under-five mortality and nutritional status in developing countries: evidence from the demographic and health surveys. *Int J Gynecol Obstet* 89:S7–S24
- Sachs J (2005) The end of poverty: economic possibilities for our time. The Penguin Group, New York
- Schlenker W, Roberts M (2009) Nonlinear temperature effects indicate severe damages to US crop yields under climate change. *Proc Natl Acad Sci* 106(37):15594–15598
- Spiedel JJ, Weiss DC, Ethelston SA, Gilbert SM (2009) Population policies, programs and the environment. *Philos Trans R Soc* 364(1532):3049–3065
- Stein H (1999) What I think: essays on economics, politics, and life. American Enterprise Institute, New York
- Szreter S (1993) The idea of the demographic transition and the study of fertility change: a critical intellectual history. *Popul Dev Rev* 19:659–701
- The Royal Society (2012) People and the planet: Policy Centre report 01/12
- The World Bank. Regional Vice-Presidency for Africa (2013) The pirates of Somalia: ending the threat, rebuilding a nation. World Bank, Washington, DC
- Turner A (2009) Population priorities: the challenge of rapid population growth. *Philos Trans R Soc* 364:2977–2984
- United Nations (2012) Department of Economic and Social Affairs. Population Division, Population Estimates and Projections Section. World Population Prospects, the 2012 Revision. Available at: <http://esa.un.org/unpd/wpp/inex.htm>. Cited 23 March 2013
- US federal government FY14 budget, actual outlays in \$billion. Available at: [http://www.usgovernmentspending.com/federal\\_budget\\_actual](http://www.usgovernmentspending.com/federal_budget_actual). Last accessed 27 May 2013
- Ward MN (1998) Diagnosis and short lead-time prediction of summer rainfall in tropical North Africa at interannual and multidecadal timescales. *J Clim* 11(12):3167–3191
- World Bank. Independent Evaluation Group (2009) Improving effectiveness and outcomes for the poor in health, nutrition and population: an evaluation of World Bank group support since 1997 World Bank Publications
- World Bank (2012) Doing business in a more transparent world. World Bank, Washington, DC
- World Business Council for Sustainable Development. Vision 2050. Available at: <http://www.wbcsd.org/vision2050.aspx>. Cited 22 March 2013
- Zulu E (2012) How to defuse sub-Saharan Africa's population bomb. *New Scientist*. Printed 26 April 2012