

World Population Passes 7 Billion

Dear Teacher,

This week, the world's population passed the 7 billion mark. The occasion gives us an opportunity to think about the implications of an expanding population for our planet, our well-being, our mission to the world as Christians and what impact so many of us competing for the earth's resources may have. So those will be the topics of this installment of **The Wired Word**.

Remember, if you wish to provide your class members with an abbreviated copy of the lesson, [click here](#), and you can send them a copy via e-mail today.

May God bless you as you teach the Scriptures this week.

The Editorial Team of **The Wired Word**



World Population Passes 7 Billion

The Wired Word for November 6, 2011

In the News

On Monday, a birth somewhere on our planet brought the human family to 7 billion. Because each day, millions of people are born and millions of others die, it was impossible to identify just who that 7-billionth baby was, but the birth was a milestone nonetheless. Speculative portraits in various media suggest that this new individual could be a Chinese or Indian male (males in China slightly outnumber females, and millions of females in India are aborted because of a preference for sons), but it's just as likely that the milestone baby was a female born elsewhere in the world.

In any case, passing this high-water population mark raised fresh concerns about whether the earth has sufficient resources to meet the needs of so many people.

Commenting on the birth, U.N. Secretary-General Ban Ki-moon said the day was “not about one newborn or even one generation” but “about our entire human family.” He went on to note that we live in “a world of contradictions” -- citing famine in the Horn of Africa, fighting in Syria and elsewhere and widespread protests against economic inequality. He acknowledged that a population of 7 billion is a challenge, but added that it's also “an opportunity, depending upon how the international community prepares for that challenge.”

Some directly challenge the idea that population growth is bad for the planet. The late economist Julian Simon argued that while more people make more problems, people are also the means by which those problems are solved. In his 1981 book *The Ultimate Resource II*, Simon said, “The ultimate resource is people -- skilled, spirited and hopeful people who will exert their wills and imaginations for their own benefit, and inevitably they will benefit not only themselves but the rest of us as well.” He also maintained that “minds matter economically as much as, or more than, hands or mouths.”

According to demographers, the world did not reach 1 billion people until 1804. It hit 2 billion in 1927, 3 billion in 1959, 4 billion in 1974, 5 billion in 1987, 6 billion in 1998. United Nations projections say we will

reach 8 billion by 2025 and 10 billion by 2083, unless affected by changes in life expectancy, access to birth control, infant mortality rates and other factors. Several agencies that try to predict future population seem to be coming to consensus that the world population will likely peak at 9.3 billion in the middle of this century and then decline somewhat in the remaining years of the century. (See the “Human Population Growth” link below.)

One way of turning high population numbers into a plus for the world may be through changes in how we educate new generations. Human resource development guru and author Lewis Perelman argues that we need to raise the potential of each mind by training, not for work or to impart knowledge for its own sake, but to spark ingenuity and creativity. Writing in *Salon*, Berin Szoka applies Perelman’s argument to the population milestone just passed, saying, “Tapping the creative potential of all 7 billion minds requires transforming education from an expensive, rigidly bureaucratic system that produces credentials (and enormous debt for students and governments) into a lifelong process that maximizes the creative potential of everyone.”

More on this story can be found at these links:

[7 Billion People Fuel Concern over World Resources. *San Francisco Chronicle*](#)

[Welcoming the 7 Billionth Neighbor. *Salon*](#)

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The Big Questions

1. How does the growing population affect the value of any single human being? Consciously or subconsciously, do you value one portion of the world’s population over another?
2. How ought the rising population affect our expectations about the amount of the world’s resources we Americans will have in the future? Do you consider the world a “zero sum” game -- in other words, there cannot be winners unless there are losers? Do you worry that increased prosperity in developing countries like China and India will mean less available resources to sustain our way of life? Or do you consider the world economy a “win-win” situation? Is prosperity for all possible? Is prosperity a right for everyone?
3. How do “stewardship of the earth” and the “green revolution” (use of higher-yield crops and scientific agricultural methods) apply to the population discussion?
4. Is the rising population good or bad news for the planet, or are there other factors that have heavier influence? Defend your answer.
5. What is the challenge for the church amid the world’s rising population?

Confronting the News with Scripture

Here are some Bible verses to guide your discussion:

Psalm 139:13-16

“For it was you who formed my inward parts; you knit me together in my mother’s womb. I praise you, for I am fearfully and wonderfully made. Wonderful are your works; that I know very well. My frame was not hidden from you, when I was being made in secret, intricately woven in the depths of the earth. Your eyes beheld my unformed substance. In your book were written all the days that were formed for me, when none of them as yet existed.” (For context, read 139:1-24.)

The Bible nowhere comments on the size of the world population, but it does make clear that no matter how many of us there are, God knows each of us personally. In the verses above, a psalmist expresses the confidence that God knows us even before our birth.

Other verses in this psalm, especially 7-12, declare that God knows all our comings and goings as well, and that no part of our lives is hidden from him.

Questions: What does the continuing growth of the population tell us about *God*? If God has made us stewards of the earth and its resources, does that include the human resource? Does your understanding of Scripture affect your views on birth control? Do you consider these unrelated subjects? Explain your answer.

Matthew 6:25

“Therefore I tell you, do not worry about your life, what you will eat or what you will drink, or about your body, what you will wear. Is not life more than food, and the body more than clothing?” (For context, read 6:25-34.)

These words of Jesus form the opening sentences of his comments on keeping our priorities right. In essence, he says that we often worry more about lesser things -- such as food and clothing -- and don't pay enough attention to God's kingdom and his righteousness (v. 33). He wasn't saying that food and clothing are not worth our consideration and effort, but they should not be our only concerns in this life, for life is more than food and clothing.

Questions: Though Jesus counsels that food and clothing are not the most important things in life, as the population increases, our ability to produce enough food and other resources for all must also increase. What hope do you see for that happening? How much concern *should* we devote to this matter? Does this Scripture suggest that we should not worry about population control or extending resources for all people? How do you interpret the tension between preparing for the future and trusting God?

John 10:16

“I have other sheep that do not belong to this fold. I must bring them also, and they will listen to my voice. So there will be one flock, one shepherd.” (For context, read 10:11-16.)

With these words, Jesus told his hearers that he had come not just to be the Savior of Israel (“this fold”), but the Savior of the world. The mark of this expanded flock is that they will all listen to his voice.

Questions: In what ways do these words of Jesus about “other sheep” cause you to think about the needs of people you will never meet who live in very different cultures? What do these words demand of us? Must other populations be specifically Christian in order to be considered one of God's flocks? What do you see as God's connection to all of us? What is our connection with each other under God?

1 Timothy 2:3-6

“This is right and is acceptable in the sight of God our Savior, who desires everyone to be saved and to come to the knowledge of the truth. For there is one God; there is also one mediator between God and humankind, Christ Jesus, himself human, who gave himself a ransom for all ...” (For context, read 2:1-7.)

No matter how many of us there are, God “desires *everyone* to be saved,” and Christ gave himself “a ransom for *all*.”

Question: In an expanding world population, what are the best ways to help people around the globe hear the gospel? Is God somehow reaching populations that have not heard the gospel or that are not receptive? Do increasing populations expand the possibilities for evangelism? Are some segments of the population “unreachable”? Why?

Revelation 7:9

“After this I looked, and there was a great multitude that no one could count, from every nation, from all tribes and peoples and languages, standing before the throne and before the Lamb, robed in white, with palm branches in their hands.” (For context, read 7:1-17.)

This is part of the vision John of Patmos had of worship in the world to come. The “great multitude . . . from every nation” that he sees is significant, for it led to an understanding that the gospel is not for just the few or for just the “chosen.” This verse doesn’t imply that everyone will be saved, but that everyone who responds to the gospel will be. What’s more, it doesn’t imply that only a “faithful few” will be saved, but a “faithful many.”

Questions: Do you actually consider Christians in other parts of the world your spiritual brothers and sisters? Why or why not?

For Further Discussion

1. If it is possible to bring a computer to class and get online, show class members the “World Population Clock” at this link: [Worldometers](#). (You will see the numbers rising rapidly as you view it.) Ask: How does this “clock” make you feel?
2. To what extent do you really consider the Chinese (where there are more English speakers than in the United States) and the Indians (the world’s largest democracy) part of our human family? Do you resent advances in the Chinese and Indian economies in manufacturing and IT? Explain your answer.
3. Although the world population continues to expand, it is not as fast as it might have been. In many parts of the world, there has been a significant decline in birth rate. This has led to concern about the “graying” of societies, and the burden this places on younger people. How do you see that being addressed in the United States?
4. Does it trouble you that the Christian population is declining even as the world population rises? How might we as Christians view this as an opportunity?
5. Did you grow up in what you consider a large or small family? How was that defined? How are these defined today in the circles within which you live?
6. If you can locate a copy of the children’s book, *If the World Were a Village*, bring it to class, summarize its contents and ask class members to respond. See the book [here](#).

Responding to the News

It is good to pray for people around the world, that they will be able to share in the blessings of life.

Other News This Week

Celebrity news websites and even world news sites were abuzz this week about the breakup of the marriage of Kim Kardashian and Kris Humphries only 72 days after the lavish wedding viewed on TV by millions. If

you choose to use this news as the basis of a class discussion, you might find some direction in the following article: [Narcissists Want Weddings, Not Marriage](#). It's probably wise to expand the discussion beyond Kardashian and Humphries to how narcissism affects all of us.

Romans 12:3 is a good scriptural starting place: *"For by the grace given to me I say to everyone among you not to think of yourself more highly than you ought to think, but to think with sober judgment, each according to the measure of faith that God has assigned."*

Consider also 1 Corinthians 13:12: *"For now we see in a mirror, dimly, but then we will see face to face."*

Closing Prayer

Thank you, O Lord, for your love so broad that it covers everyone -- all 7 billion of us ... and counting. In Jesus' name. Amen.

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Dear Class Member,

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If you wish to start thinking about our topic in advance, below is some introductory material.



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The Big Questions

Here are some of the questions we will discuss in class:

1. How does the growing population affect the value of any single human being? Consciously or subconsciously, do you value one portion of the world’s population over another?
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4. Is the rising population good or bad news for the planet, or are there other factors that have heavier influence? Defend your answer.
5. What is the challenge for the church amid the world’s rising population?

Confronting the News with Scripture

We will look at selected verses from these Scripture texts. You may wish to read these in advance for background:

Psalm 139:1-24

Matthew 6:25-34

John 10:11-16

1 Timothy 2:1-7

Revelation 7:1-17

In class, we will talk about these passages and look for some insight on the big questions, as well as talk

about other questions you may have about this topic. Please join us.

Psalm 139

¹O Lord, you have searched me and known me.

²You know when I sit down and when I rise up; you discern my thoughts from far away.

³You search out my path and my lying down, and are acquainted with all my ways.

⁴Even before a word is on my tongue, O Lord, you know it completely.

⁵You hem me in, behind and before, and lay your hand upon me.

⁶Such knowledge is too wonderful for me; it is so high that I cannot attain it.

⁷Where can I go from your spirit? Or where can I flee from your presence?

⁸If I ascend to heaven, you are there; if I make my bed in Sheol, you are there.

⁹If I take the wings of the morning and settle at the farthest limits of the sea,

¹⁰even there your hand shall lead me, and your right hand shall hold me fast.

¹¹If I say, "Surely the darkness shall cover me, and the light around me become night,"

¹²even the darkness is not dark to you; the night is as bright as the day, for darkness is as light to you.

¹³For it was you who formed my inward parts; you knit me together in my mother's womb.

¹⁴I praise you, for I am fearfully and wonderfully made. Wonderful are your works; that I know very well.

¹⁵My frame was not hidden from you, when I was being made in secret, intricately woven in the depths of the earth.

¹⁶Your eyes beheld my unformed substance. In your book were written all the days that were formed for me, when none of them as yet existed.

¹⁷How weighty to me are your thoughts, O God! How vast is the sum of them!

¹⁸I try to count them—they are more than the sand; I come to the end—I am still with you.

¹⁹O that you would kill the wicked, O God, and that the bloodthirsty would depart from me—

²⁰those who speak of you maliciously, and lift themselves up against you for evil!

²¹Do I not hate those who hate you, O Lord? And do I not loathe those who rise up against you?

²²I hate them with perfect hatred; I count them my enemies.

²³Search me, O God, and know my heart; test me and know my thoughts.

²⁴See if there is any wicked way in me, and lead me in the way everlasting.

Matthew 6:25-34

²⁵“Therefore I tell you, do not worry about your life, what you will eat or what you will drink, or about your body, what you will wear. Is not life more than food, and the body more than clothing? ²⁶Look at the birds of the air; they neither sow nor reap nor gather into barns, and yet your heavenly Father feeds them. Are you not of more value than they? ²⁷And can any of you by worrying add a single hour to your span of life? ²⁸And why do you worry about clothing? Consider the lilies of the field, how they grow; they neither toil nor spin, ²⁹yet I tell you, even Solomon in all his glory was not clothed like one of these. ³⁰But if God so clothes the grass of the field, which is alive today and tomorrow is thrown into the oven, will he not much more clothe you—you of little faith? ³¹Therefore do not worry, saying, ‘What will we eat?’ or ‘What will we drink?’ or ‘What will we wear?’ ³²For it is the Gentiles who strive for all these things; and indeed your heavenly Father knows that you need all these things. ³³But strive first for the kingdom of God and his righteousness, and all these things will be given to you as well. ³⁴“So do not worry about tomorrow, for tomorrow will bring worries of its own. Today’s trouble is enough for today.

John 10:11-16

¹¹“I am the good shepherd. The good shepherd lays down his life for the sheep. ¹²The hired hand, who is not the shepherd and does not own the sheep, sees the wolf coming and leaves the sheep and runs away—and the wolf snatches them and scatters them. ¹³The hired hand runs away because a hired hand does not care for the sheep. ¹⁴I am the good shepherd. I know my own and my own know me, ¹⁵just as the Father knows me and I know the Father. And I lay down my life for the sheep. ¹⁶I have other sheep that do not belong to this fold. I must bring them also, and they will listen to my voice. So there will be one flock, one shepherd.

1 Timothy 2:1-7

²First of all, then, I urge that supplications, prayers, intercessions, and thanksgivings be made for everyone, ²for kings and all who are in high positions, so that we may lead a quiet and peaceable life in all godliness and dignity. ³This is right and is acceptable in the sight of God our Savior, ⁴who desires everyone to be saved and to come to the knowledge of the truth. ⁵For

there is one God; there is also one mediator between God and humankind, Christ Jesus, himself human, ⁶who gave himself a ransom for all—this was attested at the right time. ⁷For this I was appointed a herald and an apostle (I am telling the truth, I am not lying), a teacher of the Gentiles in faith and truth.

Revelation 7:1-17

⁷After this I saw four angels standing at the four corners of the earth, holding back the four winds of the earth so that no wind could blow on earth or sea or against any tree. ²I saw another angel ascending from the rising of the sun, having the seal of the living God, and he called with a loud voice to the four angels who had been given power to damage earth and sea, ³saying, “Do not damage the earth or the sea or the trees, until we have marked the servants of our God with a seal on their foreheads.” ⁴And I heard the number of those who were sealed, one hundred forty-four thousand, sealed out of every tribe of the people of Israel: ⁵From the tribe of Judah twelve thousand sealed, from the tribe of Reuben twelve thousand, from the tribe of Gad twelve thousand, ⁶from the tribe of Asher twelve thousand, from the tribe of Naphtali twelve thousand, from the tribe of Manasseh twelve thousand, ⁷from the tribe of Simeon twelve thousand, from the tribe of Levi twelve thousand, from the tribe of Issachar twelve thousand, ⁸from the tribe of Zebulun twelve thousand, from the tribe of Joseph twelve thousand, from the tribe of Benjamin twelve thousand sealed. ⁹After this I looked, and there was a great multitude that no one could count, from every nation, from all tribes and peoples and languages, standing before the throne and before the Lamb, robed in white, with palm branches in their hands. ¹⁰They cried out in a loud voice, saying, “Salvation belongs to our God who is seated on the throne, and to the Lamb!” ¹¹And all the angels stood around the throne and around the elders and the four living creatures, and they fell on their faces before the throne and worshiped God, ¹²singing, “Amen! Blessing and glory and wisdom and thanksgiving and honor and power and might be to our God forever and ever! Amen.”

¹³Then one of the elders addressed me, saying, “Who are these, robed in white, and where have they come from?” ¹⁴I said to him, “Sir, you are the one that knows.” Then he said to me, “These are they who have come out of the great ordeal; they have washed their robes and made them white in the blood of the Lamb. ¹⁵For this reason they are before the throne of God, and worship him day and night within his temple, and the one who is seated on the throne will shelter them. ¹⁶They will hunger no more, and thirst no more; the sun will not strike them, nor any scorching heat; ¹⁷for the Lamb at the center of the throne will be their shepherd, and he will guide them to springs of the water of life, and God will wipe away every tear from their eyes.”

7 billion people fuel concern over world resources

Jon Gambrell, Associated Press

Tuesday, November 1, 2011

Lagos, Nigeria -- One South African mother, just 19, named her newborn "Enough" and shrugged off a nurse who questioned whether she was old enough to know how many children she wanted.

In Nigeria, newborn twins have to share a bassinet in a crowded public hospital that doesn't have enough electricity.

"Where there is life, there is hope," their mother said. But as the world's population surpasses 7 billion, fears were stirred anew about how the planet will cope with the needs of so many humans.

The United Nations marked the milestone Monday, even though it is impossible to pinpoint the arrival of the globe's 7 billionth occupant because millions of people are born and die each day.

At Lagos Island Maternity Hospital, the strain of caring for a burgeoning population was evident. The droning roar of a generator could be heard throughout one hot ward, where it powered ceiling fans and incubators. While Nigeria is oil-rich, it does not produce nearly enough power for its more than 160 million people.

Nigeria's megacity of Lagos is expected someday to surpass Cairo as the continent's most populous.

U.N. Secretary-General Ban Ki-moon said the day was "not about one newborn or even one generation" but "about our entire human family."

At a news conference in New York, he noted "a world of contradictions" - famine in the Horn of Africa, fighting in Syria and elsewhere and widespread protests against economic inequality.

"Seven billion population is a challenge," he said, and "at the same time, an opportunity, depending upon how the international community prepares for that challenge."

Demographers say it took until 1804 for the world to reach its first billion people and a century more until it hit 2 billion in 1927. Soon the numbers began to cascade: 3 billion in 1959, 4 billion in 1974, 5 billion in 1987, 6 billion in 1998.

The United Nations estimates the world population will reach 8 billion by 2025 and 10 billion by 2083. But the numbers could vary widely, depending on life expectancy, access to birth control, infant mortality rates and other factors.

India, which struggles with a deeply held preference for sons and a skewed sex ratio because of millions of

aborted female fetuses, is using the day to highlight that issue.

"It would be a fitting moment if the 7 billionth baby is a girl born in rural India," said Dr. Madhu Gupta, a gynecologist. "It would help in bringing the global focus back on girls, who are subject to inequality and bias."

According to U.S. government estimates, India has 893 girls for every 1,000 boys at birth, compared with 955 girls per 1,000 boys in the United States.

Meanwhile, China, which at 1.34 billion people is the world's most populous nation, said it would stand by its one-child policy, a set of restrictions launched three decades ago limiting most urban families to one child and most rural families to two.

"Overpopulation remains one of the major challenges to social and economic development," Li Bin, director of the State Population and Family Planning Commission, told the official Xinhua News Agency. India, with 1.2 billion people, is expected to overtake China around 2030, when the Indian population reaches an estimated 1.6 billion.

<http://sfgate.com/cgi-bin/article.cgi?f=/c/a/2011/11/01/MNSM1LOJHB.DTL>

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TUESDAY, NOV 1, 2011 6:00 AM UTC2011-11-01T06:00:00ZL, M.J, Y G:I A T

Welcoming the 7 billionth neighbor

Why we should celebrate, not worry about, the planet's growing population

BY BERIN SZOKA



Babies born on October 31st, 2010 in (top left, clockwise) Japan, the Philippines, Nigeria and Russia. (Credit: AP/Reuters)

On Monday, the world population crossed 7 billion, with more than one baby in the world's various time zones getting credit for the milestone. Some mourned this new arrival as bringing us just another step closer to what Paul Ehrlich famously called the “population bomb,” the point at which the number of people on earth explodes beyond the capacity of the planet to support them. But reaction to this statistical event seems somewhat less hysterical than for the 5 billionth (1987) and 6 billionth (1999) milestones. That's probably because population growth rates have slowed with increased empowerment of women, better family planning, and the rising cost of children relative to their

short-term productive value as unskilled laborers. Still, the pessimists' essential myth lives on in many quarters: population growth makes us all worse off.

The late economist Julian Simon devoted his life to challenging that notion. “Adding more people causes problems,” he acknowledged, “but people are also the means to solve these problems.” Simon's optimism was famously vindicated in 1990, when he won a 1980 bet with Ehrlich over commodity prices. Ingenuity had driven down prices of the very resources Ehrlich thought would be made more scarce by population growth.

Thus, while most resources are inherently limited, Simon said, what we can do with them is unlimited. “The main fuel to speed our progress is our stock of knowledge, and the brake is our lack of imagination,” he wrote in his 1981 book, “The Ultimate Resource II.” “The ultimate resource is people—skilled, spirited, and hopeful people who will exert their wills and imaginations for their own benefit, and inevitably they will benefit not only themselves but the rest of us as well.”

So Simon would have celebrated the arrival of our 7 billionth neighbor. More people means more minds—more innovators and entrepreneurs working to improve the human condition. Innovation comes not just from the introduction of a technology, but novel uses of it. Thus, while we tend to focus on inventors like Steve Jobs, no less innovative—and heroic—are, say, the fishermen in Senegal who use their cell-phones to find buyers for the day's catch before their fish spoil, something that used to seem inevitable.

This is essentially the message of Adam Smith's “Wealth of Nations:” Profit rewards people for meeting unmet needs, thus serving the greater good. Smith's “invisible hand” drives not only the constant improvement of computing power but the ongoing transformation of even the remotest villages.

Smith's less appreciated insight is that "the division of labour is limited by the extent of the market." More people means more buyers, too. "Smith's point, as economist Steven Horwitz [explains](#), "was that the degree of specialization that one would see in a given market depended upon how much demand there was for the specialized product. Thus, small towns rarely have ethnic restaurants beyond the very popular Chinese and Italian, nor do they have radio stations that specialize in very narrow musical formats.... Larger, wealthier communities can support this degree of specialization because there is sufficient demand, deriving from a larger population and a larger degree of wealth being produced."

As Horwitz concludes, "production (supply) is the source of demand." Cell phones are working to expand markets at the local level across Africa, boosting the supply of, and demand for a wide range of goods. That's also what the Internet does on a larger scale. As Harvard Law Professor Yochai Benkler [puts it](#), "a global network of communications and exchange that allows much greater flow and conversation, so that many new connections are possible on scales never before seen."

The "wealth" in the title of Benkler's "[The Wealth of Networks](#)" comes from increased cross-fertilization of minds. Matt Ridley, the self-described "[Rational Optimist](#)," put it best: these networks allow [ideas to have "sex" with each other](#).

Simon's optimism rested on his belief that "minds matter economically as much as, or more than, hands or mouths." He would have applauded the "network effects" generated by the Internet as an ever-expanding "market" for ideas.

But just as important is the rising creative potential of each mind through better "training"—not for the kind of "work" done by hands or simply applying "knowledge" that can be memorized, but training for creativity and ingenuity. We need training for *mindcraft*, argued Lew Perelman, who [prophesied the rise of digital learning technologies](#) in 1993. Tapping the creative potential of all seven billion minds requires transforming education from an expensive, rigidly bureaucratic system that produces credentials (and enormous debt for students and governments) into a lifelong process that maximizes the creative potential of everyone. It also requires countering the pessimism that pervades popular culture, right down to the movies and books that inspire our youth.

That culture of pessimism saps the very ambition most needed to innovate out of the very real problems the pessimists worry about. Ehrlich's crisis-driven mentality also fosters top-down, technocratic policymaking—as if the future were an impending disaster that required emergency planning. The optimism of Smith and Simon is pragmatic in recognizing the challenges of population growth (among other things), but also that these problems can only be solved by more and better technologies generated by more *minds* working in larger, better markets. Neither minds nor markets can flourish without freedom to experiment with new ideas, technologies and business models.

That holds true for our seven billionth neighbor whether she's born in Senegal or Seneca, New York.

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Human Population Growth

The Rate of Natural Increase (r)

Birth rate (b) – death rate (d) = rate of natural increase (r).

- birth rate expressed as number of births per 1000 per year (currently 14 in the U.S.);
- death rate expressed as the number of deaths per 1000 per year (currently 8 in the U.S.);
- So the rate of natural increase is 6 per thousand (0.006 or 0.6%).

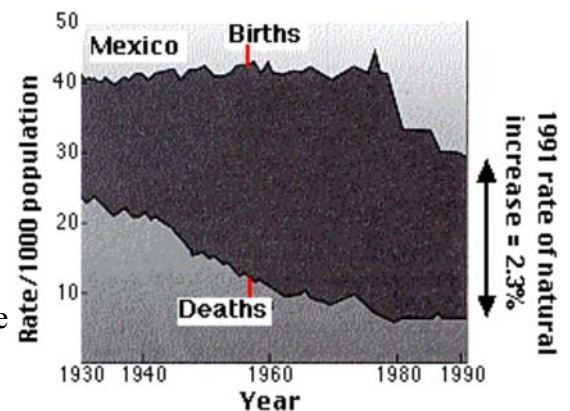
Although the value of r is affected by both birth rate and death rate, the recent history of the human population has been affected more by declines in death rates than by increases in birth rates.

The graph shows birth and death rates in Mexico since 1930. The introduction of public health measures, such as

- better nutrition
- greater access to medical care
- improved sanitation
- more widespread immunization

has produced a rapid decline in death rates, but until recently there was no corresponding decline in birth rates. In 2010, r is 1.4%. (Data from the Population Reference Bureau.)

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Although death rates declined in all age groups, the reduction among infants and children had — and will continue to have — the greatest impact on population growth. This is because they will soon be having children of their own.

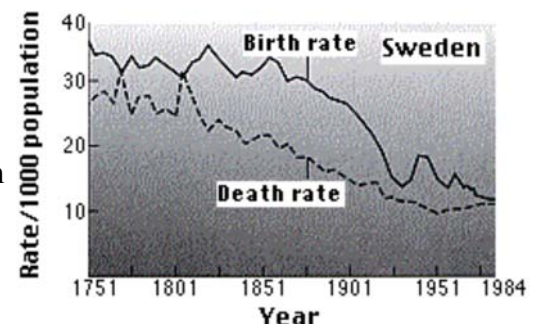
This situation, resulting in a rapid rate of population growth, is characteristic of many of the poorer regions of the world.

The Demographic Transition

Slowly declining birth rates following an earlier sharp decline in death rates are today characteristic of most of the less-developed regions of the world.

The shift from high birth and death rates to low birth as well as death rates is called the demographic transition.

This graph (based on data from the Population Reference Bureau) shows that the demographic transition began much earlier in Sweden than in Mexico and was, in fact, completed by the end of the nineteenth century. The spike in deaths in the interval between 1901 and 1926 was caused by the [worldwide influenza pandemic](#) of 1918–1919.

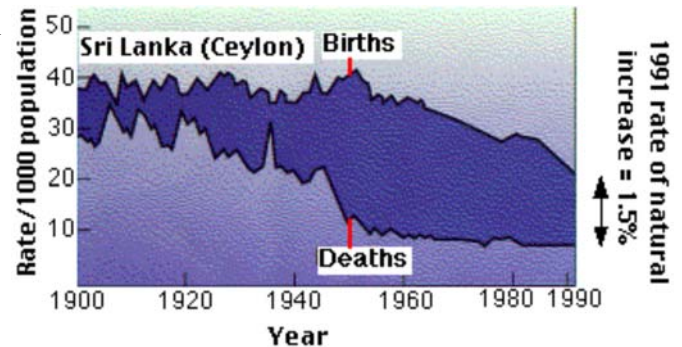


The birth rate in Sweden is now (2010) 12/1000; the death rate 10/1000, giving a rate of natural increase (r) of 0.2%.

The Story of Sri Lanka

Prior to World War II, advances in public health has been largely limited to affluent, industrialized countries. But since then, improvements in public health have been made in many of the poorer countries of the world — always with dramatic effect on death rates.

- In 1945, the death rate in Sri Lanka (then called Ceylon) was 22/1000.
- In 1946, a large-scale program of mosquito control — using [DDT](#) — was started.
- By eliminating its vector, the incidence of [malaria](#) dropped sharply.
- After 9 years, the death rate dropped to 10/1000, and by 2010 was 7.
- But a compensating decline in birth rates has come more slowly (19/1000 in 2010).
- So by 2010 the population was increasing at an annual rate of 1.2% (12/1000/year).
- At this rate the population would double in 57.5 years.



Let's see why.

Exponential Growth

The prediction that Sri Lanka will double its population in 57.5 years is based on:

- the assumption that r will remain unchanged (which is surely false)
- the mathematics of exponential growth.

The product of growth grows itself. So the growth of populations is a problem in "compound interest". At the end of each year (or whatever period you choose to use), the base against which the rate is applied has grown. Whatever figures you pick, as long as r is positive, a plot of population as time elapses will produce an exponential growth curve like this one.

The rate of population growth at any instant is given by the equation

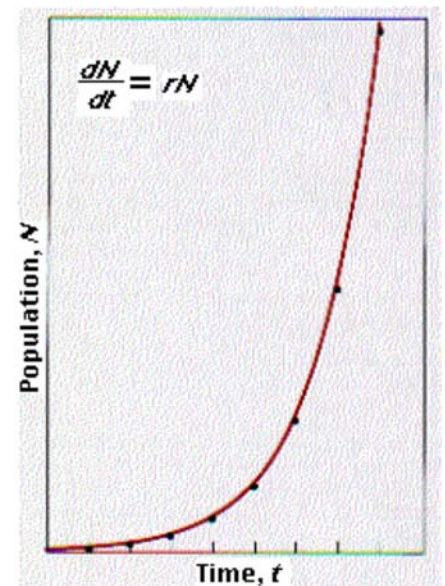
$$\frac{dN}{dt} = rN$$

where

- r is the rate of natural increase in
- t — some stated interval of time, and
- N is the number of individuals in the population at a given instant.

The algebraic solution of this differential equation is $N = N_0 e^{rt}$ where

- N_0 is the starting population
- N is the population after
- a certain time, t , has elapsed, and



- e is the constant 2.71828... (the base of natural logarithms).

Plotting the results gives this exponential growth curve, so-called because it reflects the growth of a number raised to an exponent (rt).

Doubling Times

When a population has doubled, $N = N_0 \times 2$.

Putting this in our exponential growth equation, $2N_0 = N_0 e^{rt}$

$$e^{rt} = 2$$

$$rt = \ln(\text{natural logarithm}) \text{ of } 2 = 0.69$$

$$\text{doubling time, } t = 0.69 / r$$

So Sri Lanka with an r of 1.2% (0.012) has a doubling time

$$t = 0.69 / 0.012 = 57.5.$$

(You can use the same equation to calculate how quickly an investment in, for example, a certificate of deposit will enable you to double your money.)

The Population of the World

The solid line in this graph shows estimates of the size of the world's population over the last two millennia. The estimates from 1800 to 1991 are based on more accurate data than those before.

The dotted line shows what would happen if exponential growth continued to the year 2100.

As you can see, the world's population has been growing exponentially (except during the years of the [black death](#)). How long will it continue to do so? (Since the graph was drawn, the world's population has reached 6.9 billion; that is, in 2010 we are still on course.) But can it continue indefinitely? Surely not.

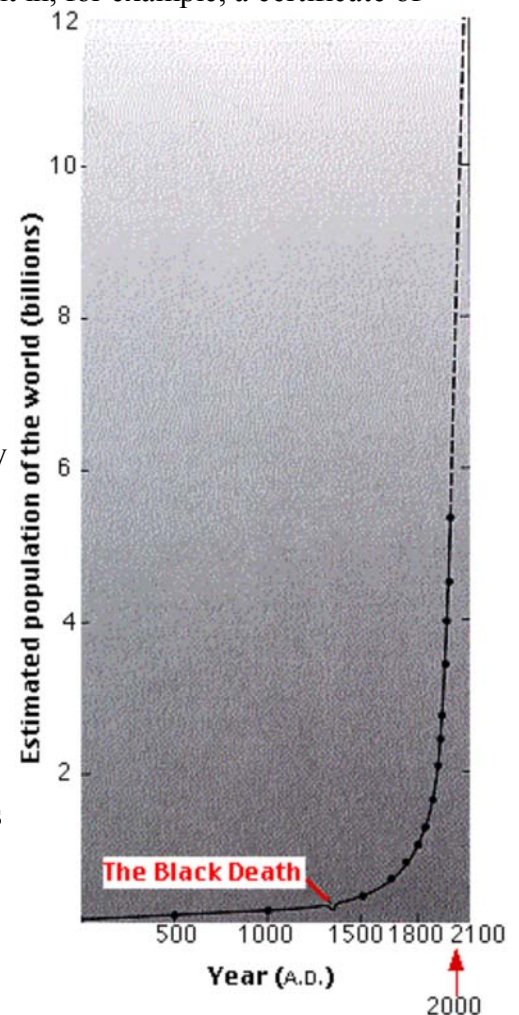
Predicting Future Population Size

With a 2010 rate of natural increase in Mexico of 1.4%, its population would be expected to double in ~49 years ($0.69 / 0.014 = 49.5$) from its 110.6 million people now to some 224 million in 2059. Will it?

No one knows for certain. What actually happens to population growth depends on a number of factors. Some of these can be estimated with some confidence, some cannot.

Two that can are:

- the **age structure** of the population and
- the **total fertility rate (TFR)**.



Total Fertility Rate (TFR)

The total fertility rate is the average number of children that each woman will have during her lifetime. The TFR is an average because, of course, some women will have more, some fewer, and some no children at all.

Theoretically, when the $TFR = 2$, each pair of parents just replaces itself.

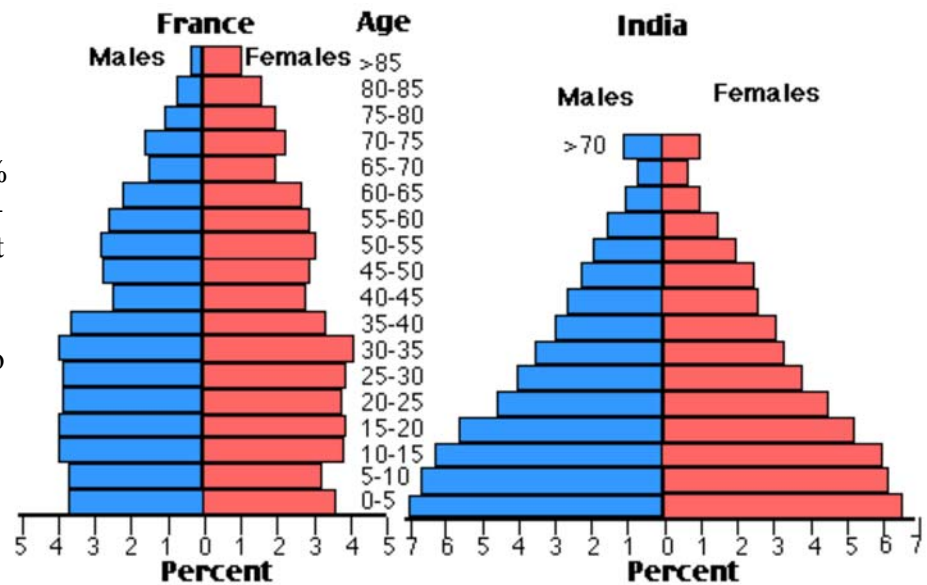
Actually it takes a TFR of 2.1 or 2.2 to replace each generation — this number is called the **replacement rate** — because some children will die before they grow up to have their own two children. In countries with low life expectancies, the replacement rate is even higher (2.2–3).

Age Structure of Populations

But even a TFR of 2.1 may not ensure **zero population growth (ZPG)**. If at one period a population has an unusually large number of children, they will — as they pass through their childbearing years — increase the r of the population even if their TFR goes no higher than 2.

Most childbearing is done by women between the ages of 15 and 49. So if a population has a large number of young people just entering their reproductive years, the rate of growth of that population is sure to rise.

These pyramids compare the age structure of the populations of France and India in 1984. The relative number (%) of males and females is shown in 5-year **cohorts**. Almost 20% of India's population were children — 15 years or less in age — who had yet to begin reproduction. When the members of a large cohort like this begin reproducing, they add greatly to birth rates. In France, in contrast, each cohort is about the size of the next until close to the top when old age begins to take its toll.



Broad-based pyramids like India's are characteristic of populations

- with high birth rates;
- low life expectancies (where many people die before reaching old age);
- advances in public health have recently reduced infant and childhood mortality.

The age structure of a population also reflects the recent pattern of mortality. In countries where injuries, starvation, and disease, etc. take a heavy toll throughout life, a plot of the age cohorts produces a broad based pyramid like that of India. In France (and other countries in western Europe) almost everyone survives until old age, and a plot of the age cohorts is scarcely a pyramid at all. So even if the TFRs were the same in both countries (they are not — in India it is 2.6, in France, 2.0), India is in for more years of rapid population growth, France is not.

The U.S. Baby Boom

The TFR in the United States declined from more than 4 late in the nineteenth century to less than replacement in the early 1930s.

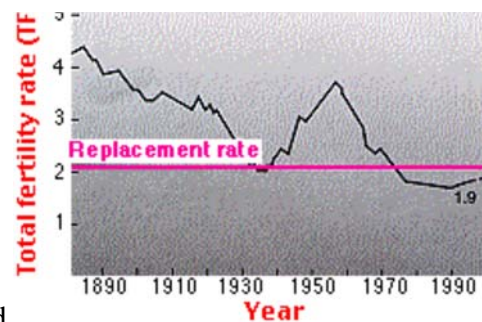
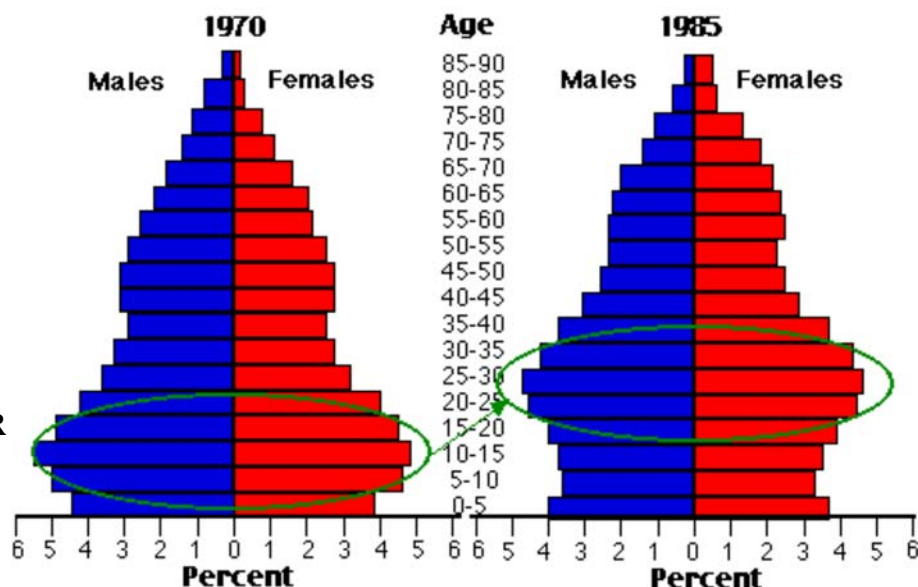
However, when the small numbers of children born in the depression years reached adulthood, they went on a childbearing spree that produced the baby-boom generation. In 1957 more children were born in the United States than ever before (or since).

These population pyramids show the baby-boom generation in 1970 and again in 1985 (green ovals).

Profound changes (e.g. enrollments in schools and colleges) have occurred — and continue to occur — in U.S. society as this bulge passes into ever-older age brackets.

The baby boomers seem not to be headed for the high TFRs of their parents. They are marrying later and having smaller families than their parents. So it looks as though the **TFR** for the baby-boom generation will not exceed **replacement rate**.

But this is **not** the same as zero population growth. Even with the current TFR of 2.0, this large cohort of people will keep the U.S. population growing during their reproductive years (current value for $r = 0.6\%$).



Looking Ahead

Exponential growth cannot continue indefinitely. If the current world value for r (1.2%) remains unchanged, the world population would grow from its current 6.9 billion to 9.5 billion over the next 40 years (2050).

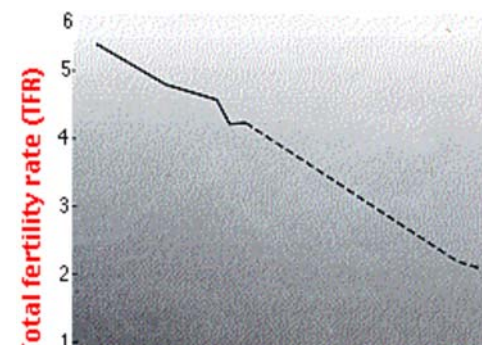
- Could the earth's resources sustain such a population?
- If not, how large a human population can live decently on this planet?

Some demographers (students of population) say we have already exceeded the number. Others say the earth can hold billions more.

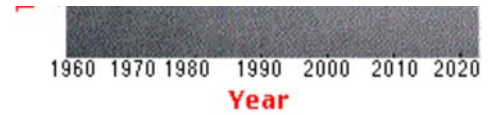
Whatever the case, there are grounds for some optimism about future population growth.

The world value for r peaked around 1990 and has declined since. This is a reflection of the decline in total fertility rates (TFRs) in undeveloped countries, presumably as the various factors involved in the demographic transition take hold, e.g.,

- improved standard of living



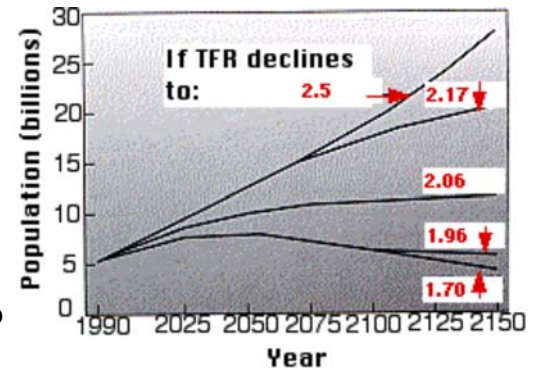
- increased confidence that your children will survive to maturity
- improved status of women
- increased use of [birth control measures](#)



The projection of future TFRs in the upper graph (from the Population Reference Bureau) predicts that the less developed countries of the world will reach replacement fertility around the year 2020. In fact, they will probably reach it sooner because by 2010 the world TFR has dropped to 2.5. Even so, will the world reach zero population growth (ZPG) then?

The lower graph (based on data from the UN Long-Range World Population Projections, 1991) gives 5 estimates of the growth of the world population from now until 2150, assuming that TFRs decline from the 1991 value of 3.4 to the values shown.

- A value of 2.06 will produce a stable population of about 11.5 billion.
- A value 5% below that (1.96) will cause the population to drop back to close to 6.1 billion while
- a value of only 5% above (2.17) would produce a population of over 20 billion and still rising.



A consensus?

The several agencies that try to predict future population seem to be moving closer to a consensus that:

- the world population will continue to grow until after the middle of this century
- reaching a peak of some 9.3 billion (up from the 7 billion expected to be reached this coming October) and then
- perhaps declining in the waning years of this century.

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14 August 2011