WPS6631

Policy Research Working Paper 6631

Population, Poverty, and Climate Change

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The World Bank
Development Economics Vice Presidency
Partnerships, Capacity Building Unit
October 2013

Policy Research Working Paper 6631

Abstract

The literature is reviewed on the relationships between population, poverty, and climate change. While developed countries are largely responsible for global warming, the brunt of the fallout will be borne by the developing world, in lower agricultural output, poorer health, and more frequent natural disasters. Carbon emissions in the developed world have leveled off, but are projected to rise rapidly in the developing world due to their economic growth and population growth—the latter most notably in the poorest countries.

Lowering fertility has many benefits for the poorest countries. Studies indicate that, in high fertility settings, fertility decline facilitates economic growth and poverty reduction. It also reduces the pressure on livelihoods, and frees up resources to cope with climate change. And it helps avert some of the projected global warming, which will benefit these countries far more than those that lie at higher latitudes and/or have more resources to cope with climate change.

Natural experiments indicate that family planning programs are effective in helping reduce fertility, and that they are highly pro-poor in their impact. While the rest of the world wrestles with the complexities of reducing emissions, the poorest countries will gain much from simple programs to lower fertility.

This paper is a product of the Partnerships, Capacity Building Unit, Development Economics Vice Presidency. It is part of a larger effort by the World Bank to provide open access to its research and make a contribution to development policy discussions around the world. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org.
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Population, Poverty, and Climate Change

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Keywords: Population, Poverty, Economic growth, Climate change, Global warming, Family Planning, Public policy

JEL codes: Q56; Q54; J13; J18

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The relationships between population dynamics, poverty, and climate change are now recognized. This paper summarizes the evidence currently available on these relationships, and their implications for the poorest countries.

The paper begins with a review of the literature on population and depletion of natural resources. This relationship has been hotly debated, with some arguing that human innovation can overcome any resource constraint. The consensus now is that while this may be true of resources that are more fully priced, it is much more difficult to manage environmental common property resources. Efforts to price the use of such resources, notably by imposing a carbon tax, have so far met with very limited success.

While the developed world generated most of the emissions that cause global warming, the brunt of the burden will be borne by the developing world. These burdens are reviewed in Section 2. Section 3 reviews the gains to the poorest countries from fertility decline − to facilitate economic growth and poverty reduction; help mitigate the burdens of climate change that they face; and reduce future increases in global warming that will impact disproportionately on them. Section 4 reviews the evidence on the effectiveness of family planning programs in helping reduce fertility. Natural experiments indicate that they are effective, and have a strong pro-poor impact.

The paper concludes that while the rest of the world wrestles with the political and technological problems of reducing per capita emissions, the poorest countries have at hand the simple and effective means of using family planning programs to improve their circumstances.

1. Population and Natural Resources

The publication of the study *Limits to Growth* (Meadows et al 1972) caused much controversy. It summarized the historical trajectory from 1900-1970 of non-renewable natural resources; pollution; population size; food production; and industrial output, and simulated their trajectory from 1970 to 2100. It concluded that sustainable development could not be achieved without curtailing population growth and the use of natural resources.

Others argued that more rapid population growth may help drive economic growth, by spurring technological innovation that can potentially stretch resources indefinitely. Boserup (1965) had argued that rising population tends to induce agricultural innovation and lead to agricultural intensification, allowing greater productivity per unit of land to feed the larger population. Simon (1981, 1996) argued that people and markets innovate in response to potential resource shortages, and therefore the resource base is effectively infinite.[1]

Simon's arguments were supported by studies of the costs of some industrial resources, which were found to have fallen sharply between 1870 and 1957, a period during which there was rapid growth in both population and industrial output (Potter and Christy 1962; Barnett and Morse 1963). For such clearly-priced resources, there are strong private incentives to find innovative ways of managing their use to keep prices down.

The concerns raised by studies forecasting resource depletion receded quickly as technological innovation rapidly raised agricultural productivity and kept the prices of some

commodities down. However, these innovations have done much less to reduce depletion of environmental common property resources.

1.1 The complexities of managing environmental common property resources

More recently, widespread concern over environmental common property resources has again raised issues of sustainable development.

A driving need for continuing adaptation and innovation is generated by the world's growing consumption needs, with increases in consumption levels per capita and population growth. Technological progress has certainly increased production, but this has not been without negative ramifications. Common property resources are under pressure from activity to meet rising consumption requirements. For example, agricultural intensification has been very effective at raising food production, but has increased fertilizer runoff, creating low-oxygen 'dead zones' in coastal oceans (Map 1).

While market forces and ingenuity can find ways to better manage the use of non-renewable resources that are clearly priced, it is proving more difficult to conserve resources that are unpriced or underpriced, such as oceans and the atmosphere. Even to understand the intricacies of environmental change is a challenging task for scientists — and organizing collective action to avert negative consequences is a challenging task for political leaders even at local levels, let alone national and global levels.

These factors combine to create a daunting list of needed adaptations and innovations, which are complex to develop as well as to implement. The World Development Report 2010 summarizes some of the measures needed just for sustainable food production (World Bank 2010). To manage land and water resources to feed growing populations and protect natural systems, they point to the need for politically daunting measures, such as:

- building flexible international agreements
- pricing carbon, food and energy
- redirecting agricultural subsidies
- strengthening the policy environment for natural resource management.

Conventional estimates of GDP growth are misleading on the sustainability of production possibilities, because they ignore the depreciation of natural capital (Arrow et al 2004, Dasgupta 2010).

> 'Since GDP is the total value of the final goods and services an economy produces, it does not deduct the depreciation of capital that accompanies production—in particular, it does not deduct the depreciation of natural capital. In the quantitative models that appear in leading economics journals and textbooks, nature is taken to be a fixed, indestructible factor of production. The problem with the assumption is that it is wrong: nature consists of degradable resources. Agricultural land, forests, watersheds, fisheries, fresh water sources, river estuaries and the atmosphere are capital assets that are self-regenerative, but suffer from depletion or deterioration when they are over-used…. To assume away the physical depreciation of capital assets is to draw a wrong picture of future production and consumption possibilities that are open to a society.' (Dasgupta 2010:6)

Moreover, 'property rights to natural capital are frequently unprotected or ill-specified....(which) typically leads to their overexploitation, and so to waste and inequity' (Dasgupta 2010: 6).

Arrow et al (2004: Table 2) estimate how much 'genuine wealth per capita' (including natural capital, human capital, and manufactured capital) changed during 1970-2000. The estimates are necessarily approximate, but they have been made carefully and the results are instructive. They find that while GDP per capita grew quite rapidly during 1970-2000 in all regions except in sub-Saharan Africa, rates of growth in 'genuine wealth per capita' were far lower. They *declined* sharply in sub-Saharan Africa and in the Middle East and North Africa (by -2.6 and -3.8 percent per year respectively). They grew very slowly (well below 1 percent per year) in South Asia and the United States. They grew rapidly only in China, due to its low population growth and heavy investment in productivity. Revising the method to include more information on growth in human capital and institutional change, Dasgupta (2010: 9-10) derives far lower estimates of growth in genuine wealth per capita for China 1970-2000, and for South Asia he estimates a *decline* of between -0.4 percent per year (India) and -1.4 percent (Pakistan).

Human ingenuity has faced an uphill task at devising ways of managing common property resources ─ given the institutional and political challenges posed in aligning divergent interests. Markets are very poor at incentivizing people not to overuse resources that are un-priced or under-priced relative to social cost (Arrow 1969, Dasgupta 2001, Stern 2006), especially in the case of transnational common resources (Dasgupta et al 1997). The consequent negative externalities need to be addressed through collective action, but in the absence of strong mechanisms for mutual coercion it is very difficult to align the interests of different stakeholders to this end. Ostrom (1990) has argued that common property can be successfully managed by user associations in small communities if eight 'design principles' are met, including the ability to effectively exclude unentitled parties. Such conditions clearly do not apply to global common resources. As Lee (1990:317) points out 'each birth inflicts costs on all others by reducing the value of their environmental birthright'.[2]

The juxtaposition of all these scientific, executive, and political challenges places high demands on national and global institutional capacity, as evidenced by the slow progress made in decades of efforts to regulate carbon emissions. The original projections of the *Limits to Growth* study for the period 1970-2000 correspond broadly with the observed trends during this period (Turner 2008, 2012).

1.2 Managing Climate Change: addressing per capita emissions and population

Models of climate change take population size into account, but typically treat it as a given (for example, Stern 2006; Nordhaus 2008, 2012). They tend to use the United Nations medium variant population projections. Using this approach, the World Bank (2010: Figure 3.5) estimates the impact of climate change on the growth in agricultural productivity required to meet rising food demand. The model incorporates projected rises in food demand due to growth in incomes as well as in population size, and shows how much harder it will be to meet that demand given anticipated climate change. A huge increase in agricultural productivity backed by greatly intensified regulation to protect natural systems will be needed.

Yet population size *is* amenable to policy, as we discuss below, and makes a big difference to the size of adjustments required on other fronts. Models vary, but the World Bank (2010) estimates that to meet the growing demand for food between 2005 and 2055, agricultural productivity will need to rise by 64 percent under the assumptions of the 'business as usual'

scenario and by a further 80 percent to offset the projected stresses arising from climate change (Figure 1). Yet the model indicates that if population remained constant at the 2005 level, agricultural productivity would need to rise only 25% under the 'business as usual' scenario ─ i.e., more of the required productivity increase under the 'business as usual' scenario is necessitated by population growth, than by increases in consumption per capita.

The developed world's carbon emissions per capita are far higher than those of the developing world, but the latter accounts for nearly all the projected increase in emissions between now and 2050 (Stern 2006:Figure 7.3). While emission rates in the developed world seem to have peaked, they are growing rapidly in the developing world due to both economic growth as well as population growth. Though China has had the steepest growth in carbon emissions with its high rate of economic growth, its estimated total emissions in 2008 were similar to that of other developing countries as a group (excluding India),[3] partly because the latter had twice the population of China (UN 2013). GDP per capita is rising rapidly across much of the developing world − including in sub-Saharan Africa in the 2000s (IMF 2010a, 2011). And nearly all the projected global population growth will take place in the developing world – whose population (excluding China and India) is projected to grow 2.7-fold between 2000 and 2100, driven largely by the six-fold increase projected for sub-Saharan Africa (UN 2013, medium variant). It is estimated that the effect of a 40% reduction in CO2 emissions per capita in developed countries between 2000 and 2050 would be entirely offset by the increase in emissions attributable to expected population growth in poorer countries over this period, even assuming no change in emissions per capita in these countries (Dyson 2005).[4]

Managing global warming may require different policy approaches in different settings. Imposing a carbon tax is strongly recommended as the simplest way to reduce carbon emissions (Stern 2006, Nordhaus 2008, 2012). By putting a price on carbon emissions, such a tax creates incentives to conserve global common property resources, while providing incentives and fiscal resources for developing cleaner technologies. However, some major polluters in the developed world have shown limited political appetite for this, while developing countries argue that this will constrain their economic growth with restrictions which the developed world did not have to face.

For countries which still have high levels of fertility – which typically are still poor and have very low per capita emission rates, the key approach seems to be to reduce fertility. Clearly they do not owe it to the world to reduce fertility to help slow the pace of climate change. Yet they have strong reasons of their own to reduce fertility, as discussed below.

2. The Unequal Impact of Climate Change

The developed world is responsible for much of the accumulation of emissions making for climate change, since they began rapid industrialization by the end of the nineteenth century. But in a twist of fate, the impact of climate change will be felt most sharply in much of the developing world, and the poorest are the most vulnerable to any shocks. Many of these countries are short of the financial resources for adaptation/mitigation efforts, and for some the capacity to act may also be hindered by poor governance (WDR 2008:245).

> "The impacts of climate change are not evenly distributed - the poorest countries and people will suffer earliest and most….First, developing regions are at a geographic disadvantage: they are

already warmer, on average, than developed regions, and they also suffer from high rainfall variability….Second, developing countries - in particular the poorest - are heavily dependent on agriculture, the most climate-sensitive of all economic sectors, and suffer from inadequate health provision and low-quality public services. Third, their low incomes and vulnerabilities make adaptation to climate change particularly difficult….At a national level, climate change will cut revenues and raise spending needs, worsening public finances." (Stern 2006:vii of summary)

Modeling the effects of climate change is subject to much uncertainty, but there is considerable consensus on its broad effects, some of which are summarized below.

(a) ***Food and water***. Global warming will reduce crop outputs at lower latitudes, undermining food security in the developing world. If temperatures rise further global food output will decrease,[5] reducing the developing world's access to imported food.

Around a third of the world's population lives in countries with moderate to high water stress (Stern 2006:63), often exacerbated by poor management of water resources (World Bank 2007:183). Rising demand for agriculture and other purposes will heighten water scarcity.

Climate change is also expected to disrupt rainfall patterns, threatening agricultural cycles and human lives with droughts and floods. These changes will affect most the poorest billion people in the world, 75 percent of whom live in rural areas and rely on agriculture for their livelihood (Stern 2006: 67).

(b) ***Health and Human Capital:*** Climate change is increasing morbidity and mortality from malnutrition, vector-borne[6] and diarrhoeal diseases − and children are the most affected (McMichael et al 2004). This can have lasting consequences for human capital: a study in Zimbabawe found that young children who became stunted as a result of a drought faced long-term negative effects on school attainment and subsequent earnings (Alderman et al 2006).

(c) ***Natural disasters:*** The frequency of natural disasters is expected to increase, affecting and even displacing large numbers of people. Low-lying coastal areas will become increasingly uninhabitable, subject to flooding and hurricanes. Sea level rise will bring salinization, salt water intrusion in groundwater aquifers, and in some areas complete inundation (WDR 2008:200).

Many countries in the most affected regions have poor preventive health systems, with low capacity for averting and controlling disease outbreaks even during routine conditions. Such capacity becomes especially critical when faced with natural disasters (Das Gupta et al 2009).

(d) ***Conflicts***. The pace of internal and international migration will rise with the combined pressures of climate change, population growth, and environmental degradation (Laczko and Aghazarm 2009, World Bank 2010, Gemenne 2011), and the migrants may not always be welcomed by people who may themselves feel under pressure. Migration from Bangladesh into parts of Northeast India has led to low-level conflict for decades, and this could be exacerbated if the densely-populated megadeltas of the Bay of Bengal are inundated by sea level rise. Land degradation and drought have already caused much movement of people in

sub-Saharan Africa. Mamdani (2001:ch 6,7) notes that one of the factors underlying the Rwanda genocide was local resentment of heavy in-migration of people seeking richer land.

3. How do the poorest countries gain from fertility reduction?

Fertility remains high in parts of the developing world, typically in the poorest countries. The least developed countries have an estimated average of 4.2 children per woman in 2010-15 (UN 2013, medium variant). The estimate for Sub-Saharan Africa is 5.1 children per woman in 2010-15, and its population is projected to rise from 0.64 to 3.82 billion between 2000 and 2100 (UN 2013, medium variant). Total Fertility Rates also remain high in a scattering of other developing countries. They remain above 3 children per woman in some larger Asian countries, such as the Philippines and Pakistan (UN 2013), and some of the least developed states of Northern India (Haub 2011:Figure 11).

Reducing fertility can benefit these countries in many ways, facilitating economic growth and poverty reduction. A large literature since the 1990s discusses the "demographic dividend" enabled when fertility declines in high fertility settings. The resultant low dependency ratios create a window of opportunity for savings, increased productivity, and investment (Higgins and Williamson 1997; Kelley and Schmidt 1996, 2005). Some of this dividend is automatic, arising simply from increasing the resources per capita for services, infrastructure, and livelihoods. However, with good policy management and investment in physical and human capital, this window of opportunity can be used to transform economies such that their growth potential remains high after the window has closed. This is evidenced especially in East Asia (Bloom and Williamson 1998, Lee 2009). The more rapid the fertility decline in a region, the wider the window of opportunity, though its duration will be shorter because the population will age more rapidly.[7]

This literature on the "demographic dividend" is sometimes interpreted as implying that fertility decline is "wasted" without strong policy settings such as those in East Asia. Yet these studies came decades after vigorous family planning programs were started in most Asian countries in the 1960s and 1970s. These were explicitly motivated by widespread poverty compounded by sharply rising population growth rates, and were viewed as an integral part of the countries' development strategy.[8] Reducing fertility itself helps reduce poverty, as evidenced in India where it mitigates some of the negative fallout of its weak economic policies and slow job growth.

Micro-studies also find that lower fertility helps reduce poverty at household level in developing countries. It has been found to be associated with better child health and schooling (Rosenzweig and Wolpin 1980; Rosenzweig and Zhang 2009), improved maternal health, increased women's labor force participation, and higher household earnings (Joshi and Schultz 2007). Young women benefited especially from access to the family planning program in Colombia, obtaining more schooling and being more likely to work in the formal sector (Miller 2010). Miller (2010:711) concluded that family planning may be 'among the most effective (and cost-effective) interventions to foster human capital accumulation'.[9]

These benefits are especially critical given the shortage of land and jobs in these countries, which leaves their growing populations ever more squeezed for livelihoods. Land

scarcity is acute in most Asian countries, and in sub-Saharan Africa available cropland per agricultural person fell by 40 percent between 1960 and 2003 (World Bank 2007:63). Some sub-Saharan African countries have considerable room for land expansion, but high rural population growth drives expansion into forest or grazing land, and large investments in infrastructure, disease control, and soil management are needed to convert these lands to productive agriculture (World Bank 2007:63). Food production per capita changed little in sub-Saharan Africa between 1961 and 2005 (Figure 2).

There is also a shortage of jobs. Levels of unemployment are already high in many countries, but the World Bank (2012:51) estimates that just to maintain in 2020 the 2005 levels of employment of the working age population, very substantial job creation is required. An additional million jobs a ***month*** will need to be generated in South Asia. Given the slow pace of job growth in this region it is fortunate that the population aged 0-14 is projected to decline soon (UN 2013, medium variant), as seen also in India (Figure 3). The report also estimates that the number of jobs in sub-Saharan Africa would have to increase by about 50 percent, which translates into employment growth of 2.7 percent a year. As the population aged 0-14 is growing sharply in sub-Saharan Africa, the numbers entering working age will continue to rise sharply for decades (Figure 3). The rapid projected growth of the young population in the least developed countries contrasts sharply with that of other developing countries (Figure 3), so countries with weak economic growth face the highest increase in numbers entering the labor force.

Population growth imposes a direct burden of resource depletion on developing countries. Arrow et al (2004:164-5) estimate that the rate of depletion of 'genuine wealth per capita' in sub-Saharan Africa during 1970-2000 was such that it would be halved about every 25 years. Kelley and Schmidt (2005) conclude that high fertility has also meant that sub-Saharan Africa has as yet benefited far less than other regions from the impact of reduced dependency ratios on output growth per capita.

Lower fertility can also help the poorest countries' efforts to mitigate the effects of climate change − so that the shocks affect fewer people, and more resources per capita are available for coping with them. These resources can be used for adaptation measures, such as efforts to slow the decline in food production. Systems for disaster management and preventive health services can be strengthened to minimize the spread of existing and emerging diseases. Such measures will make it easier to coordinate collective efforts to cope with climate change.

With less pressure on livelihoods, poor households will also be better placed to cope with the consequences of climate change. Looking to the future, slower population growth will reduce these countries' projected contribution to future climate change, which will as before have the most devastating impact on these countries.

4. Can family planning programs help lower fertility?

Government programs to promote the use of effective contraceptive methods are by no means a necessary condition of fertility decline: birth rates fell in Europe with no State encouragement. Nor are they the only policy levers to encourage lower fertility. Female education has been found associated with lower fertility by raising the age at first birth, in settings as varied as

Guatemala, Indonesia, and Nigeria.[10] The key question is whether family planning programs can advance the timing of reproductive change and accelerate it once underway.

In a highly influential paper, Pritchett (1994a) argued that family planning programs have little impact on fertility: 'Ninety percent of the differences across countries in total fertility rates are accounted for solely by differences in women's reported desired fertility…. The results contradict theories that assert a large causal role for expansion of contraceptive use in the reductions of fertility' Pritchett (1994: abstract).

Many have taken Pritchett's study as indicating that effort on family planning programs is ill-spent, but he later concludes that his estimates imply that strengthening a family planning program substantially (by 50 points out of a scale of 0-100) would reduce fertility by one birth (Pritchett 1994b: 626). Bongaarts (1997) estimates the corresponding fertility reduction at 1.4 births, but even Pritchett's lower estimate amounts to a very large difference in population momentum and size. If one birth less per woman was sustained in sub-Saharan Africa over the period 2010-2100, the region would have an estimated 2.6 billion fewer people in 2100 – more than halving the estimated total population at the end of this century (Figure 4).

A crucial gap in Pritchett's argument is that he assumes that family planning programs work only on the supply side, and overlooks their important role in reducing desired family size. He conducts cross-country regressions of Total Fertility Rates against contraceptive prevalence and against family planning effort, but in both cases he *controls for desired fertility* (Pritchett 1994: Table 3). Yet mass media outreach to reduce desired family size is a major component of family planning programs. Studies have shown that the mass media are very effective at increasing contraceptive use and reducing fertility (see below).

4.1 What do family planning programs seek to do?

Family planning programs seek to boost use of contraceptive methods by expanding their supply and accessibility, thus enabling couples to postpone or limit childbearing. This is especially important for the poor, who typically have higher numbers of unwanted children than the rich except in settings with very effective programs, such as Indonesia (Figure 5).

Family planning programs also typically seek to reduce desired family size by disseminating information on new opportunities for altering living standards through new strategies for bearing and investing in children. Parents – especially poorer parents – have imperfect information on these issues. Households also appear to face difficulties in making optimal choices that involve long-term planning horizons (see for example Cronqvist and Thaler 2004 on pension decisions). Offering simple information on contraception — or more complex messages through radio or television, such as soap operas that portray the lives of people with small families and how they access new opportunities — helps reduce imperfect information.

Media outreach has been found effective at increasing contraceptive use and lowering fertility. This has been found in many studies using cross-sectional survey data on access to media (e.g. Bhat 1996). The few quasi-randomized evaluations have found it effective at altering fertility and contraceptive use in Tanzania (Rogers et al 1999) and reducing fertility in Brazil and India (La Ferrara et al 2008; Jensen and Oster 2009).

To motivate their evaluation of the impact of Brazilian soap operas on fertility, La Ferrara et al (2008:9) report the results of an experimental focus group discussion in which adult women of middle and lowerclass backgrounds were asked to portray the families that are more frequently displayed on television, and those of common people. "The results were clear: television families are small, rich and happy; the families portrayed as common people are poor, contain more children and the faces reveal unhappiness….constant exposure to smaller, less burdened television families, may have created a preference for fewer children and greater sensitivity to the opportunity costs of raising children."

Using simple billboards, this is exactly the approach used in many countries, such as South Korea and India. Their family planning programs catalyzed demand through media blitzes, conveying images of glowing parents with 1-2 flourishing children, sometimes juxtaposed with images of overwhelmed parents surrounded by many children living in much poorer conditions. Short jingles on the radio and television reinforced the message that "a small family is a happy family".

Such media blitzes are especially important in settings where contraceptive use is not yet commonplace. By reaching entire communities, they help change social norms and reduce barriers to use. One barrier may be that women are more motivated than men to control childbearing. A study in Zambia found that women who were given contraceptive information and access without their husbands present were more likely to use them and less likely to give birth than a control group of women accompanied by their husbands (Ashraf et al 2012). A study in urban slums in Pakistan found that mothers-in-law influenced contraceptive decision-making (Fikree et al 2001). By helping shift social norms, media outreach helps empower women to use contraception.

4.2 Evaluations of family planning programs

Evaluating the impact of family-planning programs is challenging, because they are rarely randomly placed and uniformly executed. However, many studies – using very different analytical approaches including natural experiments − indicate that family planning programs affect fertility.

Schultz (2009: 4) notes that several careful evaluations of family planning programs find a negative association between 'the regional intensity of program treatment and the regional level of fertility' in a country. These include studies of the programs in Taiwan (Schultz 1973, 1992), Colombia (Rosenzweig and Schultz 1982), and Indonesia (Molyneaux and Gertler 1994). While some studies are simple cross-sectional analyses, others have gone further to analyze panel data and include fixed effects for regions and time. However, the estimated program impact may be biased by nonrandom placement.

Several studies use natural experiments or quasi-randomized trials. In the Matlab program in Bangladesh, half the villages studied for the period 1974-96 received more intensive family planning and maternal and child health program inputs from 1977-78, while the other half received regular government program inputs. Note that the country was poor and largely illiterate for much of the study period. The first set of villages showed more rapid fertility decline after the program began, and maintained 15 percent lower fertility 1982-96 (Joshi and Schultz

2007:30). This difference is especially striking given that fertility was falling rapidly across the country. Sinha (2005) found that 18 years after the Matlab program began, it accounted for a 14 percent decline in lifetime fertility (0.6 fewer births per woman) compared with women in the second set of villages. If sustained over time, this can considerably reduce the momentum of population growth, as the difference between the UN projection variants show (Figure 4).

Miller (2010) evaluated Colombia's family planning program, exploiting differences in timing of the introduction of the family planning program to estimate the impact of contraceptive availability on fertility. The program was found to have lowered fertility by about 10 percent ─ again, despite the fact that fertility was declining rapidly across the country. Households with lower fertility also showed improvements in schooling, health, and earnings. Access to family planning helped young women obtain more schooling and increased their chances of working in the formal sector.

These evaluations may tend to under-estimate the impact of family planning programs, insofar as their measures of program effort are more likely to pick up variation on the supply side. Mass communication efforts to reduce desired family size are likely to reach people regardless of whether they live in areas with higher or lower supply-side program effort.

Some recent studies have used natural experiments to examine the impact of variation in access to contraceptives, and these indicate that facilitating access to contraception is highly pro-poor – as indicated also by Figure 5. Two studies examine the impact of shifts in the application of the United States' "gag rule" (Mexico City Policy) that restricts foreign aid for family planning to any organization that may provide abortions using other funds. Jones (2011) estimates that the policy was associated with a 12 percent increase in pregnancies amongst rural women in Ghana, increasing both abortions and unintended births. The unintended births were concentrated among the poorest and least educated women, and those children had significantly lower height-for-age relative to their siblings. Bendavid et al (2011) found that after the Mexico City Policy was reinstated in 2001, abortion rates rose in sub-Saharan African countries that receive high levels of foreign assistance from the United States for family planning and reproductive health. Salas (2013) finds that policy-related disruptions in the public supply of free contraceptives in the Philippines was associated with elevated birth rates, especially among poor, less educated, and rural women.

Similar findings emerge from the analyses of natural experiments in the developed world. Kearney and Levine (2009) examined the impact of state-level Medicaid policy changes in the United States that expanded eligibility for family planning services, and found that it reduced births, particularly for teenagers and those with lower educational attainment. Bailey (2012) estimates that that federally funded family planning in the United States reduced childbearing among poor women by 19 to 30 percent between 1964 and 1973. Reflecting the findings in Bangladesh and Colombia discussed above, analyses of natural experiments in the United States and Sweden find significant female labor supply responses to differences in the provision of the birth control pill (Goldin and Katz 2002; Ragan 2013).

Jones' (2011) finding that unintended children in Ghana were more likely to be stunted than their siblings is consistent with other studies that indicate that greater investments are made in planned children. For example, Do and Phung (2010) use the fact that in Vietnam, some years are considered especially auspicious to bear children, while others may be inauspicious. They

found that larger cohorts of children are born in auspicious years, and that they have higher schooling attainment. They conclude that this is because parents are more likely to invest in planned children.

4.3 Are family planning programs likely to work in the poorest countries?

The experience of countries such as the Republic of Korea in the 1960s, and others such as Indonesia, Bangladesh or Nepal shows that sustained fertility decline can occur in poor countries, given political commitment to family planning programs. This commitment was driven by poverty and sharply rising population growth rates. For example India's censuses showed decadal growth of 11-14 percent from the 1920s, but this jumped to 22 percent in 1951-61, and 25 percent during 1961-71. Similar population growth rates were seen in the Asian region and sub-Saharan Africa (UN 2013). However, sub-Saharan Africa's small population base in the 1950s meant low increases in numbers, a situation that is changing very quickly (Figure 4).

Political commitment to family planning has sometimes been low in many sub-Saharan African countries, which may have contributed to their slow fertility decline (Cleland et al 2006, 2011; Bongaarts 2006; Machiyama 2010).[11] But this can change quickly, as evidenced by the success of the Rwandan government's concerted push since the mid-2000s to reduce fertility. Until then, both Rwanda and its neighbor Burundi were poor, densely populated countries with high fertility and weak family planning programs. Then in contrast with Burundi, Rwandan Government officials spoke out about the need to reduce fertility. A country-wide information dissemination program was implemented, along with sharply increased access to contraceptive methods. Between the DHS surveys of 2005 and 2010 the Total Fertility Rate fell from 6.1 to 4.6 children per woman, and the use of modern methods of contraception among married women rose from 10% to 45% (National Institute of Statistics of Rwanda, 2011). Meanwhile total fertility in Burundi was 6.4 in 2010 (Institut de Statistiques et d'Études Économiques du Burundi, 2010).

Many countries in sub-Saharan Africa show some fertility decline, indicating a desire to lower fertility, and family planning programs can build on this and accelerate fertility decline. These programs are likely to be most effective when accompanied by other measures addressing basic government failures that help sustain poverty and high fertility — including efforts to improve health and schooling, and to expand income-earning opportunities. Family planning programs help by increasing access to contraception, and by providing informational outreach to accelerate perception of the benefits of shifting to a more secure equilibrium in which people have fewer children and are able to invest more in them.

5. Conclusions

The management of environmental common property resources is complex because these resources are unpriced, so people have to agree to self-impose a price for using them. Their over-exploitation by countries that started industrializing early has led to global warming, the fallout of which will in an ironic twist of fate fall primarily on the developing world, much of which is still poor and has low per capita emissions. These countries will be the first to experience declines in agricultural output, poorer health outcomes, disruption of rainfall patterns,

and more frequent natural disasters which even render some areas uninhabitable. And poor people are the most vulnerable to shocks.

Yet while per capita emissions in the developed world remain much higher than the developing world, their growth seems to have peaked. Most of the projected growth in emissions derives from the developing world, due both to their economic growth and their population growth. Most of all future population growth is projected to take place in these countries, with the highest growth rates in sub-Saharan Africa and the least developed countries.

In this highly complex situation, analysts have focused on policies to reduce greenhouse gas emissions. A carbon tax is proposed as the simplest approach to reduce carbon emissions. By putting a price on carbon emissions, such a tax creates incentives to conserve their use, while providing incentives and fiscal resources for developing cleaner technologies. Some have argued that pricing carbon use could be introduced more gradually in developing countries, to impose less constraint on their potential economic growth.

Neglected in these policy debates is the fact that a substantial part of future growth in emissions derives from population growth, mostly in the poorest countries. While population size is incorporated into models of climate change, the population projections are taken as a given. Yet fertility is highly amenable to policy interventions. For countries which still have high fertility - and which typically have very low per capita emission levels at present because they are still poor, the more immediate approach might be to lower fertility.

Clearly the poorest countries cannot be expected to reduce fertility in order to help the world as a whole, especially when they are suffering from the excesses perpetrated by the rest of the world. However, they have much to gain from lowering fertility. This will increase their available resources per capita to invest in the human and physical capital needed for economic growth. It will also increase per capita resources to strengthen systems for disaster management and for disease prevention and control, to help them cope with the multiplicity of stresses from climate change. It will reduce growth in the demand for jobs and livelihoods. And household-level studies show that lower fertility is associated with better schooling and health outcomes and greater female laborforce participation. Fertility decline in poor countries yields a substantial "demographic dividend" in reducing poverty and vulnerability, even without the large additional gains that can be obtained with strong economic policies.

Lower fertility will also benefit the poorest countries by reducing the pace of future global warming, the consequences of which accrue far more to them than to the developed world − both because the developed world lies mostly at higher latitudes that are less negatively affected by climate change, and because they have far greater resources to cope with climate change.

The means to lowering fertility are well-documented. Family planning programs help by increasing access to contraception, and by catalyzing demand for contraception through intensive media outreach. Studies show that not only are family planning programs effective at helping lower fertility, but that they are highly pro-poor in their impact. Easier access to family planning benefits most women who are poor, uneducated, and live in rural areas – those who are least able to access family planning on their own. Family planning programs are a simple, effective, and relatively inexpensive way to achieve a multiplicity of benefits for poor countries.

While the rest of the world wrestles with the political and technological complexities of cutting emissions, family planning programs offer the poorest countries a simple and effective means to improve their circumstances.

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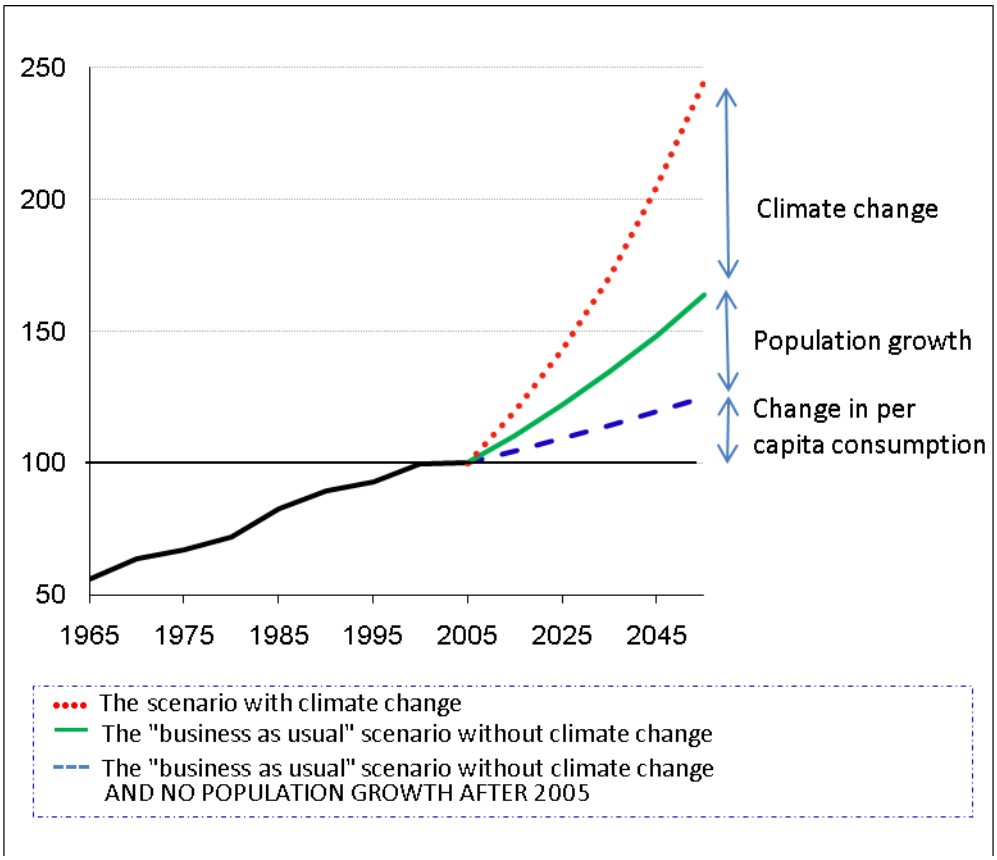
Figure 1: Required growth in agricultural productivity under different assumptions of climate change and population growth

Population growth and climate change mean that increases in agricultural productivity must accelerate to meet the growing food demands as incomes rise



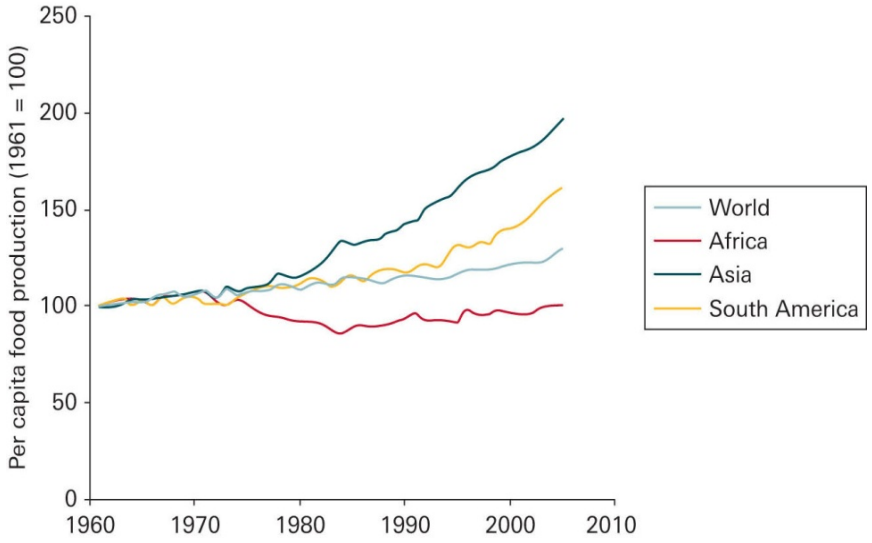
Source: World Bank (2010) *World Development Report 2010*: Figure 3.5 (derived from Lotze-Campen et al 2009). We thank Dr Lotze-Campen for disaggregating the "business as usual" scenario into two estimates: (1) with population held constant at the 2005 level, and (2) the WDR 2010's "business as usual" scenario, which includes anticipated population increase to 9 billion by 2055.

Explanatory note from the original figure in the WDR 2010:

"The figure shows the required growth in an agricultural productivity index under two scenarios. In this index, 100 indicates productivity in 2005. The projections include all major food and feed crops. The green line represents a scenario without climate change of global population increasing to 9 billion in 2055; total calorie consumption per capita and the dietary share of animal calories increasing in proportion to rising per capita income from economic growth; further trade liberalization (doubling the share of agricultural trade in total production over the next 50 years); cropland continuing to grow at historical rates of 0.8 percent a year; and no climate change impacts. The orange line represents a scenario of climate change impacts and associated societal responses (IPCC SRES A2): no CO2 fertilization, and agricultural trade reduced to 1995 levels (about 7 percent of total production) on the assumption that climate change-related price volatility triggers protectionism and that mitigation policy curbs the expansion of cropland (because of forest conservation activities) and increases demand for bioenergy (reaching 100 EJ [10^{18} joules] globally in 2055)."

Note: The original explanatory note said it was the required annual growth, Dr Lotze-Campen corrected this by deleting the word "annual".

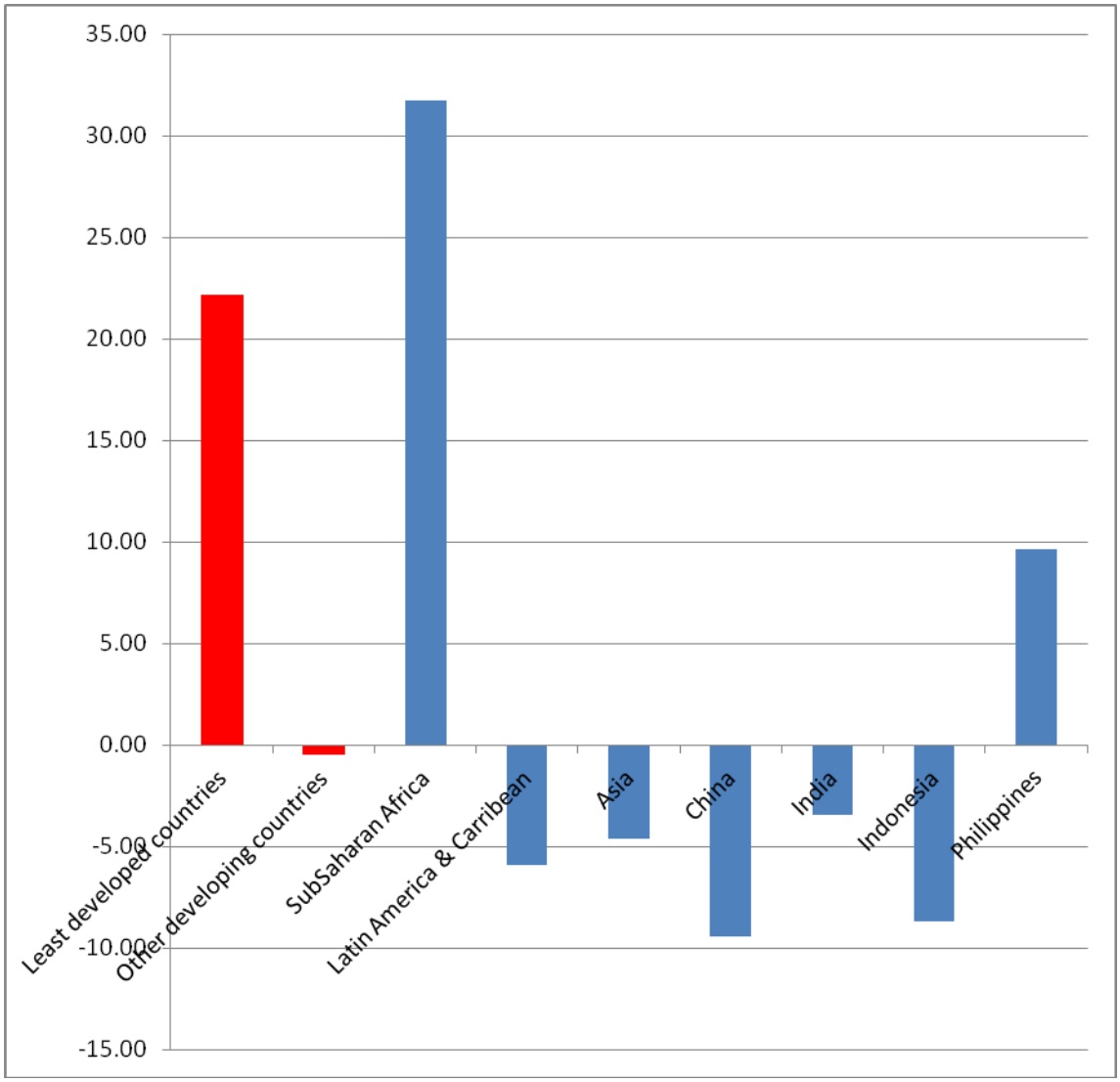
Figure 2: Changes in food production per capita, 1961-2005



Source: The Royal Society 2009: Figure 1.4

Figure 3 Projected Percent Change in Population aged 0-14 years, 2015-2030

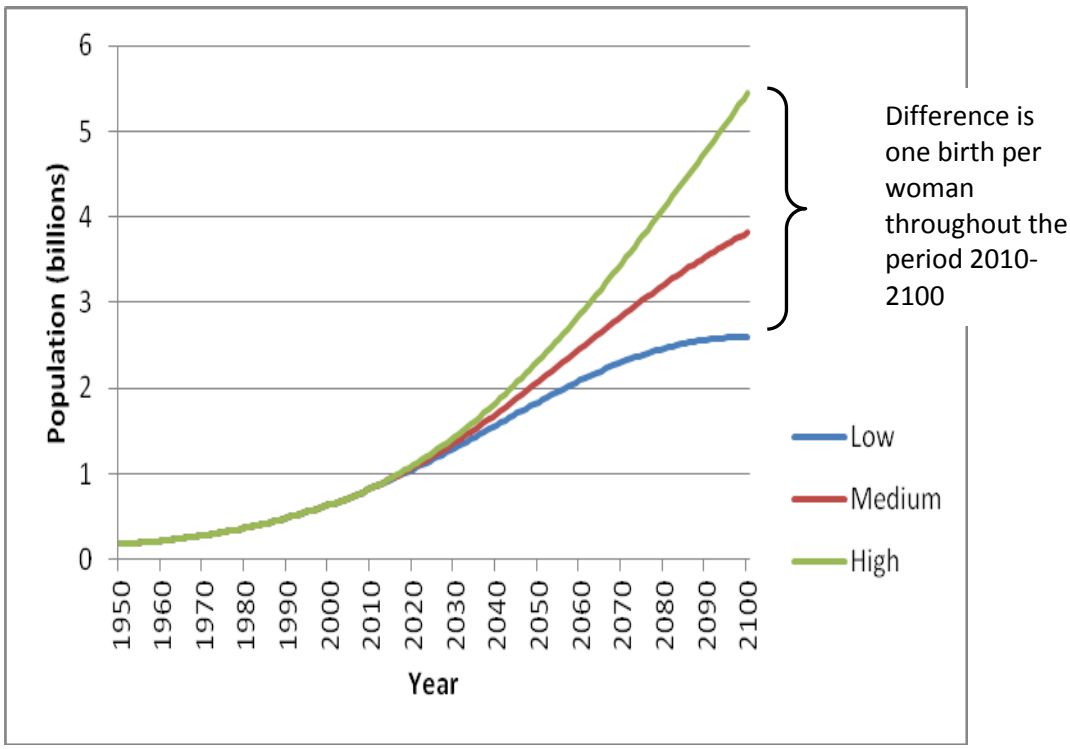
Countries with weak economic growth will face high increase in numbers entering the labor force



***Source*:** United Nations (2013), medium variant

Figure 4: Population projections for sub-Saharan Africa

Maintaining one less birth per woman reduces projected population size in 2100 by 2.8 billion

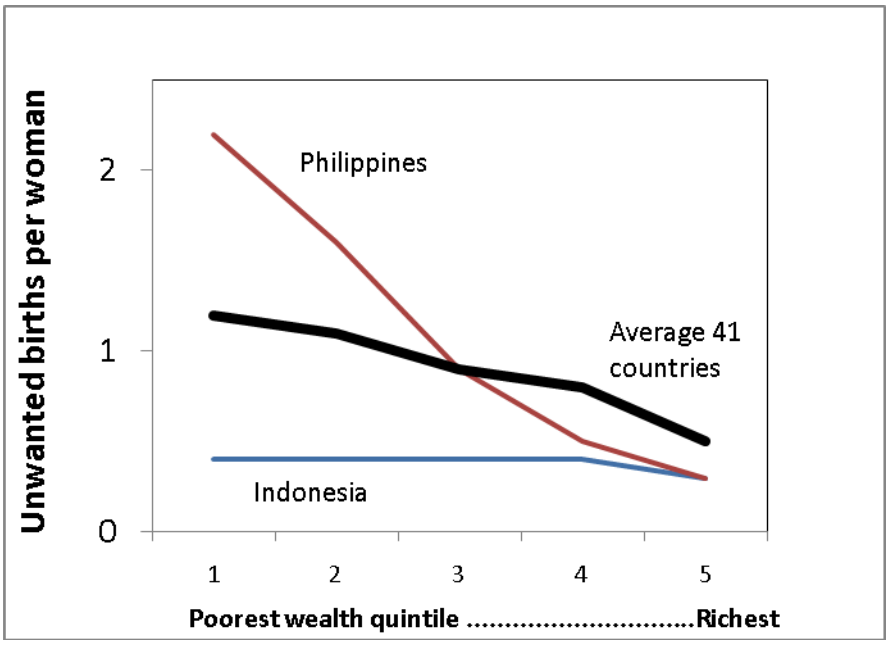


Source: United Nations (2013).

Note: The UN creates the high and low variants by keeping the TFR 0.5 births higher or lower than the median variant throughout the projection period. Hence the total difference between the high and low variants is 1 birth per woman.

Figure 5: Unwanted fertility is higher among the poor,

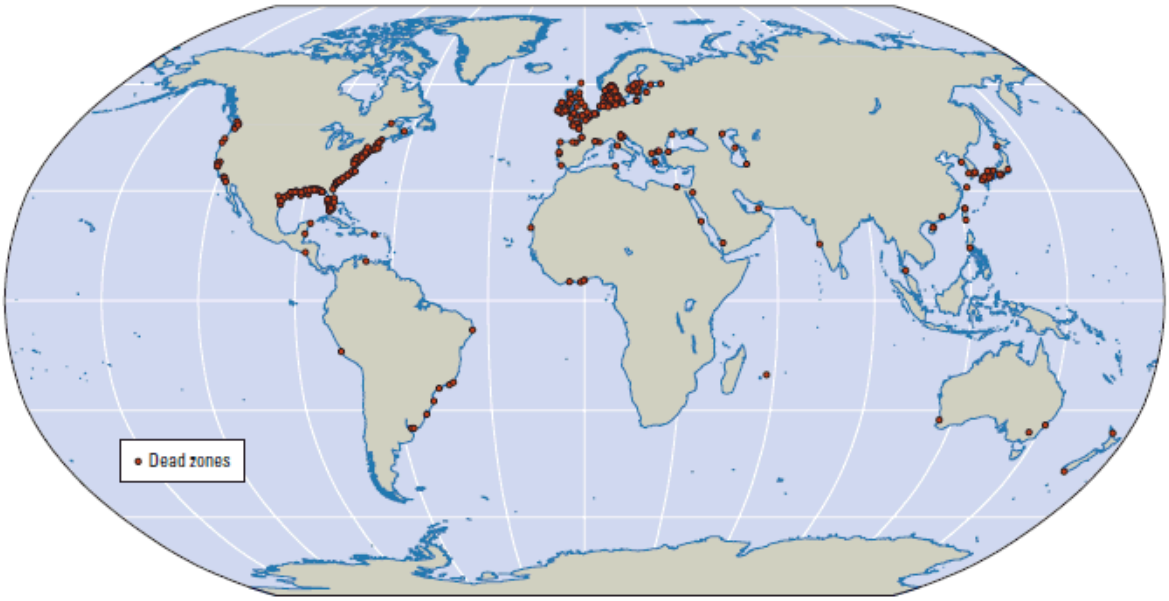
and effective family planning programs can reduce this gap



Source: Gillespie et al (2007): Table 1

Map 1:

Intensive agriculture in the developed world has contributed to the proliferation of dead zones



Source: Diaz and Rosenberg 2008.

Source: World Bank (2010) *World Development Report 2010*: Map 3.4 (derived from Diaz and Rosenberg 2008).

Explanatory note from the original figure in the WDR 2010: "In the developed world intensive agriculture has often come at high environmental cost, including runoff of excess fertilizers leading to dead zones in coastal areas. Dead zones are defined as extreme hypoxic zones, that is, areas where oxygen concentrations are lower than 0.5 milliliters of oxygen per liter of water. These conditions normally lead to mass mortality of sea organisms, although in some of these zones organisms have been found that can survive at oxygen levels of 0.1 milliliter per liter of water."

Endnotes

Acknowledgements: Comments from Emmanuel Jimenez and an anonymous reviewer were very helpful for revising the draft, all errors remain mine. This work was supported by the William and Flora Hewlett Foundation [Trust Fund TF070424 to the World Bank, and grant number 2012-7611to the Population Reference Bureau].

[1] Simon and Boserup both argued that higher population densities can increase the economies of scale in providing productivity-enhancing infrastructure and services such as transport and extension services (Glover and Simon 1975; Boserup 1981).

[2] See also Lee and Miller (1990).

[3] United States Environmental Protection Agency (nd) Global Greenhouse Gas Emissions Data http://www.epa.gov/climatechange/ghgemissions/global.html (accessed 5 June 2013).

[4] Many have estimated that slowing population growth could substantially reduce carbon emissions (see for example Meadows et al 1972, Bongaarts 1992, and O'Neill et al (2010).

[5] World Bank 2007:200; FAO 2009: 29, Stern 2006: 67, Potsdam Institute 2012.

[6] For example, PAHO has estimated that the incidence of dengue, another vector-borne disease, has risen in the temperate as well as the tropical zones of the Americas.

[7] Other macro-studies indicate that rapid population growth can constrain economic growth (Galor and Weil 2000; Weil and Wilde 2009), and reduce growth in income per capita (Acemoglu and Johnson 2007). For reviews of studies of the relationship between population and economic growth, see Johnson and Lee (1986: preface); Kelley (1988); and Das Gupta et al (2011).

[8] See for example Jones (1982) on Vietnam, Das Gupta (1995) on India, and the official presentation of the South Korean family planning program made at the IUSSP General Population Conference, Busan August 2013.

[9] Some studies in the developed world also find high fertility is negatively associated with child schooling and female labor-force participation (Black et al 2005; Caceres-Delpiano 2006; Angrist and Evans 1998; Conley and Glauber 2006). Other studies do not find evidence of a quantity-quality trade-off in childbearing (Angrist et al 2010).

[10] Behrman et al 2006; Breierova and Duflo 2004; Osili and Long 2008.

[11] Zimbabwe offers an example of rapid fertility decline with strong political will, but it was not a poor country at the time.