# Population

*The key problem facing humanity in the coming century is how to bring a better quality of life -- for 8 billion or more people -- without wrecking the environment entirely in the attempt.*

*- Edward O. Wilson*

## Exponential Growth

 When I was born in 1971, there were roughly 3.8 billion people on the planet. Today, that number has about doubled and world is now housing about 7 billion people. Most of us don’t pay attention to population; the numbers have little relevance to our lives. I would bet that you can’t even comprehend 7 billion people. But population is important because each person born has an impact on the world. They consume water, food, timber and oil. They throw away diapers, bottles, cell phones, and appliances. Even if each and every person on the planet consumed less and threw away less, environmental destruction would still increase because every year there is more people consuming those resources. A discussion of environmental issues without a discussion of population growth is futile.

 But it is important to remember that not all populations are created equal. Populations are not growing everywhere equally and populations everywhere are not using the same amount of resources. In first world nations, there are fewer of us and we are not growing very fast, but each of us uses far more resources. In third world nations, there are billions more people and they are growing at a faster rate, but their per-person consumption of resources is only a fraction of ours. But as we begin to make sure every single person on the planet is living like an American, the world’s role model, our discussion becomes not whether there are enough planetary resources to care for 300 million Americans, but 8 billion people and growing.

 To first understand the urgency of addressing population issues, we must understand how populations grow. Many of you may be familiar with arithmetic growth. This means that each year, something grows by a set amount each year. If we were to graph this kind of growth, it would look like a diagonal line rising on a graph. Populations, however, do not grow arithmetically, but exponentially. Thomas Malthus first identified this type of population growth in 1798 when the world population was less than 1 billion people. Before explaining this type of growth, go to this website and write down the number you see: [www.worldometers.info/world-population/](http://www.worldometers.info/world-population/). The number will be moving fast, so just do the best you can. Also write down the time you read the number. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 To explain exponential growth, work through this hypothetical problem with me. Let's say I wanted to hire you to work for me for a year and I gave you two options for payment.  In the first option, I could pay you a flat fee of $1 million dollars.  Sounds enticing, doesn't it?  But let's say the second option meant that I would pay you 1 penny for the first day, 2 pennies for the second day, 4 pennies for the third day, 8 pennies the 4th day, 16 pennies the 5th day, etc.  But, I would only pay you for the first 10 days of work.  You would then be required to work for me, for free, for the remainder of the year.   What would you choose?  The million dollars or the pennies doubling each day?  What would be the most profitable?

What if you learned that after one week’s worth of work, 7 days, you only earned 64 cents?  Or that after 2 weeks, you've only earned 81 dollars and 92 cents.  Would you prefer the million dollars then?  It turns out that if you choose the pennies a day to begin with, by day 30, you will have earned $5,368,709 and 12 cents.  In just 5 more days, you would earn $171,798,691 and 80 cents.  By the 40th day, you will have earned in the billions at $5,497,558,139.  48 days would bring you into the trillions, and you would be earning in the octillions by the 100th day. How did this number get so big, so quickly, when it stayed in the pennies and the dollars for so long?  This type of growth is called exponential growth.  In the beginning, growth is slow because you are only doubling pennies, then dollars, and then into the hundreds of dollars.  Even, several weeks later, you're only in the thousands.  This seems to pale in comparison to the one million dollars offered.  But what starts off as slow growth, quickly escalates when you're working with bigger numbers rather than smaller numbers.  Doubling pennies or dollars doesn't produce much.  But when you finally get to the thousands, the doubling picks up the pace.  Once you're in the millions, you're now quickly escalating the value to much larger numbers.  If you were to graph this growth on a chart, it would form a curve that is shaped like a J.  Slow growth over a period of time, which quickly escalates into huge values.

This growth is how the Earth's human population has been growing.  In the entire history of humanity, population has remained relatively stable and low in the millions of people.  It took until only about 200 years ago, 1800, to reach 1 billion people.  One took tens of thousands of years to reach, then only took 130 years more to double and reach 2 billion people, in 1927. Currently, it takes less than 12 years to add 1 billion people to the planet. The chart below shows the dramatic escalation of population growth over time.





Exponential growth is directly related to the rate of growth. To understand this, think about a savings account. If you want to see your money grow over time, you’ll want to put it into an account with the greatest interest rate so you see the greatest return on your investment. If you put $20,000 in the bank at 3% interest, you’ll see your account grow $600 dollars the first year, $618 the second year, and so on. But if your interest rate is at 6%, you’ll make $1,200 the first year and $1,272 the second year, more than double the gain. The rate of population growth around the world has actually been decreasing over time. Today, most people around the world have fewer children, with greater numbers of people in first world nations having only 1 or often no children in their lifetimes. An average number of 2 children per couple is considered the replacement rate for population growth and would lead to approximately a zero rate of population growth, or population stabilization. If a couple has two children, they have one child to replace one parent and one child to replace the other parent. The number of people added to the planet is held constant, leading to a 0% growth rate. The world population growth rate today is approximately 1.15%, much smaller than at any other time in history.



 While this is cause for celebration, the growth rate is dependent on the number of people on the planet. Let’s look at the bank account example, while it is good to put your money in an account with the greatest interest rate, the amount of money you will make will depend on how much money you put in that account. You will make $1,200 at 6% interest on $20,000. But let’s say you put more money in that account, say $50,000. Even with a smaller interest rate of 3%, you would make more money, $1,500. This holds true for population growth. The world population growth rate hit it’s highest point in the 1960’s, with a world growth rate of more than 2%. But the world population was much smaller then, only about 3 billion people. So let’s do the math. With a world population of 3 billion and a growth rate of 2%, in the 1960’s we were adding 60,000,000 or 60 million people to the planet every year. Today, however, our world population base is 7 billion. With a 1.1% growth rate we are currently adding 77,000,000, 17 million people more every year.

## Malthus

 In 1798, a political economist by the name of Thomas Malthus began to see the first hint of exponential population growth and the problems it may be causing. He made his argument in a still controversial paper called *Essay on the Principle of Population.* In this essay he made a link of exponential population growth to deteriorating living conditions in nineteenth century Europe, arguing that populations will grow unchecked until environmental limits bring growth to a screeching halt with poverty, hunger, overcrowding, and resource scarcity. Simply put, we won’t slow our population growth until lack of food and water forces us to. While some of his ideas are controversial and approach social Darwinist ideas of Herbert Spencer, he argues that humans, like animals, have a tendency to overproduce, even beyond what they can possibly provide for and feed. While he demonstrates that populations are growing exponentially, he points out that food is only growing arithmetically, meaning the amount of food available is growing, but at a steady amount each year, (also known as linear growth). Exponential growth will quickly overtake food production. This means that at some point, there will be more people than food and resources available. The chart below depicts each type of growth, showing how exponential growth while remaining much lower than linear growth for a while, quickly overtakes and surpasses linear growth.



Where he became controversial is where he placed the blame for the problem and the solutions he proposed to address this imminent collapse. Malthus blamed the poor arguing that their unwillingness to control their own fertility was to blame for their own poverty, an argument that still has power today. He argued that family size, particularly that of the lower classes, should be limited. His ideas overlap with Herbert Spencer, a sociologist of the same time frame who argued that the poor, who he believed held biologically inferior qualities, should be given no aid so they die off, no longer serving as a drain on a developing society. Malthus, controversially, also adopted the idea that the poor should not be allowed to reproduce, at least in the same numbers as the upper classes.

It is true that poverty is related to population growth. Today, poor countries have much higher population growth rates, with some exceeding 3%, while many first world countries have hit population stabilization, with growth rates between -.3% and +.3%.

While Malthus adopted eugenics ideas (only allowing biologically superior people to reproduce and eliminating the biologically inferior) in his solutions, his ideas have had an impact in the environmental movement today because he was the first to argue that resources are not unlimited. Human populations cannot grow infinitely, expecting resources to always be plentiful. The ideas from Malthus are similar to the biological concept of Overshoot. Overshoot is a concept explained by biologists in which animal populations follow a pattern in which they overproduce their population size, extend their resource use beyond the carrying capacity of the environment, and slide into a die off as their population numbers sharply dwindle to below the carrying capacity. The Overshoot movement argues that human are heading into a similar die-off pattern as we have currently overshot the Earth’s carrying capacity. The numbers calculated suggest that the Earth’s population is currently living at 1.2 times the available resources of the planet. (source?)

## Strains on the Environment

 While Thomas Malthus identified food as the critical resource, overpopulation leads to an overuse of a wide variety of resources, from water to trees to fossil fuels. Since Thomas Malthus, the risk of adverse impacts on human populations is becoming more widely apparent. One startling revelation of overpopulation leads to more dense living conditions in which diseases and other pathogens are more easily spread. Exponential population growth is putting incredible strains on the environment for water, food, natural resources and disease prevention.

One fifth of all water used comes from non-renewable sources, like underground aquifers that do not replenish themselves quickly.  97.5% of all water on Earth is salt water, leaving only 2.5% as fresh water. Nearly 70% of that fresh water is frozen in the icecaps of Antarctica and Greenland; most of the remainder is present as soil moisture, or lies in deep underground aquifers as groundwater not accessible to human use.  Less than 1% of the world's fresh water supply is accessible for direct human uses. This is the water found in lakes, rivers, reservoirs and those underground sources that are shallow enough to be tapped at an affordable cost. Only this amount is regularly renewed by rain and snowfall, and is therefore available on a sustainable basis. The largest source of water must be desalinated at an inordinately expensive cost, which is currently done in several places in the Middle East using the excess wealth generated from oil production. Desalination requires costly plants that can remove salt from ocean or salty water sources and is generally cost prohibitive for most countries. All other sources of water simply won’t be replaced into the natural environment at the same rate we use it.

Most of the water used for humans is used in agriculture which is responsible for 92% of the total water used globally. (UNESCO\_IHE, 2010 waterfootprint.org) Most of the water used throughout the world is not consumed and after used is returned to water supplies as surface runoff. This water is, however, contaminated with chemicals and pesticides or bacteria and other diseases. This is contamination of water supplies is generally the source of cholera outbreaks that cost thousands of lives and millions of dollars, for primarily poor nations throughout the world. Another sizable use of water is industry and energy production which must use water to cool down their machinery. The water is drawn to flush their systems for cooling and the heated water is then released back into the water source, usually with some manufacturing residuals. Larger populations mean more energy production, manufacturing and agriculture. According to UNESCO-IHE Institute for Water Education report in 2010, production of only 1 kilogram of beef requires 15 thousand liters. When looking at only the Netherlands, a 150 gram soy burger uses about 160 liters of water, where a burger requires about 1,000 liters. Comparing countries, each person in China uses about 1070 cubic meters of water per year, 1380 cubic meters for each Japanese, and 2840 cubic meters for each person in the United States. Most of our tremendous water usage doesn’t come from our showers and dishwashers but from all the water used to provide all of us our timber, manufacturing goods and all of our hamburgers. The United Nations' Global Environment Outlook 4 report estimates that one out of every 3 people on the planet will not have enough water to meet their needs by 2025.

Aside from water usage, energy and resource use has increased as well because of population growth. World energy use increased 70% from 1990 until 2008, not only because of population growth but because of per capita increases of 41%. So not only are there more people to consume energy, but each person is consuming more and more as our world becomes more and more dependent on cars, machinery and electronic gadgets. In the United States, even states with mild climates are seeing people install air conditioners and heating systems. You may know people who have turned on the air conditioner when it reaches into the 80’s outside, a temperature that never would have called for an air conditioner before. In addition to energy usage which requires extraction of oil, natural gas and coal, other minerals used in manufacturing are being extracted at ever increasing rates. According to the US Geological Survey several minerals are already declining in amount extracted each year, meaning miners are able to get less and less out of the earth each year. These include bauxite, copper, iron ore, magnesium, phosphate rock, potash, tin, titanium and zinc. Only time will tell if alternatives will be found for each before it becomes prohibitively expensive to mine what’s left.

Probably the scariest threat to population growth is the threat of diseases. We’ve all seen movies or read books like Contagion or The Stand where some disease spreads through the world killing off large populations in the process. It’s scary, particularly when we see increases in AIDS, H1N1, the Bird Flu, SARS, West Nile Virus, malaria, dengue fever, cholera, hepatitis, rotavirus, typhoid and yellow fever. While many of these diseases are treatable, if not curable, they tend to prosper in countries with the densest populations. This is no coincidence. Germs and the insects or rodents that carry them thrive best when they are able to spread to new hosts, and dense populations mean an abundance of new hosts. Sparse, rural living means that diseases may die with the host before being able to reproduce in other individuals. In 1800, less than 3 percent of the world’s population lived in cities, by 1900; it was up to 14%. Today, about half of the world’s population lives in cities. In 2008, there were over 400 cities around the world with populations larger than 1 million people. (Population Reference Bureau) Crowded cities become breeding grounds for mosquitoes and other disease bearing insects and rodents. Sanitation systems become overburdened creating infestations, with many items in cities that hold stagnate water such as old tires, tin cans, and other containers.

Not only are sanitation issues associated with crowded cities a problem, but the density of humans in close quarters are also an instigator of more and deadlier diseases. Parts of Africa have dealt with malaria epidemics in part because of increased density of populations. Malaria is spread by infected mosquitoes, and increased population means that mosquitoes have greater contact with human hosts with greater ability to spread malaria from person to person. In isolated populations, mosquitoes are less likely to have been exposed to other infected humans and are therefore, less likely to be infected themselves and spread the virus. What this means is that dense populations in Africa must resort to using stronger pesticides like DDT to curb mosquito populations exposing these populations and the local environment to harsher chemicals.

Dense populations not only increase the transmission of diseases from person to person because of an abundance of available hosts, but diseases are given the freedom to evolve into more virulent forms. (Cowley 1993) Viruses and bacteria like all life forms change and evolve over time, adapting to their new environment. Biologically most ‘germs’ are relatively benign. You are covered in viruses and bacteria, both internally and externally. Many of them are even helpful, aiding your digestion process. Generally speaking, germs that harm their host are not doing themselves any favors. After all, if they harm the host, they put their own existence in jeopardy. If you kill off your food supply, you kill yourself. The same analogy could be made of humans on this planet. But, if there are more people in close contact then it doesn’t matter as much if the germ harms their host, they can simply transfer to a new host and expand. As evidence of this theory, diseases that can exist in the external environment for longer periods of time or can live on a mosquito waiting for a new host like diphtheria and malaria can afford to be more aggressive. It is not consequence to them if the host suffers or dies when they can simply wait patiently for a new host to infect.

One theory argues that this may have been the evolutionary pattern of the AIDS virus from primates to humans. With varying strains of the AIDS virus, some strains are simply more virulent than other strains. HIV/AIDS was first described in the medical community in the early 1980’s when populations in Rwanda, Zaire, Zambia and Uganda began seeing large groups of people being sickened and dying from the disease. Despite its appearance on the global scene in the early 1980’s, blood samples from as early as 1959 show evidence of the antibodies. Evidence suggests that the earliest strains may have been less deadly with the most virulent strains popping up in the densest populations of Africa. Of the two major strains of the AIDS virus, HIV-1 and HIV-2, HIV-1 is the most virulent and common, causing 90% of all AIDS deaths. HIV-2 is the gentler version found more in West Africa. In isolated regions of Africa like Senegal, the HIV-2 virus appears to be gentler, but more aggressive in the urban more populated area of the Ivory Coast. Therefore, AIDS appears more aggressive when it can move through crowded populations more quickly, but must remain more harmless when less able to do so in isolated, sparsely populated populations. If this theory is true, it means that population growth and denser urban living will have an impact on the appearance of virulent diseases and more harmful strains of diseases already in existence. This already played itself out in history with the Black Plague. It moved rapidly through the densely populated cities of Europe until the population was culled enough, (some cities lost between 30% to 50% of their population). Once the populations were culled, the disease receded into the background. High populations of our future could mean an appearance of deadly diseases unless we are able to control their transmission.

## First World vs. Third World Growth

 Most of the world’s population growth has taken place in poor countries of the Third World. Growth rates vary from the negatives for several first world countries like Russia, Japan, and Germany, to well over 3% in poor nations like Kuwait, Yemen, Congo and Ethiopia. (<http://news.wikinut.com/Trends-in-World-Population-Growth/15m_r4oj/>) But the big question is what is driving the high population growth in these poor nations were families are less financially able to care for many children. To understand why families in poor nations have more children, we have to look at the economic, social and religious implications of children. In the United States, children are viewed as a financial burden. You have a child because you want to share your love with another live and provide for that child, but it will cost you. Aside from the financial costs of the pregnancy and deliver, you will have to clothe them, feed them, decorate their room, and buy them a cellphone, iPod, and Xbox, and pay for babysitters and daycare. And this is just their early years. Eventually you will have to pay for their college education. You could spend tens of thousands of dollars over the course of their life. This is not something we jump into lightly. Not only is their financial pressure to have fewer children, but families with large numbers of children are socially unique. In fact, they are so rare, that we make special shows about them on cable television. There are social pressures to have fewer children, particularly in higher pay and more demanding careers. Additionally, birth control is readily available and ubiquitous. There is no need to get pregnant if you don’t want to. In a wealth nation among wealth individuals, all the social cues push towards fewer children. A growth of families with only 1 or even no children is a growing trend. According to the Census Bureau, 41 states showed a decline in married couples with children. As recently as 2000, households made up of married couples with children were less than 20% in only one state. Just 10 years later, it is 31 states. In first world nations, children's cost is a built-in incentive to limit the number of children.  More children equals a lower quality of life, at least financially.



 In poor nations, the role of children in society is remarkably different. Rather than viewed as a liability, they are often viewed as an asset, particularly male children. Giving birth to a child in an agricultural economy is the equivalent of giving birth to little workers.  By very young ages, they can fetch water, feed chickens, care for and milk animals, harvest fields, and even earn outside income.  What is an economic liability in the United States is an economic asset in poorer nations. Children as young as 4 or 5 can begin doing basic chores such as fetching water; an important task for areas of the world without running water. By the age of 9 or 10, they can begin basic agricultural work, and by 12 they are often working outside the home for extra income.

 Despite the economic benefits of children for families in the third world, a primary reason women still have many children is social status and religious motivations. Societies in which women are held in low regard restrict women’s social contribution to child bearing and they have a lot of children, generally beginning at a very young age. When women are able to pursue education, careers and leadership positions in the community, their birth rates subsequently decline. The formula is actually straight forward, economic progress of women leads to lower birth rates and better standards of living for families. The World Bank was well aware of this relationship in the early 1990’s when they said "educating girls quite possibly yields a higher rate of return than any other investment available in the developing world.” (Summers)

 Countries in East Asia and Latin America have seen improvement in the education of girls and are experiencing the benefits of that equality. Unfortunately, in the countries with the highest growth rates, situated in Africa, the Middle East and South Asia, education among girls is lagging behind that of boys. When education of girls fall behind, cultural forces are at play. In these countries, boys are responsible for taking care of their elderly parents. Girls will join her husband’s family, taking on the care taking responsibilities of her in-laws. Encouraging economic security of a daughter provides no direct gains for parents. It is an economic investment that can only benefit another family. Additionally, the return on investment for educating sons is far greater than for daughters. School can be expensive in these countries which often do not subsidize education fully, with families having to pay school fees, and buy books and uniforms. Where you will see a return on that investment with earned income, the price seems worth it. For daughters, though, the cost is viewed as wasted money. First, women help out in the household during the day, and the time they spend in school is lost labor. Second, their economic opportunities are limited; meaning their return on investment is much lower. With less future economic opportunities, it is not surprising that parents are averse to educating their daughters. Multinational corporations encourage this disparity by relegating women to rote monotonous jobs that pay very low wages. Finally, countries without gender equality are very dangerous places for women outside the home. Parents fear for their daughter’s safety and the cultural traditions support very protective roles of men over women. Sending girls to school often puts women at risk for violence. In countries like Afghanistan, the risk is so high that schools for girls are often in secret locations, hidden to protect both the teachers and students.

 Without education and economic opportunities for women, they are limited to their roles as mothers and caretakers. Social status for women is only linked with bearing children, particularly male children. Given the role of women in these nations, at a social level, investment in education for girls has been insufficient. Economic policies adopted by these countries generally require greater push for economic investment in multinational corporations rather than government spending on social programs. This is true, despite the evidence that educating the women is not only the best way to reduce birth rates, but also produce sustainable economic growth.

## Demographic Transition Theory

 While Malthus argued that populations would continue to grow unchecked, the population growth of Europe has belied that trend. Demographer Frank W. Notestein in 1945 set forth a critique of the Malthusian argument that addressed the declining population rates of Europe and other developed nations. Notestein argued that the initial stages of economic and agricultural development raise population growth rates, before settling to a stable population. Following the trend of Europe, he argued that nations begin with relative population stability in their early years, followed by population growth with the rise of agriculture and industry, ending with population stability in modern, economically developed societies. He argues that population stability is a direct result of increasing wealth and development. Notestein discusses the trends in each of these three stages:

Stage 1: Historically, civilizations had high birth rates coupled with high death rates. Women gave birth to many children over a life time, with very few of them surviving into adult hood. Child birth, childhood diseases, malnutrition, poor sanitation and hygiene contributed to this high death rate. Life expectancies only reached the 30’s or 40’s. Knowing that many infants would not survive into adult hood, families were encouraged to have many children who could help work on the farm and be a source of labor. Large numbers of children were idealized. Additionally, birth control was not wide spread and for families, there were no social pressures to reduce the number of children, but to expand the number of births. At this stage, however, the population remained stable as high birth rates were canceled out by high death rates.

Stage 2: During the industrial and agricultural revolution, the high mortality rates for children were mitigated by many advances in improved sanitation, vaccinations, diseases, child birth, and medical care. Agriculture meant a stable food supply limiting the extent of famines. Fewer mothers and newborns died in child birth. Vaccinations mean more children survived childhood. Sanitation and other structural improvements reduced the likelihood of people dying from diseases spread in urban waste. With a drastic drop in death rates populations grew and grew rapidly. At this stage birth rates did not follow the declining death rates. Societies still valued large families. Defined as a cultural lag, where cultural values generally follow behind technological advances, the desire to have many children did not correspond with the technological and medical advances that helped reduce the death rate. Simply knowing your children were all likely to survive into adult hood, didn’t mean that families stopped having more children. But because of this lag, this stage is characterized by relatively high birthrates, but low death rates. The result was rapidly increasing population growth. Europe’s population exploded during this stage.

Stage 3: Eventually, the birth rate stabilizes as social norms and expectations catch up to the technological and medical advances of development. Increased economic improvement means that children’s role in societies change from workers to luxuries. In well-developed economies, small families become the ideal. Many children are a financial burden with their corresponding costs for day care, college, and consumer items. Additionally, in wealthy nations, the emphasis is on luxury and quality of life rather than large families. Birth control becomes easily accessible and women have fewer children later in life. With a low death rate and low birth rate, the population stabilizes. European nations took centuries to move through all three stages, while some wealthy nations, like the United States, have still not yet reached population stabilization. Issues like immigration and religion are considered some of the biggest obstacles to population stabilization in the United States, preventing us from reaching stabilization like Europe.

While the Demographic Transition Theory does a very good job explaining the population growth rates of Europe, it has been a very poor predictor of population growth for the rest of the world. While most nations, rich and poor, have seen falling death rates due to advances in medical care and technology, this has not been followed by declining birth rates. The question is why? In Sweden, France, Germany, and other European nations, as their quality of life has improved into a consumer culture, women have chosen to have fewer children. This pattern has not developed elsewhere. The primary reason for this pattern is that Notestein identified a correct pattern, but misunderstood the causes of the declining birthrates.

Women in first world nations, following economic development, began to have smaller numbers of children later in life, not because of economic development, but because of the economic parity that was ushered in by modernization. If we look at the history of child birth among women, we see that it closely follows the participation of women in the economic and political spheres of social life. Hunting and gathering communities generally have low birthrates, primarily because women contribute as much as 80% of the caloric food supplies by gathering. This is an activity that can easily be shared with their role as mothers. With children strapped on their backs, they can work all day. Furthermore, the extended time they spend breastfeeding their children slows their reproductive rate, as nursing women have lower fertility.

As societies progressed into the agricultural era, the heavy machinery meant that women were no longer the primary food producers. Their role in the economy was limited and they became increasingly restricted to the home front as housewives. Birthrates increased as women saw their social status and economic participation decline. Economic development of the modern era changed this role of women in Europe. Wealth for a nation meant an increase in the kinds of jobs that women could easily move into despite their role as mothers. Service sector jobs meant a whole host of economic opportunities for women. With this growth in the job market, societies saw the benefit of employing women and began to offer accommodations geared towards women, offering paid maternity leave, child care and medical care. Interestingly, despite the fear that these may encourage the number of children women would have, it actually decreased their birth rates. With these incentives, women came closer and closer to economic equality with men and responded by participating more in the work force and less on the home front. Birth rates declined, and not because of economic growth but gender equality.

 Among many countries of the third world, economic development has not translated into gender equality for women. As transnational corporations have moved in to establish manufacturing, women are relegated to low status, low paying jobs. Mining jobs and much of the skilled factory work is left to men leaving women with few opportunities outside of child birth. Economic development in these countries has not been brought by these countries but to these countries from outside first world corporations. As a result, the jobs that are developed are not the kinds of service section jobs requiring higher levels of education that lift women higher on the socioeconomic ladder. Those jobs still remain in the first world. Without economic and educational opportunities for women, birth rates remain steadfastly high.

## Age Structures

 What if, in a hypothetical scenario, people around the world were able to lower their birthrate and from this moment forward, all women only gave birth to two children, no more. What would happen? Two children is considered replacement rate, each child replacing each parent and should lead to zero population growth. Would the world’s population begin to decrease, would it stabilize, or would the global population still continue to increase? Before addressing the answer, let’s look at China. China implemented a one-child only policy in 1979 under Chinese leader Deng Xiaoping. While many people believe the rule is applied to all Chinese, it is actually only applied to the ethnic Han Chinese living in urban areas. Rural Chinese are exempt, primarily because of the economic need for more children. Despite the application to only city dwelling Chinese, it has had an impact on the reproductive rate of the Chinese, reducing the average number of births per women to 1.7, lower than the 2.1 held by the United States. Germany, which has reached population stabilization, currently averages 1.4 births per woman. (Matt Rosenberg) Theoretically, with a birthrate lower than the replacement rate, their growth rate should not only stabilize, but decrease. But has it? This policy has been effect for more than 30 years, and has their population growth stabilized? No. While their growth rate has decreased from more than 2.5% in the 1970’s to .5% today, it has still not reached population stabilization. During the period from 1980 until today, years under the one-child only policy, their population grew by 300 million people, and their population is currently at 1.3 billion, almost 20% of the entire world’s population. Their population is expected to peak in the late 2010’s at 1.4 billion, where it is then projected to decline, more than 40 years after implementing the policy.

 The question is why. Why will it take 40 years after reducing fertility rates to reduce the growth in the population in China? The reason has to do with age structures, reproductive age and population momentum. Let’s start by talking about age structures. Every society has members in every age group: 1-5, 6-13, 14-21, etc., all the way to the oldest age groups of those 85 and older. But not every society has the same proportion of their population in each age group. Some societies have more people in the younger age groups, and some societies have more people in the older age groups. For instance, you have probably heard references to America’s aging society, which is creating problems with social security, Medicare and other benefits for the elderly. What this discussion is referring to is that prior to 50 years ago, families had a lot of children and the population of the United States had a lot of children under the age of 18. Coupled with an average life expectancy of about 67 years, the age structure of the United States looked like this:



Each bar represents an age group with the youngest age groups on bottom and the oldest age groups on top. Boys are on the left and girls are on the right. With an age structure, roughly the shape of a triangle, you can see that most of the population is very young, far more children than elderly. With an age structure like this, that country will see rapid population growth. A lot more people are being born than are dying. The first bar would be the number of young children entering the population and the top bars would be the number of people leaving through death.

 Another point of consideration is the number of women in the middle bars, roughly between the ages of 15 and 45. They are important because they are the size of the population of women in their reproductive years, the women who have, are, or will give birth. Now, let’s get back to our original question. What would happen if all women across the globe, today, limited the children they bore to 2 and no more? To answer this question, we would have to look at not only all the women in their reproductive years, many of whom have already given birth to more than one child, but all the young girls who have yet to grow up and have their own children. These children would swell up into their reproductive years, meaning that for the next 40 years we would still see increasing numbers of women who become of age to have children. It would take about 40 years because we would have to start will all of the young infant girls, less than 1, and wait for them to pass their reproductive years which could last until their early 40’s.

 During this 40 year time period, there would be less and less children born, slowly changing the shape of the age structure, until it looked more like a rectangle than a triangle. With a new age structure of a balanced number of young children to elderly citizens, the number of people born would equalize the number of people dying.



 An age structure like modern day Kenya, Algeria and Saudi Arabia shows rapid population growth as compared to that of the United States, Australia and Canada, which shows slow population growth. As you can see from the figure, that the Slow Growth age structure shows a less pronounced triangle, with fewer children compared to that of older Americans. This is indicative of the aging of America that is so often discussed. In time, that age structure will continue to shrink on the bottom, expanding on the top, forming a shape much like that of Denmark, Austria and Italy. The number of children is balanced by the number of older citizens leading to zero population growth. In some places in the world, women are having so few children, that there are actually more older citizens than young children. Germania, Bulgaria and Hungry show this level of negative growth.

 What this means is that population growth cannot be stopped overnight. It takes time for children to expand into their reproductive years, increasing the population. The age structure takes time to change shape from a triangle to a rectangle, roughly 40 years, depending on the shape of the age structure to begin with. In other words, population growth can be compared to a freight train, with so much momentum that it cannot stop immediately. If you apply the brakes to a fast moving freight train, it can take miles for it to finally stop. Translating this knowledge to our future understanding of population growth means that even if we were to act today to address population growth and apply one-child only laws throughout the world, we would still see population growth for decades. As it stands, the world growth rate is decelerating and the world population growth rate is expected to reach zero, by all reasonable predictions, within the next 100 years. However, with 100 more years of growth, the world population is projected to reach 12 billion people before stabilizing. The primary question is, can the planet handle a population of 12 billion people, 5 billion more than what it is already handling?

## Consumption vs. Population

  While it may appear easy, after this discussion, to point fingers at the third world and simply blame them for the problem, it would be missing the real reason we even discuss population growth: impact on the planet. Impact on the planet is not just a function of the number of people, it is also a function of how many resources do each of those individuals consume. The reality is that the world could support several billion people, as long as each of those people was using a very modest amount of resources. This would include a lifestyle similar to that of Europeans where people lived in smaller homes, heated and air conditioned their homes only in extreme circumstances, used primarily public transportation, ate more calories from the bottom of the food chain, and bought much fewer unnecessary items.

 There may be more people in the third world, but people of the third world simply do not consume as many resources as those from the United States. We make up about 5% of the world’s population, but consume 25% of the world’s resources. The American lifestyle requires large homes, gas guzzling vehicles, and lots of shopping. This translates into tremendous consumption that doesn’t increase our happiness, lifespan, or life quality. Consider these numbers. One person in the United States uses as many resources as: 3 Japanese, 6 Mexicans, 14 Chinese, 38 Indians, 168 Bangladeshi, and 531 Ethiopians. On average, we use 100 times the resources as a typical person from a third world country. Even when we compare ourselves to other first world nations, we use *twice* as many resources as a European. Clearly it is not the size of the population that is of the utmost important, but the amount of global impact a population has. With increasing economic pressure to push the consumer lifestyle of Americans onto the rest of the world in the name of global economic growth, the large populations of Asia, India, and Africa will become increasingly more problematic. The planet simply cannot sustain the levels of consumption maintained in the United States for 7 billion people and growing.

 Since you have been reading this issue, I would like you to revisit an activity you did at the beginning of this chapter. Go back to the website www.worldometers.info/world-population/. Write this new number down. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Now, subtract the first number from this number and write it here: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Just in the time you have been reading about this issue, this number represents how many more people are on the planet. This is not how many people who were born; this is how many people were born minus how many people died. This is how many more people there are. How much time passed between getting the first number and the second number? This can give you an idea of how quickly the world’s population is growing.

## Summary