GENI Global Energy Network Institute

The Population Picture

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Abstract

The human population of planet Earth has been steadily increasing since our species' emergence almost 200,000 years ago. The technological advances that accompanied the agricultural and more recent industrial revolutions allowed for the explosive population growth that began in the 20th century and has carried our numbers to almost 7 billion today. An overview of past and current growth trends is provided here, as well as forecasts for future growth based on these trends. The current population explosions in developing and some developed regions can be attributed to inadequate access to birth control, large desired family size, and other social factors that vary over time and space. These factors are explored with a look at what the densely inhabited Earth of the future may be like if solutions to overpopulation are not actively pursued. Proposed solutions for slowing and eventually capping growth rates take inspiration from successful fertility reduction efforts implemented in the past. The case for a global energy network is solidified with data provided to support a positive correlation between electrification and decreased fertility.

I. Introduction

IN A TIME WHEN almost every aspect of our planet's health is under inspection, it is baffling how frequently discussions surrounding the number of its most influential inhabitants, 7 Billion strong in October of 2011, and the role those numbers will play in its future is omitted. In the year 2011, there is worldwide concern for everything from the stress on world fisheries that supply huge amounts of food to people everywhere, to mass deforestation of rainforests that are home to over 50% of unique species, to rising global temperatures that may result in multitudes of devastating global changes in the next fifty years. It would be difficult to pick out a single issue under the "environmental" wingspan that didn't stem from the problem of too many people using too much. So do we focus on fixing the population problem or the consumption and waste problems? The answer to that should be a combination of both. The two are interconnected in such a manner that one cannot be resolved without resolution of the other.

As a race, we humans have been increasingly aware of the dreary trajectory that we have been on since the industrial revolution allowed for explosive growth in population size and resource consumption. Wheels are turning in many regions of the world to begin the grueling path towards rectifying the consumption and waste problem. This is a huge task encompassing monster long-term projects - like the transition to renewable resource use and decreasing global CO_2 emissions and to smaller scale regional projects like local recycling promotion. To say we humans have *'a'* consumption and waste problem is misleading. That implies that there is *'a'* 'solution. There are infinite factors in our consumption and waste problem, and, therefore, infinite avenues to pursue. While the population side of the problem is tremendously complex, the bottom line is simpler. More people consume and waste more. Fewer people consume and waste less. Building a sustainable world *will* be more difficult with more people. In many nations and regions, gains made in efficiency and conservation will be negated by population growth. The consumption and waste problem will be an exponentially larger beast to tackle with an exponentially larger population in the near and distant future. Taking steps now to ensure reduction and stabilization of global fertility will only begin to alleviate the already pounding pressure to change our ways.

Understanding the implications of a growing population on a finite planet is the first step towards achieving a global movement towards population stabilization and potential reduction in the future. This is a problem that is in the hands of the people. Getting the will of the human race behind a change is the only way to achieve the change without force. But this change must happen and must happen soon. Ideally, solutions like those outlined in this paper can be implemented successfully, before strict regulations like those enforced in certain countries in the past must be put in place globally. But the priority should lie in the result, not the means. Those with concern about man's right to a peaceful existence should remember this: A world where 8 billion to 10 billion people are competing for diminishing resources *will not* be a peaceful one.

2. The Population of Planet Earth

2.1 Current Population Size

In mid-2011, the US Census Bureau estimates that the World population sits at roughly 6.93 billion people. Demographics, distribution, birth rates and death rates vary widely across the globe, but one trend remains largely intact: This number is growing in most regions. With a global growth rate of 1.19%, that means that 2.4 new people are born every second. With a global death rate of only 1.78 deaths per second, this translates to an annual increase of over 76 million people per year.[1]

To consider the populations of individual regions, countries are grouped here into six major geographical areas: Africa, Asia, Europe, Latin America and the Caribbean, Northern America, and Oceania. As a classification method, regions can be categorized as more or less developed. Of the six, the more developed regions include Europe, Northern America, Australia/New Zealand of the Oceania region, and Japan of the Asian region. Less developed regions include Africa, Latin America and the Caribbean, Asia (excluding Japan), and Oceania (excluding Australia/New Zealand).[2]

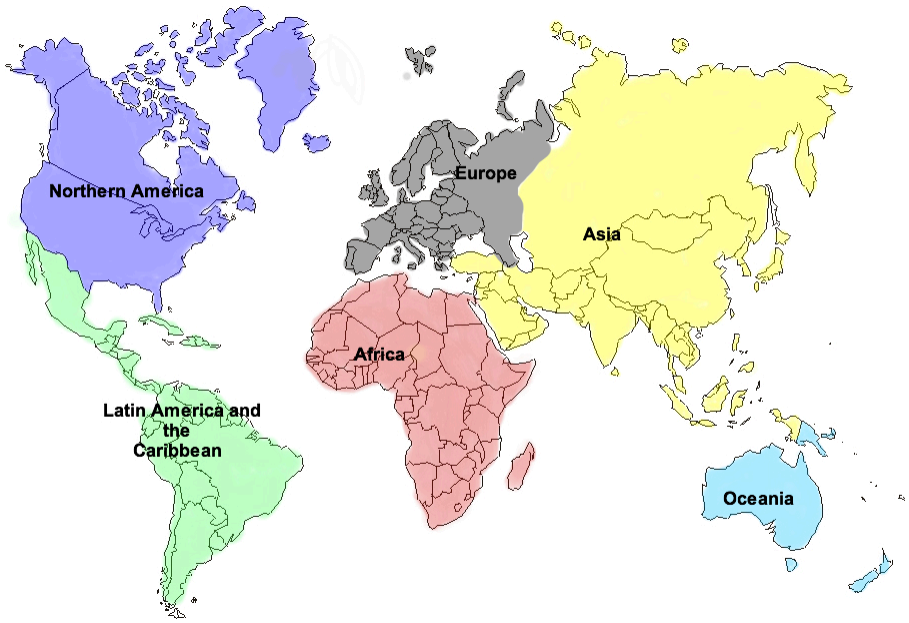


Figure 1. Earth's Geographical Regions
The six major geographical regions of the Earth, as defined by the United Nations: Northern America, Latin America and the Caribbean, Europe, Africa, Asia, and Oceania[2]

1. "World Development Indicators", World Bank Group. 2011. http://data.worldbank.org/data-catalog/world-development-indicators
2. "World Population to 2300", United Nations Department of Economic and Social Affairs, Population Division. 2004. http://www.un.org/esa/population/publications/longrange2/WorldPop2300final.pdf

In the year 2010, Asia tops the world population tally with an estimated 4.17 billion inhabitants. This should come as no surprise considering that the region contains the two most populous countries on the planet, China and India (the third being the United States), and makes up almost 30% of the planet's land area-[3] more than any other region. In second place after Asia is Africa with 1.03 billion, followed by Europe with 732.76 million, then by Latin America and the Caribbean with 588.65 million, then Northern America with 351.66 million, and lastly Oceania with 35.84 million.[4]

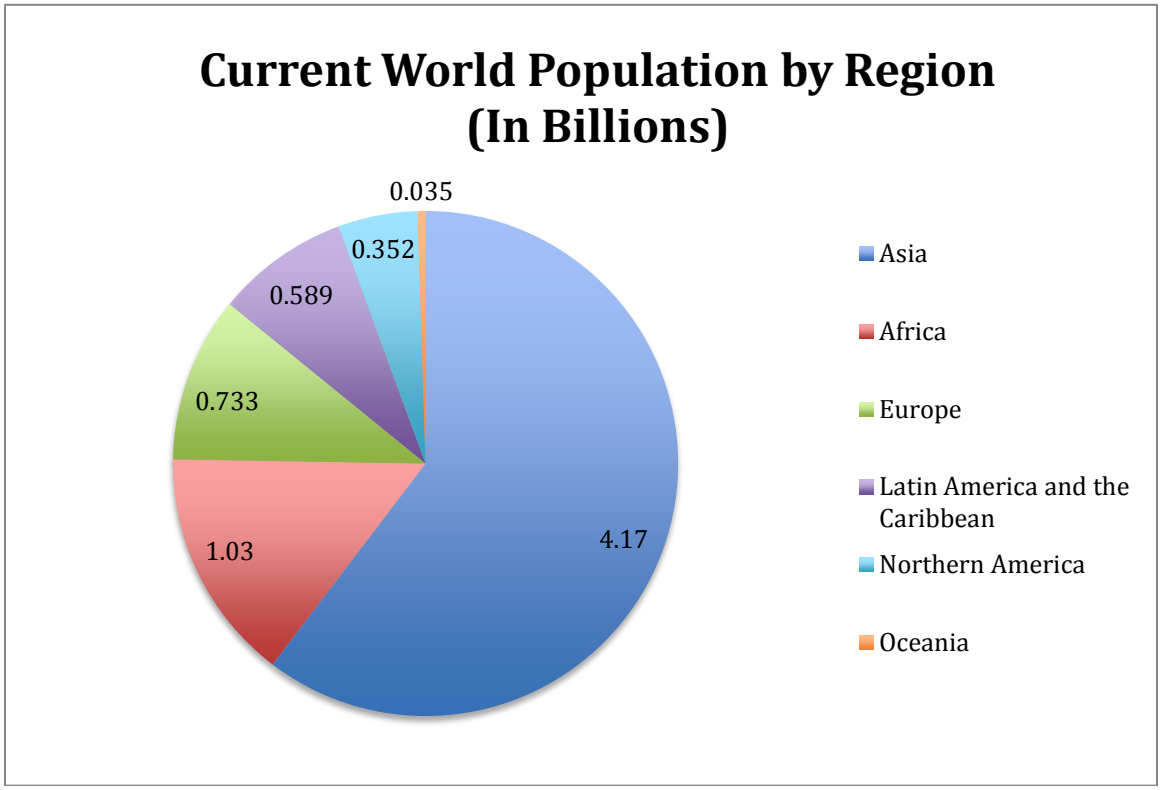


Figure 2. Current World Populations by United Nation's defined Region (in Billions)
Asia alone is home to roughly 61 percent of the human population and contains the two most populous countries, China and India. The only other region to surpass the 1 billion-citizen mark is Africa, which lies at just above 1 billion. [4]

3. Asia Geography Notes, The World Atlas. 2010. http://www.worldatlas.com/webimage/countrys/as.htm
4. "World Population Prospects: The 2006 Revision" and "World Urbanization Prospects: The 2007 Revision", Population Division of the Department of Economic and Social Affairs and the United Nations Secretariat. http://esa.un.org/unup

Human population growth over recorded history has followed an exponential growth curve. Between 10,000 BC and AD 1, the population went from somewhere below 10 million to roughly 250 million. This number doubled over the next 1500 years. It took only 300 years for it to double again and reach 1 billion. The last 200 years saw a population explosion that took us from the 1 billion mark in 1800 to over 6 billion in the year 2000, with more than half of that growth occurring between 1960 and now.[5]

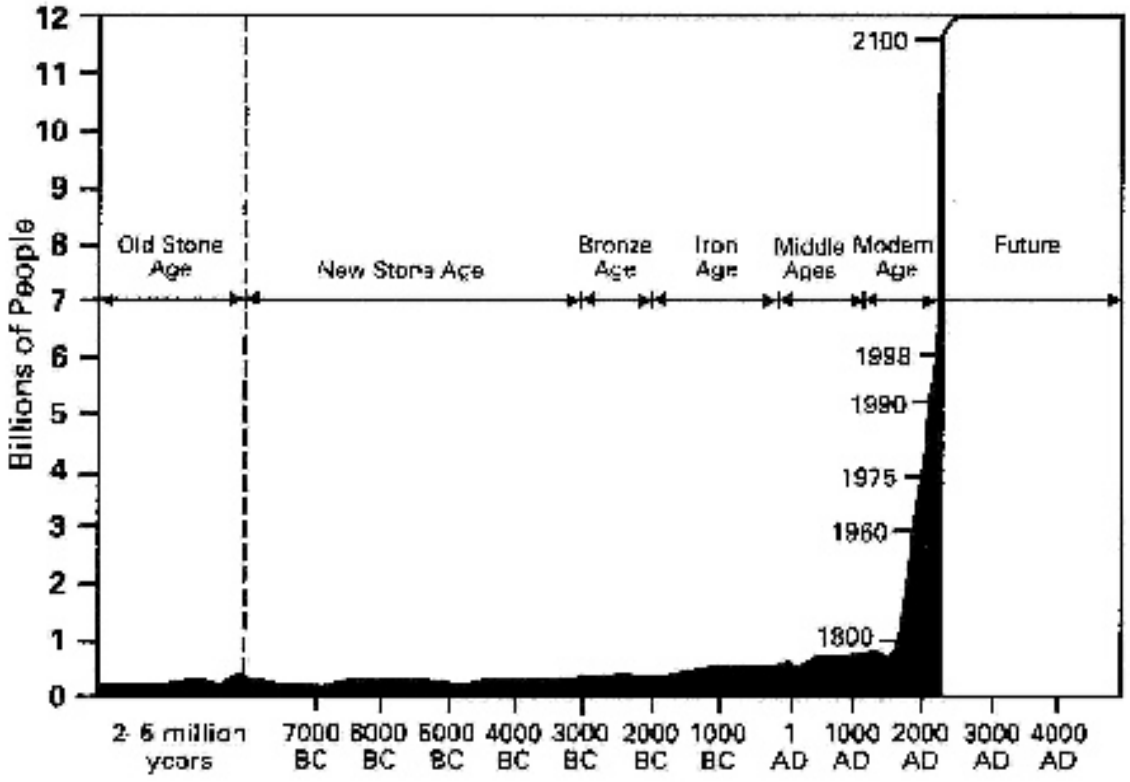


Figure 3. World Population Throughout History
World population does not reach the 1 billion mark until just before AD 1800. Growth skyrocketed to add another 5 billion by AD 2000 and is expected to continue growing at an accelerating rate for the next 50-100 years. The exponential curve observed lasts for roughly 250 years.[6]

2.2 Growth Rates

Fertility is defined as number of children born per woman. Expressed as a rate, this represents the average number of children born per woman of a population over her lifetime if she were to experience the age specific fertility rate for the region and she were to survive through her reproductive years. The global fertility rate in 2011 is roughly 2.46.[7] A more useful unit of measure for these purposes is the growth rate, which is calculated by subtracting the crude death rate from the crude birth rate of a given region. Because life expectancy, infant mortality, and other variables differ widely across the

5. Cohen, Joel E. Lecture Notes, Laboratory of Populations. Rockefeller and Columbia Universities, New York. 2005. http://www.earth.columbia.edu/events/2005/documents/PDFCohen.pdf
6. McFall Jr., Joseph A. *Population, A Lively Introduction*, Population Bulletin, Volume 46, Number 2, October 1991, Pages 3-43. Population Reference Bureau, Washington, D.C. http://www.prb.org/pdf07/62.1LivelyIntroduction.pdf

world, reporting growth rates can give a more accurate portrayal of a region's population picture as they express these factors. Currently, the global growth rate is 1.092%, which translates to a doubling time of roughly 64 years, assuming that we're at a fixed rate.[8]

Replacement fertility is the number of children born per woman that would result in no net change of the human population. Because the global male:female ratio is so near 1:1, replacement fertility would lie at 2 children per woman were all offspring to survive through their reproductive years. Since this is not the case, replacement fertility always lies above 2. Growth rates are declining worldwide, but they are far from reaching zero. As long as the rate is positive, the population is growing. With a current global fertility rate of 2.46, and replacement fertility closer to an estimated 2.1, there is plenty of room for improvement. Rejoicing in the decline of birthrates is warranted, but no excuse to cease efforts in the push towards replacement level fertility.[8]

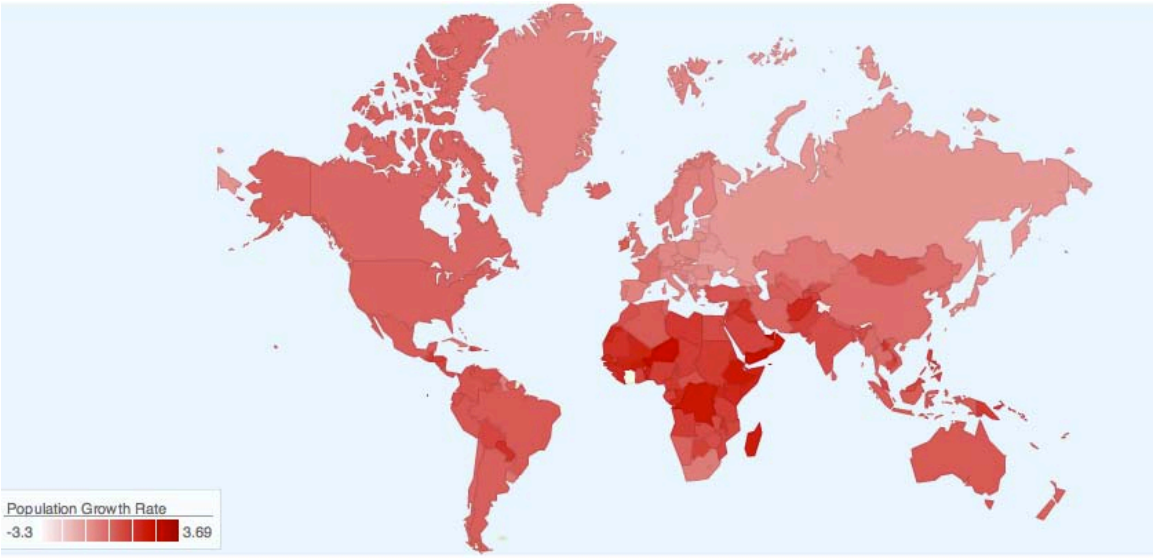


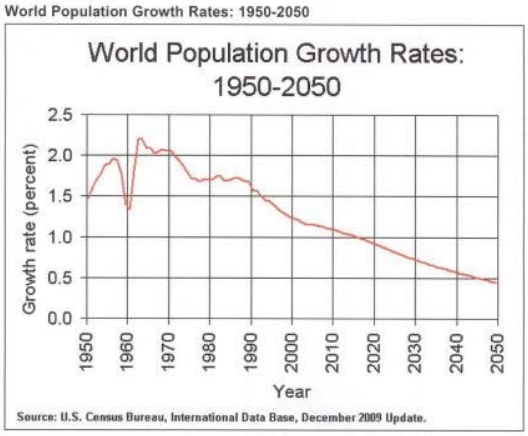
Fig 4. Population Growth Rates by Country
This figure, generated in 2011, shows average population growth rates for the year. The deeper shades of red correspond to higher growth rates. Growth rates decrease with lessening color intensity. Few countries, mostly European, have growth rates below zero. Countries with the highest growth rates are concentrated in Africa and the Middle East. It is not uncommon at this time for the more quickly growing countries to have growth rates above 3 percent.[9, 10]

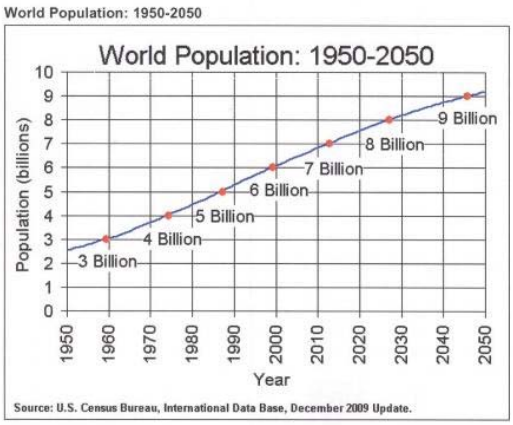
7. The World Factbook, Central Intelligence Agency. May 26, 2011. https://www.cia.gov/library/publications/the-world-factbook/geos/xx.html
8. World Bank Group, Social Modules. 2011. http://www.worldbank.org/depweb/english/modules/social/pgr
9. The World Factbook, ISSN 1553-8133, Central Intelligence Agency, August 2009. http://www.cia.gov/library/publications/the-world-factbook/index.html
10. ChartsBin Statistics collector team, Current World Population Growth Rate, June 10, 2011. http://chartbin.com/view/xr6

2.3 Projections to 2050

As countries transition to different states of economic development, resource use; availability of medicine; electricity availability; and many other factors fluctuate. Growth rates per region are in constant oscillation. But these rates tend to follow comprehensible trends and can, therefore, be used to predict population sizes and demographic trends in the future.

According to the United Nation's most recent estimates, world population is projected to increase from 6.1 billion in 2000 to approximately 8.9 billion in 2050. While the average annual growth rate of 0.77 percent over this time period is less than half of the average growth rate of 1.76 percent for the previous 50 year stretch from 1950 to 2000, it will still result in a 47 percent population increase.[11] Were growth patterns to continue on the same exponential trajectory that the latter half of the twentieth century saw, the human population would quickly reach staggering numbers that nobody could argue to be sustainable. Fortunately, a multitude of factors consistently contribute to shrinking growth rates. Were the current international growth rate of roughly 1.2 percent to remain for the next 50 years, the population in 2060 would be 12.4 billion: a 3.5 billion increase from the UN's projected 8.9 billion at that time. This deficit between the projection based on the current growth rate and the UN's much smaller projection is due to assumed continued decreases in the international growth rate. But the "assumed" decreases depend on active efforts in the global movement towards population stabilization. These include family planning efforts, rural electrification, and female education, alongside current trends expected to extend over this time period. Using language such as "assumed" may lead people to believe birth rate decreases are a passive element of the future demographic trends. This is not the case. There is, alternatively, assumed *activism*. It is crucial that activism in working methods aimed at population stabilization only rise in priority for humans.





Figures 5, 6. World population growth rates and population growth projections to 2050
Both figures report data up to 2009 and projections to 2050. The first graph depicts declining growth rates up to and through 2050 but as the second figure shows, the decline in growth rates still results in large population growth as the declining rate is still above zero.[12]

11. "World Population to 2300," United Nations Department of Economic and Social Affairs, Population Division. 2004.

As shown in Figure 7, the twentieth century was expected to be the last in which more people live in rural than in urban environments. In 2010, it was estimated that 50.6% of people lived in urban areas, leaving the remaining 49.4% in rural settings.[13] By 2015, an estimated 6 out of 7 (85.7%) people will reside in developing countries, up from 4 out of 5 (80%) in 1998. More developed regions hold 75% of their populations in urban areas, while the same measurement in less developed regions is only 45.3%. By 2050, these numbers are projected to change dramatically. Forty years from now, the proportion of people living in urban areas in more developed regions may jump to a proportion near 86%. More striking is the potential increase to 67% of those living in urban areas in less developed regions.[14] This is an important distinction to make because people living in urban areas tend to consume resources and produce waste more rapidly than those living in rural areas. Increasing urbanization will also play a role in the future growth rate decreases, as fertility rates tend to decline from rural to urban areas (due to factors such as heightened availability of contraceptives and education in urban regions).

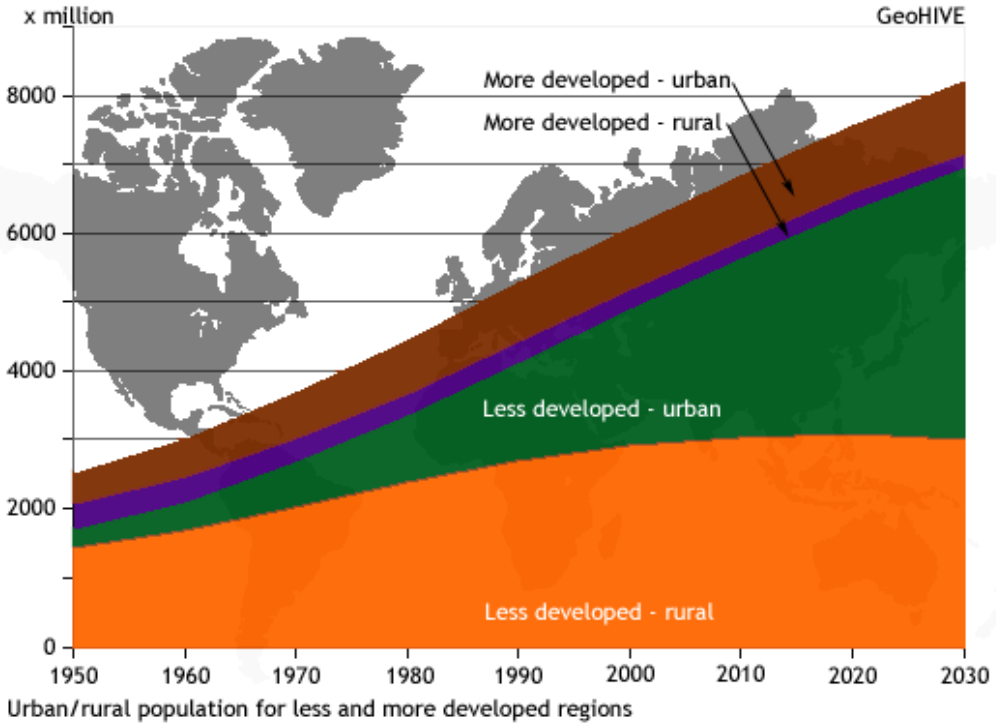


Figure 7. Urban vs. Rural Population Distributions to 2030
Population growth is relatively small in more developed urban regions and actually declines slightly in more and less developed rural regions. The substantial growth projected to occur to 2030 and through 2050, as data suggests, occurs mostly in less developed urban regions. For the first time in recorded history, just before 2010, more people resided in urban than rural regions.[15]

12. U.S. Census Bureau, International Data Base, June 2011 Update. http://www.census.gov/population/international/data/idb/worldpopgraph.php
13. U.S. Census Bureau, Geography Division and Geographic Standards and Criteria Branch, August 17, 2010. http://www.census.gov/geo/www/ua/2010urbanruralclass.html
14. Cohen, Joel E. "World Population in 2050: Assessing the Projections". May 2010. http://www.bos.frb.org/economic/conf/conf46/conf46d1.pdf
15. "World Population Prospects: The 2004 Revision and World Urbanization Prospects: The 2003 Revision." United Nations Population Division. http://geohive.com/earth/pop_rururb.aspx

It is estimated that 95% of growth up to 2050 will occur in the swiftly expanding metropolitan centers of developing countries. There are upsides and downsides to this. Because of the decline in fertility for urban areas, these population explosions will be accompanied by declines in birth rates. The populations will continue to grow exponentially, but the growth rate will decrease until eventually they approach replacement levels. For most rapidly expanding developing regions, this is not expected to happen until after 2075,[16] but will play a crucial role in the stabilization of the global population anticipated to occur around the same time. But, the capacity for a rise in resource consumption and waste production due to this rapid development up until that time is a huge cause for concern. Smart development of these quickly growing regions is the only hope for a future where the world in 2050 can sustain populations of the sizes foreseen.[17]

Figure 8. Photograph of slums in Mumbai, India.[18]
As one of Mumbai's most notoriously crowded districts, the Dharavi slums are home to more than a million people. In a place where more than 18,000 people crowd into an acre, it is not uncommon for people to walk miles to reach clean water despite being urban residents. Poverty stricken regions like this are quickly popping up all around the world's rapidly expanding metropolitan centers in poor countries. With growth in such areas occurring at a pace far speedier than anyone can keep up with, the lack of electricity, clean water, sanitation efforts, and other necessities makes life as a slum-dweller near miserable.

16. "World Population to 2300", United Nations Department of Economic and Social Affairs, Population Division. 2004. http://www.un.org/esa/population/publications/longrange2/WorldPop2300final.pdf
17. Cohen, Joel E. Lecture Notes, Laboratory of Populations. Rockefeller and Columbia Universities, New York. 2005. http://www.earth.columbia.edu/events/2005/documents/PDFCohen.pdf
18. Newell, Joel. "Mumbai Slums", 2007. http://www.panoramio.com/photo/1526900

Figure 9. This young girl is a third generation resident of Mumbai's Dharavi slums.[19]
This one meter wide lane is commonplace in a region with people packed too tightly for even rickshaws to fit on the streets.[20]

2.4 Projections to 2300

Making projections as far into the future as 2300 involves analyzing previous trends and behaviors and combining that information with the extension of current patterns to create a "plausible scenario" forecast that can be taken as no more than that. These are projections, not predictions. The United Nation's Report "Population Projections to 2300" provides multiple outcomes based on low, medium, and high levels of possible fertility through those times. Numbers reported here will assume the medium scenario fertility for simplicity's sake. It must also be noted that the medium fertility scenario has been cited as "most likely" by many critics. Reports such as this provide a framework on which to base choices now.

World population is assumed to vary only minutely after reaching the 8.92 billion mark in 2050. It is projected to peak around 9.2 billion in 2075, growing only 3.4 percent in that time, dip to 8.43 billion by 2175, and rise gradually to stabilize around 8.97 before and through 2300.[21]

19. Bendiksen, Jonas. Photographer for National Geographic. 2007. http://ngm.nationalgeographic.com/2007/05/dharavi-mumbai-slum/jacobson-text
20. Jacobson, Mark. "Mumbai's Shadow City", *National Geographic.* July 2011. http://ngm.nationalgeographic.com/2007/05/dharavi-mumbai-slum/jacobson-text
21. "World Population to 2300", United Nations Department of Economic and Social Affairs, Population Division. 2004. http://www.un.org/esa/population/publications/longrange2/WorldPop2300final.pdf

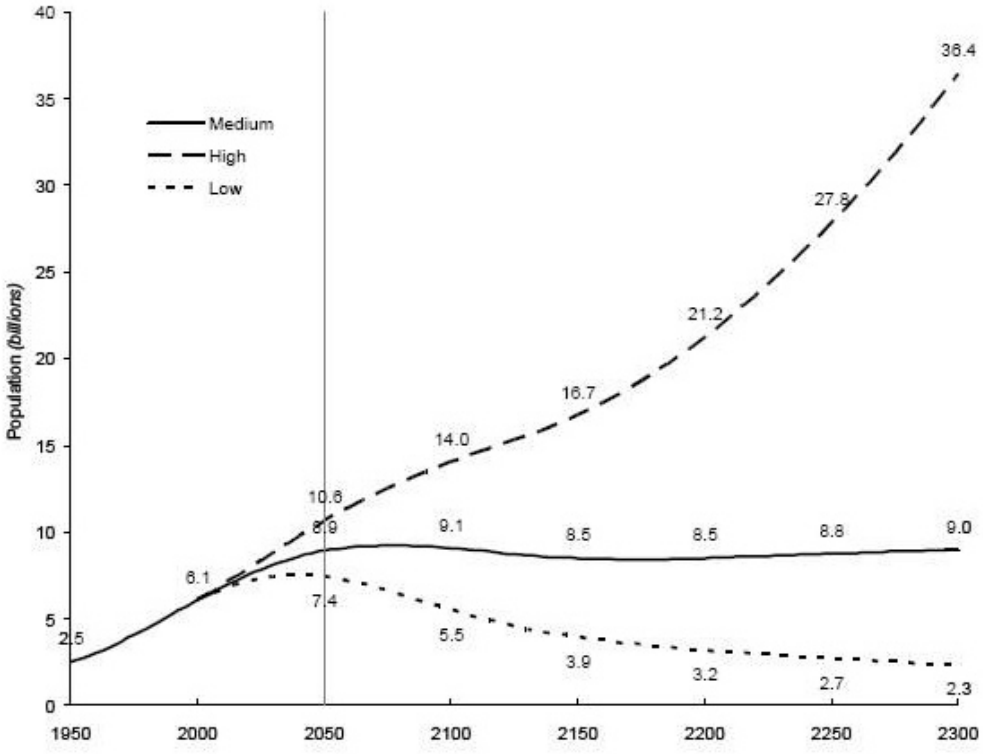


Figure 10.[22] Population Projections to 2300
The United Nations reports low, medium, and high variant projections of population growth to 2300. The variance in projections depends on low, medium and high levels of fertility assumed for the future, with the medium variant cited as most likely. In the medium projection, represented by the solid line in the figure, population peaks around 2075 at 9.2 billion and dips slightly after to stabilize at 8.97 billion before and through 2300.[22]

3. Demographic Trends

Demographic studies are designed to identify trends in the subject population's fertility and mortality, migration, geographic distribution, and composition. Hypotheses can be made about a population's future size, composition, etc. based on trends identified now and in the past.[23] Here, fertility and population composition of developed and undeveloped regions are examined.

3.1 Population Stabilization

Population growth stabilizes when birth rates are equal to death rates. At this point in time, replacement fertility rates are near 2.1 for developed, and closer to 2.3 for less

22. "World Population to 2300", United Nations Department of Economic and Social Affairs, Population Division. 2004. http://www.un.org/esa/population/publications/longrange2/WorldPop2300final.pdf
23. Hobbs, Frank and Stoops, Nicole. *Demographic Trends in the 20th Century,* U.S. Census Bureau, Census 2000 Special Reports, Series CENSR-4, U.S. Government Printing Office, Washington DC, 2002. http://www.census.gov/prod/2002pubs/censr-4.pdf

developed countries. If all children born reached child-bearing age and reproduced, global replacement fertility would always lie at 2 per woman assuming that the male: female ratio were to also stay at 1:1, but because all children do not reach maturity (less so in developing countries, hence the 0.2 increase in replacement rate) and have their own offspring, and because not all choose or are able to produce offspring, replacement fertility rates lie above 2.[24]

Currently, most developed regions are generally experiencing little to no population growth with the majority of growth happening in developing regions. Things begin to change with the availability of medical care and electricity that accompany economic growth. This commonly results in a decrease in infant mortality and an increase in average lifespan, phenomena that are occurring in many regions like Sub-Saharan Africa and territories in India. In developed countries, where access to these amenities have long since been established, birth rates tend to be similar to death rates and population growth is now, or has long since been, near stable. In developing countries, the decrease in birth rates tends to lag many years behind the decrease in death rates, resulting in huge population growth before the two begin to equalize and approach replacement.

3.2 Age Structure and the Demographic Window

Countries transitioning into heightened states of economic development must also go through a demographic transition before fertility rates decline. The age structure in countries with high fertility rates reflect large numbers of people in child-bearing age and younger, which will result in added years of relatively high fertility rates as the younger populations reach child-bearing age. During the point at which birth rates start to fall, the age pyramid becomes less bottom heavy as the proportion of younger people shrinks. Gradually, the population enters what is called the demographic window.[25] This is the stage in which the proportion of the population of working age is prominent. The UN population Department states that at least 65 percent of a country's population must be between 15 and 65 years of age for it to be considered within the 'demographic window.[26] During these times, the proportion of non-working citizens that depend on others for financial support is relatively low. This is known as the level of dependency. Low levels of dependency are correlated with high economic growth as more earned capital is invested in the society's economy. Most developed nations are currently in their demographic window, a period that typically lasts 30-40 years before an aging population

24. Rosenburg, Matt. "Total Fertility Rate", About.com. May 5, 2010. http://geography.about.com/od/populationgeography/a/fertilityrate.htm
25. Spoorenberg, Thomas. "The Demographic Window, Development, and Population Policy Implications in Mongolia", Laboratory of Demography and Family Studies, University of Geneva & Population Teaching and Research Center, National University of Mongolia. ACMS Speaker Series, November 8, 2007. http://www.mongoliacenter.org/docs/2007/spoorenberg_abstract.pdf
26. Bloom, David E., David Canning, and Jaypee Sevilla, "The Demographic Dividend: A New Perspective on the Economic Consequences of Population Change". RAND, 2003. http://www.rand.org/pubs/monograph_reports/2007/MR1274.pdf

again tips the scales back towards a heightened dependency ratio and decreasing economic growth. But nations do not typically begin the cycle again with increasing birth rates. Instead, sustained lowered birth rates typically follow. India was expected to enter the demographic window in 2010. China has been in its demographic window since 1990. Much of Africa will not enter the demographic window until 2045, at the earliest.[27] The sooner developing countries experiencing explosive growth can achieve the lowered birth rates associated with this demographic transition, the better. This can be encouraged by continuing to support and build family planning programs, and by promoting sustainable economic projects that may not only ensure a future of economic prosperity, but also aid in smarter development within these regions.

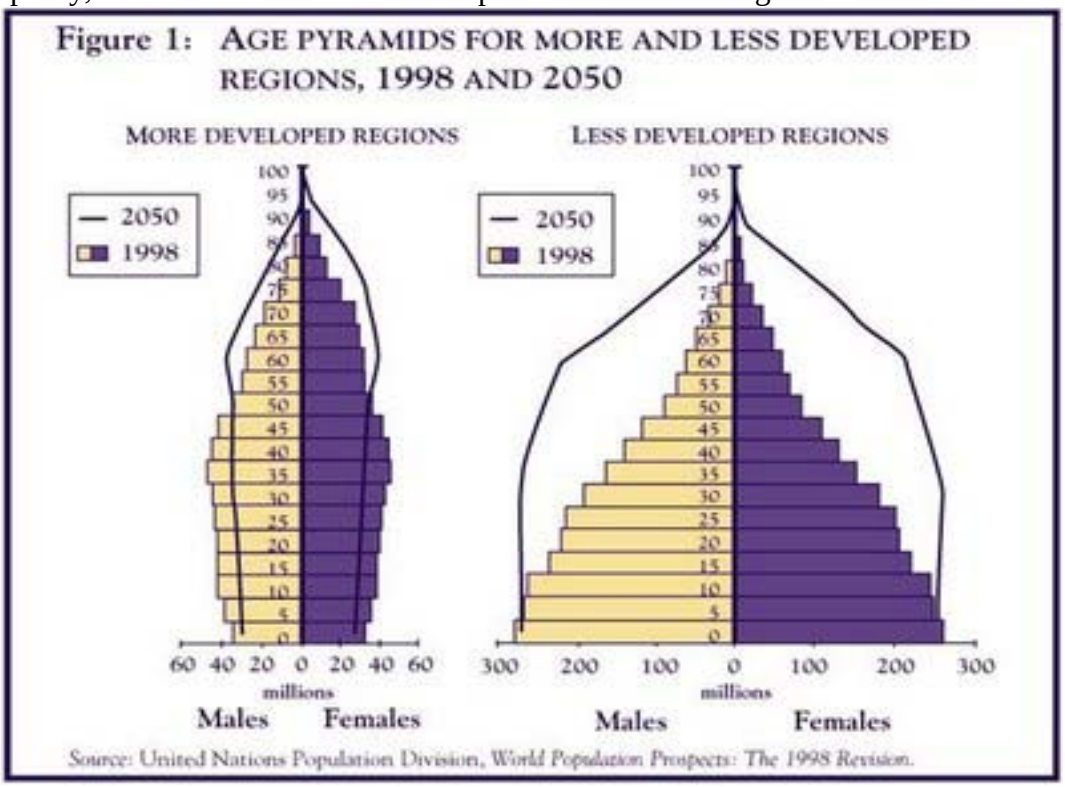


Figure 11.[28] Age Pyramids for More and Less Developed Regions, 1998 and 2050
More developed regions have generally been in or recently out of their demographic window period as of 2010. Here, the age pyramid in 1998 for more developed regions shows that the majority of the population is of working age, while the proportion of older (above 65) and younger (below 15) is small. By 2050, as birth rates stay low, the aging population results in a large proportion of the population beyond working age. At this point, developed regions, as a whole, have left the demographic window. Less Developed regions in 1998 are pre-demographic window, with the largest proportion of the population under 15. Population will continue to grow for these regions as the young populations enter

27. Spoorenberg, Thomas. "The Demographic Window, Development, and Population Policy Implications in Mongolia", Laboratory of Demography and Family Studies, University of Geneva & Population Teaching and Research Center, National University of Mongolia. ACMS Speaker Series, November 8, 2007. http://www.mongoliacenter.org/docs/2007/spoorenberg_abstract.pdf
28. "World Population Prospects: The 1998 Revision", United Nations Population Division. http://minterdial.com/2008/07/heir-hunters-or-probate-genealogists-and-aging-octogenarians/

childbearing age. By 2050, less developed regions as a whole will be close to entering the demographic window as the large increase in younger populations years before will enter working age. Economic growth associated with nations in the demographic window will contribute to decreases in birth rates in these nations during that time.[29]

The global decline in growth rates can be attributed to declines in fertility rates as countries all over the world experience the side effects of development, and family planning programs gain popularity. But the stall in fertility decline preceding a region's entry into its demographic window can allow for population explosion. The case is such in as many as 15 African countries, where the on-going stall in fertility decline will likely account for a large portion of the projected 2-3 billion person gain in global population over the next 40 years. Fertility decline in many African regions is thought to have considerably slowed in the second part of the 1990s and early 2000s due to a variety of reasons[30]. When considering the design of global family planning practices, countries experiencing an exaggerated latency in fertility decline must be given special attention. It is especially important to make efforts towards speedy declines in fertility in countries where resources are already strained, as are many of those on the African continent.

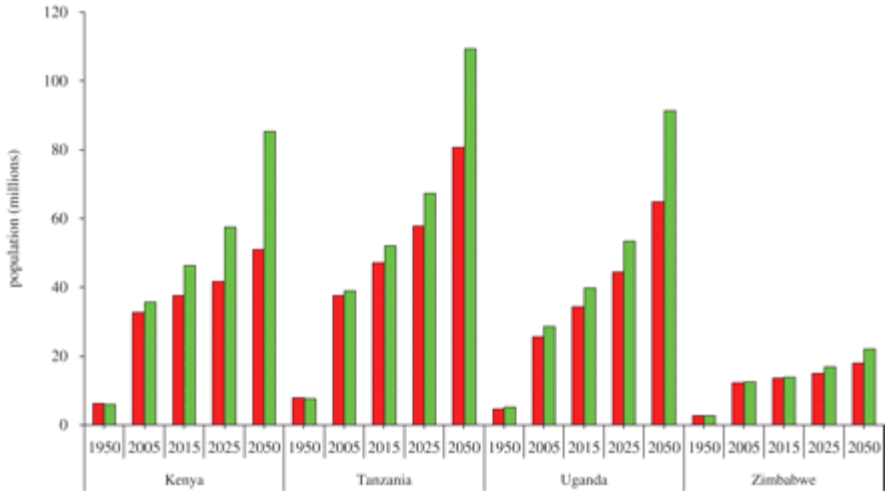


Figure 12.[30] Changes in future population projections in selected African countries before and after the stall in fertility decline (in millions)
Red bars represent projections made in 1998 by the United Nations; green bars represent projections made in a 2008 revision. Due to unforeseen stalls in fertility declines in these and other African regions, the populations of these regions are projected to be substantially larger by 2050 than previously forecasted. Pushing to increase the speed of fertility decline in these regions could spare the addition of millions on these already strained countries.[30]

29. "World Population Prospects: The 1998 Revision", United Nations Population Division. http://minterdial.com/2008/07/heir-hunters-or-probate-genealogists-and-aging-octogenarians/
30. Ezeh, Alex C., Blessing U. Mberu and Jacques O. Emina. "Stall in Fertility Decline in Eastern African Counties: Regional Analysis of Patterns, Determinants, and Implications", Philosophical Transactions of the Royal Society, Biological Sciences. ISSN: 1471-2970. 2011. Http://rstb.royalsocietypublishing.org/content/364/1532/2991.full

4. Why Is the Population Growing?

Many factors contribute to the common trends for birth rates to be much higher in developing countries and higher in some developed countries relative to others. Prevalent trends contributing to quickly growing populations include heightened desire for large family sizes to account for high regional infant mortality rates due to disease as a result of lack of sanitation and medical care or famine, lack of education, lack of female rights, reduced availability of birth control, and others.

4.1 Access to Birth Control

In developed nations, where population growth tends to be a fraction of that in developing nations, availability and use of birth control is commonplace. This is not the case for the planet as a whole. An estimated 215 million women who want to avoid pregnancy worldwide are not using an affective method of contraception. In fact, 40 percent of the 186 million pregnancies that occur in developing countries each year are unintended. This results in about 74.4 million pregnancies per year that were either unwanted, or not wanted at the time.[31] It was estimated that 41% of the world's 208 million pregnancies in 2008 were unintended.[32] Were the family planning needs in developing countries met, unintended pregnancies could be reduced from 74.4 million to 22 million.[31] A UNICEF publication in 1992 stated: "If all women were able to decide how many children to have and when to have them, the rate of population growth would fall about 30%".[33]

31. "Facts on Investing in Family Planning and Maternal and Newborn Health", Guttmacher Institute, New York, NY. November 2010. http://www.guttmacher.org/pubs/FB-AIU-summary.pdf
32. Singh, Sushella, Gilda Sedge and Rubina Hussain, "Studies in Family Planning", The Population Council. Volume 41, Issue 2, pgs. 241-250, December 2010. http://onlinelibrary.wiley.com/doi/10.1111/j.1728-4465.2010.00250.x/abstract
33. Ryerson, William N. *Sixteen Myths About Population*, Population Media Center.

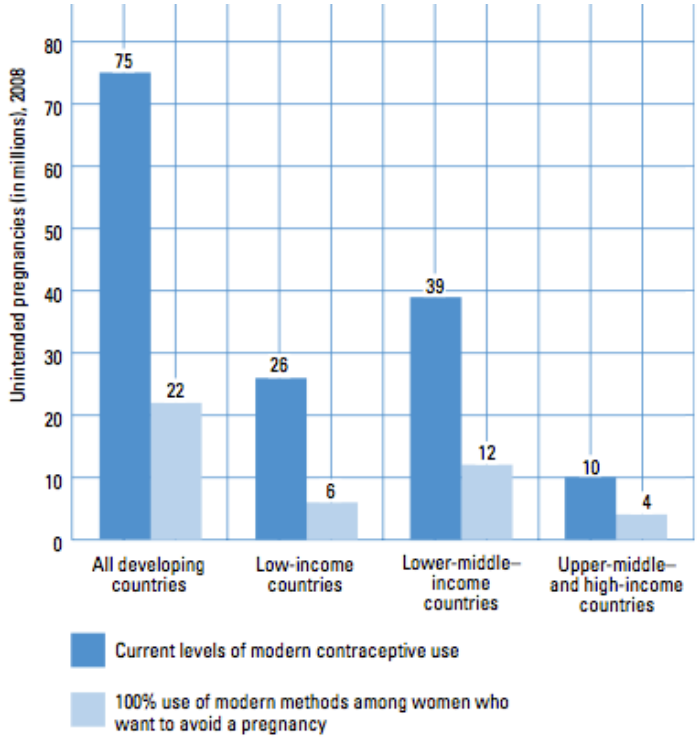


Figure 13.[34] Unintended Pregnancies with Current Levels of Modern Contraceptive Use, and with 100% Use of Modern Contraceptives Among Women Who Want to Avoid Pregnancy
75 million unintended pregnancies in developing countries in 2008 could have been reduced to 22 million had all of the women who wanted to avoid pregnancy been properly using a modern contraceptive[34]

EXAMPLES OF UNMEASURED BENEFITS FOR WOMEN AND FAMILIES	EXAMPLES OF UNMEASURED BENEFITS FOR SOCIETY
▪ Healthy birthspacing and smaller families, which improve women's health[15-21]	▪ Reduced public-sector spending on health services for long-term consequences of mothers' and newborns' ill health[22]
▪ Improved education and status for women[23,24]	▪ Reduced public-sector spending on education, childhood vaccinations, malaria prevention, water and sanitation[25,26]
▪ Improved well-being of families because of mothers' survival[22,27,28]	▪ Reduced transmission of HIV/AIDS from use of male and female condoms[29,30]
▪ Better nutrition and education for children, especially girls[16,25,27,31-33]	▪ Reduced mother-to-child transmission of HIV/AIDS from family planning use among, and recommended care for, women with HIV[29]
▪ Prevention of high-risk pregnancies (i.e., those among teenagers, women older than 35 and women with many children)[18,34]	▪ Improved productivity and higher income; greater savings and investment[27]
▪ Longer time to breast-feed, which improves infant health and survival[17,35-37]	▪ Potential for faster economic growth when the working population has fewer children to support[38,39]
▪ Fewer women suffering from anemia, which is disabling and poses a risk for future births[40-42]	▪ Reduced population pressure on scarce natural resources (e.g., water, forests, arable farmland)[43-46]
▪ Reduced suffering and stigma due to fistula, infertility and other reproductive health problems[22,27,41,47,48]	▪ Greater equality between men and women[27,49]
▪ More of parents' time and income allocated to each child[27]	▪ Less discrimination against girls[9,11,27]

Figure 14. Unmeasured benefits of meeting the unmet need for family planning services.
This table includes some of the positive social, economic, environmental and demographic impacts that the modern contraceptives, female education, and other elements of comprehensive family planning services could provide. Many factors other than decreased birth rates are positively influenced when people are able to avoid unwanted and unhealthy pregnancies.[35]

34. "Facts on Investing in Family Planning and Maternal and Newborn Health", Guttmacher Institute, New York, NY. November 2010. http://www.guttmacher.org/pubs/FB-AIU-summary.pdf
35. "Adding It Up 2009", The Guttmacher Institute, Special Analyses, 2009. http://www.guttmacher.org/pubs/AddingItUp2009.pdf

4.2 Desired Family Size

Family planning efforts have been in effect in many developing regions for varying amounts of time, with most achieving dramatic drops in their region's birth rates. But availability of contraception is not the only variable in the family size equation. *Desired* family size is a woman's preference that changes across landscapes, depending on the social and cultural backdrop that she calls home. There are many trends that play roles in determining birth rates per region, but these trends do not always transcend borders. To implement a global plan for population stabilization, determining which trends hold true worldwide and developing strategies that operate along those lines will be crucial.

Figure 15.[36] Rural African Farming Family
For African farmers, big families are a result of more than just a lack of birth control. They are status symbols, as well as "insurance policies." Parents desire large families to help in the fields, provide financial support when they can earn their own incomes, and account for the high probability of some of their young not making it to adulthood.

In poor countries, where modern medicine and sanitation efforts have yet to spread, infant mortality tends to be high and average life spans tend to be relatively short. It is commonplace for women in these countries to have more children to account for the heightened probability of early death of these children. Family sizes tend to be much larger in developing countries where more people earn a living in a non-industrial setting. Says Indian scholar Warkatul Akmam in an article pertaining to women's education and fertility rates, "*Demand for children is affected by four principal classes of factors: direct economic costs and benefits of children, costs with regard to time, income and wealth, and preferences and norms. Modernization has implications for all the factors mentioned above. With modernization, the costs (economic and time) of children increase, the benefits decrease and preferences and norms change. Money tends to be used for the purchase of consumer goods rather than for having and raising more children*".[37] As developing countries move into states of greater economic development, family sizes tend to decrease for these reasons.

36. Invisible Children, March 2010. http://blog.invisiblechildren.com/2010/03/africa-underpopulated-ugandas-pop-will-tripple-in-30-years/
37. Akmam, Warkatul, "Women's Education and Fertility Rates in Developing Countries, with Special Reference to Bangladesh", University of Rajshahi, Bangladesh, Eubios Journal of Asian and International Bioethics 12, 2002. http://www.eubios.info/EJ124/ej124i.htm

4.3 Female Education

The positive correlation between female education and decreased fertility is a result of a multitude of factors. Most of these are influenced by the extent of the woman's autonomy, which can be considered a product of education. This autonomy can be established via the gain of knowledge, which likely includes some exposure to the modern world, the progression of decision-making ability, the interaction with a wider social circle, the acquisition of skills that may allow them to work outside the home, and an emotional autonomy that may increase their level of self-worth.[38] Continued education may also substantially delay the age of women's first marriages, decreasing the number of child bearing years. It has also been associated with greater numbers of women not marrying at all, in which cases the number of children they are likely to bear sharply decreases.[39]

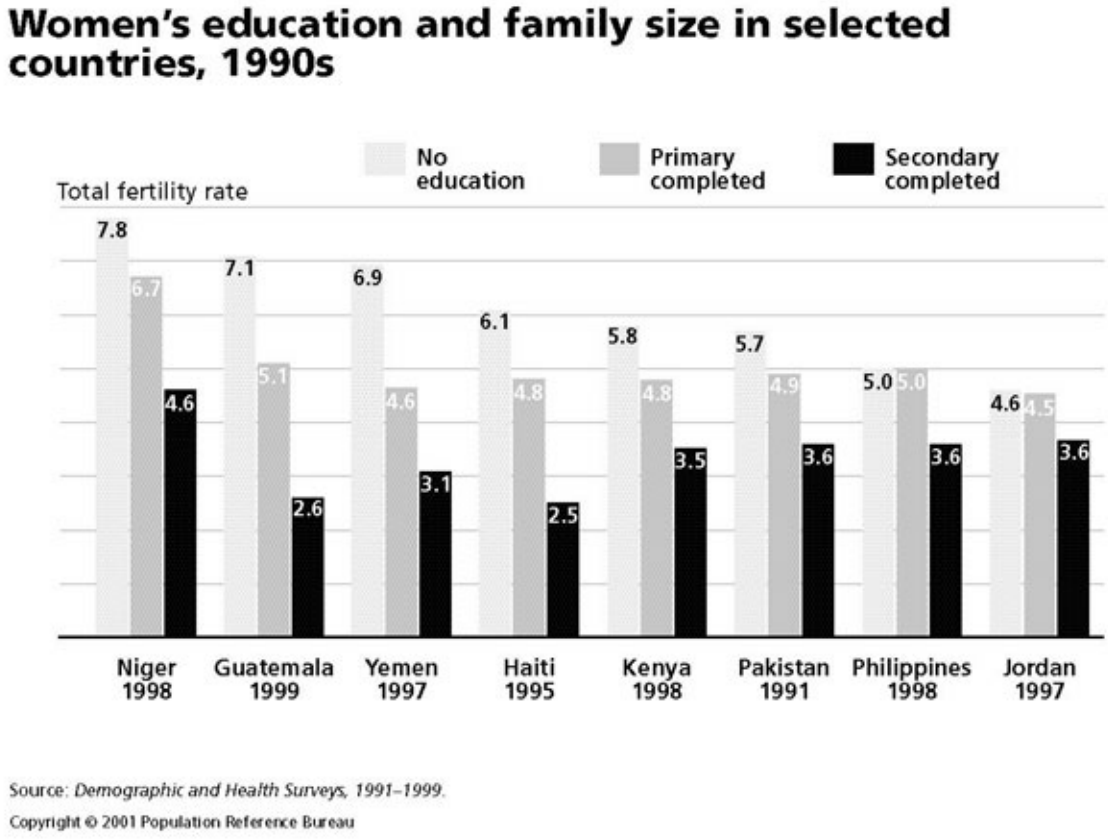


Figure 16.[40] The relationship between fertility and women's education
A study of female education in relationship to family size in 8 developing countries in the 1990's

38. Jejeebhoy, Shireen J. *Women's Education, Autonomy, and Reproduction Behavior: Experience from Developing Countries*, Pg. 13 Oxford: Clarendon Press, 1995.
39. "Women's Education and Fertility Behavior", United Nations. Department for Economic and Social Information and Policy Analysis, Population Division. Pg. 46. New York: United Nations. 2010.
40. *Demographic and Health Surveys, 1991-1999*, Population Reference Bureau, 2001. http://www.prb.org/Educators/TeachersGuides/HumanPopulation/Women.aspx

portrays a notable trend in the decrease of fertility with higher education. In all cases, total fertility takes substantial decreases with higher levels of schooling. The autonomy that frequently accompanies more educated female lifestyles can be greatly credited in this correlation.[41]

4.4 Other Social Factors

The 1990 Demographic and Health Survey found that in Nigeria, Africa's largest country, over half of the women questioned about their ideal family size responded by saying *"It is up to God."* These are women who do not use contraception and are not wishing to use contraception.[42] Many of the world's religions set up their followers to shun birth control methods, as many teachings include denying people the right to decide how many children to have. Many works have been published which examine the relationships between world religions and birth control practices and mentalities, often citing the frequency of birth control prohibition and discouragement included in the teachings of many major religions.[43,44,45] Another common theme in developing countries with gender-stratified societies like those in much of Sub-Saharan Africa, where the fertility rate was at 5.1 in 2008[46] is 'son preference.' If a couple desires to have two living sons, they will end up having on average 3.9 children.[42]

4.5 Overpopulation Trumps Development

As referenced above, people tend to have fewer offspring for both economic and social reasons in more developed countries. The 'catch 22' lies in the fact that overpopulation tends to severely slow economic development. This positive feedback loop keeps developing regions from reaching the higher economic state that supports population stabilization. The poor countries where rapid population growth is occurring are the ones least able to support their numbers. As under-developed societies scramble to provide food, medical care, and other resources to quickly growing populations, the money devoted to economic development in wealthier countries is unavailable. Large numbers of children dependent on each working adult leaves little income available at the personal and national level to form investment capital. Without investment capital, economies are depressed, unemployment is high, and the country is unable to devote money to education, government, and other areas that tend to contribute to long-term economic productivity.[39] The transition towards a higher state of development is heavily impeded,

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41. "Demographic and Health Surveys, 1991-1999", Population Reference Bureau, 2001. http://www.prb.org/Educators/TeachersGuides/HumanPopulation/Women.aspx
42. Ryerson, William N. *Sixteen Myths About Population*, Population Media Center. http://www.populationpress.org/essays/essay-myths7.html
43. Smith, Janet E. *Humanae Vitae: A Generation Later*, University of Dallas, 1991. http://www.goodmorals.org/smith6.htm
44. Fadl, Abdul. Abortion, Birth Control & Surrogate Parenting: An Islamic Perspective. American Trust Publications, June 1989.
45. Crawford, S. Cromwell. World Religions and Global Ethics, Paragon House, 1989.
46. "The State of the World's Children", United Nations Children's Fund, UN Data. July 14, 2010. http://data.un.org/Data.aspx?d=SOWC&f=inID%A127

resulting in diminished quality of life for its residents, inefficient growth that contributes to environmental harm, and an imbalanced division of resources. The combination of these factors results in a latency in the development of factors that precede diminished family size. Hopeless conflict seems to be the undeniable fate for countries that have tipped the population scale.

It has been argued that increases in population in more developed countries can lead to economic boosts as increases in consumer numbers increases demand for goods. But the real measure of economic welfare is not gross national product or national income. It is per capita income. Societies with huge gaps between the rich and poor may commonly generate large national incomes, but the division of wealth is so off-balance that national revenue may benefit very few. Stimulating increases in gross domestic product by having larger numbers of people buying fewer necessities does not result in healthier economies and societies. The larger populations become, especially in dense urban regions, the more people must depend on larger entities to provide them with life necessities. Available space and resources decline with increasing numbers, disabling people from providing entirely for themselves. Due to streamlined business practices, larger populations become easier to feed, provide electricity, provide goods, etc. Small business is continually stamped out by big business as the "cheaper and faster" model also results in the largest profits for those on top. Today, as big business runs the tables for many markets in developed countries, the massive profits generated infrequently trickle down to maintain the economic welfare of the common masses. Instead, those on top of the big business pyramid reap huge gains, often widening the gap between themselves and the people for whom these businesses "provide."[47] For these people, larger populations = larger profits. For everyone else, larger populations = less space, less national money available for education, security, healthcare, etc. In 2010, the wealthiest 1% of the global population owned 43% of global assets. The wealthiest 10% of the global population owned 83% of global assets.[48] The gap between the developed rich and developing poor of the world only continues to widen.

5. Global Implications of Population Growth

"The preventative population checks including sexual abstinence, delayed marriage, use of modern contraception and others will be replaced by positive checks like war, famine, and disease, as has happened many times in the past, without affirmative action regarding the prior," stated influential British scholar Thomas Robert Malthus in his work, *An Essay on the Principle of Population*, first published in 1798.[49]

47. Tobias Michael. *World War III- Population and the Biosphere at the End of the First Millennium,* Continuum Publishers, New York. 1994.
48. *Global Wealth Report,* Credit Suisse Research Institute. October 2010. http://thewisebuck.com/wp-content/uploads/2010/10/credit_suisse_global_wealth_report1.pdf
49. Malthus, Thomas Robert. *An Essay on the Principle of Population, 1st Edition.* London: J. Johnson, 1798. http://www.econlib.org/essays/essay-kraft.html

The Earth becomes home to more and more people every day. Numbers are rising in different regions for different reasons. But what does this mean for the Earth as a whole? What does this mean for people who aren't living in areas experiencing population explosions? What does this mean for people who are? What does it mean for all other life on Earth?

5. 1 Carrying Capacity

Debate surrounding the determination of Earth's maximum sustainable human population has been on the table for centuries. The largest number of inhabitants an environment can sustain indefinitely, given the resources available within that environment, is dubbed its 'carrying capacity.' Many would argue that Earth has long since surpassed its natural carrying capacity, but the human species' ability to alter its surroundings makes this a subjective discussion. More complex variables than those in non-human population biology are present. For example, man's ability to farm and produce more food than would naturally be available in a given space alters the number of consumers the land can provide for. The rabbit hole gets deeper. While that land produces more food for one species and may allow for that isolated population to grow, it takes more resources to grow more food and, therefore, takes away space, energy, and water from unrelated species that would otherwise naturally exist there.

5.11 The Earth Is a System

Although the earth is a large and complex place with many distinct ecosystems, it is a system. When a finite resource is heavily exploited in one area of an isolated system, it is less available for use in the rest of the system. While the agricultural revolution marked a shift towards man's ability to support large populations, it also marked the beginning of a huge movement towards imbalanced global resource use. When one region uses large amounts of resources, less are available for other regions - thus the huge gap in resource consumption between developed and developing nations. For example, the United States is home to only 5 percent of the global population, but accounts for roughly 25 percent of global energy use. Because of this, small leaps in our population size result in huge leaps of global energy use. The same is true for US contribution to greenhouse gas emissions, as the two are directly related.[50]

5.12 The Real Cost

Worldwide resource use is so off-balance today that the cost of almost anything we use or produce is far below that of the true cost of that item on the environment, because we fail to see the Earth as a whole system. This concept outlines the idea of externalized costs, where the price of something does not reflect the actual cost of it on all parties involved. This socio-economical term describes how a business maximizes its profits by off-

50. Kraft, Michael E. *Population Policy for the 21st Century,* University of Wisconsin-Green Bay. http://populationpress.org/essays/essay-kraft.html

loading indirect costs and forcing negative effects onto a third party.[51] This is one of the biggest failures of our global economy today. If the price of gas in the United States (where people use more gas per capita than anywhere else on Earth, by a long shot) actually reflected the toll it takes on the environment to extract, transport and clean it, the undervalued labor of the people working to extract, transport and clean it, the increased value it should have as the remaining amount dwindles with every gallon used, the cost of the US war efforts involved in maintaining control over petroleum-rich countries, and many other factors, the price per gallon would be much higher in the United States than it actually is. Because so many of these factors are non-quantifiable, and because the parties getting shorted along the way are so disconnected from the businesses reaping the profits at the end of the chain, an economy that is set up the way ours is will continue to function in such a way until the true costs pile up and result in a collapse of some or many of the cheated parties. The biggest loser in the picture is arguably the environment. And when the environment ultimately loses, everyone loses.

Says Lester R. Brown, President of the Earth Policy Institute, in his essay *World On Edge*, "*We delude ourselves with our accounting system. Leaving such huge costs off the books is a formula for bankruptcy. Environmental trends are the lead indicators telling us what lies ahead for the economy and ultimately for society itself. Falling water tables today signal rising food prices tomorrow. Shrinking polar ice sheets are a prelude to falling coastal real estate values… We are facing a situation in economics today similar to that in astronomy when Copernicus arrived on the scene, a time when it was believed that the sun revolved around the Earth. Just as Copernicus had to formulate a new astronomical worldview after several decades of celestial observations and mathematical calculations, we too must formulate a new economic worldview based on several decades of environmental observations and analyses.*"[52]

The concepts of carrying capacity and externalized costs are closely connected, because we cannot really measure the impact a population has on its environment without balancing out how their resource consumption and waste production affect the rest of the planet. This is primarily what makes defining the Earth's carrying capacity such an arduous task. Remembering that Earth is a system is key when determining how important it is to stay below carrying capacity. Those residing in nations where population growth is stable or declining cannot turn their heads on places where the case is not such. While the trash and crowding plaguing a severely overpopulated area may be far from the eyes of foreigners, the polluted water that escapes from these areas will eventually make it to the ocean that circulates around the whole planet. The destabiliza-

51. Budny, R. and R. Winfree. *Some Simple Arguments About Cost Externalization and its Relevance to the Price of Fusion Energy*, Department of Ecology and Evolutionary Biology, Princeton University. September 27, 1999. http://www.apam.columbia.edu/SMproceedings/11.ContributedPapers/11.Budny_Winfree.pdf
52. Brown, Lester R. *World On the Edge: How to Prevent Environmental and Economic Collapse*, Earth Policy Institute. Norton & Company, January 6, 2011. http://www.populationpress.org/publication/2011-1-brown.html

tion of the atmosphere, promoted mostly by a relatively small percentage of the world's population, is an *immediate* problem for *all* of Earth's inhabitants, considering that the atmosphere is common to all parts of Earth's surface. Modern farmers must answer to ever-increasing pressures to produce more food with less space, forcing them to employ the use of pesticides and genetically modified crops to meet these demands and increase revenue. Pesticides leak through to the groundwater tables that provide for local residents and lead eventually to oceans, remain in the soil for generations, and can be incorporated into the tissues of the part of a plant that will later be consumed by people. Using genetically modified seeds results in the cultivation of crops that are no longer the same species that evolution took millions of years to perfect. Gene transfer to non-target organisms, reduced effectiveness of pesticides, and unintended harm to other species are only a handful of the problems identified with genetically modified crops.[53] So many of the practices designed to support large populations, including practices in food production, energy production, goods manufacturing, transportation, and almost *every* other avenue of industry, have side affects that are harmful to the environment and/or directly harmful to the people participating in these practices.

Many would say that the maximum load of people the planet can support should rely on the ability of these people to provide food, water, space, etc. for themselves. If these were the only parameters in defining carrying capacity, it could be entirely possible for the Earth to support many billions more. But to take the other estimated 1.74 million other species (this not including single celled organisms, bacteria and the estimated many more yet to be discovered), and the infinitely variable environments they thrive in into consideration, the plausible carrying capacity would surely be far less. If we are to seek a future in which the diversity of Earth's species and ecosystems rivals what it is today, and what has been in times before the human population exploded, we must strive to keep our numbers at a level that fits within much smaller confines than the number we could reach if only human numbers and health are considered.

5.2 An Earth With 9 Billion Humans

Many believe that worldwide development of family planning programs at this time would be in vain because of all the evidence pointing towards a leveling of population growth in the not too distant future. While it may be comforting to know that infinite exponential growth is unlikely, taking a closer look at what a world with 9 billion people will be like may be reason enough to consider taking a more aggressive approach to preventing our numbers from reaching such a height.

5.21 Global Warming

With more people come more greenhouse gas emissions. Processes in modern industry and human activities result in the creation of these gases that when released into the air,

53. Genome Programs, US Department of Energy. November 5, 2008. http://www.ornl.gov/sci/techresources/Human_Genome/elsi/gmfood.shtml

eventually alter the makeup of our atmosphere. The burning of fossil fuels and biomass also result in the emission of aerosols that contribute to the shift in the atmosphere's composition. These changes likely have and will influence precipitation, storms, sea level, and most famously the phenomenon dubbed Global Warming, which refers to an ultimate increase in our planet's average temperatures. Temperatures are expected to rise from somewhere between 1.5 and more than 4 degrees Fahrenheit by the year 2050 due to a buildup of gases that create an incubation affect.[54] The wheels are already in motion that will incur these changes with the number of people on our planet today, but with an estimated 30 percent more people on Earth to contribute to these issues by 2050, things will likely get much worse. Efforts to decrease greenhouse gas emissions are negated by the addition of more people every day. As developing countries move towards states of heightened economic development, the amount of greenhouse gases emitted per person increases.

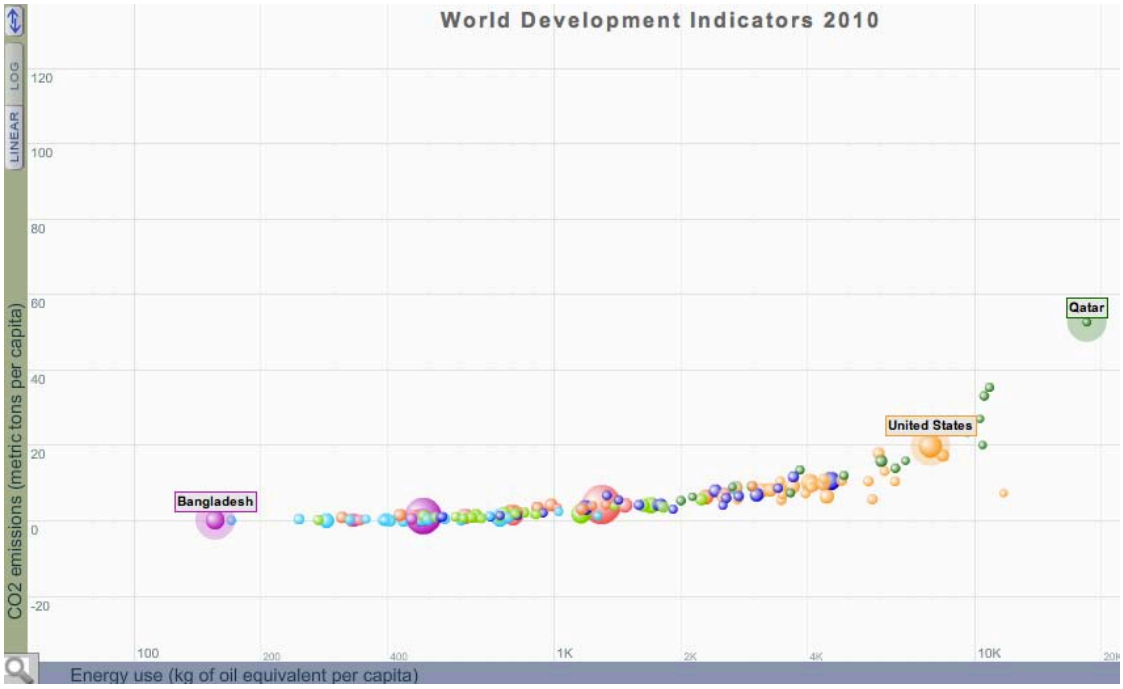

Figure 17[55]. Energy use (kg of oil equivalent per capita) vs. CO2 Emissions (metric tons per capita) by country

A positive correlation exists here. With increasing amounts of per capita energy consumption, increasing amounts of CO2 are emitted. Carbon Dioxide emissions reported here are those stemming from the burning of fossil fuels and the manufacture of cement. Large amounts of data suggest that a positive correlation exists between a given region's energy use per capita and the state of the region's economic development. This data, therefore, suggests a positive relationship between a country's state of economic development and said country's carbon dioxide emissions. Data is plotted on a linear scale.[55]

54. Solomon, S..,D. Qin and M. Manning. *IPCC,2007: Climate Change 2007: The Physical Science Basis.* Contribution of Working Group I to eh Fourth Assessment Report of the Intergovernmental Panel on Climate Change, http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-ts.pdf
55. World Bank Data Visualizer, 2010 Data. http://devdata.worldbank.org/DataVisualizer/

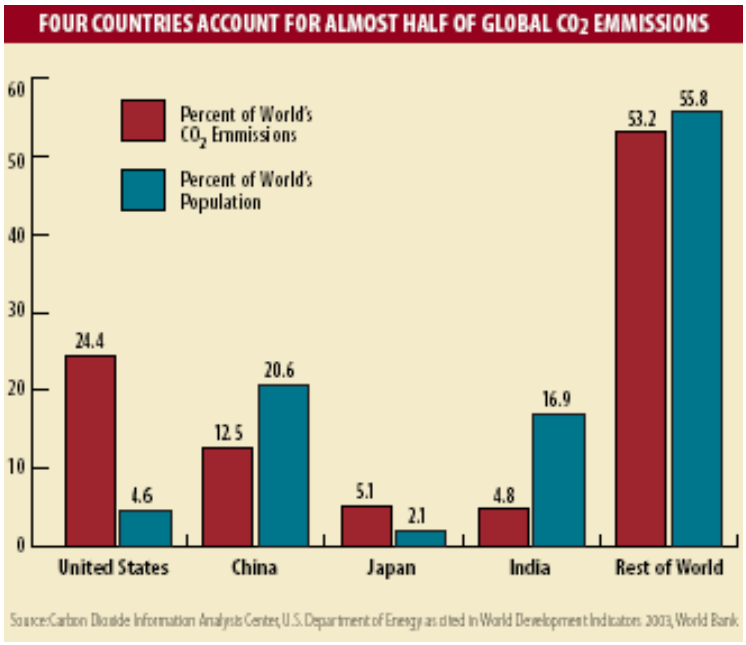

***Figure 18.*[56] Four Countries Vs. The Rest of the World**
Not surprisingly, 3 out of 4 countries here (US, China, India) fill the first 3 slots on the world's most populated countries list. Is it any wonder that the most populous countries produce the most CO_2? No. But with an estimated 195 countries in the world, it would seem that some might be taking more than their fair share. The United States produces almost 25% of the world's CO_2 emissions while attributing to only 4.6% of the population. Were China, Japan and India to follow the United States' lead, those four countries would account for over 78% of CO_2 emissions. In such a scenario, CO_2 emissions would increase four-fold from what they are today.

What does this mean for us? According to *National Geographic*, it may result in the extinction of more than a million species worldwide as climates change alters environments.[57] As temperatures rise, melting of mountain glaciers and ice caps, and melting of the Antarctic and Greenland Ice Sheets increases. This leads to the destruction of the local species and a rise in sea levels. Extrapolating these trends out to 2050 sees sea levels raising enough to wreak potential havoc on coastal territories worldwide. Rising sea levels inundate low-lying lands, erode beaches, intensify flooding, and increase the salinity of rivers and other freshwater bodies including groundwater tables.[58]

Also at risk are the Atlantic cold-water currents that circulate through the ocean as freshwater runoff increases and threatens to throw off this crucial ocean circuit. The currents transport warm, surface waters towards the poles and cold, deep waters toward the equator to ensure relative temperature equalization across the globe's waters, and propagate an important nutrient flow that sustains many of our marine eco-systems and fragile food chains. Many scientists believe the chance of a circulation shutdown could

56. Carbon Dioxide Information Analysis Center, U.S. Department of Energy as cited in World Development Indicators 2003, World Bank. http://cdiac.ornl.gov/
57. Roach, John. "By 2050 Warming to Doom Million Species", National Geographic News. July 12, 2004. http://news.nationalgeographic.com/news/2004/01/0107_040107_extinction.html
58. "Coastal Zones and Sea Level Rise", Environmental Protection Agency. 2007. http://www.epa.gov/climatechange/effects/coastal/index.html

be as high as 30 percent if temperatures continue to rise at predicted rates.[59]

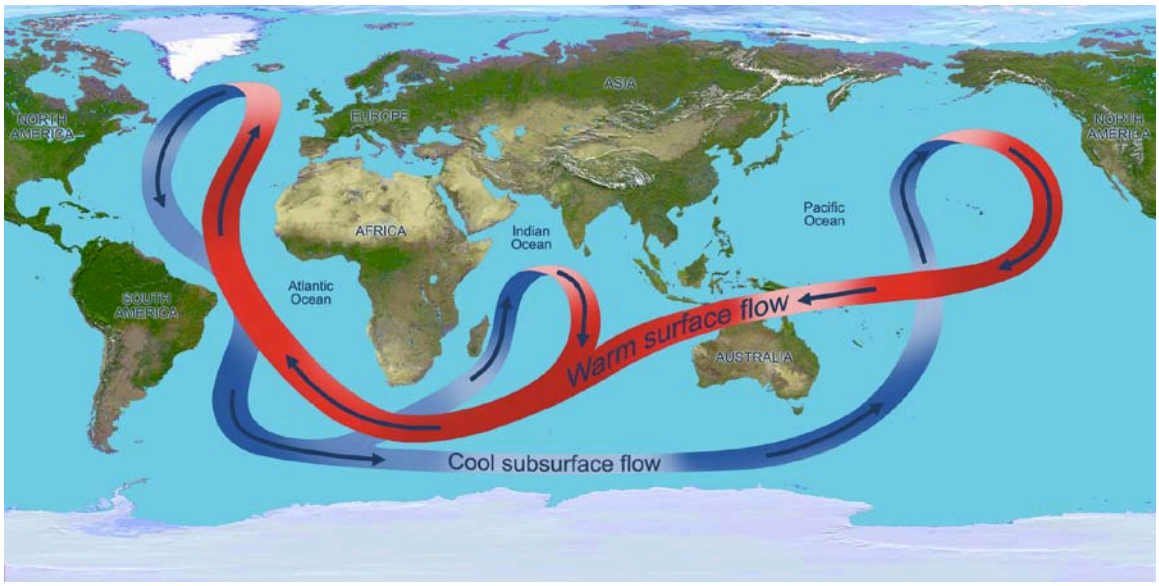

Figure 19. Generalized model of global water currents

The worldwide conveyor belt of ocean currents in place today help to distribute polar cold water into the warmer, central regions to heat up before heading back to colder areas. This process keeps climates in polar directions warmer than would otherwise be and maintains a crucial nutrient flow through our oceans. Climate change as a result of Global Warming could disrupt these currents in the future.[60]

5.22 Food and Water Supply

Stresses on global food and water supply will only increase with an added 2 billion mouths to feed. Marine biologists at the Food and Agriculture Organization report that *"all 17 of the planet's major oceanic fisheries are being fished at or beyond capacity, with 9 in a state of collapse"*.[61] There are more than 430 million people today living in countries considered to be "water stressed," meaning there is not enough clean water to supply inhabitants with. Because the vast majority of clean water shortages occur in developing countries with largely growing populations, the percentage of the world's population living in water stressed countries could increase by over 300 percent.[62]

59. Roach, John. "Global Warming may Alter Atlantic Currents, Study Says". National Geographic News. June 27, 2005. http://news.nationalgeographic.com/news/2005/06/0627_050627_oceancurrent.html
60. NASA, California Institute of Technology, Pasadena, CA. http://www.nasa.gov/topics/earth/features/atlantic20100325.html
61. Brown, Lester R. Eco-Economy: Building an Economy for the Earth. Earth Policy Institute, 2001. http://www.earth-policy.org/books/eco/eech3_ss2
62. Norton, W.W.. *Last Oasis: Facing Water Scarcity*. Worldwatch Institute: New York. 1992. http://www.earth-policy.org/books/eco/eech3_ss2

Using global food supply, distribution, and consumption data, a 1994 report estimated that over 1 billion of the planet's residents lived, at the time, in "utter poverty," a condition that "implies hunger among those persons."[63] That number has increased since then. Roughly 800 million people today, over three times the population of the United States, are "chronically undernourished."[64] Many of the agricultural practices developed in order to produce much larger and more productive crops per area have resulted in increased soil erosion, polluted ground and surface water; and increased pesticide use has caused serious public health and environmental problems.[65]

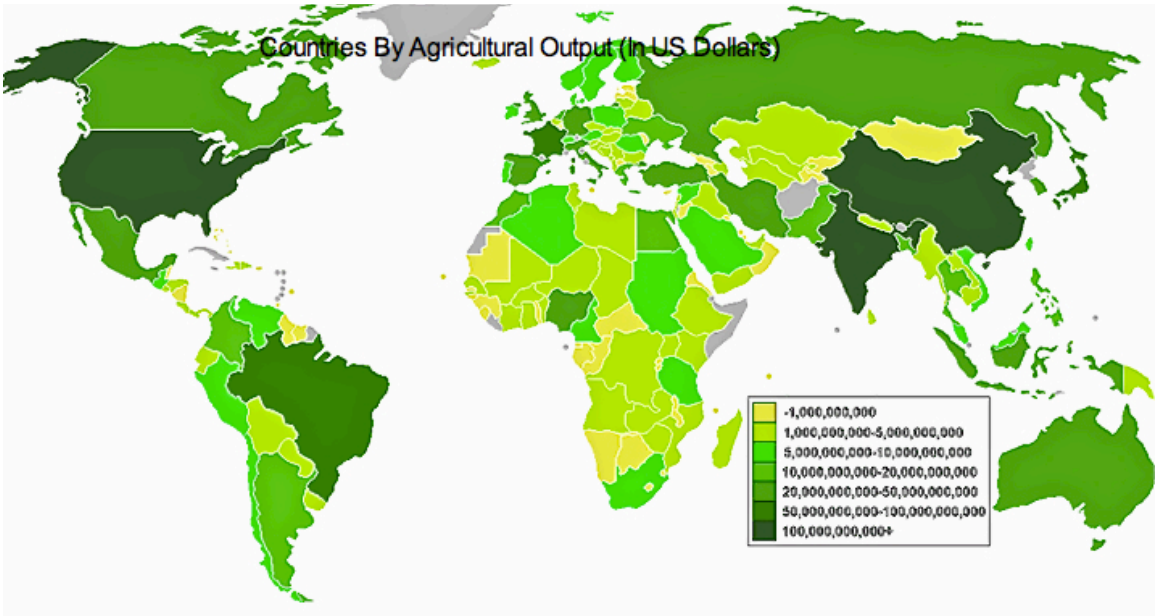

Figure 20. Countries by Agricultural Output, 2009
Countries represented in darker colors contribute more to agricultural output. Value of crop output is reported in US dollars, with a range from below $1 million (yellow) to over $100 million (darkest green). Africa, a projected leader in population growth for the next 50+ years, produces relatively small amounts of agriculture while expecting large growth to come. A heavy reliance on foreign aid and food imports will be necessary to keep many African residents from starving.[66]

63. Kindall, Henry W., and David Pimentil. "Constraints on the Expansion of the Global Food Supply". AMbio Vol. 23 No. 3, May 1994. The Royal Swedish Academy of Sciences. http://dieoff.org/page36.htm
64. Runge, C. Ford, Benjamin Senauer, Phillip G. Pardey, and Mark W. Rosengrant. *Ending Hunger by 2050*, International Food Policy Research Institute. Washington DC, 2009. http://www.ifpri.org/sites/default/files/pubs/pubs/ib/ib14.pdf
65. World Health Organization/United Nations Environment Programme, 1989. Public Health Impact of Pesticides Used in Agriculture. WHO/UNEP, Geneva
66. DeCarbonnel, Eric. *Catastrophic Fall in 2009 Global Food Production*, Centre for Research on Globalization. 2009. http://www.globalresearch.ca/index.php?context=viewArticle&code=DEC20090210&articleId=12252

Many countries experiencing large population growth already do not produce adequate amounts of food for their people and, therefore, rely heavily on foreign imports. The cost of transport alone in the global food distribution picture is huge. Significantly larger amounts of aid will need to be provided to developing regions unable to provide for their own residents.

To eradicate poverty and provide adequate food to all people in 2050, world food production will have to *double* from what it was in 2010.[67] A report from the United Nation's Food and Agriculture Organization states that *"According to the Millennium Ecosystem Assessment, 15 out of 24 ecosystem services examined are already being degraded or used unsustainably. These include capture fisheries and water supply."*[68] Increasing pressure to produce more food and extract more from Earth systems will only intensify stress and damage.

5.23 Energy Consumption and Supply

In the past 50 years, while the world population doubled, world energy consumption tripled. Renewable sources of energy such as wind and solar contribute to less than 2 percent of global energy needs, meaning that we depend on non-renewable resources for our primary fuel sources.[69] Considering the rapid industrialization of several Asian and Latin American countries, the demand for energy is increasing daily. As non-renewable energy supplies such as petroleum are diminishing further over time, demand will increase. The threat of draining the energy supplies that our modern human life-style depends on becomes more imminent with even more people demanding resources. The race to establish dependable renewable energy sources *will* become a priority as our standards of living are threatened with continued resource depletion, but the day will only come sooner than it has to with more people fighting over the remainders.

In Lindsey Grant's 2005 book, *The Collapsing Bubble: Growth and Fossil Energy*, Grant addresses the future of the world's growing population in the face of depleting fossil fuel stores, with special attention to the United States. Combining projections of population growth in the next 100 years with economic analysis and fuel availability, he recognizes that an economy based on growth is unsustainable. Economic reform, a decline in population size, and rapid development of non-fossil fuel sources will be necessary if Americans are to avoid collapse. He addresses the era beyond fossil fuels, acknowledging that alternative lifestyles and energy sources will allow us to be more responsible and

67. FAO, United Nations. 2009 Agricultural Data. http://faostat.fao.org/site/339/default.aspx
68. "How to Feed the World in 2050", FAO. United Nations. http://www.fao.org/fileadmin/templates/wsfs/docs/expert_paper/How_to_Feed_the_World_in_2050.pdf
69. Thirunarayanapuram, Desikan. "Resource Conservation, Population, and Sustainable Development". Toward the 21st Century Series, no. 3. Population Institute: Washington DC. 1997.

sustainable citizens of the Earth, but only at a lower population, with "less consumptive habits." Grant states*: "I would not bet that the human race can manage this most difficult of transitions-this retreat from overshoot-without turmoil, but we have an opportunity to try."*[70]

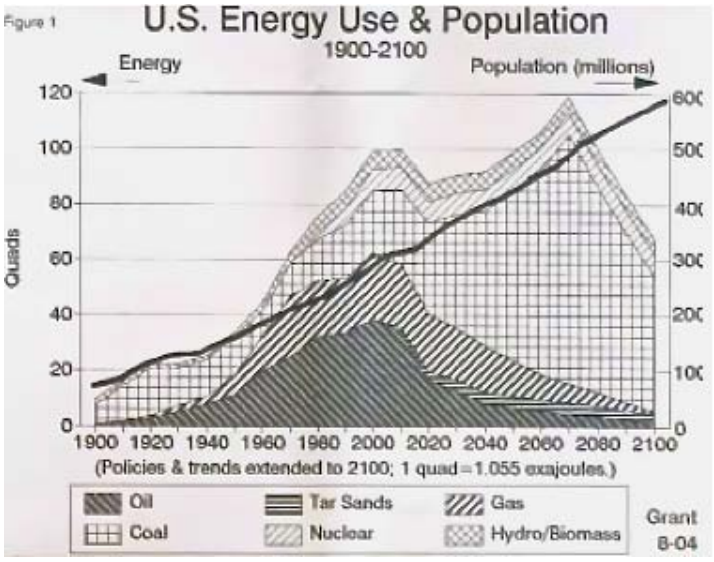

Figure 21. U.S. Energy Use & Population
This figure, that dons the cover of Lindsey Grant's The Collapsing Bubble: Growth and Fossil Energy, displays the history and projected future of U.S. energy consumption along with the projected population size based on the middle estimate in the Census Bureau's report. Consumption peaks around 2080 and quickly drops off as coal supplies reach their peak supply, while the U.S. population approaches 600 million. Note that the use of coal, which here accounts for much of the energy supply up to 2080, has been identified as one of the more environmentally destructive fuel sources and a large contributor to greenhouse gas emissions.[70]

5.24 Global Security

Global security is compromised as wars are waged over these finite resources. Industrialized nations will result to force to sustain unsustainable lifestyles. With the huge population growth of the next 50 years occurring in poor countries already ill-equipped to handle their numbers, increasing dependence on foreign aid will create pressures on industrialized countries to divvy up the responsibility of providing for these places who desperately need assistance. Water stressed regions will reach elsewhere for clean water. Because water also is a finite resource, the water diverted to water stressed regions will be less available for local regions and potentially lead to further disputes.

70. Grant, Lindsey. *The Collapsing Bubble: Growth and Fossil Energy.* Seven Locks Press, 2005.

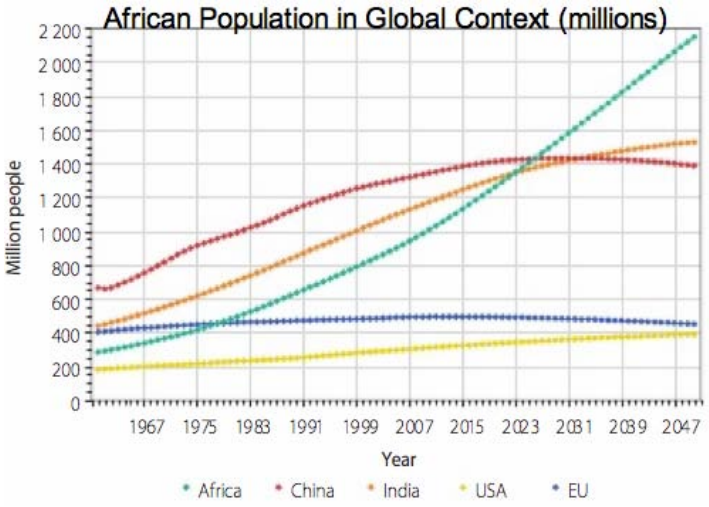

Figure 22. African Population in Global Context (in millions)
Populations of Africa, China, India, USA, and Europe, from 1967 to projected numbers in 2047. Populations of all displayed regions are declining or are close to decline by 2047, while Africa still displays rapid growth.[71]

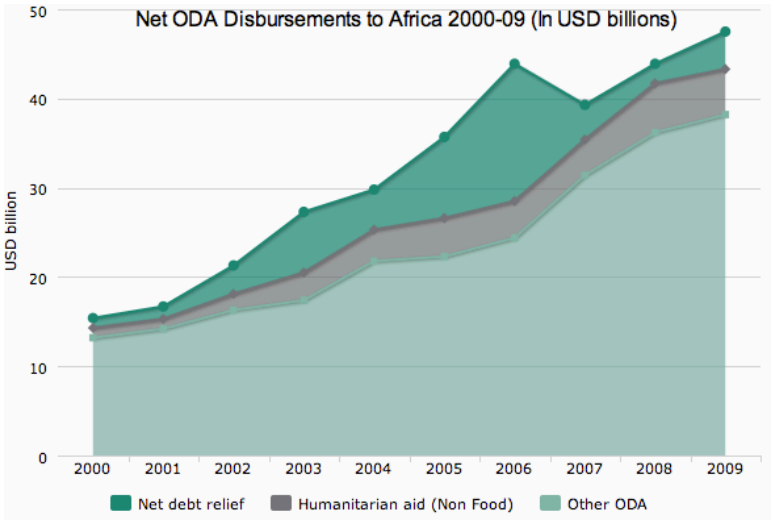

Figure 23. Net ODA (official development aid) Disbursements to Africa 2000-09
As seen here, the population of Africa has been growing and will continue to grow rapidly for at least the next 50 years. In conjunction, aid to Africa has been steadily increasing and is projected to increase as the population explodes. Increasing humanitarian aid, debt relief, official development aid, and private capital inflow from donor countries will be necessary to save millions of Africans from starvation.[72]

6. Slowing Population Growth

If simply handing out birth control to people in every corner of the world would guarantee sharp declines in birth rates, it is plausible that plans would be in the works to see a project like this through. But the task is much larger. Birth control is expensive; many women won't take it because they don't understand it; many cultures don't support the use of it; and many women *want* large families for many different reasons. Family

71. Cilliers, Jakkie, Barry Hughes and Jonathan Moyer. *African Futures 2050,* Institute for Security Studies. South Africa, 2011. http://www.scribd.com/doc/47603525/African-Futures-Project-Africa-2050
72. . *StatExtracts,* Organization for Economic Co-operation and Development. 2011. http://stats.oecd.org/Index.aspx?DataSetCode=AEO11_OVERVIEW_CHAPTER2_FIG4_EN

planning programs that have worked and will work integrate education, medical aid, and other elements into the picture. The hope is to develop region-specific programs catered to *each and every* territory experiencing population growth.

6.1 What Has Worked

A family planning revolution took place in developing nations from the 1960's to the 1990's. In an era where birthrates skyrocketed to the highest numbers in history, governments across the world conceived of and implemented programs to eradicate the explosive growth of the 1960's. Though the population today has more than doubled since then and is still growing, birth rates have been dropping consistently ever since. The family planning efforts of the time saw whole societies coming together to bring birth rates down for the first time in history. Had these efforts not been made, it is possible that the ever-declining birth rates we are seeing now would not have been reduced as much as they have, if at all. The positive results of the programs set up then and since are a testament to the success of well-implemented programs and should provide a framework for future fertility reduction aspirations.

The World Bank's 2007 report, *The Global Family Planning Revolution*, provides summaries and analyses of family planning programs executed during that era.[73] A country-by-country look at successful operations makes it clear that effective schemes were region specific. Because the reasons for high fertility will always vary across the globe, effective schemes too will always vary across the globe. Successful programs in the Middle East and North Africa, Europe and Central Asia, Latin America and the Caribbean, East Asia and the Pacific, South Asia, and Sub-Saharan Africa are closely examined.

Stories like Iran's successful family planning efforts between 1961 and 2004 are proof that smart, aggressive plans *do* decrease birth rates. In just one decade Iran dropped its population growth rate from one of the highest to one of the lowest in the developing world. Family planning programs put into effect in the 1960's were dismantled by Iranian leader Ayatollah Khomeini in the 1980's, after an 8-year war with Iraq, in an attempt to raise a larger army. When citizens responded by upping birth rates, population growth peaked at 4.2 percent. When the environmental degradation, overcrowding, and unemployment that resulted in such huge birth rates became a threat to Iran's future, the Iranian government restored it's family planning development efforts and achieved a drop to a 2 percent growth rate in 1994, and saw it fall to 1.2 percent by 2004.[73]

73. "The Global Family Planning Revolution: Three Decades of Population Policies and Programs", The World Bank, Washington D.C. 2007. http://siteresources.worldbank.org/INTPRH/Resources/GlobalFamilyPlanningRevolution.pdf

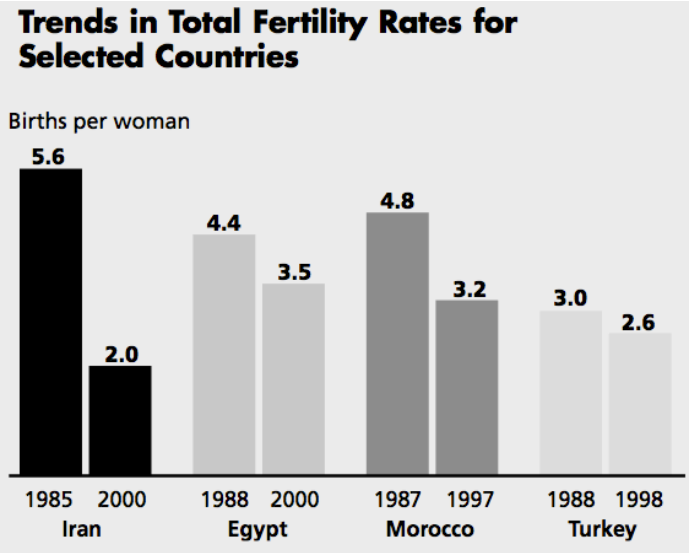

Figure 24. Trends in Total Fertility Rates for Selected Countries
Iran has shown a significant reduction in fertility as a result of aggressive family planning programs. Neighboring countries that lack such programs have much less drastic decreases in fertility in similar time frames.[74]

The plan involved a huge media launch to encourage small families, the construction of 15,000 rural clinics to provide contraception and contraceptive education to rural citizens, the introduction and cost-free availability of a range of modern contraceptives, a surge in female education and literacy, and the requirement of all couples to take a class on modern contraceptives before being issued a marriage license[75]. The success of such programs in an Islamic Fundamentalist country such as Iran should be catalyst enough to set up like programs suited specifically for countries like Niger, Uganda, and Mali (With birth rates of 7.68, 6.73, and 6.54 respectively, these are at the top of the world's birth rate charts). With the world birth rate lying at 2.56 and replacement fertility near 2.1, there is much ground left to cover. But the goal is *far* from unobtainable. Using successful programs like those outlined in the World Bank's report as models, designing policies to curb population explosions before we hit the 9 billion mark is physically feasible, and not only financially possible, but perhaps financially responsible?

6.2 What Could Work

1 in 4 women who want to avoid a pregnancy are not using a modern method. The Guttmacher Institute estimates that the gap in the yearly cost for meeting the total need

74. Programme of Action of the International Conference on Population and Development, United Nations Population Fund. Cairo, 1994. http://www.unfpa.org/public/home/sitemap/icpd/International-Conference-on-Population-and-Development/ICPD-Programme#ch7b
75. Brown, Lester R. "Plan B 2.0, Rescuing a Planet Under Stress and a Civilization in Trouble". W.W. Norton & Company, New York, NY. 2006.

for modern family planning worldwide would cost an additional $6.7 billion annually.[76]

The conclusion of Cairo's International Conference on Population and Development held in 1994 looked to developing countries to cover two thirds of the cost of global family planning efforts, while developed countries covered the rest.[77] At the time, the total estimate for family planning programs was set at an annual $22 billion by 2015. The $6.7 billion dollar gap currently comes from a deficit of 20 percent from developing nations and 50 percent from the industrialized donor nations.[78] The Iraqi war, arguably fueled by the US desire to maintain control over petroleum rich land, consumes such an enormous amount of taxpayers' money each year that a mere $6.7 billion dollars a year pales in comparison. Spent & approved war spending of US taxpayers' funds ran at over $900 billion through 2010.[79] What if the United States focused less on the brutal and expensive short-term fix for fossil fuel depletion and allocated the relatively small amount of money necessary to set up the long-term fix for global birth rate reduction instead?

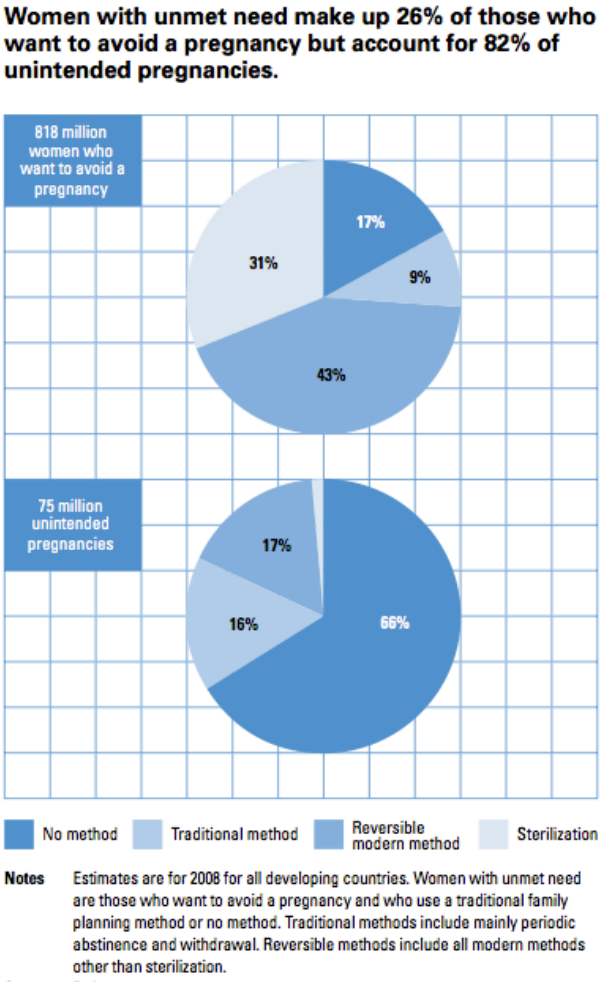

Figure 25. Unmet Contraceptive Needs
Data from all developing countries in 2008 shows that women with the unmet need for contraceptives make up 26% of those who want to avoid pregnancy, but account for 82% of unintended pregnancies. The addition of an annual 6.7 billion dollars to the global family planning budget could close the gap in the need for contraceptives and make a huge cut in unintended pregnancies.[76]

76. "Facts on Investing in Family Planning and Maternal and Newborn Health", Guttmacher Institute, New York, NY. November 2010. http://www.guttmacher.org/pubs/FB-AIU-summary.pdf
77. *Programme of Action of the International Conference on Population and Development*, United Nations Population Fund. Cairo, 1994. http://www.unfpa.org/public/home/sitemap/icpd/International-Conference-on-Population-and-Development/ICPD-Programme#ch7b
78. Brown, Lester R. "Plan B 2.0, Rescuing a Planet Under Stress and a Civilization in Trouble". W.W. Norton & Company, New York, NY. 2006.
79. "Tracking Variables of Reconstruction & Security in Post-Saddam Iraq", Iraq Index, Brookings. Nov 30, 2010. http://brookings.edu/iraqindex.

6.3 Global Electrification via the Global Energy Grid

The ultimate solution for capping population growth on this planet will depend on the coupling of aggressive regional family planning programs with the re-structuring of resource stressed regions to ensure smart economic development. A case for an interconnected global energy grid has been made for many reasons. Here, the potential for a global energy grid to aid in the reduction of global birth rates is discussed.

6.31 What is the Global Energy Grid?

Today, energy production and consumption is a region-specific practice. Roughly 83 percent of the world energy consumption is fueled by non-renewable sources while the remaining 17 percent comes from various renewables.[80] Some countries, like Denmark, have been able to make the transition towards a diminishing reliance on "dirty" energy by increasing wind power generation to reach almost 20% of their country's energy needs.[81] However, the United States, the world's largest energy consumer, still fulfills only 7% of its electrical energy needs with non-renewable sources.[82] Most industrialized countries have a ways to go in terms of changing their energy picture. But there is an alternative.

Per capita energy consumption has a direct positive relationship with quality of life. Research shows that with increased energy consumption comes heightened levels of literacy, increased lifespans, access to clean water, and importantly, decreased birth rates.[83] Developing countries lacking electricity have much to gain with the emergence of plans to extend electrical energy grids into their territories.

In 1969, scientist, inventor, and philosopher Buckminster Fuller posed the critical question *"How do we make the world work for 100% of humanity, in the shortest possible time, through spontaneous cooperation, without ecological damage or disadvantage to anyone?"*[84] At the core of his solution lay the then-innovative proposal to connect the world with one, continuous electricity network. By connecting power grids across the globe, the capacity to tap into remote, renewable sources and transmit that energy into every corner of the world becomes a possibility. Wind, solar, hydro, geothermal and every other source of renewable energy are abundant throughout our

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80. *Key World Energy Statistics,* International Energy Agency, 2010. http://www.iea.org/textbase/nppdf/free/2010/key_stats_2010.pdf
81. *Danish Energy Policy, Vision: 100% Independence of Fossil Fuels,* Danish Energy Agency. Copenhagen, Denmark 2010. http://www.ens.dk/en-US/Info/news/Factsheet/Documents/DKEpol.pdf%20engelsk%20til%20web.pdf
82. *Renewable Energy Trends in Consumption and Electricity, 2008.* U.S. Energy Information Administration, Statistics & Analysis. 2008. http://www.eia.gov/cneaf/solar.renewables/page/trends/rentrends.html
83. World Bank Data Visualizer, World Development Indicators 2010. The World Bank Group 2010. http://devdata.worldbank.org/DataVisualizer/
84. Global Energy Network Institute, http://www.geni.org/globalenergy/donors/benefits/index.shtml

many environments, but we did not plan our cities and energy sinks around these resources. To tap into these resources at the local level and feed them into one network could allow for constant availability of clean energy. Solar panels in a day hemisphere's remote deserts could feed into the network that provides the energy to run cities in the other hemisphere's night, simultaneously. Wind plants in the Himalayas could provide 24/7 energy into the network that supplies low-lying, wind free urban centers previously depending on inefficient, polluting coal fire plants for their energy needs. The possibilities are endless. The GEG allows for the oxymoron of a global localization of energy production: local energy production of any region's abundant renewable energy source, at a global level. Once the transmission grid were set up, the transportation of electricity would be efficient, cheap, and almost spontaneous - unlike that of petroleum, the world's current leading fuel source.

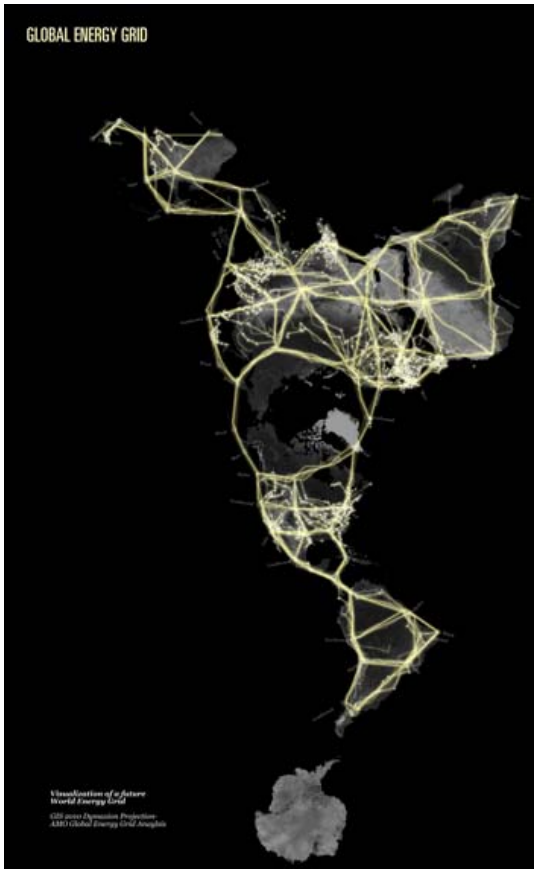

Figure 26. A Global Energy Grid
A conceptual configuration of a global energy network that connects electrical grids between all territories.[85]

Of course, the existence of a GEG wouldn't solve all of our energy problems. Successful execution of a clean energy grid would depend on the development and construction of the technologies necessary to harvest the renewable energy sources in an efficient enough way to make the monopoly of non-renewables on the energy market a thing of the past. Much of modern technology is designed to run on non-renewable fuels, such as the huge majority of the transportation sector that relies on petroleum-based fuel. But the electric cars are out there. The other designs are out there. And the potential for a re-design of *everything* we produce and rely on to a clean energy system may pave the way for a new era in economic prosperity. Many revolutions will have to come together for the complete revamp necessary to halt the global poverty, famine, and environmental destruction set in motion by man's current practices. But the GEG could be the foundation for this change. At the very least, it could solve a large part of one of the largest issues of the 21st century.

85. Thackara, John. GIS 2010 Dymaxion Projection, AMO Global Energy Grid Analysis. http://www.doorsofperception.com/archives/2011/02/renewable_energ.php

6.32 The GEG and Global Declines in Birthrates

A large body of research shows that increasing amounts of available electricity in developing regions results in decreasing birth rates. The reductions in birth rates are a function of many factors that vary with the amount of electric availability. The World Bank's 2007 data collection indicates that a positive correlation exists between electric power consumption in kWh per capita and life expectancy, access to improved sanitation facilities and water sources, and internet users. A negative correlation with infant mortality, malnutrition prevalence, and fertility exists in the same comparison.[86] Explanations for these correlations are briefly described in the above section entitled Desired Family Size and have been researched extensively elsewhere.[87] Many studies have been conducted to track birth rates in rural regions after the introduction of electricity, with conclusions continually supporting these relationships. The potential for a global energy grid that provides electricity to every person on the planet to aid in the reduction of the high birth rates in currently under-developed regions is real. And because large population growth can hinder economic development, decreases in large growth could encourage accelerated economic development on top of the advantages that electrical availability would incur. Access to modern energy is the gateway to development in a world where health care, education, and income growth are direct results of electric availability.

6.33 Energy Use and Development

The images below are a product of the World Bank's Data Visualizer. Data for lifespan, population percentages, access to clean water and improved sanitation facilities, infant mortality, and fertility rates for countries able to provide the appropriate statistics are plotted against per capita energy use in kg of oil. Per capita energy use is reported here instead of electric consumption because in the argument for a global energy grid lies the hope that most, if not all energy use across the globe could some day be converted to delivery via electricity and trends portrayed here are valuable indicators for all regions, not just the developing countries that would benefit from the introduction of electricity. While the introduction of electric availability alone in developing regions lacking that luxury tends to be enough to spur changes necessary to improve the quality of life for residents and lead to declines in birth rates, reporting total energy use in a country encompasses use of electricity. As shown, the tendency for heightened energy use to result in positive gains in quality of life indicators and declines in fertility holds true for data reported by the majority of countries here.

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86. World Bank Data Visualizer, World Development Indicators 2010. The World Bank Group 2010. http://devdata.worldbank.org/DataVisualizer/
87. "The Benefits of Rural Electrification", Independent Evaluation Group (IEG), The World Bank Group. http://web.worldbank.org/WBSITE/EXTERNAL/EXTOED/EXTRURELECT/0,,contentMDK:21604845~menuPK:4489096~pagePK:64829573~piPK:64829550~theSitePK:4489015~isCURL:Y,00.html

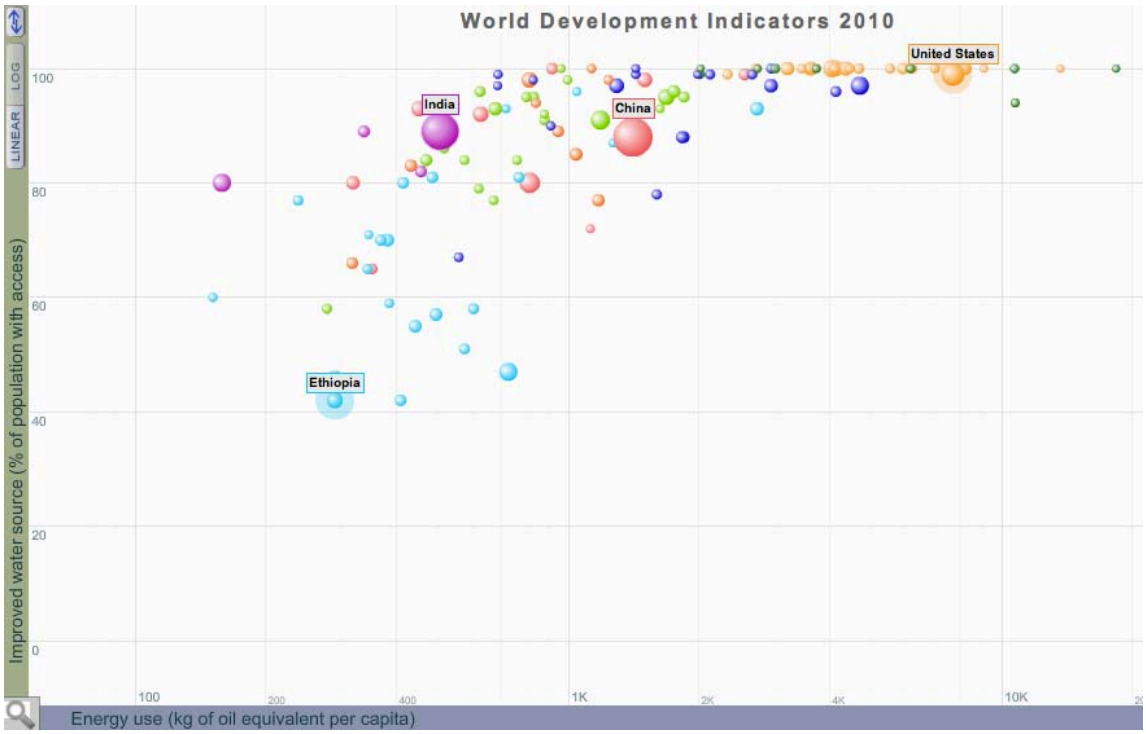

Figure 27. Energy Use (kg of oil equivalent per capita) vs. Improved Water Source (% of population with access).
A positive correlation exists between these two factors. With increased amounts of energy consumed per capita, larger proportions of these residents have access to improved water sources. Access to an improved water source refers to the availability of at least 20 liters per person per day from an improved source within one kilometer of the dwelling. An improved source is defined as a source likely to provide safe water, such as a household connection, public standpipe, protected well or spring, or any other constructed or regulated storage/distribution method. Outliers exist. Data is plotted on a linear scale.[88,89]

88. World Bank Data Visualizer, World Development Indicators 2010. The World Bank Group 2010. http://devdata.worldbank.org/DataVisualizer/
89. World Health Organization and United Nations Children's Fund, Joint Measurement Programme (JMP) http://www/wssinfo.org/

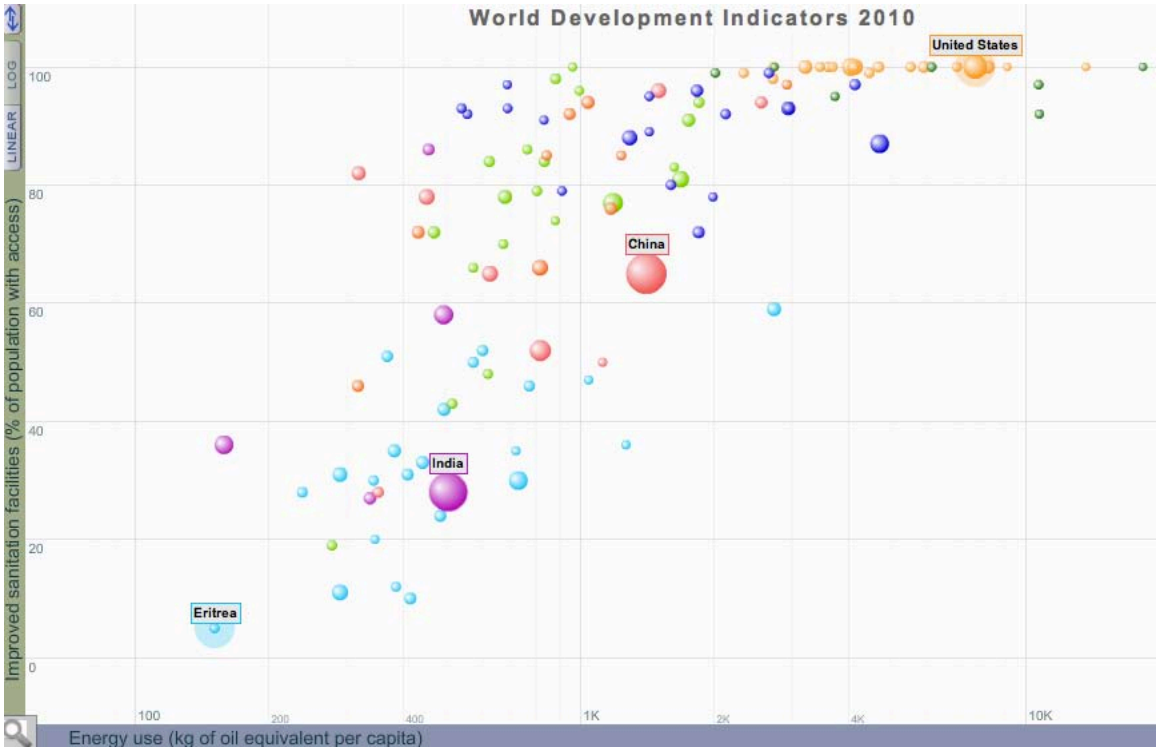

Figure 28. Energy Use (kg of oil equivalent per capita) vs. Improved Sanitation Facilities (% of population with access).

A positive correlation exists between these two factors. With increased amounts of energy consumed per capita, larger proportions of residents have access to improved sanitation facilities. Access to improved sanitation facilities refers to the percentage of population with at least adequate access to excreta disposal facilities that can effectively prevent human, animal, and insect contact with excreta. Improvements in sanitation practices lead to decreases in disease, which lead to decreases in infant mortality and increases in life expectancy. All of these lead to declines in fertility. Outliers exist. Data is plotted on a linear scale.[90,91]

90. World Bank Data Visualizer, World Development Indicators 2010. The World Bank Group 2010. http://devdata.worldbank.org/DataVisualizer/
91. World Health Organization and United Nations Children's Fund, Joint Measurement Programme (JMP) http://www/wssinfo.org/

Figure 29. Energy Use (kg of oil equivalent per capita) vs. Life Expectancy at Birth, Total (in years). A positive correlation exists between these two factors. With increased amounts of energy consumed per capita, the life expectancy in years of residents increases. Life expectancy at birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life. Outliers exist. Data is plotted on a linear scale.[92,93,94,95]

92. World Bank Data Visualizer, World Development Indicators 2010. The World Bank Group 2010. http://devdata.worldbank.org/DataVisualizer/
93. "World Population Prospects: The 2008 Revision", United Nations Population Division. New York, United Nations, Department of Economic and Social Affairs. 2009.
94. Statistics and Demography Programme, Secretariat of the Pacific Community. 2009.
95. U.S. Census Bureau: International Database 2010

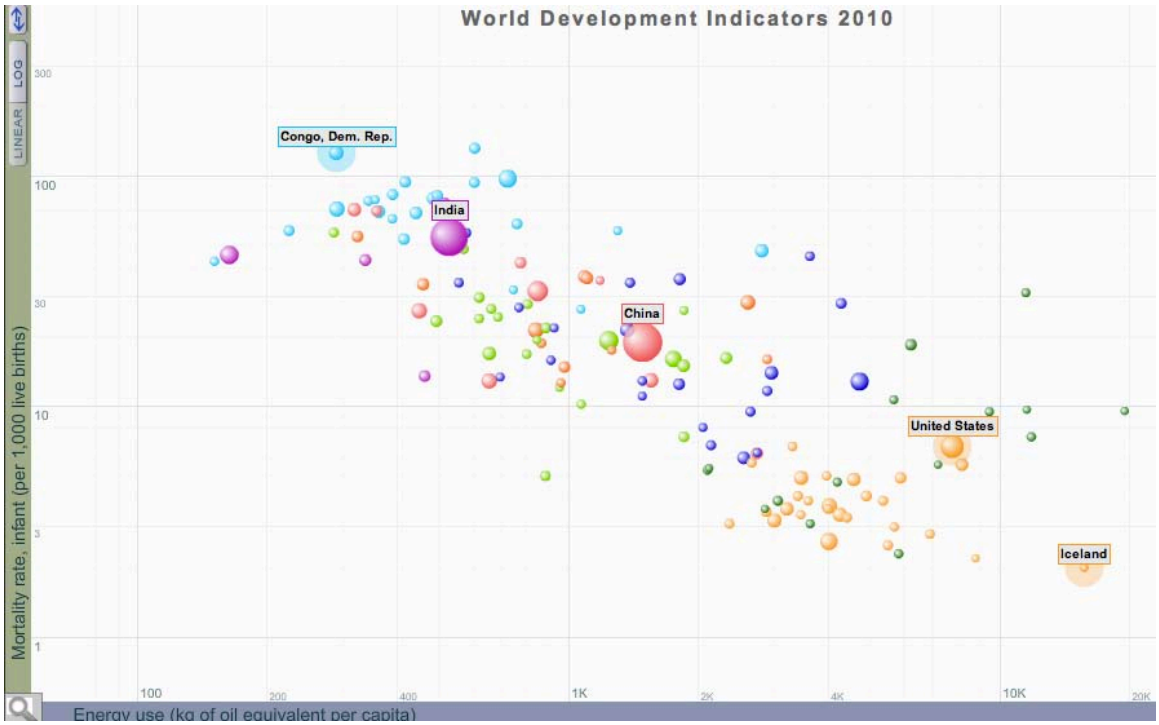

Figure 30. Energy Use (kg of oil equivalent per capita) vs. Mortality Rate, Infant (per 1,000 live births). A negative correlation exists between these two factors. With increased amounts of energy consumed per capita, the infant mortality rate decreases. Infant mortality rate is the number of infants dying before reaching one year of age, per 1,000 live births in a given year. Women in countries with high infant mortality rates tend to have more offspring to account for the increased possibility of offspring loss. The same reasoning can be used to explain why regions with lower infant mortality rates sustain lower birth rates. Outliers exist. Data is plotted on a logarithmic scale.[96,97]

96. World Bank Data Visualizer, World Development Indicators 2010. The World Bank Group 2010. http://devdata.worldbank.org/DataVisualizer/
97. Inter-agency Group for Child Mortality Estimation (UNICEF, WHO, World Bank, UNPD, universities and research institutions)

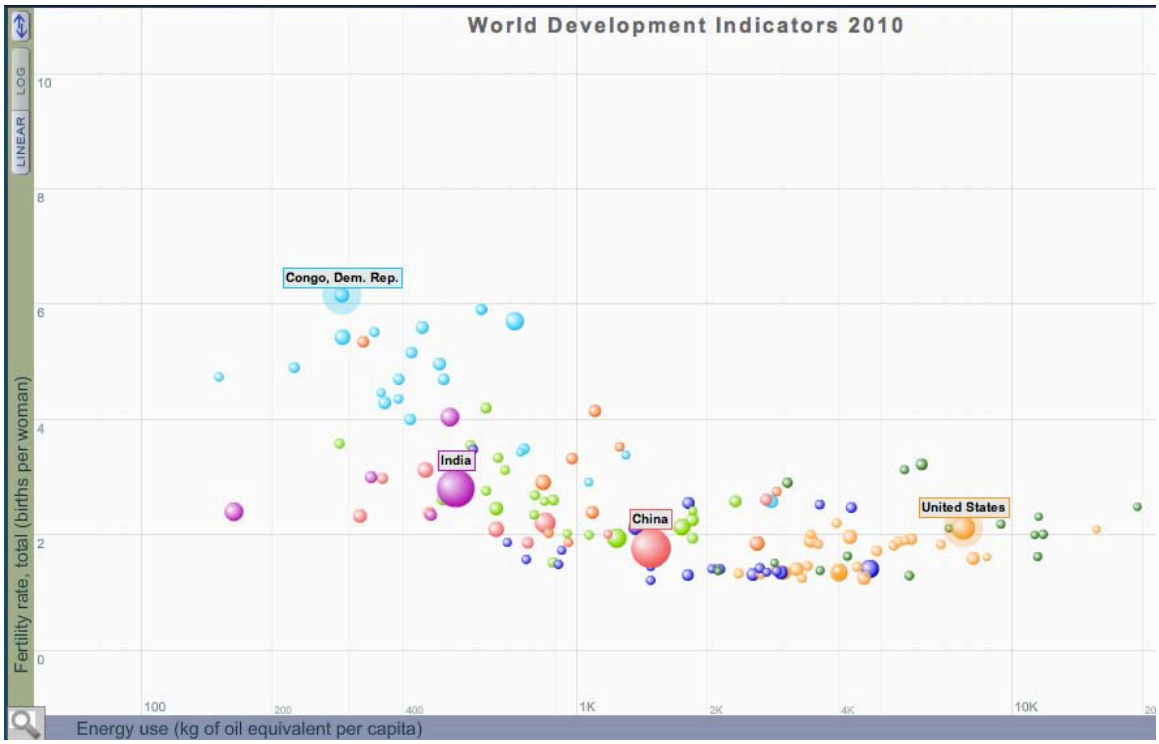

Figure 31. Energy Use (kg of oil equivalent per capita) vs. Fertility Rate, Total (births per woman) A negative correlation exists between these two factors. With increased amounts of energy consumed per capita, fertility rates decrease. Total fertility rate represents the number of children to be born to a woman who lives to the end of her childbearing years and bear children in accordance with current age-specific fertility rates. Outliers exist. Data is plotted on a linear scale.[98]

6.34 A Shift in Resource Use

It is easily arguable that a worldwide electrification project would not only lead to the slowing of the now booming population growth, but also greatly improve the quality of life for the billions of people that don't currently have access to the luxuries provided by electricity. But to model all future societies moving towards greater states of development after the mega-consumer societies of the developed world today would be disastrous. The United States, for example, consumes 25% of the world's resources while harboring only 5% of the world's population.[99] Were the developing countries that are contributing to the largest population growth to move towards a state of development dependent on extreme consumption like the United States', diminishing population growth would be a positive side effect of an ultimately negative progression. For the introduction of a GEG to be 100 % productive in man's journey towards a sustainable existence, the economic development that would be a product of a GEG would have to be sustainable development. Measures of economic prosperity in burgeoning markets must

98. World Bank Data Visualizer, World Development Indicators 2010. The World Bank Group 2010. http://devdata.worldbank.org/DataVisualizer/
99. *Global Wealth Report,* Credit Suisse Research Institute. October 2010. http://thewisebuck.com/wp-content/uploads/2010/10/credit_suisse_global_wealth_report1.pdf

not depend on the same things our mega-consumer societies of today depend on. Increasing per capita energy consumption must not be coupled with increasing CO_2 emissions. Poor countries must not attempt to increase the standard of living for its inhabitants by increasing the ability of its people to consume resources. Sustainable development must focus on the creation of sustainable markets in developing societies. Sustainable industries must focus on the development of economies based on services and practices that do not drain finite resource pools and destroy the environment. Markets based on the creation and sustenance of green products and services worldwide could create the wave of prosperity necessary to bring developing societies into new levels of affluence. Regions all over could create capital by the harvesting of local clean energy to be fed into the global energy network. Family planning programs to be put in place in the future could include education on smart growth and sustainable living practices, along with similar programs put in place in basic education settings worldwide.

Introducing global policy ensuring that greenhouse gas emissions continue to decrease in developed societies now and do not increase with developing societies in the future will be necessary to ensure electric availability does not result in further greenhouse gas emitting practices like they have in the past. Policy requiring increasing amounts (to an eventual 100 percent) of the energy supplied to fuel the GEG be renewable sources will ensure a decreasing reliance on non-renewable energy sources. Increasing capital investment in green technology development and deployment in wealthy regions will aid in decreasing reliance of unsustainable technology use and dirty energy consumption, and potentially lead to the development of products and practices that can be incorporated into developing regions' budding markets.

6.35 From the Drawing Board to Reality

Establishing a global energy network is a monstrous task. In a world where we divide our land via borders and separate governing entities, the prospect of developing a globe-spanning system involves getting *everyone* on the same page. Examples of how difficult it is to achieve change within the United States' borders alone are infinite. Obtaining unanimous support for a global energy grid will be arduous at present times considering the monopoly that non-renewable fuel suppliers have on the energy industry. But petroleum, natural gas, coal, and other non-renewable fuel stores are constantly dwindling. As the push towards transitioning to renewable energy around the world gains momentum with technological advances and rising support, the possibility of harvesting enough renewable energy at local levels to supply a global network will become real.

Renewable energy projects carried out at the local level can cater to whichever energy sources are abundant in specific regions. It is up to every country and region to push for the acceleration of these projects within their borders and to citizens of the earth everywhere to encourage others to support these projects as well. It has been the mission of various organizations to educate and encourage world leaders to adopt the idea of a global energy grid in hopes that those with influence can soon push forward on a project of this scale. Designing a proposal for the grid to be presented at international conferences like the World Economic Forum, summits on population, sustainable develop-

ment, and renewable energy, and United Nations meetings could rally global support for a project that could bring cheap renewable electricity to all people while cultivating international cooperation, creating millions of jobs, improving quality of life, and decreasing birth rates. The Global Energy Grid is an evolving concept that has already taken form in some places.

Jeremy Rifkin, American economist and founder of the Foundation of Economic Trends, looks beyond the 20th century model of centralized energy and describes the foundation of a new energy age in his book *The Third Industrial Revolution: How Lateral Power is Transforming Energy, the Economy, and the World.* [100] As an advisor on the European Union on Climate Change and Energy Security, he has played a large role in devising the scheme that will transform Europe into a renewable energy leader by veering away from the antiquated view that energy should be captured at few remote sites and then distributed outwards to where energy sources do not exist. The presiding vision of a global energy grid relies in part on the existing system that circumscribes the fossil fuel age, and could entertain a more plausible, efficient, and successful future were all of its advocates to adopt some of the ideals that Rifkin has. He recognizes that renewable energy sources are abundant in different forms in almost every corner of the planet, and should not be extracted and distributed with the same rules that govern how we have managed energy extraction, storage, and distribution in the past. He focuses more on the development of localized micro power plants that harvest renewable energy on site and eventually feed into a central system via the exchange of an internet based system that is designed to track virtual units of available energy. Instead of physically transmitting remotely harvested energy across continents or across the globe, everyone is fitted with the ability to harvest energy based on what renewable sources are locally available, and a worldwide system is created and sustained by this virtual system. A simple, and thus-far successful, plan to re-fit buildings and ensure that new buildings within the European union will be equipped to harvest energy locally, alongside larger scale projects like wind farms that capture energy in regions where specific sources are particularly abundant, has been adopted and mandated in the European Union. Since its adoption, Europe has become the global leader in the renewable energy movement. This revised vision of a Global Energy Network is an example of how concepts evolve when people are willing to forego past ideals and explore new ways of thinking.

7. Conclusion

The time has come for global leaders and governments to recognize that the Earth can no longer support above-replacement fertility.

7.1 Imagine That

We are consumers by nature, every living thing on this planet is. The difference is that we do not have a role in a chain like all other organisms. They consume and waste, but

100. Rifkin, Jeremy. *The Third Industrial Revolution: How Lateral Power Is Transforming Energy, The Economy, and the World.* Palgrave, Macmillan 2011, New York NY 10010

their waste becomes another creature's consumption. There is nothing dishonorable about being a consumer, but the tables begin to turn when the consumer is no longer a participant in a cycle. Humans took themselves out of the loop when they developed the ability to rearrange nature to better fit their needs. The complete lack of respect for the balance in the natural world is a man-made phenomenon. Practices developed by people wanting to make more money by increasing the efficiency of their product or their product's production are now the mandated norm as the sustenance of large populations depend on them, with no regard for how destructive that practice may be. What if we could develop practices with the main goal in mind being efficiency *and* sustainability because they didn't have to provide for an ever-increasing population? What if the re-design of industry were to result in practices that took only what was sustainable to drain from the resource pool and created something consumable for another life form on the other end of production? What if the evolution of human industry were to move towards finding a place for humans to fit in the consumption and waste cycle that *all* other life fits into? The permaculture movement, which holds that vision as its most precious totem, is already a small but growing presence in the green movement.

All other species are able to take their place in nature's consumption and waste cycle, because it is Nature who decides how big their populations can grow. Populations in nature grow only as big as their resource pool allows them to. Without ever being aware, populations within ecosystems wax and wane as the energy/food provider below them on the chain, and the consumer population above them, fluctuate. We cannot function in this balanced cycle that the rest of nature participates in while our population pays no regard to the volume and health of all that sustains us. It is only when our numbers reflect that which our providers of air, food, energy, space, and all else that we require can sustainably provide, and the consumers of our waste can consume, that we can hope to exist in lasting cooperation with the rules of nature. What if we could stabilize our population at a number that could function more harmoniously with the *natural world?*

With evolving concepts like a global energy grid, a growing communication infrastructure based on the instantaneous transmission of information via the Internet, and a population increasingly aware of the economic, social, and physical changes the world is already beginning to face, we are on the precipice of revolution. A revolution that will find its footholds in the development of sustainable energy sources that fuel an energy-dependent economy will only be truly sustainable with a sustainable population. The backbone of sustainability is the capacity to endure. As humans, we have evolved into a space where we wish not only to survive, but to survive comfortably: to survive freely. We demand clean, adequate space, nourishing and appetizing foods, the technologies to transport us locally and globally, the freedom of choice surrounding decisions about how and where to live. We have acquired a taste for luxury and the threat of its denial is difficult for people to accept. This denial is the social and political barrier that has kept us balancing on the precipice. It cannot be ignored that most of what we enjoy and require as living beings will be at risk with a growing population. The stewardship that we must present as intelligent life forms on this planet requires us to make responsible choices about the use of resources for the sake of future human generations, and for all other inhabitants of this planet that do not possess the element of choice that we do.

Happy and healthy people use resources. Sustaining a happy and healthy population in a world with finite resources will depend on maintaining a finite population.

"If the earth must lose that great portion of its pleasantness which it owes to things that the unlimited increase of wealth and population would extirpate from it, for the mere purpose of enabling it to support a larger, but not a better or happier population, I sincerely hope, for the sake of posterity, that they will be content to be stationary, long before necessity compels them to it."- John Stuart Mill, 1848, *The Art of Living*[101]

"It's time for those people who are pushing for more and more population growth--and who refuse to see the clear warning signals--to simply admit that they don't really care if others stay in poverty, ignorance and chaos. Because, in fact, that is what they are really saying."… "The fact is, we know now what works in developing countries to limit population growth: a reasonably non-corrupt representative government, appropriate forms of economic freedom, a just legal system, a wise diversification of economic resources and income, a high investment in education, women's rights AND family planning." - Georgie Anne Geyer, 1999, Population Press[102]

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