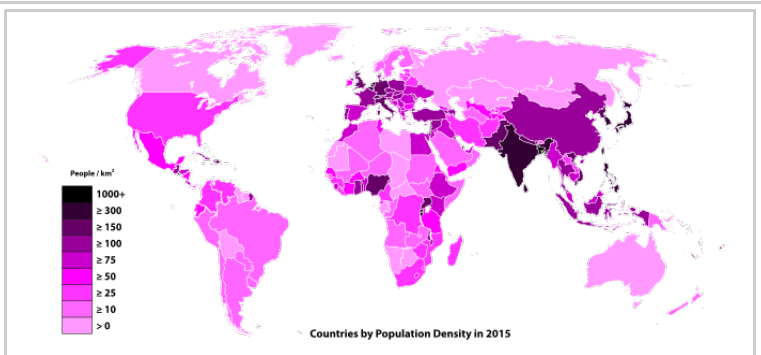
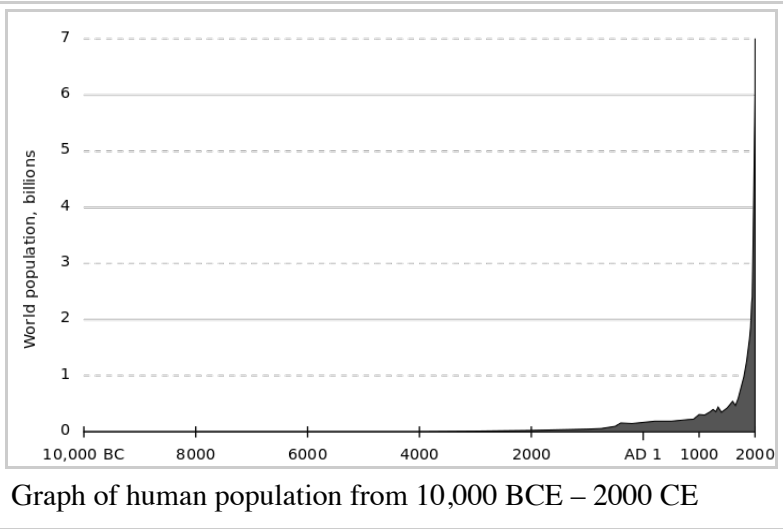


Human overpopulation

From Wikipedia, the free encyclopedia

Human overpopulation occurs if the number of people in a group exceeds the carrying capacity of the region occupied by that group. Overpopulation can further be viewed, in a long term perspective, as existing when a population cannot be maintained given the rapid depletion of non-renewable resources or given the degradation of the capacity of the environment to give support to the population.^[1]

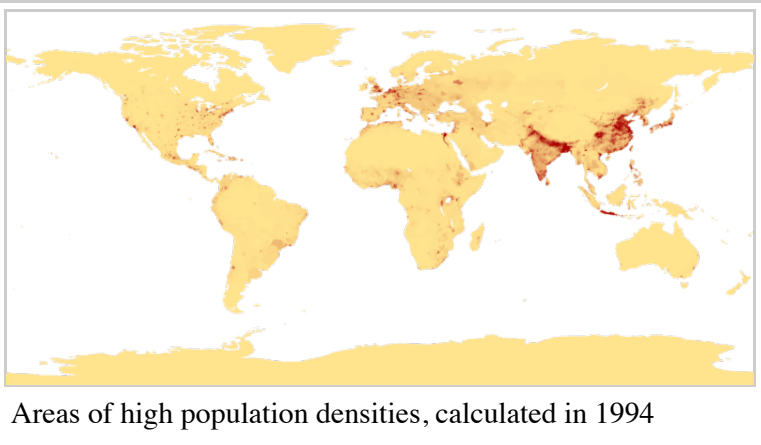
The term *human overpopulation* often refers to the relationship between the entire human population and its environment: the Earth,^[2] or to smaller geographical areas such as countries. Overpopulation can result from an increase in births, a decline in mortality rates, an increase in immigration, or an unsustainable biome and depletion of resources. It is possible for very sparsely populated areas to be overpopulated if the area has a meager or non-existent capability to sustain life (e.g. a desert). Advocates of population moderation cite issues like quality of life, carrying capacity and risk of starvation as a basis to argue against continuing high human population growth and for population decline.



Map of population density by country, per square kilometer. (See *List of countries by population density*.)

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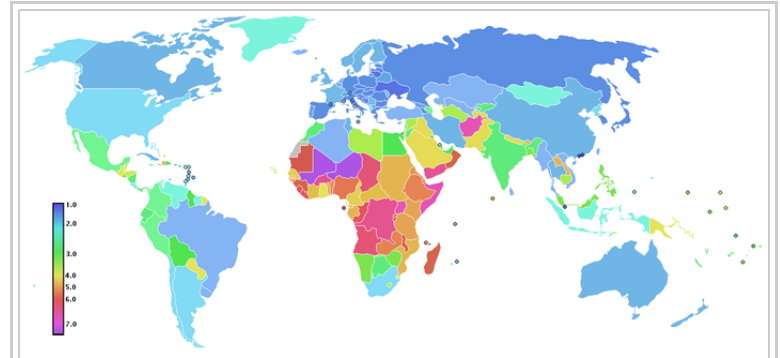
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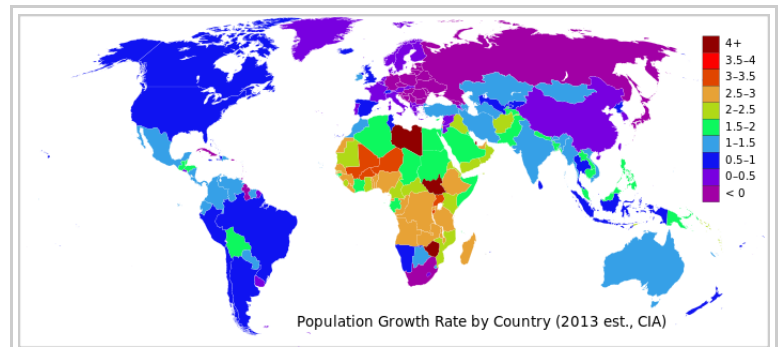
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Human population growth rate in percent, with the variables of births, deaths, immigration, and emigration – 2013

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Overview

The human population has been growing continuously since the end of the Black Death, around the year 1350,^[3] although the most significant increase has been in the last 50 years, mainly due to medical advancements and increases in agricultural productivity. The rate of population growth has been declining since the 1980s. The United Nations has expressed concern on continued excessive population growth in sub-Saharan Africa.^[4] Recent research has demonstrated that those concerns are well grounded.^[5] As of December 31, 2015 the world's human population is estimated to be 7.293 billion by the United States Census Bureau,^[6] and over 7 billion by the United Nations.^{[7][8][9]} Most contemporary estimates for the carrying capacity of the Earth under existing conditions are between 4 billion and 16 billion. Depending on which estimate is used, human overpopulation may or may not have already occurred. Nevertheless, the rapid recent increase in human population is causing some concern. The population is expected to reach between 8 and 10.5 billion between the year 2040^{[10][11]} and 2050.^[12] In May 2011, the United Nations increased the medium variant projections to 9.3 billion for 2050 and 10.1 billion for 2100.^[13]

The recent rapid increase in human population over the past three centuries has raised concerns that the planet may not be able to sustain present or future numbers of inhabitants. The InterAcademy Panel Statement on Population Growth, circa 1994, stated that many environmental problems, such as rising levels of atmospheric carbon dioxide, global warming, and pollution, are aggravated by the population expansion.^[14] Other problems associated with overpopulation include the increased demand for resources such as fresh water and food, starvation and malnutrition, consumption of natural resources (such as fossil fuels) faster than the rate of regeneration, and a deterioration in living conditions. Wealthy but highly populated territories like Britain rely on food imports from overseas.^[15] This was severely felt during the World Wars when, despite food efficiency

initiatives like "dig for victory" and food rationing, Britain needed to fight to secure import routes. However, many believe that waste and over-consumption, especially by wealthy nations, is putting more strain on the environment than overpopulation.^[16]

Most countries have no direct policy of limiting their birth rates, but the rates have still fallen due to education about family planning and increasing access to birth control and contraception. Only China has imposed legal restrictions on having more than one child. Extraterrestrial settlement and other technical solutions have been proposed as ways to mitigate overpopulation in the future.

History of concern

Concern about overpopulation is an ancient topic. Tertullian was a resident of the city of Carthage in the second century CE, when the population of the world was about 190 million (only 3-4% of what it is today). He notably said: "What most frequently meets our view (and occasions complaint) is our teeming population. Our numbers are burdensome to the world, which can hardly support us.... In very deed, pestilence, and famine, and wars, and earthquakes have to be regarded as a remedy for nations, as the means of pruning the luxuriance of the human race." Before that, Plato, Aristotle and others broached the topic as well.^[17]

Throughout history, population growth has usually been slow despite high birth rates, due to war, plagues and other diseases, and high infant mortality. During the 750 years before the Industrial Revolution, the world's population increased very slowly, remaining under 250 million.^[18]

By the beginning of the 19th century, the world population had grown to a billion individuals, and intellectuals such as Thomas Malthus predicted that mankind would outgrow its available resources, because a finite amount of land would be incapable of supporting a population with a limitless potential for increase.^[19] Mercantillists argued that a large population was a form of wealth, which made it possible to create bigger markets and armies.

During the 19th century, Malthus's work was often interpreted in a way that blamed the poor alone for their condition and helping them was said to worsen conditions in the long run.^[20] This resulted, for example, in the English poor laws of 1834^[20] and in a hesitating response to the Irish Great Famine of 1845–52.^[21]

The UN Population Assessment Report of 2003 projects that the world population will plateau by 2050 and will remain stable until 2300. Alex Berezhnow, editor of *RealClearScience*, states that overpopulation is not a Western world problem, and people often cite China and India as major population contributors; however, he notes that with rising wealth in those countries, population growth will begin to slow, and this is a proven factor in the economic stability of nations.^[22]



Thousands of scooters make their way through the city of Hồ Chí Minh, Vietnam.

Human population

History of population growth

The human population has gone through a number of periods of growth since the dawn of civilization in the Holocene period, around 10,000 BCE. The beginning of civilization roughly coincides with the receding of glacial ice following the end of the last glacial period.^[24] It is estimated that between 1-5 million people, subsisting on hunting and foraging, inhabited the Earth in the period before the Neolithic Revolution, when human activity shifted away from hunter-gathering and towards very primitive farming.^[25]

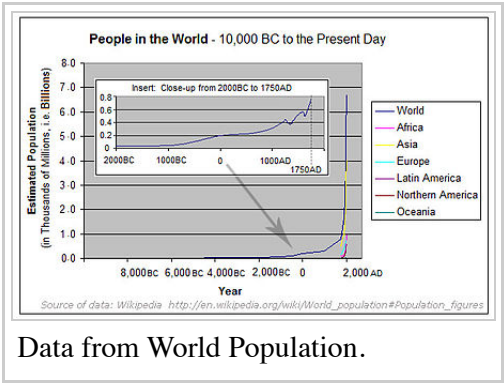
Around 8000 BCE, at the dawn of agriculture, the population of the world was approximately 5 million.^[26] The next several millennia saw a steady increase in the population, with very rapid growth beginning in 1000 BCE, and a peak of between 200 and 300 million people in 1 BCE.

The Plague of Justinian caused Europe's population to drop by around 50% between 541 and the 8th century.^[27] Steady growth resumed in 800 CE.^[28] However, growth was again disrupted by frequent plagues; most notably, the Black Death during the 14th century. The effects of the Black Death are thought to have reduced the world's population, then at an estimated 450 million, to between 350 and 375 million by 1400.^[29] The population of Europe stood at over 70 million in 1340;^[30] these levels did not return until 200 years later.^[31] England's population reached an estimated 5.6 million in 1650, up from an estimated 2.6 million in 1500.^[32] New crops from the Americas via the Spanish colonizers in the 16th century contributed to the population growth.^[33]

In other parts of the globe, China's population at the founding of the Ming dynasty in 1368 stood close to 60 million, approaching 150 million by the end of the dynasty in 1644.^{[34][35]} The population of the Americas in 1500 may have been between 50 and 100 million.^[36]

Encounters between European explorers and populations in the rest of the world often introduced local epidemics of extraordinary virulence. Archaeological evidence indicates that the death of around 90% of the Native American population of the New World was caused by Old World diseases such as smallpox, measles, and influenza.^[37] Europeans introduced diseases alien to the indigenous people, therefore they did not have immunity to these foreign diseases.^[38]

Population ^[4]	
Year	Billion
1804	1
1927	2
1959	3
1974	4
1987	5
1999	6
2011	7
2020	7.7 (estimate) ^[23]



Data from World Population.

After the start of the Industrial Revolution, during the 18th century, the rate of population growth began to increase. By the end of the century, the world's population was estimated at just under 1 billion.^[39] At the turn of the 20th century, the world's population was roughly 1.6 billion.^[39] By 1940, this figure had increased to 2.3 billion.^[40]

Dramatic growth beginning in 1950 (above 1.8% per year) coincided with greatly increased food production as a result of the industrialization of agriculture brought about by the Green Revolution.^[42] The rate of human population growth peaked in 1964, at about 2.1% per year.^[43] For example, Indonesia's population grew from 97 million in 1961 to 237.6 million in 2010,^{[44][45]} a 145% increase in 49 years. In India, the population grew from 361.1 million people in 1951 to just over 1.2 billion by 2011,^{[46][47]} a 235% increase in 60 years.

There is concern over the sharp population increase in many countries, especially in Sub-Saharan Africa, that has occurred over the last several decades, and that it is creating problems with land management, natural resources and access to water supplies.^[49]

Continent	1900 population ^[48]
Africa	133 million
Asia	904 million
Europe	408 million
Latin America and Caribbean	74 million
North America	82 million

Population growth 1990–2009 (%) ^[41]	
World	28.4%
Africa	58.4%
Middle East	53.4%
Asia (except China)	36.9%
Latin America	32.0%
OECD North America	25.1%
China	17.3%
OECD Europe	9.9%
OECD Pacific	9.5%
Non-OECD Europe and Eurasia	-2.7%

The population of Chad has, for example, grown from 6,279,921 in 1993 to 10,329,208 in 2009.^[50] Vietnam, Mexico, Nigeria, Egypt, Ethiopia and the DRC are witnessing a similar growth in population. The situation is most acute in western, central and eastern Africa.^[5] Refugees from places like Sudan have further strained the resources of neighboring states like Chad and Egypt. Chad is also host to roughly 255,000 refugees from Sudan's Darfur region, and about 77,000 refugees from the Central African Republic, while approximately 188,000 Chadians have been displaced by their own civil war and famines, have either fled to either the Sudan, the Niger or, more recently, Libya.^[51]

Projections of population growth

According to projections, the world population will continue to grow until at least 2050, with the population reaching 9 billion in 2040,^{[53][54]} and some predictions putting the population in 2050 as high as 11 billion.^[55] Walter Greiling projected in the 1950s that world population would reach a peak of about nine billion, in the

21st century, and then stop growing, after a readjustment of the Third World and a sanitation of the tropics.^[56]

According to the United Nations' World Population Prospects report:^[57]

Continent	Projected 2050 population ^[52]
Africa	1.8 billion
Asia	5.3 billion
Europe	628 million
Latin America and Caribbean	809 million
North America	392 million

- The world population is currently growing by approximately 74 million people per year. Current United Nations predictions estimate that the world population will reach 9.0 billion around 2050, assuming a decrease in average fertility rate from 2.5 down to 2.0.^{[58][59]}
- Almost all growth will take place in the less developed regions, where today's 5.3 billion population of underdeveloped countries is expected to increase to 7.8 billion in 2050. By contrast, the population of the more developed regions will remain mostly unchanged, at 1.2 billion. An exception is the United States population, which is expected to increase by 44% from 2008 to 2050.^[60]
- In 2000–2005, the average world fertility was 2.65 children per woman, about half the level in 1950–1955 (5 children per woman). In the medium variant, global fertility is projected to decline further to 2.05 children per woman.
- During 2005–2050, nine countries are expected to account for half of the world's projected population increase: India, Pakistan, Nigeria, Democratic Republic of the Congo, Bangladesh, Uganda, United States, Ethiopia, and China, listed according to the size of their contribution to population growth. China would be higher still in this list were it not for its one-child policy.
- Global life expectancy at birth is expected to continue rising from 65 years in 2000–2005 to 75 years in 2045–2050. In the more developed regions, the projection is to 82 years by 2050. Among the least developed countries, where life expectancy today is just under 50 years, it is expected to increase to 66 years by 2045–2050.
- The population of 51 countries or areas is expected to be lower in 2050 than in 2005.
- During 2005–2050, the net number of international migrants to more developed regions is projected to be 98 million. Because deaths are projected to exceed births in the more developed regions by 73 million during 2005–2050, population growth in those regions will largely be due to international migration.
- In 2000–2005, net migration in 28 countries either prevented population decline or doubled at least the contribution of natural increase (births minus deaths) to population growth.
- Birth rates are now falling in a small percentage of developing countries, while the actual populations in many developed countries would fall without immigration.^[58]

Urban growth

In 1800 only 3% of the world's population lived in cities. By the 20th century's close, 47% did so. In 1950 there were 83 cities with populations exceeding one million; but by 2007 this had risen to 468 agglomerations of more than one million.^[61] If the trend continues, the world's urban population will double every 38 years, according to researchers. The UN forecasts that today's urban population of 3.2 billion will rise to nearly 5 billion by 2030, when three out of five people will live in cities.^[62]

The increase will be most dramatic in the poorest and least-urbanised continents, Asia and Africa. Projections indicate that most urban growth over the next 25 years will be in developing countries.^[63] One billion people, one-seventh of the world's population, or one-third of urban population, now live in shanty towns,^[64] which are seen as "breeding grounds" for social problems such as crime, drug addiction, alcoholism, poverty and unemployment. In many poor countries, slums exhibit high rates of disease due to unsanitary conditions, malnutrition, and lack of basic health care.^[65]

In 2000, there were 18 megacities – conurbations such as Tokyo, Beijing, Guangzhou, Seoul, Karachi, Mexico City, Mumbai, São Paulo and New York City – that have populations in excess of 10 million inhabitants. Greater Tokyo already has 35 million, more than the entire population of Canada (at 34.1 million).^[66]

By 2025, according to the *Far Eastern Economic Review*, Asia alone will have at least 10 hypercities, those with more than 19 million, including Jakarta (24.9 million people), Dhaka (25 million), Karachi (26.5 million), Shanghai (27 million) and Mumbai (33 million).^[67] Lagos has grown from 300,000 in 1950 to an estimated 15 million today, and the Nigerian government estimates that city will have expanded to 25 million residents by 2015.^[68] Chinese experts forecast that Chinese cities will contain 800 million people by 2020.^[69]



Urban areas with at least one million inhabitants in 2006. 3% of the world's population lived in cities in 1800, rising to 47% at the end of the twentieth century.

Causes

From a historical perspective, technological revolutions have coincided with population explosions. There have been three major technological revolutions – the tool-making revolution, the agricultural revolution, and the industrial revolution – all of which allowed humans more access to food, resulting in subsequent population explosions.^{[70][71]} For example, the use of tools, such as bow and arrow, allowed primitive hunters greater access to high energy foods (e.g. animal meat). Similarly, the transition to farming about 10,000 years ago greatly increased the overall food supply, which was used to support more people. Food production further increased with the industrial revolution as machinery, fertilizers, herbicides, and pesticides were used to increase land under cultivation as well as crop yields.^[72] In short, similar to bacteria that multiply in response to increased food supply, humans have increased their population as soon as food became more abundant as a result of technological innovations.



Street in Kathmandu

Significant increases in human population occur whenever the birth rate exceeds the death rate for extended periods of time. Traditionally, the fertility rate is strongly influenced by cultural and social norms that are rather stable and therefore slow to adapt to changes in the social, technological, or environmental conditions. For example, when death rates fell during the 19th and 20th century – as a result of improved sanitation, child immunizations, and other advances in medicine – allowing more newborns to survive, the fertility rate did not adjust downward fast enough, resulting in significant population growth. Prior to these changes, seven out of ten children died before reaching reproductive age, while today about 95% of newborns in industrialized nations reach adulthood.^[73]

Agriculture

Agriculture has been the main factor behind human population growth. This dates back to prehistoric times, when agricultural methods were first developed, and continues to the present day, with fertilizers, agrochemicals, large-scale mechanization, genetic manipulation, and other technologies.^[74] Morgan Freeman, in a discussion about human overpopulation, described what he blamed as "the tyranny of agriculture".^[75]

Psychological factors

Human psychology and the cycle of entrenched poverty, as well as the rest of the world's reaction to it, are also causative factors. Areas with greater burden of disease and warfare, contrary to popular belief, do not experience less population growth over the long term, but far more over a sustained period as poverty becomes further entrenched. This is because parents and siblings who have experienced calamitous conditions suffer from a kind of post traumatic stress syndrome about losing their family members and overcompensate by having "extra" babies. These extra babies and calamities fuel a vicious cycle, and only in the small minority of cases does it cease. As this cycle is compounded over generations, calamities such as disaster or war take on a multiplier effect. For example, the AIDS crisis in Africa is said to have killed 30 million to date, yet during the last two decades money and initiatives to lower population growth by contraception have been sidelined in favor of combating HIV,^[76] feeding the population explosion that we see in Africa today. In 1990, this continent's population was roughly 600 million; today it is over 1,050 million, 150 million more than if the HIV/AIDS crisis had never occurred.^[77]

Extremes

Population growth rates between 1950 and 2012 range from a 0.5% increase in the case of Bulgaria to a more than 100 fold increase for the United Arab Emirates (from 79,050 to 8.5 million).^[78] Roughly half of all nations have quadrupled their populations since 1950.^[78]

Demographic transition

The theory of demographic transition held that, after the standard of living and life expectancy increase, family sizes and birth rates decline. However, as new data has become available, it has been observed that after a certain level of development the fertility increases again.^[79] This means that both the worry that the theory generated about aging populations and the complacency it bred regarding the future environmental impact of population growth are misguided.

Factors cited in the old theory included such social factors as later ages of marriage, the growing desire of many women in such settings to seek careers outside child rearing and domestic work, and the decreased need of children in industrialized settings. The latter factor stems from the fact that children perform a great deal of work in small-scale agricultural societies, and work less in industrial ones; it has been cited to explain the decline in birth rates in industrializing regions.

Many countries have high population growth rates but lower total fertility rates because high population growth in the past skewed the age demographic toward a young age, so the population still rises as the more numerous younger generation approaches maturity.

"Demographic entrapment" is a concept developed by Maurice King, Honorary Research Fellow at the University of Leeds, who posits that this phenomenon occurs when a country has a population larger than its carrying capacity, no possibility of migration, and exports too little to be able to import food. This will cause starvation. He claims that for example many sub-Saharan nations are or will become stuck in demographic entrapment, instead of having a demographic transition.^[80]

For the world as a whole, the number of children born per woman decreased from 5.02 to 2.65 between 1950 and 2005. A breakdown by region is as follows:

- Europe – 2.66 to 1.41
- North America – 3.47 to 1.99
- Oceania – 3.87 to 2.30
- Central America – 6.38 to 2.66
- South America – 5.75 to 2.49
- Asia (excluding Middle East) – 5.85 to 2.43
- Middle East & North Africa – 6.99 to 3.37
- Sub-Saharan Africa – 6.7 to 5.53

Excluding the observed reversal in fertility decrease for high development, the projected world number of children born per woman for 2050 would be around 2.05. Only the Middle East & North Africa (2.09) and Sub-Saharan Africa (2.61) would then have numbers greater than 2.05.^[81]

Carrying capacity

Some groups (for example, the World Wide Fund for Nature^{[82][83]} and Global Footprint Network) have stated that the carrying capacity for the human population has been exceeded as measured using the Ecological Footprint. In 2006, WWF's "Living Planet Report" stated that in order for all humans to live with the current consumption patterns of Europeans, we would be spending three times more than what the planet can renew.^[84]

Humanity as a whole was using, by 2006, 40 percent more than what Earth can regenerate.^[85] However, Roger Martin of Population Matters states the view: "the poor want to get rich, and I want them to get rich," with a later addition, "of course we have to change consumption habits,... but we've also got to stabilise our numbers".^[86]

But critics question the simplifications and statistical methods used in calculating Ecological Footprints. Therefore, Global Footprint Network and its partner organizations have engaged with national governments and international agencies to test the results – reviews have been produced by France, Germany, the European Commission, Switzerland, Luxembourg, Japan and the United Arab Emirates.^[87] Some point out that a more refined method of assessing Ecological Footprint is to designate sustainable versus non-sustainable categories of consumption.^{[88][89]} However, if yield estimates were adjusted for sustainable levels of production, the yield figures would be lower, and hence the overshoot estimated by the Ecological Footprint method even higher.



A family planning placard in Ethiopia. It shows some negative effects of having too many children.

Other studies give particular attention to resource depletion and increased world affluence.^{[90][91]}

In a 1994 study titled *Food, Land, Population and the U.S. Economy*, David Pimentel and Mario Giampietro estimated the maximum U.S. population for a sustainable economy at 200 million.^[92] And in order to achieve a sustainable economy and avert disaster, the United States would have to reduce its population by at least one-third, and world population would have to be reduced by two-thirds.^[93]

Many quantitative studies have estimated the world's carrying capacity for humans, that is, a limit to the world population.^[94] A meta-analysis of 69 such studies suggests a point estimate of the limit to be 7.7 billion people, while lower and upper meta-bounds for current technology are estimated as 0.65 and 98 billion people, respectively. They conclude: "recent predictions of stabilized world population levels for 2050 exceed several of our meta-estimates of a world population limit".^[95]

Effects of human overpopulation

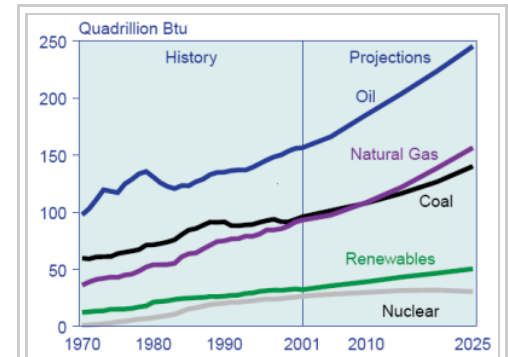
Raw numbers of people are only one factor in the effects of people. The lifestyle (including overall affluence and resource utilization) and the pollution (including carbon footprint) are equally important. In 2008 the New York Times stated that the inhabitants of the developed nations of the world consume resources like oil and metals at a rate almost 32 times greater than those of the developing world, who make up the majority of the human population.^[96]

Some problems associated with or exacerbated by human overpopulation and over-consumption are:

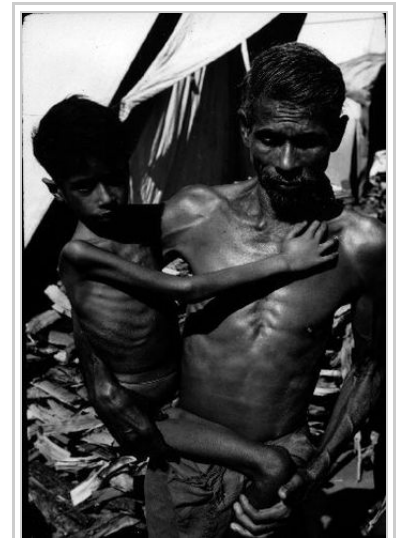
- Inadequate fresh water^[97] for drinking as well as sewage treatment and effluent discharge. Some

countries, like Saudi Arabia, use energy-expensive desalination to solve the problem of water shortages.^{[98][99]}

- Depletion of natural resources, especially fossil fuels.^[100]
- Increased levels of air pollution, water pollution, soil contamination and noise pollution. Once a country has industrialized and become wealthy, a combination of government regulation and technological innovation causes pollution to decline substantially, even as the population continues to grow.^[101]
- Deforestation and loss of ecosystems^[102] that valuably contribute to the global atmospheric oxygen and carbon dioxide balance; about eight million hectares of forest are lost each year.^[103]
- Changes in atmospheric composition and consequent global warming.^{[104][105]}
- Loss of arable land and increase in desertification.^[106] Deforestation and desertification can be reversed by adopting property rights, and this policy is successful even while the human population continues to grow.^[107]
- Mass species extinctions^[108] from reduced habitat in tropical forests due to slash-and-burn techniques that sometimes are practiced by shifting cultivators, especially in countries with rapidly expanding rural populations; present extinction rates may be as high as 140,000 species lost per year.^[109] As of February 2011, the IUCN Red List lists a total of 801 animal species having gone extinct during recorded human history.^[110]
- High infant and child mortality.^[111] High rates of infant mortality are associated with poverty. Rich countries with high population densities have low rates of infant mortality.^[112]
- Intensive factory farming to support large populations. It results in human threats including the evolution and spread of antibiotic resistant bacteria diseases, excessive air and water pollution, and new viruses that infect humans. , 1972]]
- Increased chance of the emergence of new epidemics and pandemics.^[113] For many environmental and social reasons, including overcrowded living conditions, malnutrition and inadequate, inaccessible, or non-existent health care, the poor are more likely to be exposed to infectious diseases.^[114]
- Starvation, malnutrition^[115] or poor diet with ill health and diet-deficiency diseases (e.g. rickets). However, rich countries with high population densities do not have famine.^[116]
- Poverty coupled with inflation in some regions and a resulting low level of capital formation. Poverty and inflation are aggravated by bad government and bad economic policies. Many countries with high population densities have eliminated absolute poverty and keep their inflation rates very low.^[117]
- Low life expectancy in countries with fastest growing populations.^[118]
- Unhygienic living conditions for many based upon water resource depletion, discharge of raw sewage^[119] and solid waste disposal.



World energy consumption & predictions, 1970–2025.



A child suffering extreme malnutrition in India

However, this problem can be reduced with the adoption of sewers. For example, after Karachi, Pakistan installed sewers, its infant mortality rate fell substantially.^[120]

- Elevated crime rate due to drug cartels and increased theft by people stealing resources to survive.^[121]
- Conflict over scarce resources and crowding, leading to increased levels of warfare.^[122]
- Less personal freedom and more restrictive laws. Laws regulate interactions between humans. Law "serves as a primary social mediator of relations between people". The higher the population density, the more frequent such interactions become, and thus there develops a need for more laws and/or more restrictive laws to regulate these interactions. It was even speculated by Aldous Huxley in 1958 that democracy is threatened due to overpopulation, and could give rise to totalitarian style governments.^[123]
- David Attenborough described the level of human population on the planet as a multiplier of all other environmental problems.^[124]

Many of these problems are explored in the dystopic science fiction film *Soylent Green*, where an overpopulated Earth suffers from food shortages, depleted resources and poverty and in the documentary "Aftermath: Population Overload".

Some economists, such as Thomas Sowell^[125] and Walter E. Williams^[116] argue that third world poverty and famine are caused in part by bad government and bad economic policies. Most biologists and sociologists see overpopulation as a serious threat to the quality of human life.^{[102][126]}

Resources

Overpopulation does not depend only on the size or density of the population, but on the ratio of population to available sustainable resources. It also depends on how resources are managed and distributed throughout the population.

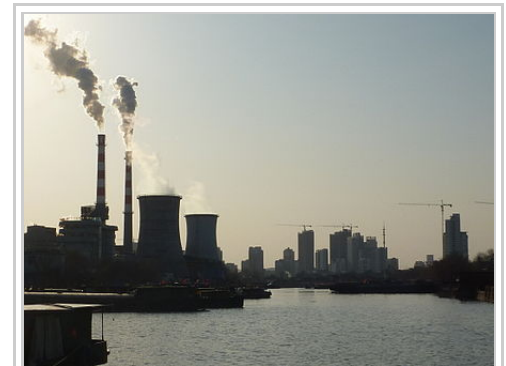
The resources to be considered when evaluating whether an ecological niche is overpopulated include clean water, clean air, food, shelter, warmth, and other resources necessary to sustain life. If the quality of human life is addressed, there may be additional resources considered, such as medical care, education, proper sewage treatment, waste disposal and energy supplies. Overpopulation places competitive stress on the basic life sustaining resources,^[127] leading to a diminished quality of life.^[126]

Directly related to maintaining the health of the human population is water supply, and it is one of the resources that experience the biggest strain. With the global population at about 7.125 billion, and each human theoretically needing 2 liters of drinking water, there is a demand for 14.25 billion liters of water each day to meet the minimum requirement for healthy living (United). Weather patterns, elevation, and climate all contribute to uneven distribution of fresh drinking water. Without clean water, good health is not a viable option. Besides drinking, water is used to create sanitary living conditions and is the basis of creating a healthy environment fit to hold human life. In addition to drinking water, water is also used for bathing, washing clothes and dishes, flushing toilets, a variety of cleaning methods, recreation, watering lawns, and farm irrigation. Irrigation poses one of the largest problems, because without sufficient water to irrigate crops, the crops die and then there is the problem of food rations and starvation. In addition to water needed for crops and food, there is limited land area dedicated to food production, and not much more that is suitable to be added. Arable land,

needed to sustain the growing population, is also a factor because land being under or over cultivated easily upsets the delicate balance of nutrition supply. There are also problems with location of arable land with regard to proximity to countries and relative population (Bashford 240). Access to nutrition is an important limiting factor in population sustainability and growth. No increase in arable land added to the still increasing human population will eventually pose a serious conflict. Only 38% of the land area of the globe is dedicated to agriculture, and there is not room for much more. Although plants produce 54 billion metric tons of carbohydrates per year, when the population is expected to grow to 9 billion by 2050, the plants may not be able to keep up (Biello). Food supply is a primary example of how a resource reacts when its carrying capacity is exceeded. By trying to grow more and more crops off of the same amount of land, the soil becomes exhausted. Because the soil is exhausted, it is then unable to produce the same amount of food as before, and is overall less productive. Therefore, by using resources beyond a sustainable level, the resource become nullified and ineffective, which further increases the disparity between the demand for a resource and the availability of a resource. There must be a shift to provide adequate recovery time to each one of the supplies in demand to support contemporary human lifestyles. ^{[128][129][130]}

David Pimentel has stated that "With the imbalance growing between population numbers and vital life sustaining resources, humans must actively conserve cropland, freshwater, energy, and biological resources. There is a need to develop renewable energy resources. Humans everywhere must understand that rapid population growth damages the Earth's resources and diminishes human well-being."^{[131][132]}

These reflect the comments also of the United States Geological Survey in their paper *The Future of Planet Earth: Scientific Challenges in the Coming Century* (<http://www.usgs.gov/newsroom/article.asp?ID=653>). "As the global population continues to grow...people will place greater and greater demands on the resources of our planet, including mineral and energy resources, open space, water, and plant and animal resources." "Earth's natural wealth: an audit" by *New Scientist* magazine states that many of the minerals that we use for a variety of products are in danger of running out in the near future.^[133] A handful of geologists around the world have calculated the costs of new technologies in terms of the materials they use and the implications of their spreading to the developing world. All agree that the planet's booming population and rising standards of living are set to put unprecedented demands on the materials that only Earth itself can provide.^[133] Limitations on how much of these materials is available could even mean that some technologies are not worth pursuing long term.... "Virgin stocks of several metals appear inadequate to sustain the modern 'developed world' quality of life for all of Earth's people under contemporary technology".^[134]



An industrial area, with a power plant, south of Yangzhou's downtown, China

On the other hand, some researchers, such as Julian L. Simon and Bjørn Lomborg believe that resources exist for further population growth. In a 2010 study, they concluded that "there are not (and will never be) too many people for the planet to feed" according to *The Independent*.^[135] Some critics warn, this will be at a high cost to the Earth: "the technological optimists are probably correct in claiming that overall world food production can be increased substantially over the next few decades...[however] the environmental cost of what Paul R. and

Anne H. Ehrlich describe as 'turning the Earth into a giant human feedlot' could be severe. A large expansion of agriculture to provide growing populations with improved diets is likely to lead to further deforestation, loss of species, soil erosion, and pollution from pesticides and fertilizer runoff as farming intensifies and new land is brought into production."^[136] Since we are intimately dependent upon the living systems of the Earth,^{[137][138][139]} some scientists have questioned the wisdom of further expansion.

According to the Millennium Ecosystem Assessment, a four-year research effort by 1,360 of the world's prominent scientists commissioned to measure the actual value of natural resources to humans and the world, "The structure of the world's ecosystems changed more rapidly in the second half of the twentieth century than at any time in recorded human history, and virtually all of Earth's ecosystems have now been significantly transformed through human actions."^[140] "Ecosystem services, particularly food production, timber and fisheries, are important for employment and economic activity. Intensive use of ecosystems often produces the greatest short-term advantage, but excessive and unsustainable use can lead to losses in the long term. A country could cut its forests and deplete its fisheries, and this would show only as a positive gain to GDP, despite the loss of capital assets. If the full economic value of ecosystems were taken into account in decision-making, their degradation could be significantly slowed down or even reversed."^{[141][142]}

Another study by the United Nations Environment Programme (UNEP) called the Global Environment Outlook^[143] which involved 1,400 scientists and took five years to prepare comes to similar conclusions. It "found that human consumption had far outstripped available resources. Each person on Earth now requires a third more land to supply his or her needs than the planet can supply." It faults a failure to "respond to or recognize the magnitude of the challenges facing the people and the environment of the planet..." "The systematic destruction of the Earth's natural and nature-based resources has reached a point where the economic viability of economies is being challenged – and where the bill we hand to our children may prove impossible to pay"... The report's authors say its objective is 'not to present a dark and gloomy scenario, but an urgent call to action'. It warns that tackling the problems may affect the vested interests of powerful groups, and that the environment must be moved to the core of decision-making... '^[144]

Although all resources, whether mineral or other, are limited on the planet, there is a degree of self-correction whenever a scarcity or high-demand for a particular kind is experienced. For example, in 1990 known reserves of many natural resources were higher, and their prices lower, than in 1970, despite higher demand and higher consumption. Whenever a price spike would occur, the market tended to correct itself whether by substituting an equivalent resource or switching to a new technology.^[145]

Fresh water

Fresh water supplies, on which agriculture depends, are running low worldwide.^{[146][147]} This water crisis is only expected to worsen as the population increases.^[148]

Potential problems with dependence on desalination are reviewed below, however, the majority of the world's freshwater supply is contained in the polar icecaps, and underground river systems accessible through springs and wells.

Fresh water can be obtained from salt water by desalination. For example, Malta derives two thirds of its freshwater by desalination. A number of nuclear powered desalination plants exist;^{[149][150]} However, the high costs of desalination, especially for poor countries, make impractical the transport of large amounts of desalinated seawater to interiors of large countries.^[151] The cost of desalination varies; Israel is now desalinating water for a cost of 53 cents per cubic meter,^[152] Singapore at 49 cents per cubic meter.^[153] In the United States, the cost is 81 cents per cubic meter (\$3.06 for 1,000 gallons).^[154]

According to a 2004 study by Zhou and Tol, "one needs to lift the water by 2000 m, or transport it over more than 1600 km to get transport costs equal to the desalination costs. Desalinated water is expensive in places that are both somewhat far from the sea and somewhat high, such as Riyadh and Harare. In other places, the dominant cost is desalination, not transport. This leads to somewhat lower costs in places like Beijing, Bangkok, Zaragoza, Phoenix, and, of course, coastal cities like Tripoli." Thus while the study is generally positive about the technology for affluent areas that are proximate to oceans, it concludes that "Desalinated water may be a solution for some water-stress regions, but not for places that are poor, deep in the interior of a continent, or at high elevation. Unfortunately, that includes some of the places with biggest water problems."^[155] Another potential problem with desalination is the byproduction of saline brine, which can be a major cause of marine pollution when dumped back into the oceans at high temperatures."^[155]

The world's largest desalination plant is the Jebel Ali Desalination Plant (Phase 2) in the United Arab Emirates, which can produce 300 million cubic metres of water per year,^[156] or about 2500 gallons per second. The largest desalination plant in the US is the one at Tampa Bay, Florida, which began desalinating 25 million gallons (95000 m³) of water per day in December 2007. A 17 January 2008, article in the *Wall Street Journal* states, "Worldwide, 13,080 desalination plants produce more than 12 billion gallons of water a day, according to the International Desalination Association."^[157] After being desalinated at Jubail, Saudi Arabia, water is pumped 200 miles (320 km) inland though a pipeline to the capital city of Riyadh.^[158]

However, new data originating from the GRACE experiments and isotopic testing done by the IAEA show that the Nubian aquifer—which is under the largest, driest part of the earth's surface, has enough water in it to provide for "at least several centuries". In addition to this, new and highly detailed maps of the earth's underground reservoirs will be soon created from these technologies that will further allow proper budgeting of cheap water.^[159]

Food

Some scientists argue that there is enough food to support the world population,^{[160][161]} and some dispute this, particularly if sustainability is taken into account.^[162]

Many countries rely heavily on imports. Egypt and Iran rely on imports for 40% of their grain supply. Yemen and Israel import more than 90%. And just 6 countries – Argentina, Australia, Canada, France, Thailand and the USA – supply 90% of grain exports. In recent decades the US alone supplied almost half of world grain exports.^{[163][164]}

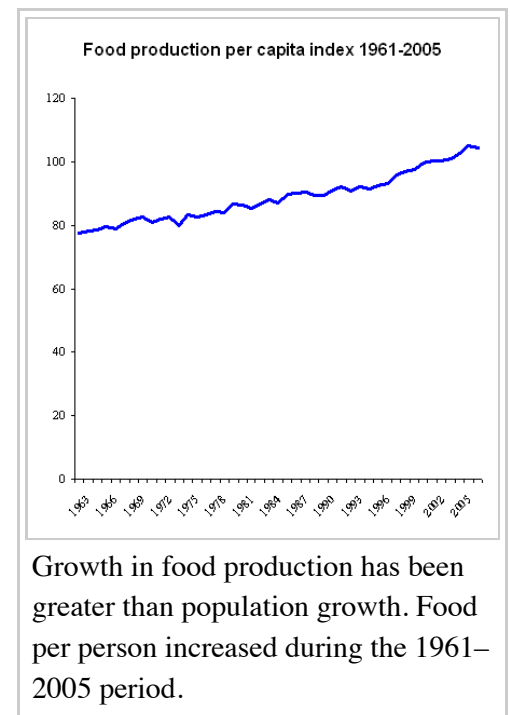
A 2001 United Nations report says population growth is "the main force driving increases in agricultural demand" but "most recent expert assessments are cautiously optimistic about the ability of global food production to keep up with demand for the foreseeable future (that is to say, until approximately 2030 or 2050)", assuming declining population growth rates.^[165]

However, the observed figures for 2007 show an actual increase in absolute numbers of undernourished people in the world, 923 million in 2007 versus 832 million in 1995.;^[166] the more recent FAO estimates point to an even more dramatic increase, to 1.02 billion in 2009.^[167]

Global perspective

The amounts of natural resources in this context are not necessarily fixed, and their distribution is not necessarily a zero-sum game. For example, due to the Green Revolution and the fact that more and more land is appropriated each year from wild lands for agricultural purposes, the worldwide production of food had steadily increased up until 1995. World food production per person was considerably higher in 2005 than 1961.^[168]

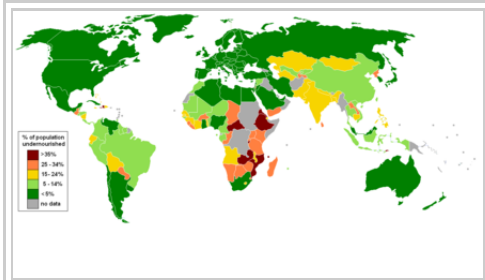
As world population doubled from 3 billion to 6 billion, daily calorie consumption in poor countries increased from 1,932 to 2,650, and the percentage of people in those countries who were malnourished fell from 45% to 18%. This suggests that Third World poverty and famine are caused by underdevelopment, not overpopulation.^[169] However, others question these statistics.^[170] From 1950 to 1984, as the Green Revolution transformed agriculture around the world, grain production increased by over 250%.^[171] The world population has grown by about four billion since the beginning of the Green Revolution and most believe that, without the Revolution, there would be greater famine and malnutrition than the UN presently documents.^{[42][172]}



The number of people who are overweight has surpassed the number who are undernourished. In a 2006 news story, MSNBC reported, "There are an estimated 800 million undernourished people and more than a billion considered overweight worldwide." The U.S. has one of the highest rates of obesity in the world.^[173] However, studies show that wealthy and educated people are far likelier to eat healthy food,^[174] indicating obesity is a disease related to poverty and lack of education and excessive advertising of unhealthy eatables at cheaper cost, high in calories, with little nutritive value are consumed.^{[175][176]}

The Food and Agriculture Organization of the United Nations states in its report *The State of Food Insecurity in the World 2006*, that while the number of undernourished people in the developing countries has declined by about three million, a smaller proportion of the populations of developing countries is undernourished today than in 1990–92: 17% against 20%. Furthermore, FAO's projections suggest that the proportion of hungry

people in developing countries could be halved from 1990–92 levels to 10% by 2015. The FAO also states "We have emphasized first and foremost that reducing hunger is no longer a question of means in the hands of the global community. The world is richer today than it was ten years ago. There is more food available and still more could be produced without excessive upward pressure on prices. The knowledge and resources to reduce hunger are there. What is lacking is sufficient political will to mobilize those resources to the benefit of the hungry."^[177]



Percentage of population suffering from malnutrition by country, according to United Nations statistics.

As of 2008, the price of grain has increased due to more farming used in biofuels,^[178] world oil prices at over \$100 a barrel,^[179] global population growth,^[180] climate change,^[181] loss of agricultural land to residential and industrial development,^{[182][183]} and growing consumer demand in China and India^{[184][185]} Food riots have recently taken place in many countries across the world.^{[186][187][188]} An epidemic of stem rust on wheat caused by race Ug99 is currently spreading across Africa and into Asia and is causing major concern. A virulent wheat disease could destroy most of the world's main wheat crops, leaving millions to starve. The fungus has spread from Africa to Iran, and may already be in Afghanistan and Pakistan.^{[189][190][191]}

Food security will become more difficult to achieve as resources run out. Resources in danger of becoming depleted include oil, phosphorus, grain, fish, and water.^{[192][193]} The British scientist John Beddington predicted in 2009 that supplies of energy, food, and water will need to be increased by 50% to reach demand levels of 2030.^{[194][195]} According to the Food and Agriculture Organization (FAO), food supplies will need to be increased by 70% by 2050 to meet projected demands.^[196]

Africa

In Africa, if current trends of soil degradation and population growth continue, the continent might be able to feed just 25% of its population by 2025, according to UNU's Ghana-based Institute for Natural Resources in Africa.^[197]

Hunger and malnutrition kill nearly 6 million children a year, and more people are malnourished in sub-Saharan Africa this decade than in the 1990s, according to a report released by the Food and Agriculture Organization. In sub-Saharan Africa, the number of malnourished people grew to 203.5 million people in 2000–02 from 170.4 million 10 years earlier says *The State of Food Insecurity in the World* report. In 2001, 46.4% of people in sub-Saharan Africa were living in extreme poverty.^[198]

Asia

According to a 2004 article from the BBC, China, the world's most populous country, suffers from an "obesity surge". The article stated that, "Altogether, around 200 million people are thought to be overweight, 22.8% of the population, and 60 million (7.1%) obese".^[199] More recent data indicate China's grain production peaked in the mid-1990s, due to increased extraction of groundwater in the North China plain.^[200]

Other countries

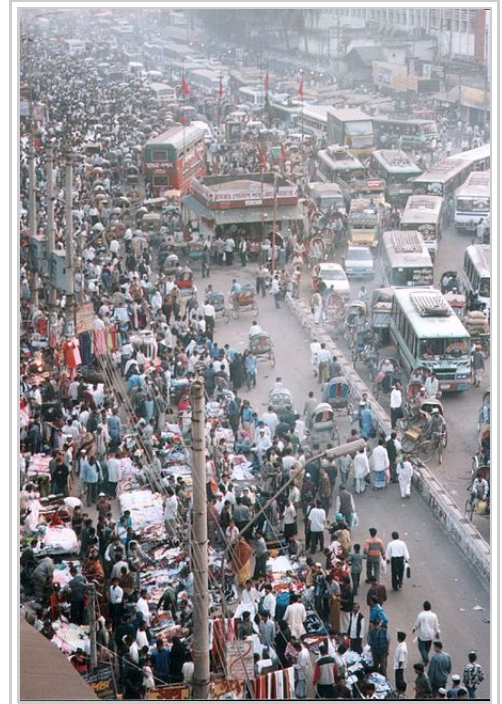
Nearly half of India's children are malnourished, according to recent government data.^[201] Japan may face a food crisis that could reduce daily diets to the austere meals of the 1950s, believes a senior government adviser.^[202]

Population as a function of food availability

Thinkers from a wide range of academic fields and political backgrounds—including agricultural scientist David Pimentel,^[203] behavioral scientist Russell Hopfenberg,^[204] right-wing anthropologist Virginia Abernethy,^[205] ecologist Garrett Hardin,^[206] ecologist and anthropologist Peter Farb, journalist Richard Manning,^[207] environmental biologist Alan D. Thornhill,^[208] cultural critic and writer Daniel Quinn,^[209] and anarcho-primitivist John Zerzan,^[210]—propose that, like all other animal populations, human populations predictably grow and shrink according to their available food supply, growing during an abundance of food and shrinking in times of scarcity.

Proponents of this theory argue that every time food production is increased, the population grows. Most human populations throughout history validate this theory, as does the overall current global population. Populations of hunter-gatherers fluctuate in accordance with the amount of available food. The world human population began increasing after the Neolithic Revolution and its increased food supply. This was, subsequent to the Green Revolution, followed by even more severely accelerated population growth, which continues today. Often, wealthier countries send their surplus food resources to the aid of starving communities; however, proponents of this theory argue that this seemingly beneficial notion only results in further harm to those communities in the long run. Peter Farb, for example, has commented on the paradox that "intensification of production to feed an increased population leads to a still greater increase in population."^[211] Daniel Quinn has also focused on this phenomenon, which he calls the "Food Race" (comparable, in terms of both escalation and potential catastrophe, to the nuclear arms race).

Critics of this theory point out that, in the modern era, birth rates are lowest in the developed nations, which also have the highest access to food. In fact, some developed countries have both a diminishing population and an abundant food supply. The United Nations projects that the population of 51 countries or areas, including Germany, Italy, Japan, and most of the states of the former Soviet Union, is expected to be lower in 2050 than in 2005. This shows that, limited to the scope of the population living within a single given political boundary,



Dhaka street crowds. Bangladesh.

particular human populations do not always grow to match the available food supply. However, the global population as a whole still grows in accordance with the total food supply and many of these wealthier countries are major *exporters* of food to poorer populations, so that, "it is through exports from food-rich to food-poor areas (Allaby, 1984; Pimentel et al., 1999) that the population growth in these food-poor areas is further fueled."^[203]

Regardless of criticisms against the theory that population is a function of food availability, the human population is, on the global scale, undeniably increasing,^[212] as is the net quantity of human food produced — a pattern that has been true for roughly 10,000 years, since the human development of agriculture. The fact that some affluent countries demonstrate negative population growth fails to discredit the theory as whole, since the world has become a globalized system with food moving across national borders from areas of abundance to areas of scarcity. Hopfenberg and Pimentel's findings support both this^[203] and Quinn's direct accusation that "First World farmers are fueling the Third World population explosion."^[213] Additionally, the hypothesis is not so simplistic as to be rejected by any single case study, as in Germany's recent population trends; clearly other factors are at work to limit the population in wealthier areas: contraceptive access, educational programs, cultural norms and, most influentially, differing economic realities from nation to nation.

As a result of water deficits

Water deficits, which are already spurring heavy grain imports in numerous smaller countries, may soon do the same in larger countries, such as China or India, if technology is not used.^[214] The water tables are falling in scores of countries (including Northern China, the US, and India) owing to widespread overdrafting beyond sustainable yields. Other countries affected include Pakistan, Iran, and Mexico. This overdrafting is already leading to water scarcity and cutbacks in grain harvest. Even with the overpumping of its aquifers, China has developed a grain deficit. This effect has contributed in driving grain prices upward. Most of the 3 billion people projected to be added worldwide by mid-century will be born in countries already experiencing water shortages. One suggested solution is for population growth to be slowed quickly by investing heavily in female literacy and family planning services.^[215] Desalination is also considered a viable and effective solution to the problem of water shortages.^{[152][153]}

After China and India, there is a second tier of smaller countries with large water deficits – Algeria, Egypt, Iran, Mexico, and Pakistan. Four of these already import a large share of their grain. Only Pakistan remains self-sufficient. But with a population expanding by 4 million a year, it will also soon turn to the world market for grain.^[164]

Land

The World Resources Institute states that "Agricultural conversion to croplands and managed pastures has affected some 3.3 billion [hectares] – roughly 26 percent of the land area. All totaled, agriculture has displaced one-third of temperate and tropical forests and one-quarter of natural grasslands."^{[216][217]} Forty percent of the land area is under conversion and fragmented; less than one quarter, primarily in the Arctic and the deserts,

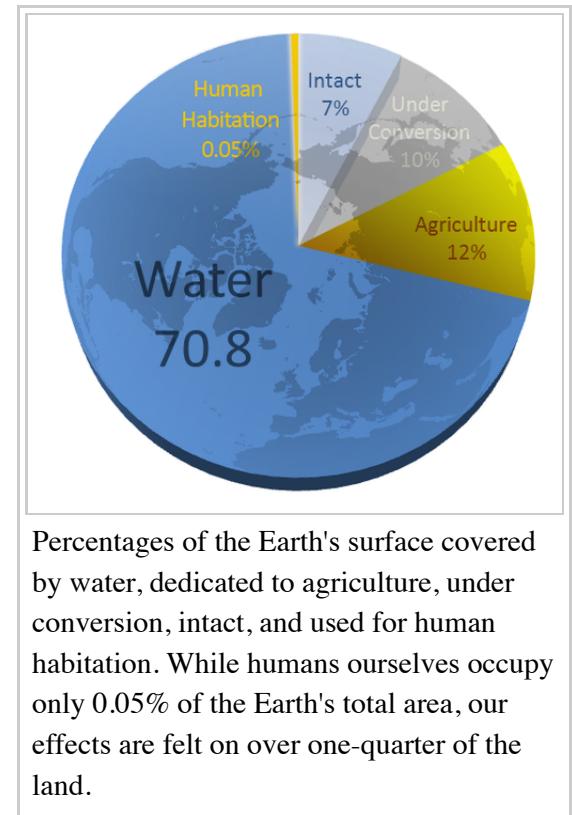
remains intact.^[218] Usable land may become less useful through salinization, deforestation, desertification, erosion, and urban sprawl. Global warming may cause flooding of many of the most productive agricultural areas.^[219] The development of energy sources may also require large areas, for example, the building of hydroelectric dams. Thus, available useful land may become a limiting factor. By most estimates, at least half of cultivable land is already being farmed, and there are concerns that the remaining reserves are greatly overestimated.^[220]

High crop yield vegetables like potatoes and lettuce use less space on inedible plant parts, like stalks, husks, vines, and inedible leaves. New varieties of selectively bred and hybrid plants have larger edible parts (fruit, vegetable, grain) and smaller inedible parts; however, many of these gain of agricultural technology are now historic, and new advances are more difficult to achieve. With new technologies, it is possible to grow crops on some marginal land under certain conditions. Aquaculture could theoretically increase available area. Hydroponics and food from bacteria and fungi, like quorn, may allow the growing of food without having to consider land quality, climate, or even available sunlight, although such a process may be very energy-intensive. Some argue that not all arable land will remain productive if used for agriculture because some marginal land can only be made to produce food by unsustainable practices like slash-and-burn agriculture. Even with the modern techniques of agriculture, the sustainability of production is in question.

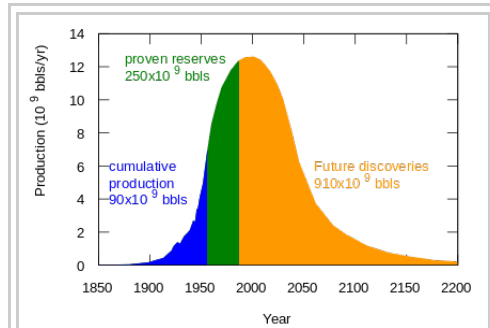
Some countries, such as the United Arab Emirates and particularly the Emirate of Dubai have constructed large artificial islands, or have created large dam and dike systems, like the Netherlands, which reclaim land from the sea to increase their total land area.^[221] Some scientists have said that in the future, densely populated cities will use vertical farming to grow food inside skyscrapers.^[222] The notion that space is limited has been decried by skeptics, who point out that the Earth's population of roughly 6.8 billion people could comfortably be housed an area comparable in size to the state of Texas, in the United States (about 269,000 square miles or 696,706.80 square kilometres).^[223] However, the impact of humanity extends over a far greater area than that required simply for housing.

Fossil fuels

Population optimists have been criticized for failing to take into account the depletion of the petroleum required for the production of fertilizers and fuel for transportation, as well as other fossil fuels.^[224] In his 1992 book *Earth in the Balance*, Al Gore wrote, "... it ought to be possible to establish a coordinated global program to accomplish the strategic goal of completely eliminating the internal combustion engine over, say, a twenty-five-year period..."^[225] Approximately half of the oil produced in the United States is refined into gasoline for use in internal combustion engines.^[226]



The report *Peaking of World Oil Production: Impacts, Mitigation, and Risk Management*, commonly referred to as the Hirsch report, was created by request for the US Department of Energy and published in February 2005.^[227] Some information was updated in 2007.^[228] It examined the time frame for the occurrence of peak oil, the necessary mitigating actions, and the likely impacts based on the timeliness of those actions. It concludes that world oil peaking is going to happen, and will likely be abrupt. Initiating a mitigation crash program 20 years before peaking appears to offer the possibility of avoiding a world liquid fuels shortfall for the forecast period.



M. King Hubbert's prediction of world petroleum production rates. Modern agriculture is totally reliant on petroleum energy.

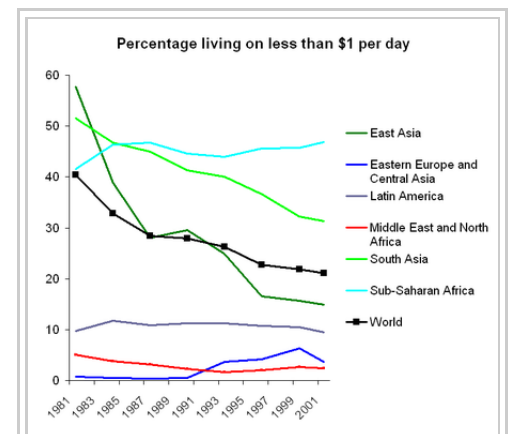
Optimists counter that fossil fuels will be sufficient until the development and implementation of suitable replacement technologies — such as nuclear power or various sources of renewable energy — occurs.^[229] Methods of manufacturing fertilizers from garbage, sewage, and agricultural waste by using thermal depolymerization have been discovered.^{[230][231]}

Wealth and poverty

The United Nations indicates that about 850 million people are malnourished or starving,^[115]

and 1.1 billion people do not have access to safe drinking water.^[97] Some argue that Earth may support 6 billion people, but only if many live in misery. The proportion of the world's population living on less than \$1 per day has halved in 20 years, but these are inflation-unadjusted numbers and likely misleading.^[232]

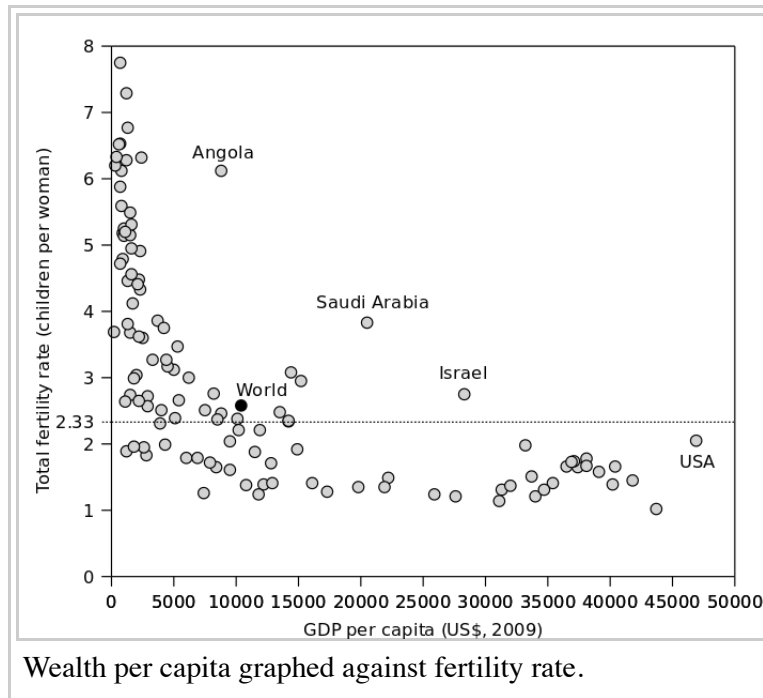
The UN Human Development Report of 1997 states: "During the last 15–20 years, more than 100 developing countries, and several Eastern European countries, have suffered from disastrous growth failures. The reductions in standard of living have been deeper and more long-lasting than what was seen in the industrialised countries during the depression in the 1930s. As a result, the income for more than one billion people has fallen below the level that was reached 10, 20 or 30 years ago". Similarly, although the proportion of "starving" people in sub-Saharan Africa has decreased, the absolute number of starving people has increased due to population growth. The percentage dropped from 38% in 1970 to 33% in 1996 and was expected to be 30% by 2010.^[170] But the region's population roughly doubled between 1970 and 1996. To keep the numbers of starving constant, the percentage would have dropped by more than half.^{[141][233]}



As the world's population has grown, the percentage of the world's population living on less than \$1 per day (adjusted for inflation) has halved in 20 years. The graph shows the 1981–2001 period.

As of 2004, there were 108 countries in the world with more than five million people. All of these in which women have, on the average, more than 4 children in their lifetime, have a per capita GDP of less than \$5000. Only in two countries with per capita GDP above ~\$15,000 do women have, on the average, more than 2

children in their lifetime: these are Israel and Saudi Arabia, with average lifetime births per woman between 2 and 4.



As their income increases, women are liberated and tend to have fewer "quantity kids", as in two in place of six.^[234]

The correlation does not imply cause and effect, and can be linked to the interplay of birth rates, death rates and economic development.

Poor living conditions can also cause a very bad effect on the population; diseases such as malaria and HIV/AIDS can also contribute to this. Lack of nutrients, poor sanitation and poor health institutions. Death rate and birth rate can also have a negative effect on the population.

Environment

Overpopulation has substantially adversely impacted the environment of Earth starting at least

as early as the 20th century.^[126] According to the Global Footprint Network, "today humanity uses the equivalent of 1.5 planets to provide the resources we use and absorb our waste".^[235] There are also economic consequences of this environmental degradation in the form of ecosystem services attrition.^[236] Beyond the scientifically verifiable harm to the environment, some assert the moral right of other species to simply exist rather than become extinct. Environmental author Jeremy Rifkin has said that "our burgeoning population and urban way of life have been purchased at the expense of vast ecosystems and habitats. ... It's no accident that as we celebrate the urbanization of the world, we are quickly approaching another historic watershed: the disappearance of the wild."^[237]

Says Peter Raven, former President of the American Association for the Advancement of Science (AAAS) in their seminal work AAAS Atlas of Population & Environment (<http://atlas.aaas.org/>), "Where do we stand in our efforts to achieve a sustainable world? Clearly, the past half century has been a traumatic one, as the collective impact of human numbers, affluence (consumption per individual) and our choices of technology continue to exploit rapidly an increasing proportion of the world's resources at an unsustainable rate. ... During a remarkably short period of time, we have lost a quarter of the world's topsoil and a fifth of its agricultural land, altered the composition of the atmosphere profoundly, and destroyed a major proportion of our forests and other natural habitats without replacing them. Worst of all, we have driven the rate of biological extinction, the permanent loss of species, up several hundred times beyond its historical levels, and are threatened with the loss of a majority of all species by the end of the 21st century."

Further, even in countries which have both large population growth and major ecological problems, it is not necessarily true that curbing the population growth will make a major contribution towards resolving all environmental problems.^[238] However, as developing countries with high populations become more industrialized, pollution and consumption will invariably increase.

The Worldwatch Institute said in 2006 that the booming economies of China and India are "planetary powers that are shaping the global biosphere". The report states:

The world's ecological capacity is simply insufficient to satisfy the ambitions of China, India, Japan, Europe and the United States as well as the aspirations of the rest of the world in a sustainable way.^[239]



Traffic congestion in Ho Chi Minh City, Vietnam

It said that if China and India were to consume as much resources per capita as the United States, in 2030 they would each require a full planet Earth to meet their needs.^[240] In the long term these effects can lead to increased conflict over dwindling resources^[241] and in the worst case a Malthusian catastrophe.

Many studies link population growth with emissions and the effect of climate change.^{[242][243]}

Warfare and conflict

“ excessive growth may reduce output per worker, repress levels of living for the masses and engender strife. Confucius (551 – 479 BC)^[244] ”

“ Overpopulation in various countries has become a serious threat to the health of people and a grave obstacle to any attempt to organize peace on this planet. Albert Einstein – physicist 1879 – 1955^[245] ”

It has been suggested^[246] that overpopulation leads to increased levels of tensions both between and within countries. Modern usage of the term "lebensraum" supports the idea that overpopulation may promote warfare through fear of resource scarcity and increasing numbers of youth lacking the opportunity to engage in peaceful employment (the youth bulge theory).

Criticism of this hypothesis

The hypothesis that population pressure causes increased warfare has been recently criticized on the empirical grounds. Both studies focusing on specific historical societies and analyses of cross-cultural data have failed to find positive correlation between population density and incidence of warfare. Andrey Korotayev, in

collaboration with Peter Turchin, has shown that such negative results do not falsify the population-warfare hypothesis.^[247]

Population and warfare are dynamical variables, and if their interaction causes sustained oscillations, then we do not in general expect to find strong correlation between the two variables measured at the same time (that is, unlagged). Korotayev and Turchin have explored mathematically what the dynamical patterns of interaction between population and warfare (focusing on internal warfare) might be in both stateless and state societies. Next, they have tested the model predictions in several empirical case studies: early modern England, Han and Tang China, and the Roman Empire. Their empirical results have supported the population-warfare theory: that there is a tendency for population numbers and internal warfare intensity to oscillate with the same period but shifted in phase (with warfare peaks following population peaks).

Furthermore, they have demonstrated that in the agrarian societies the rates of change of the two variables behave precisely as predicted by the theory: population rate of change is negatively affected by warfare intensity, while warfare rate of change is positively affected by population density.^{[247][248][249]}

Mitigation measures

There are several mitigation measures that have been or can be applied to reduce overpopulation. All of these mitigations are ways to implement social norms. Overpopulation is an issue that threatens the state of the environment in the above-mentioned ways and therefore societies must make a change in order to reverse some of the environmental effects brought on by current social norms. In societies like China, the government has put policies in place that regulate the number of children allowed to a couple. Other societies have already begun to implement social marketing strategies in order to educate the public on overpopulation effects. "The intervention can be widespread and done at a low cost. A variety of print materials (flyers, brochures, fact sheets, stickers) needs to be produced and distributed throughout the communities such as at local places of worships, sporting events, local food markets, schools and at car parks (taxis / bus stands)."^[250]

Such prompts work to introduce the problem so that social norms are easier to implement. Certain government policies are making it easier and more socially acceptable to use contraception and abortion methods. An example of a country whose laws and norms are hindering the global effort to slow population growth is Afghanistan. "The approval by Afghan President Hamid Karzai of the Shia Personal Status Law in March 2009 effectively destroyed Shia women's rights and freedoms in Afghanistan. Under this law, women have no right to deny their husbands sex unless they are ill, and can be denied food if they do."^[251]

Education and empowerment

One option is to focus on education about overpopulation, family planning, and birth control methods, and to make birth-control devices like male/female condoms, pills and intrauterine devices easily available.

Worldwide, nearly 40% of pregnancies are unintended (some 80 million unintended pregnancies each year).^[252] An estimated 350 million women in the poorest countries of the world either did not want their last child, do not want another child or want to space their pregnancies, but they lack access to information, affordable means and services to determine the size and spacing of their families. In the United States, in 2001, almost half of

pregnancies were unintended.^[253] In the developing world, some 514,000 women die annually of complications from pregnancy and abortion,^[254] with 86% of these deaths occurring in the sub-Saharan Africa region and South Asia.^[255] Additionally, 8 million infants die, many because of malnutrition or preventable diseases, especially from lack of access to clean drinking water.^[256]

Women's rights and their reproductive rights in particular are issues regarded to have vital importance in the debate.^[257]

"The only ray of hope I can see – and it's not much – is that wherever women are put in control of their lives, both politically and socially; where medical facilities allow them to deal with birth control and where their husbands allow them to make those decisions, birth rate falls. Women don't want to have 12 kids of whom nine will die." — David Attenborough^[258]

Egypt announced a program to reduce its overpopulation by family planning education and putting women in the workforce. It was announced in June 2008 by the Minister of Health and Population Hatem el-Gabali. The government has set aside 480 million Egyptian pounds (about \$90 million US) for the program.^[259]

The business magnate Ted Turner proposed a "voluntary, non-imposed" one-child family scenario. A "pledge two or fewer" campaign is run by Population Matters (a UK population concern organisation), in which people are encouraged to limit themselves to small family size.

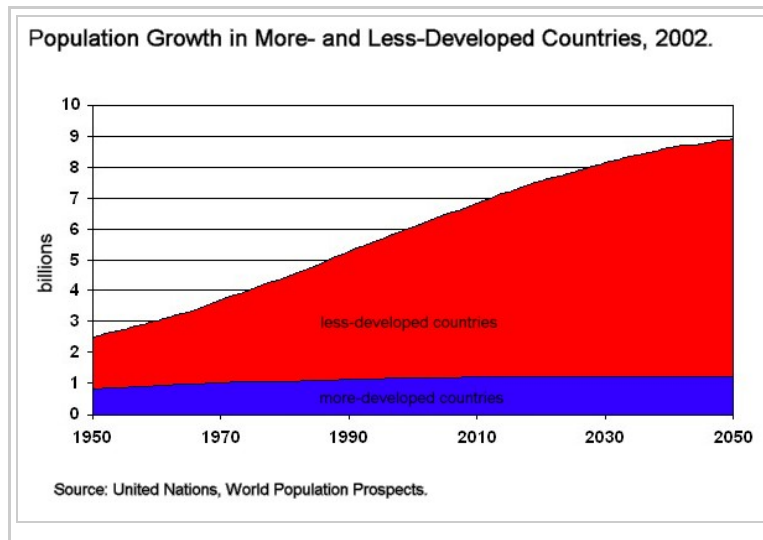
Birth regulations

Overpopulation is related to the issue of birth control; some nations, like the People's Republic of China, use strict measures to reduce birth rates. Religious and ideological opposition to birth control has been cited as a factor contributing to overpopulation and poverty.^[260]

Sanjay Gandhi, son of late Prime Minister of India Indira Gandhi, implemented a forced sterilization programme between 1975 and 1977. Officially, men with two children or more had to submit to sterilization, but there was a greater focus on sterilizing women than sterilizing men. Some unmarried young men, political opponents and ignorant men were also believed to have been sterilized. This program is still remembered and criticized in India, and is blamed for creating a public aversion to family planning, which hampered government programmes for decades.^[261]

Urban designer Michael E. Arth has proposed a "choice-based, marketable birth license plan" he calls "birth credits".^[262] Birth credits would allow any woman to have as many children as she wants, as long as she buys a license for any children beyond an average allotment that would result in zero population growth. If that allotment was determined to be one child, for example, then the first child would be free, and the market would determine what the license fee for each additional child would cost. Extra credits would expire after a certain time, so these credits could not be hoarded by speculators. The actual cost of the credits would only be a

fraction of the actual cost of having and raising a child, so the credits would serve more as a wake-up call to women who might otherwise produce children without seriously considering the long term consequences to themselves or society.^{[263][264]}



Another choice-based approach, similar to Arth's birth credits, is financial compensation or other benefits (free goods and/or services) by the state (or state-owned companies) offered to people who voluntarily undergo sterilization. Such compensation has been offered in the past by the government of India.^[265]

In 2014 the United Nations estimated there is an 80% likelihood that the world's population will be between 9.6 billion and 12.3 billion by 2100. Most of the world's expected population increase will be in Africa and southern Asia. Africa's population is expected to rise from the current one billion to three or four billion by 2100, and Asia could add another

billion in the same period.^[266] Because the median age of Africans is so low (e.g. Uganda = 15 years old) birth credits would have to limit fertility to one child per two women to reach the levels of developed countries immediately. For countries with a wide base in their population pyramid it will take a generation for the people who are of child bearing age to have their families.^[264] An example of demographic momentum is China, which added perhaps 400,000 more people after its one-child policy was enacted. Arth has suggested that the focus should be on the developed countries and that some combination of birth credits and additional compensation supplied by the developed countries could rapidly lead to zero population growth while also quickly raising the standard of living in developing countries.^[264]

Infectious agents

During the Apartheid in South Africa, the regime's Chemical and Biological Warfare unit created artificial "infertility toxins" as a bioweapon to sterilize the black population.^[267]

There are also natural diseases, such as chlamydia, gonorrhea and even some diseases that produce no physical discomfort at all (such as some specific adeno-associated viruses^[268]) that may also cause sterilization of males and/or females in the population.^{[269][270][271]} Whereas the natural occurrence of these diseases is not sufficient to significantly reduce the population problem, large-scale production of these diseases and human-induced release of such diseases could quite well be used as a mitigation measure.

Extraterrestrial settlement

In the 1970s, Gerard O'Neill suggested building space habitats that could support 30,000 times the carrying capacity of Earth using just the asteroid belt and that the Solar System as a whole could sustain current population growth rates for a thousand years.^[272] Marshall Savage (1992, 1994) has projected a human population of five quintillion throughout the Solar System by 3000, with the majority in the asteroid belt.^[273] Freeman Dyson (1999) favours the Kuiper belt as the future home of humanity, suggesting this could happen within a few centuries.^[274] In *Mining the Sky*, John S. Lewis suggests that the resources of the solar system could support 10 quadrillion (10^{16}) people. In an interview, Stephen Hawking claimed that overpopulation is a threat to human existence and "our only chance of long-term survival is not to remain inward looking on planet Earth but to spread out into space."^[275]

K. Eric Drexler, famous inventor of the futuristic concept of molecular nanotechnology, has suggested in *Engines of Creation* that colonizing space will mean breaking the Malthusian limits to growth for the human species.

It may be possible for other parts of the Solar System to be inhabited by humanity at some point in the future. Geoffrey Landis of NASA's Glenn Research Center in particular has pointed out that "[at] cloud-top level, Venus is the paradise planet", as one could construct aerostat habitats and floating cities there easily, based on the concept that breathable air is a lifting gas in the dense Venusian atmosphere. Venus would, like also Saturn, Uranus, and Neptune, in the upper layers of their atmospheres, even afford a gravitation almost exactly as strong as that on Earth (*see* colonization of Venus).^[276]

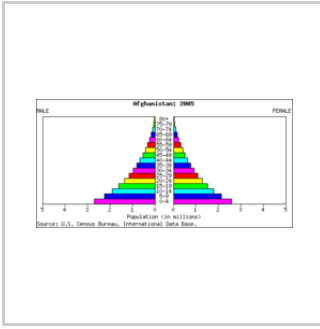
Many authors, including Carl Sagan, Arthur C. Clarke,^[277] and Isaac Asimov,^[278] have argued that shipping the excess population into space is not a viable solution to human overpopulation. According to Clarke, "the population battle must be fought or won here on Earth".^[277] The problem for these authors is not the lack of resources in space (as shown in books such as *Mining the Sky*^[279]), but the physical impracticality of shipping vast numbers of people into space to "solve" overpopulation on Earth. However, Gerard O'Neill's calculations show that Earth could offload all new population growth with a launch services industry about the same size as the current airline industry.^[280]

The StarTram concept, by James R. Powell (the co-inventor of maglev transport) and others, envisions a capability to send up to 4 million people a decade to space per facility.^[281] A hypothetical extraterrestrial colony could potentially grow by reproduction alone (i.e., without any immigration), with most of the inhabitants being the direct descendants of the original colonists.

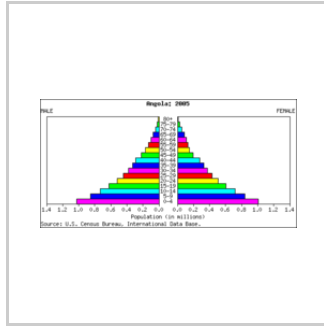
Urbanization

Despite the increase in population density within cities (and the emergence of megacities), UN Habitat states in its reports that urbanization may be the best compromise in the face of global population growth.^[282] Cities concentrate human activity within limited areas, limiting the breadth of environmental damage.^[283] But this mitigating influence can only be achieved if urban planning is significantly improved^[284] and city services are properly maintained.

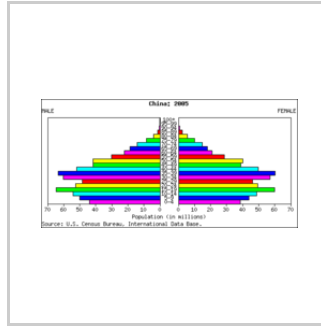
Graph gallery



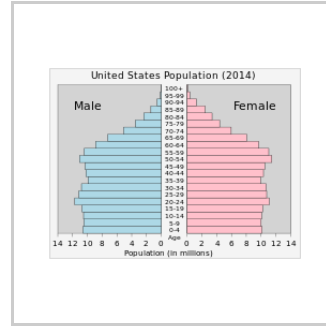
Afghanistan shows a classic youth bulge.



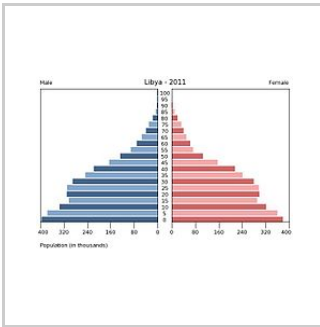
Angola shows the same, even more pronounced.



China had an extreme youth bulge until the 1960s, when it sharply curbed partly as an effect of the one-child policy.



Compare the population pyramid of the USA which was bulging until the 1960s and has steadily slimmed since.



A population pyramid based on the 2011 Libyan population.

See also

- Accelerating change (population growth is a factor)
- Behavioral sink, a rat over-population experiment
- Demographic trap
- Eugenics
- Ethnic bioweapon
- Human migration
- Human population control
- Fertility and intelligence
- List of most highly populated countries
- List of population concern organizations



Wikiquote has quotations related to: ***Human overpopulation***

- List of organisations campaigning for population stabilisation
- Malthusianism
- Overexploitation
- People smuggling
- Population ageing
- Population pyramid
- Reserve army of labour
- Risks to civilization, humans and planet Earth
- Tragedy of the commons
- Elephant in the room

Other:

- Overpopulation in companion animals
- Overpopulation in wild animals
- Political demography

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- The Environmental Politics of Population and Overpopulation (http://berkeley.academia.edu/OzzieZehner/Papers/911571/The_Environmental_Politics_of_Population_and_Overpopulation/) A University of California, Berkeley summary of historical, contemporary and environmental concerns involving overpopulation.
- CK-12 Agriculture and human population growth (<http://www.ck12.org/earth-science/Agriculture-and-Human-Population-Growth/>)
- Overpopulation, overconsumption – in pictures (<http://www.theguardian.com/global-development-professionals-network/gallery/2015/apr/01/over-population-over-consumption-in-pictures>) (April 2015), *The Guardian*

External links

- What's your number?



Look up **overpopulation** in Wiktionary, the free dictionary.



Wikibooks has a book on the topic of: **Introduction to Sociology/Demography**

(http://populationaction.org/Articles/Whats_Your_Number/seeandsave.php?date=-14346000000), by Population Action International

- What's your number? (<http://www.bbc.co.uk/news/world-15391515>), by the BBC

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