Recognize the importance of studying human populations in the environmental sciences.

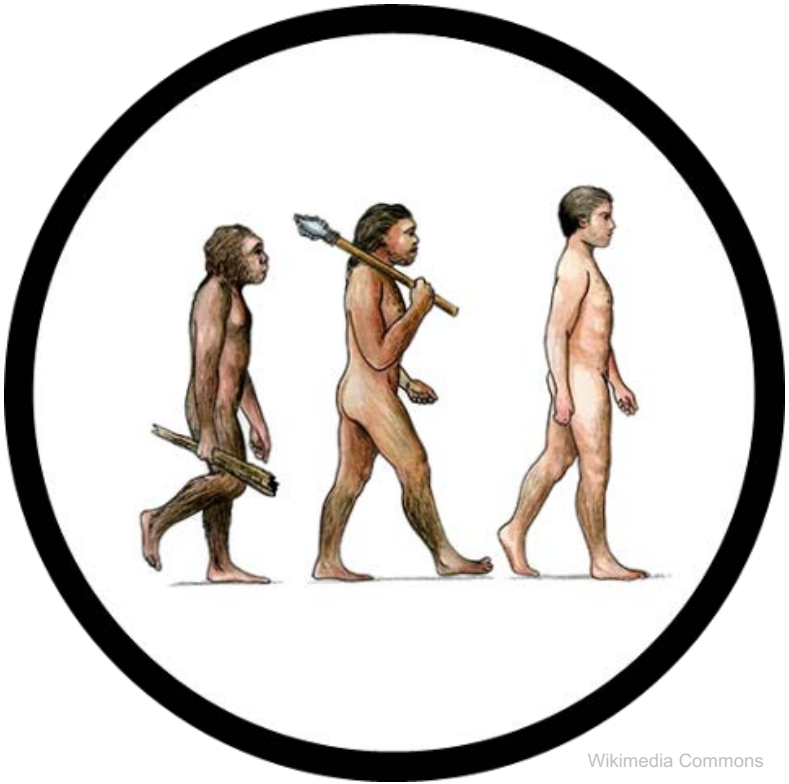
HUMAN POPULATIONS

Image by Rafael Defavari from Wikimedia Commons

Environmental Science

an interdisciplinary field of research that seeks to understand the natural world and *our relationship to it*

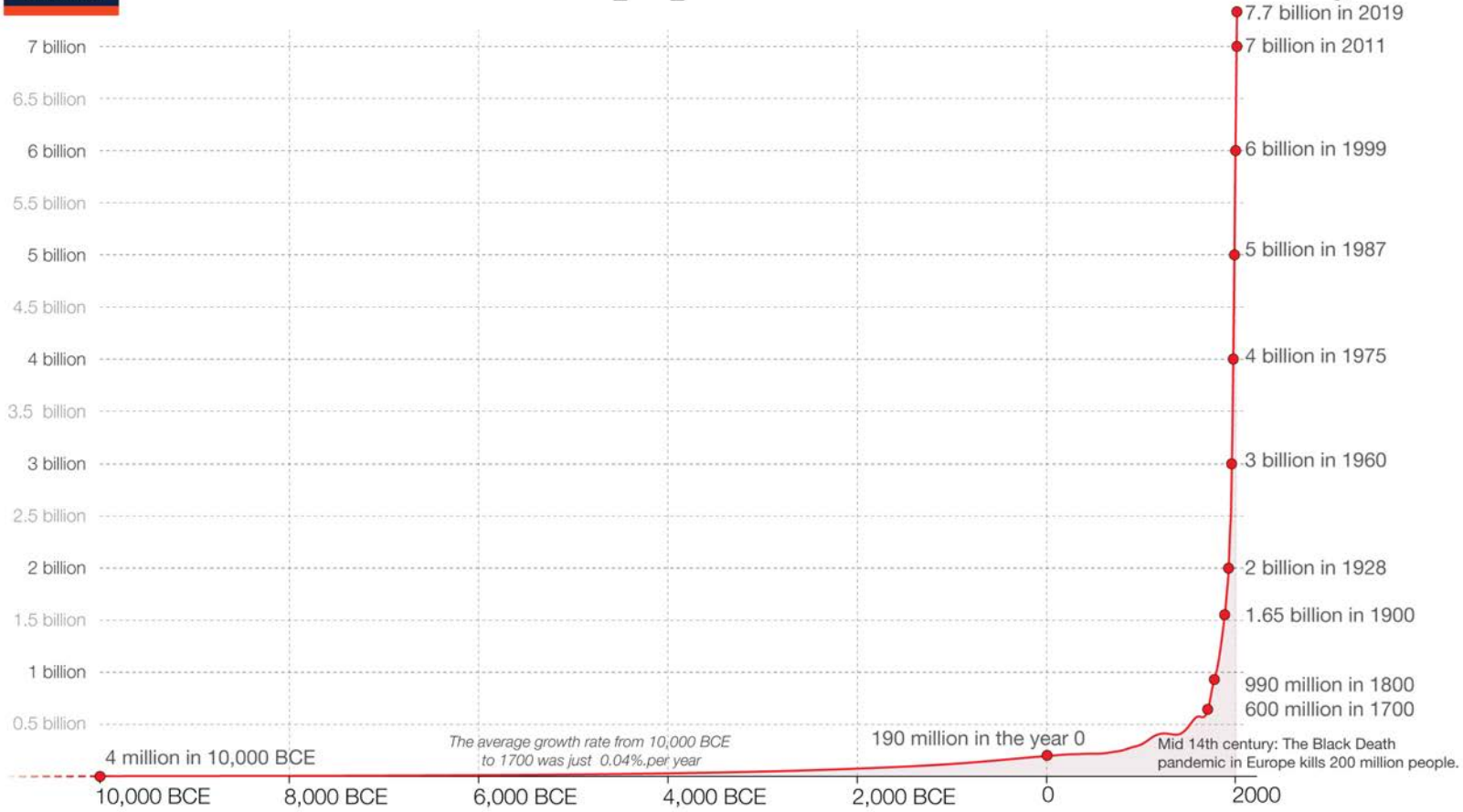
Since we emerged as our own species some 200,000 years ago, we have grown from a few thousands individuals to over 7 billion!



Wikimedia Commons

Image by NASA from Flickr

The size of the world population over the last 12.000 years



Based on estimates by the *History Database of the Global Environment* (HYDE) and the United Nations. On OurWorldinData.org you can download the annual data.
This is a visualization from OurWorldinData.org, where you find data and research on how the world is changing.

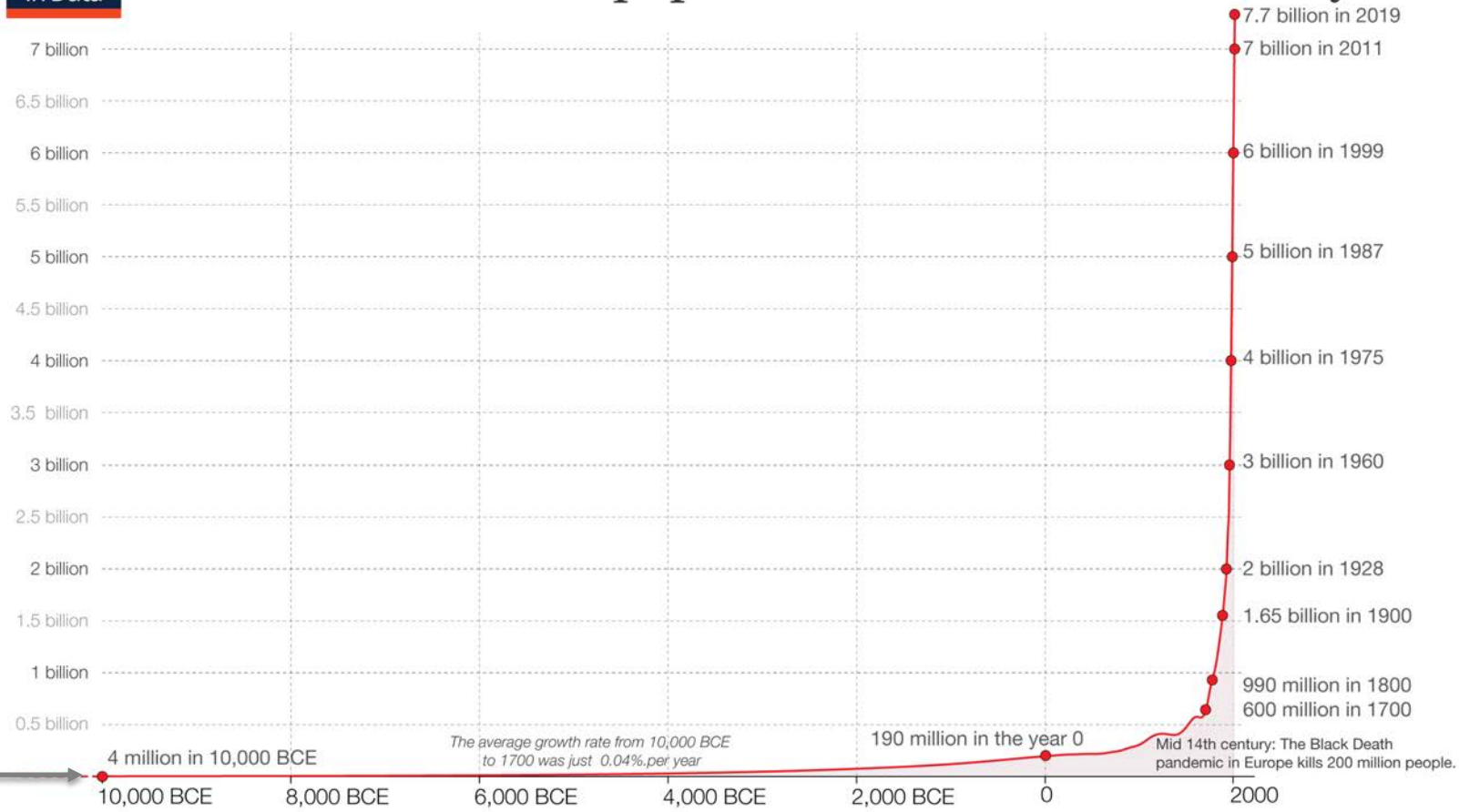
Analyze and categorize human populations using population ecology techniques.

Population Ecology

A branch of biology that deals with the number of individuals of a particular species found in an area and how and why those numbers increase or decrease over time.

When applied to humans we call it demography.

The size of the world population over the last 12.000 years

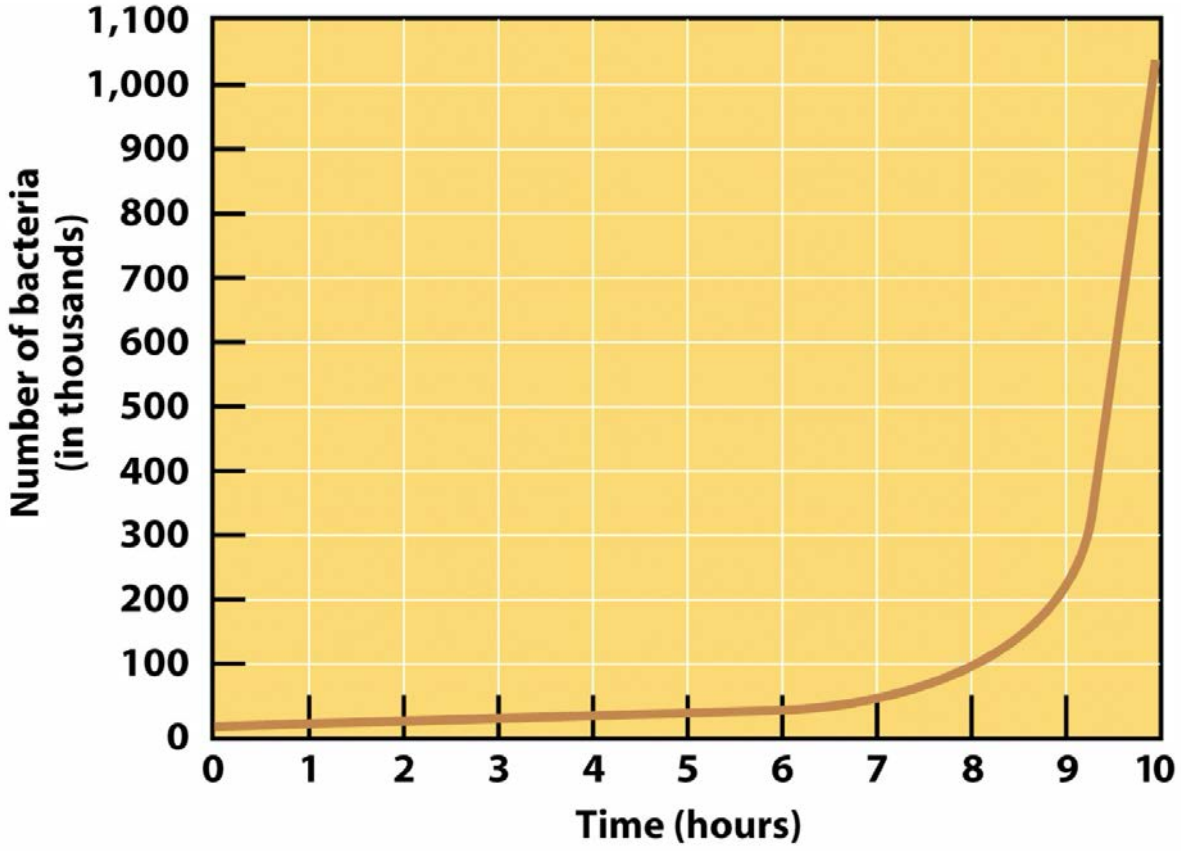


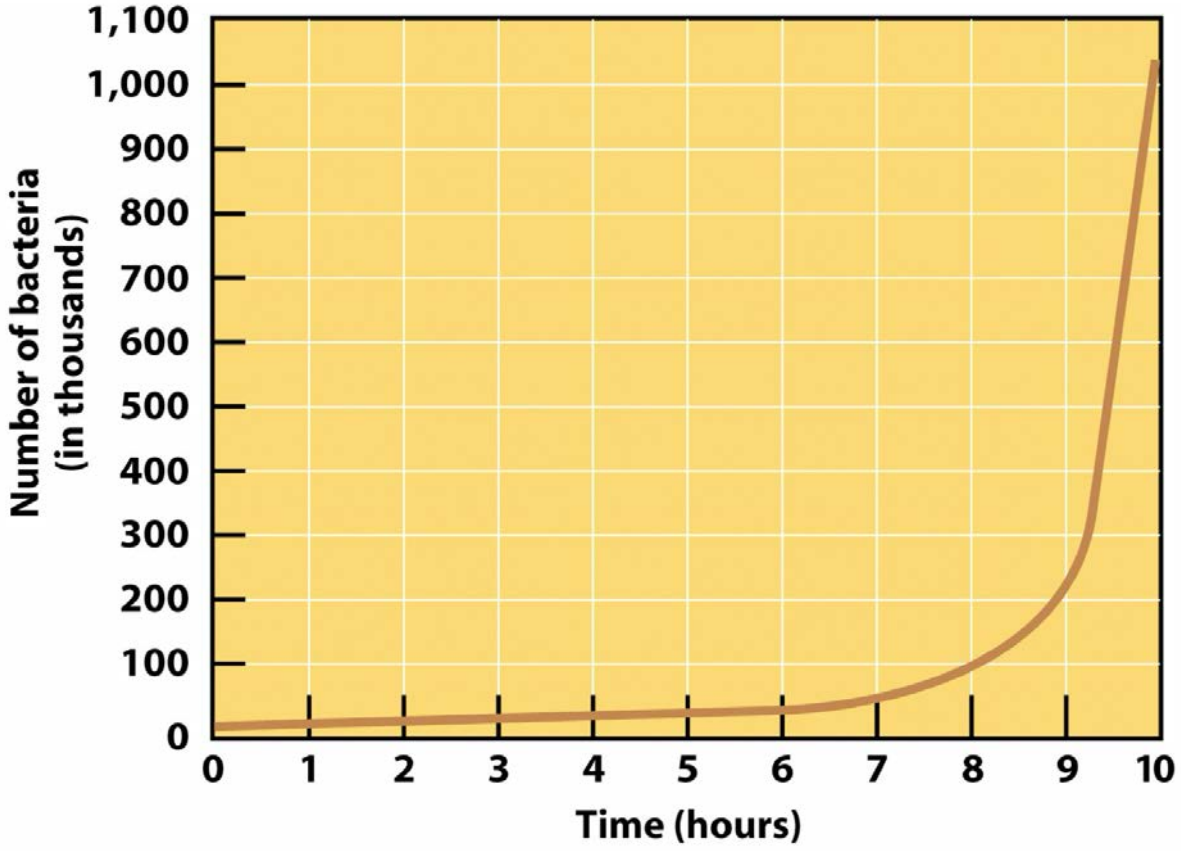
Agricultural Revolution
10000-8000 BCE

Based on estimates by the *History Database of the Global Environment* (HYDE) and the United Nations. On OurWorldinData.org you can download the annual data.
This is a visualization from OurWorldinData.org, where you find data and research on how the world is changing.

Exponential Population Growth

- Also known as logarithmic growth
- Growth depends on size of population
  - Small population = small growth
  - Large population = large growth


Number of bacteria (in thousands)
1,100
1,000
900
800
700
600
500
400
300
200
100
0
0
1
2
3
4
5
6
7
8
9
10
Time (hours)



Population of bacteria = 2^n

n = number of doubling times that have passed

Doubling Time = amount of time required for the population to double in size, assuming the current growth rate remains constant

What is the bacteria population after 24 hours?

Population of bacteria = 2^n **Bacteria doubling time = 30 minutes**

$$n = \frac{24\ hours}{1}\ x\ \frac{2\ doubling\ times}{1\ hour} = 48 \text{ doubling times}$$

Therefore the population of bacteria after 24 hours of growth is:

$$Population\ of\ bacteria = \ 2^{48} = 281{,}474{,}976{,}710{,}656$$

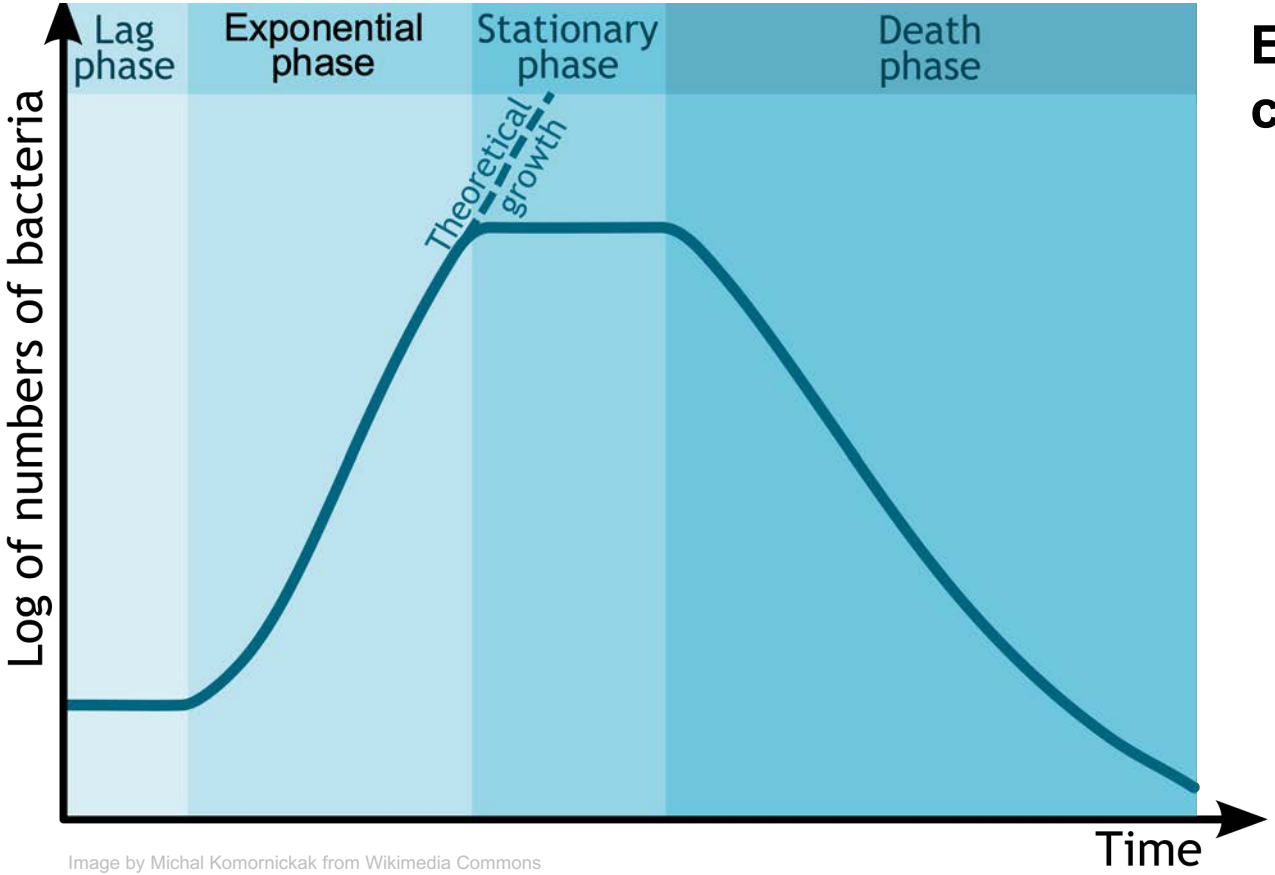


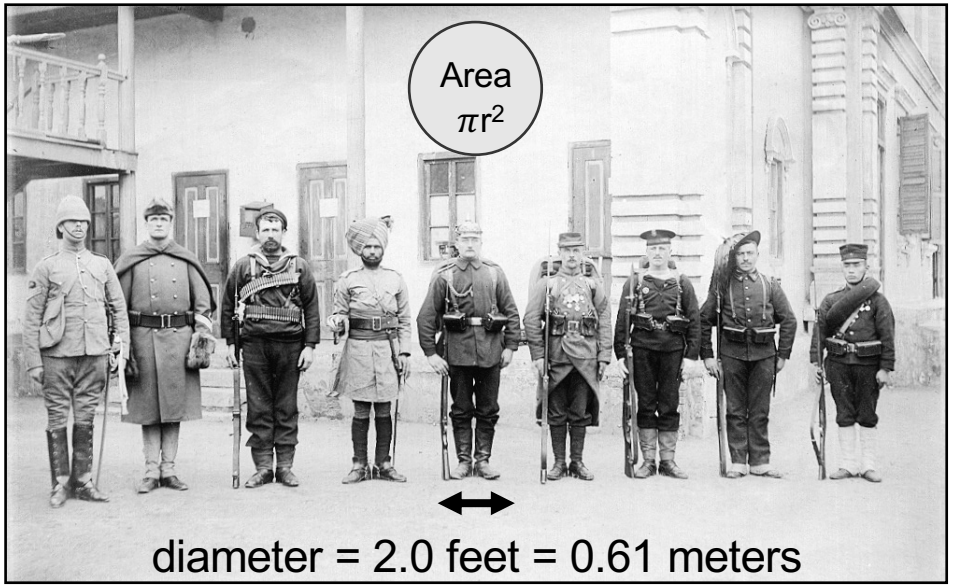
Image by Michal Komornickak from Wikimedia Commons

Exponential growth cannot last forever!

How much space does one human occupy?

$$Area = \pi \left(\frac{1}{2}\ x\ 0.61\ m\right)^2$$

Area of one human = 0.292 m^2



How much space do 8 billion humans occupy?

8,000,000,000 humans x 0.292 m^2 ≈ 2,300,000,000 m^2 = **2,300 km^2**


New York City ≈ 1,500 km²


Columbus ≈ 550 km²

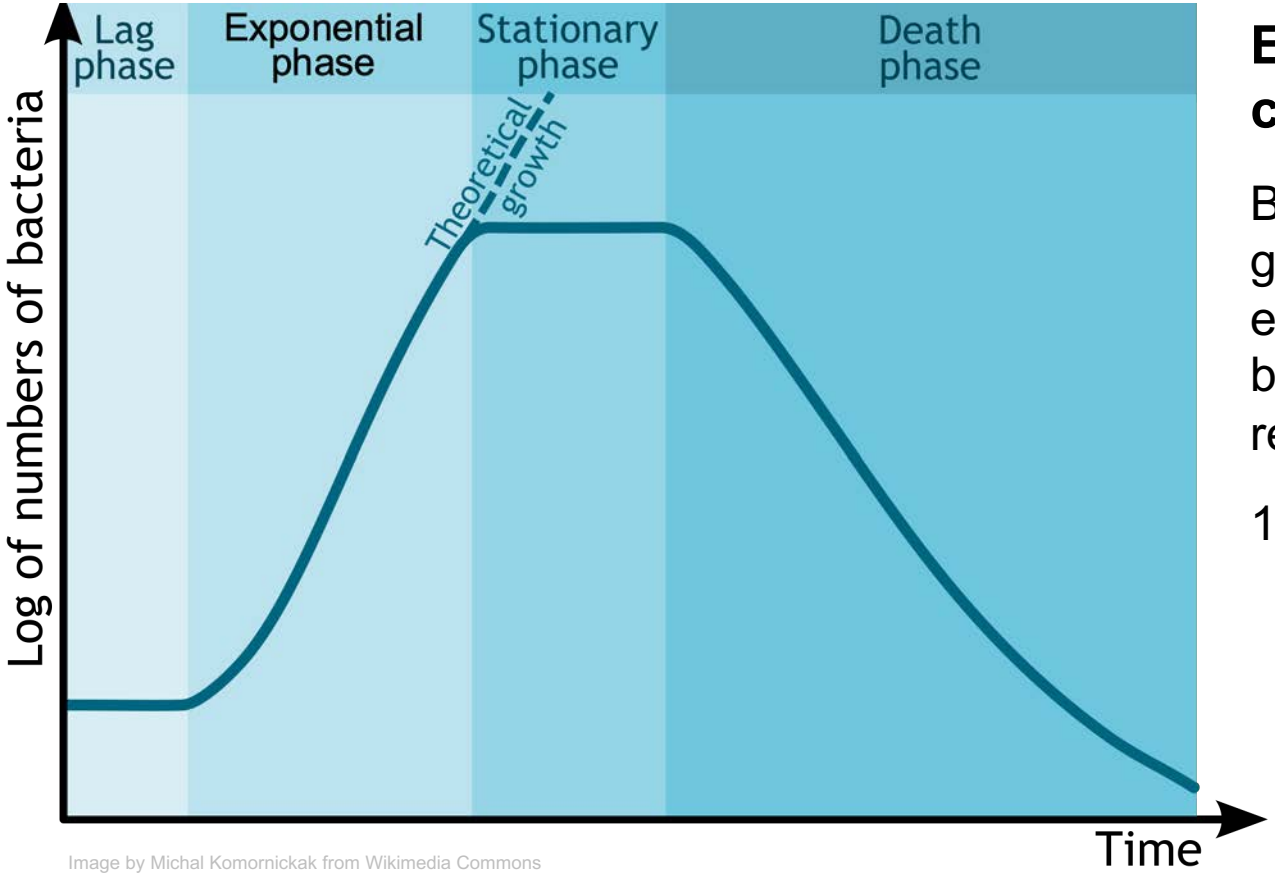
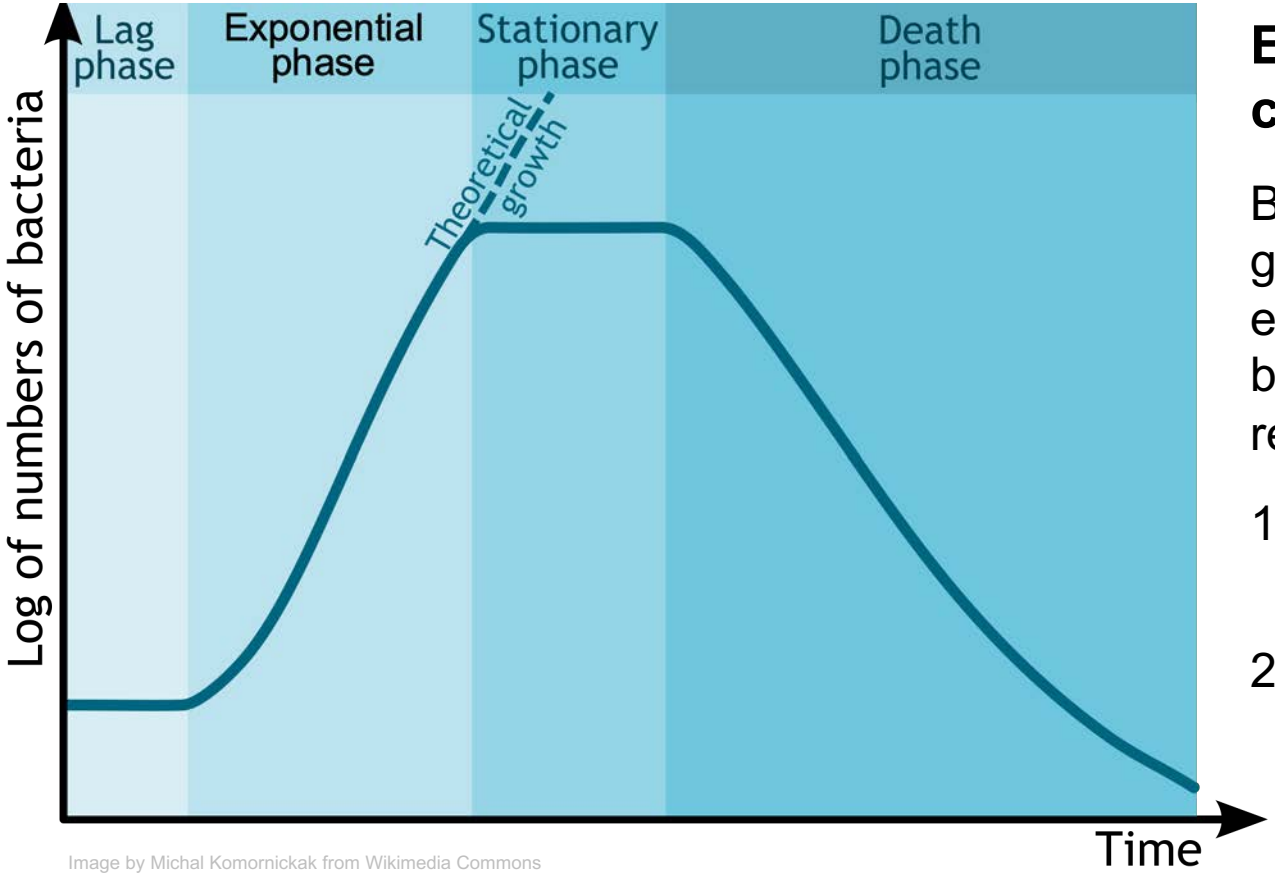


Image by Michal Komornickak from Wikimedia Commons

Exponential growth cannot last forever!

Bacterial population growth slows and eventually declines because of two main reasons:

1. Run out of resources *(famine & war)*



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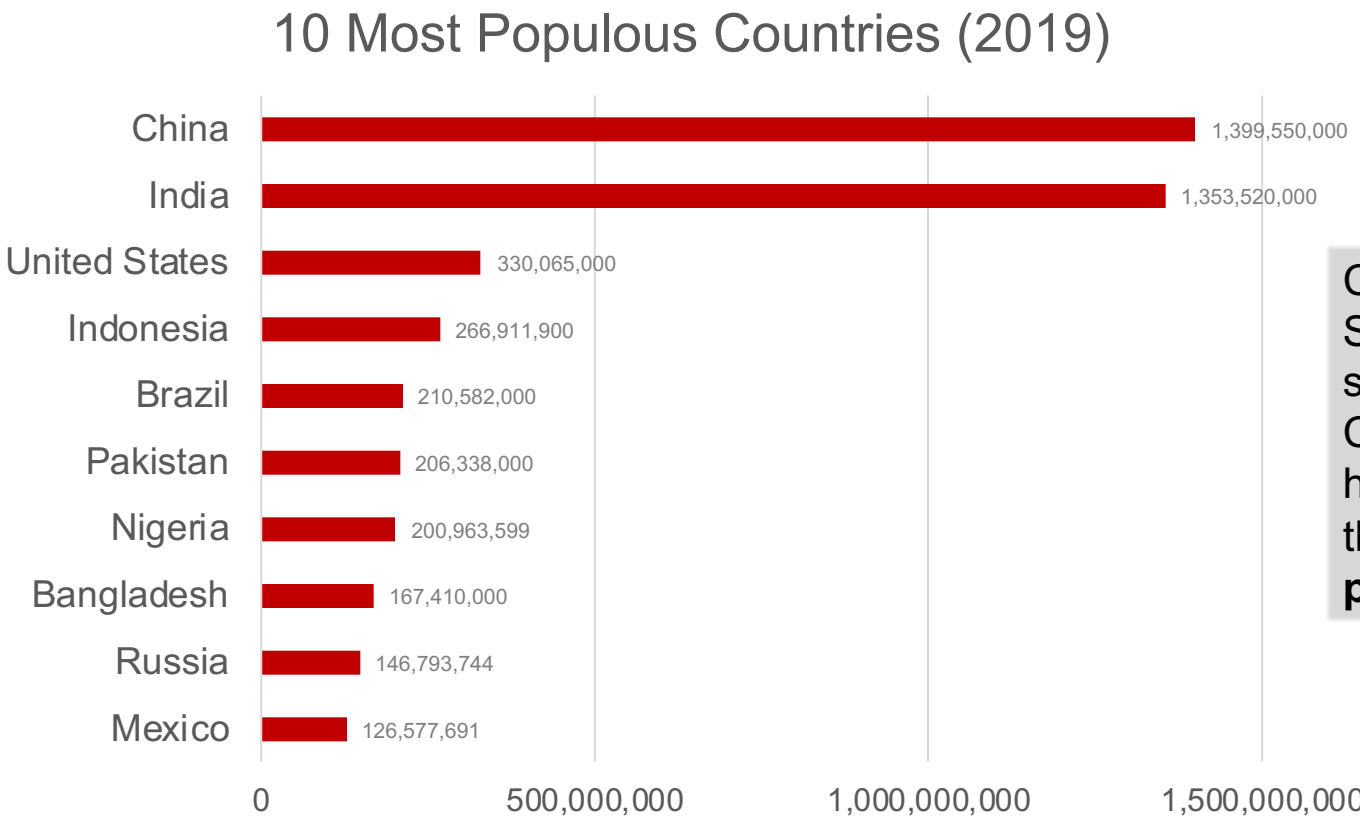
Bacterial population growth slows and eventually declines because of two main reasons:

1. Run out of resources *(famine & war)*
2. Waste products become toxic *(pollution & disease)*

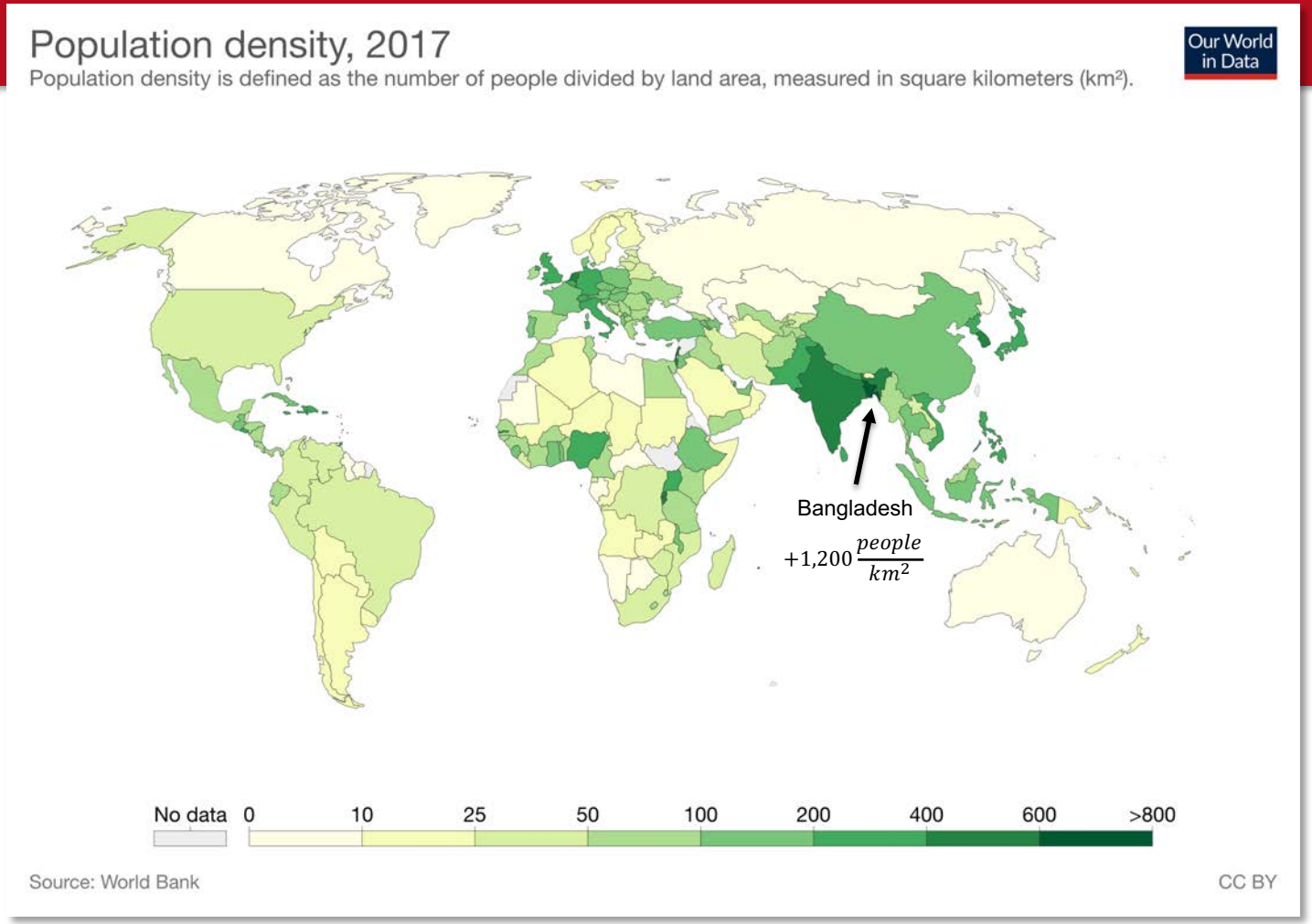


China and the United States have about the same land area, but China has a much higher population and therefore greater **population density**.

Bangladesh has among the highest densities in the world.

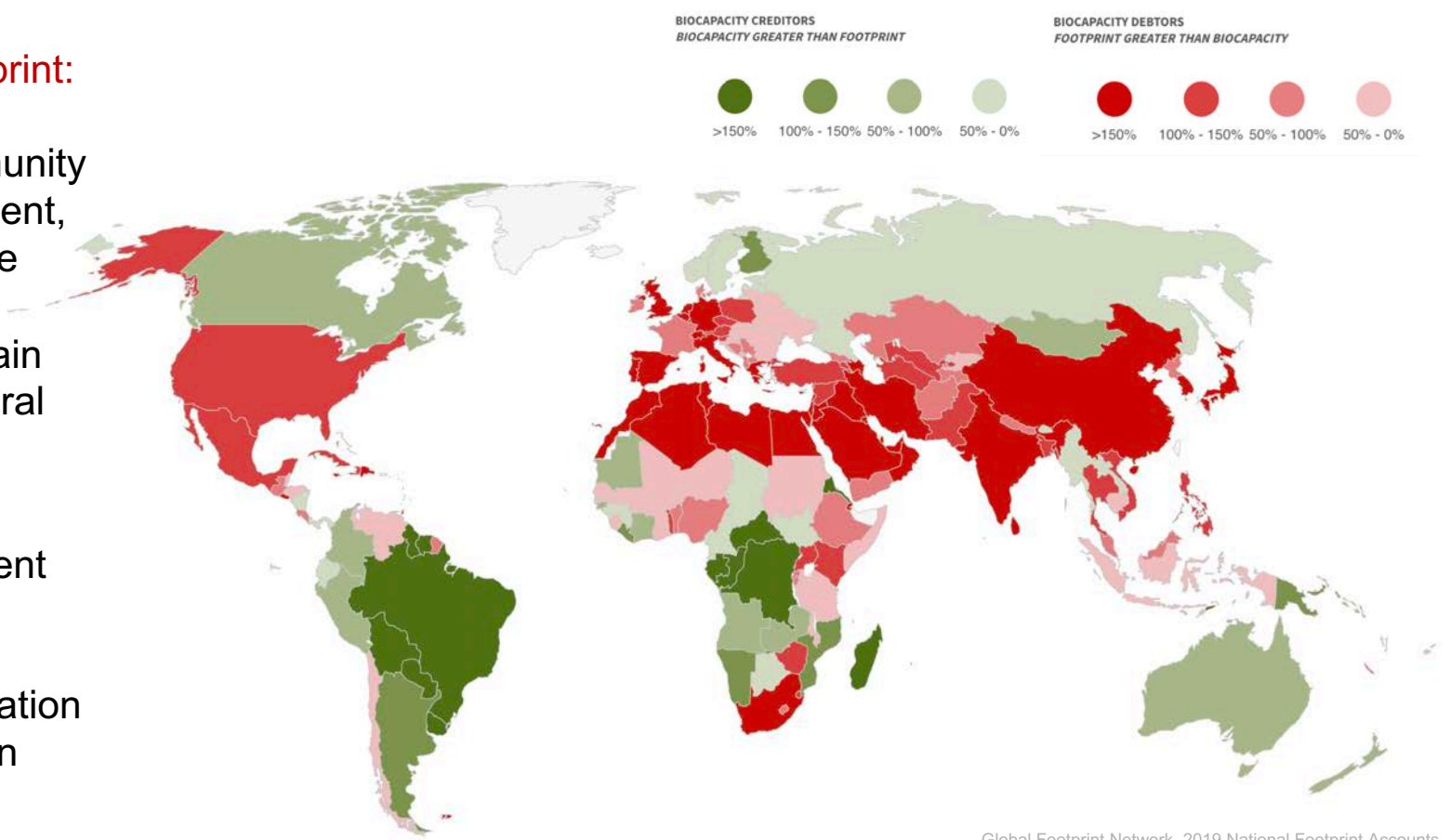
The most densely populated areas in the world tend to be in coastal areas or close to major waterways.

About 90% of the people on Earth live on 10% of the surface area, and most are north of the equator.



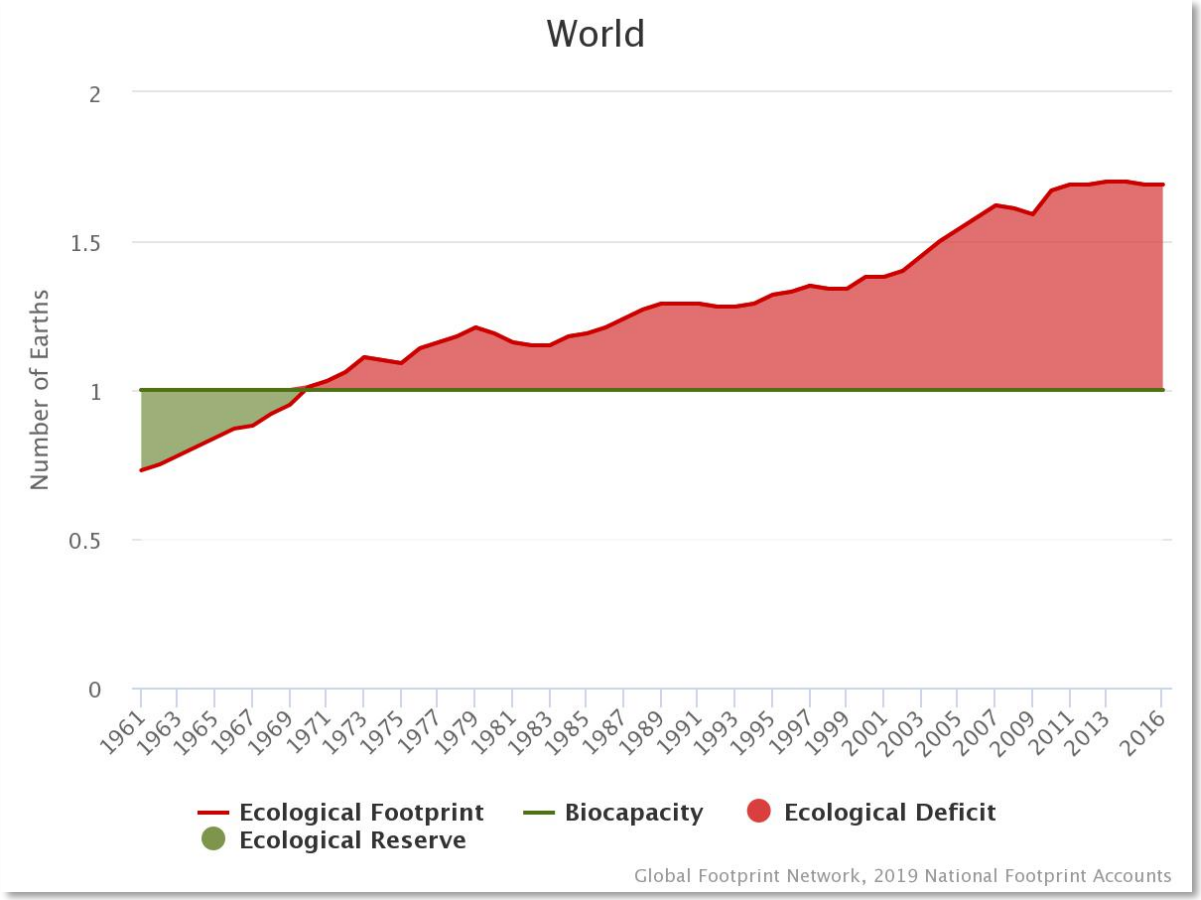
Ecological Footprint: the impact of a person or community on the environment, expressed as the amount of land required to sustain their use of natural resources.

Every environment has a carrying capacity: the maximum population size the area can support.

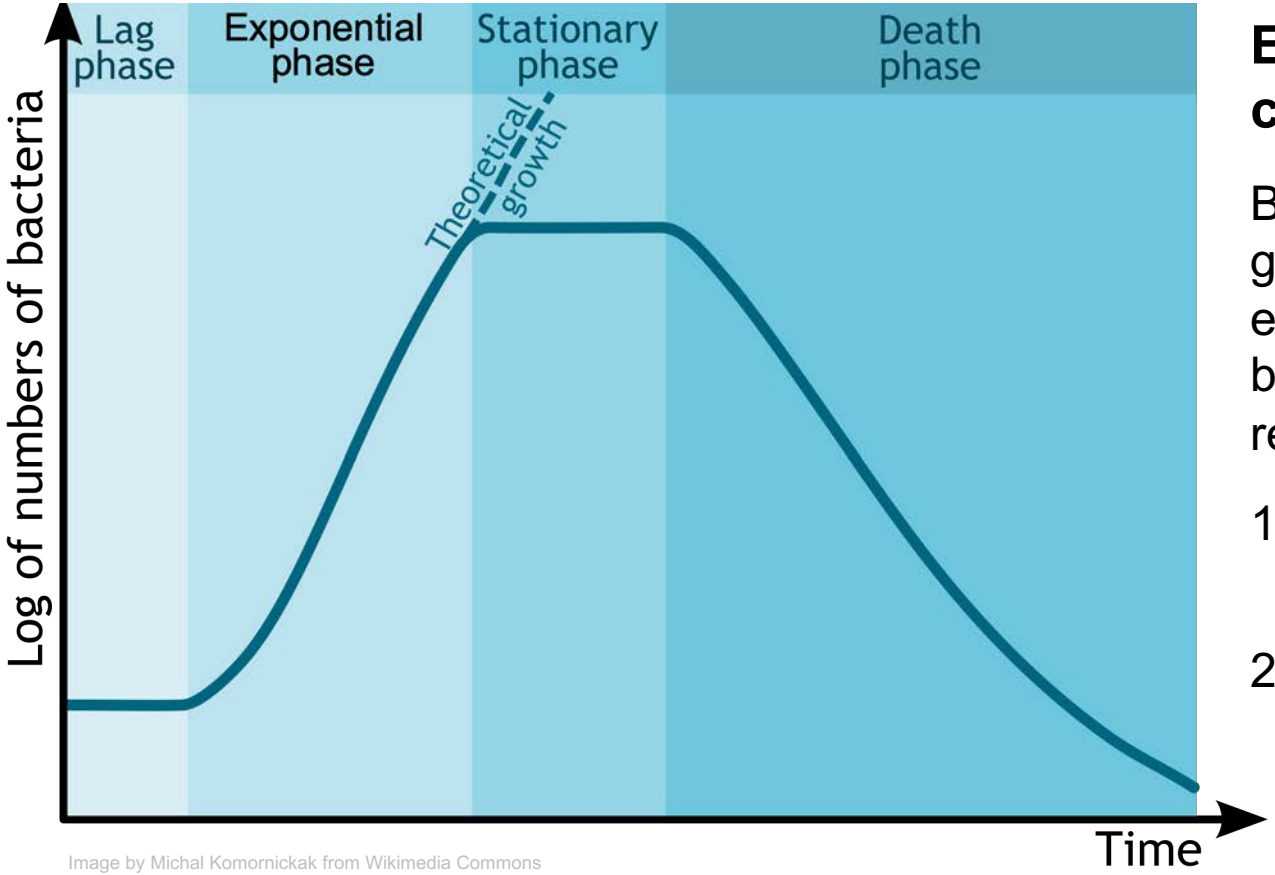


Global Footprint Network, 2019 National Footprint Accounts

As our population grows, so does our demand for natural resources. At our current rate of consumption, the human population is using 1.75 earths worth of resources.



Describe how and why human populations change and be able to read and interpret related graphs and diagrams.



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Growth Rate

- percent increase of population size over time
- affected by births, deaths, and the number of people moving into or out of a regional population

Zero Population Growth

This occurs when the number of people born equals the number of people dying; in other words, replacement fertility rate is reached.

Reaching zero population growth takes two steps:

1. Identifying why birth rates are high
2. Taking steps to reduce them

Pronatalist Pressures

- Policies or cultural beliefs that encourage families to have more children (i.e. work the family farm, tend to household chores, care for aging parents, religious beliefs, high prestige or social status)
- Agrarian societies tend to have high pronatalist pressures
- High infant mortality rate and desire to have survivors

Demographic Factors (2013 data)	World	More Developed Nations	Less Developed Nations
Population Size	7 billion	1.3 billion	5.9 billion
% growth rate	1.2	0.1	1.40
Crude birth rate	20	11	22
Crude death rate	8	10	7
Total fertility rate	2.5	1.6	2.6
Infant mortality rate	40	5	44
Life expectancy	70	78	69
Wealth (per capita GNP)	$11,690	$35,800	$6,600

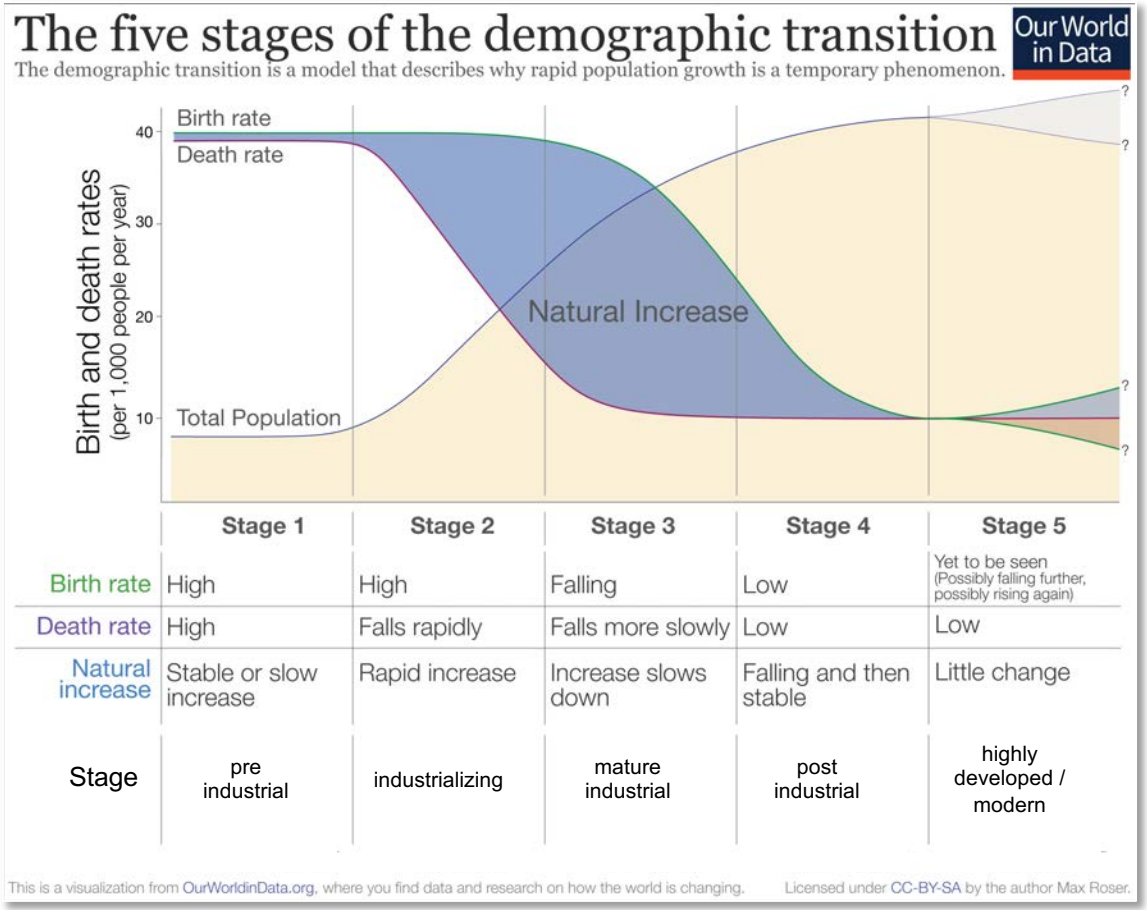
Data from Environmental Science for a Changing World

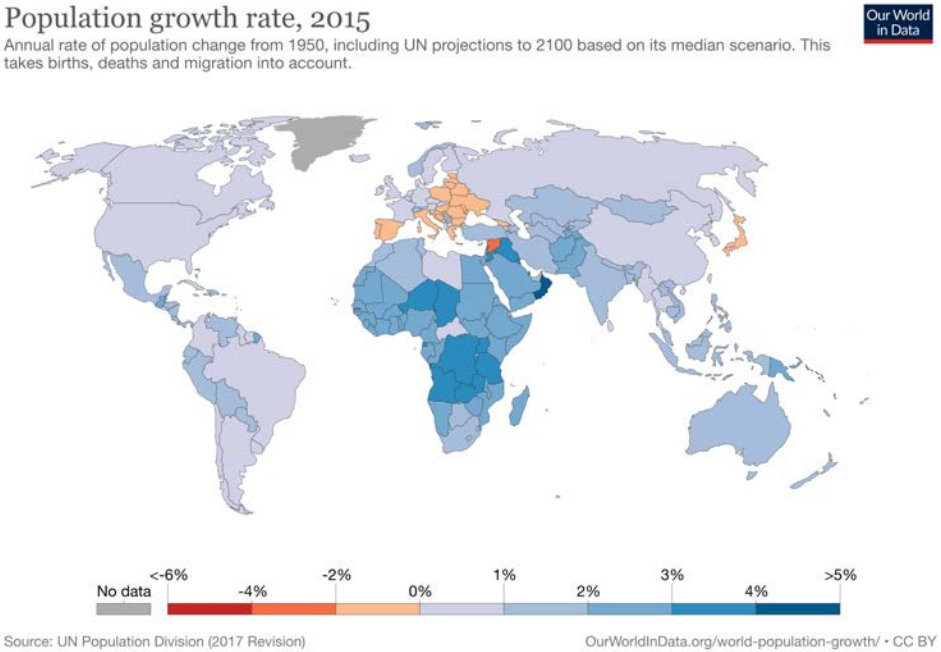
Demographic Factors

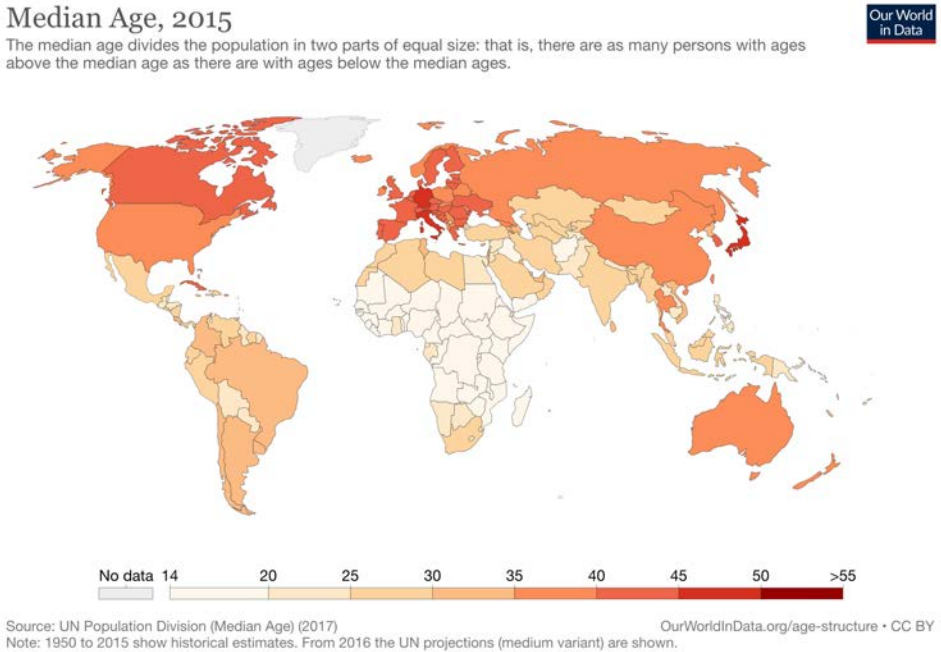
- Health, education, economic conditions, and cultural influences
- Large differences between developed and developing nations.
- Higher death rate in developed nations due to aging population.
- Higher infant mortality rates in developing nations reveal the differences in quality of life and health care.

Demographic transition is a sequence of 5 stages. It suggests that as a country's economy changes from preindustrial to postindustrial, low birth and death rates replace high birth and death rates.

Most population growth occurs during this transition when death rates are lower than birth rates.

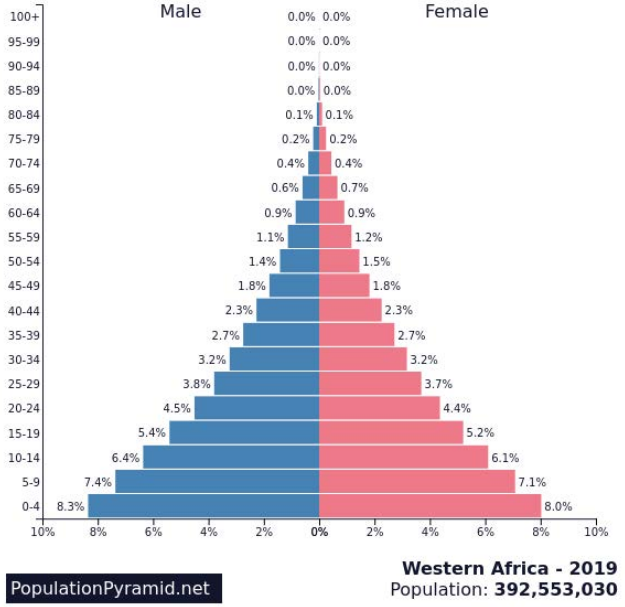






The fastest growing regions are those with a youthful or very young population.

Demographers use age structure diagrams to predict the future growth potential of a population.



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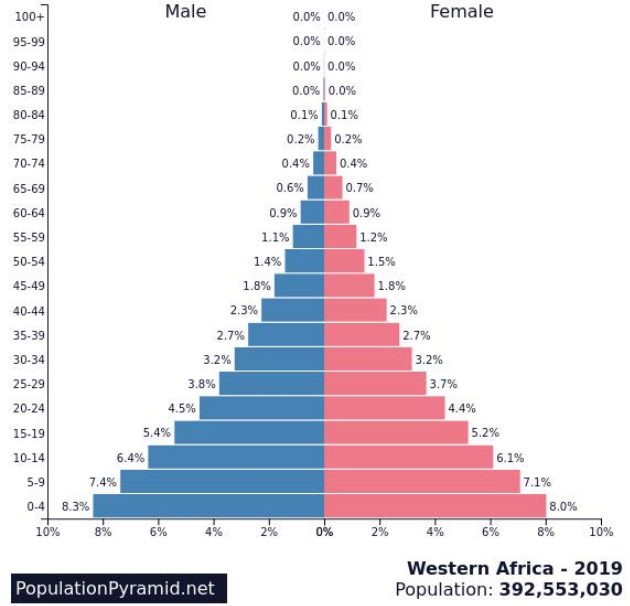
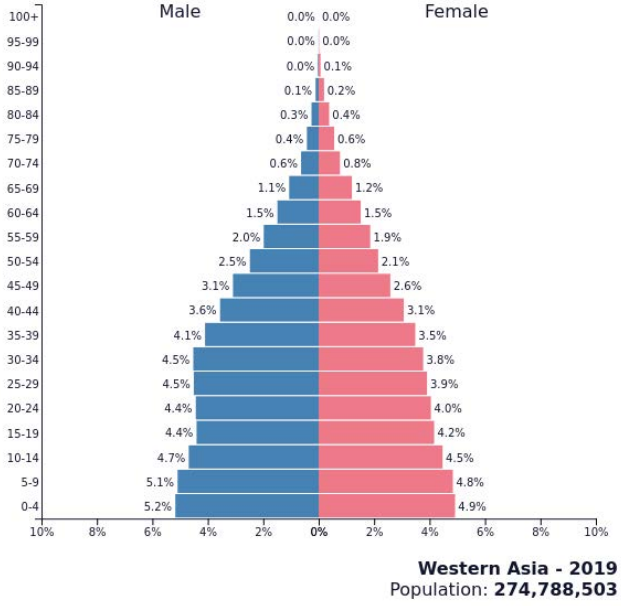
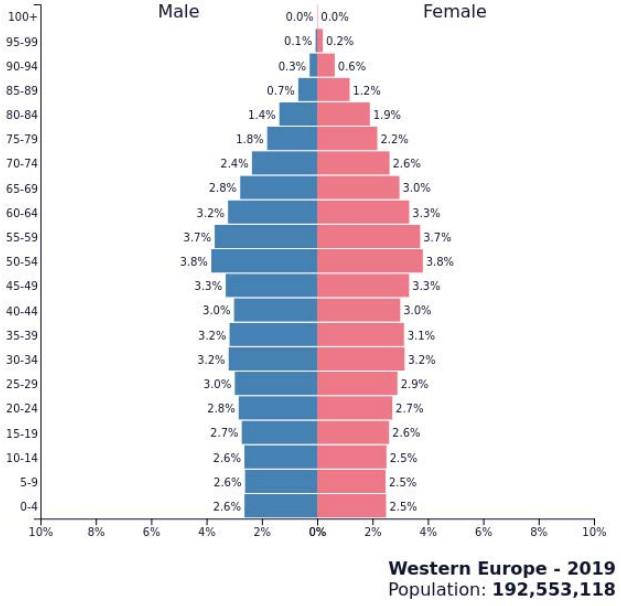
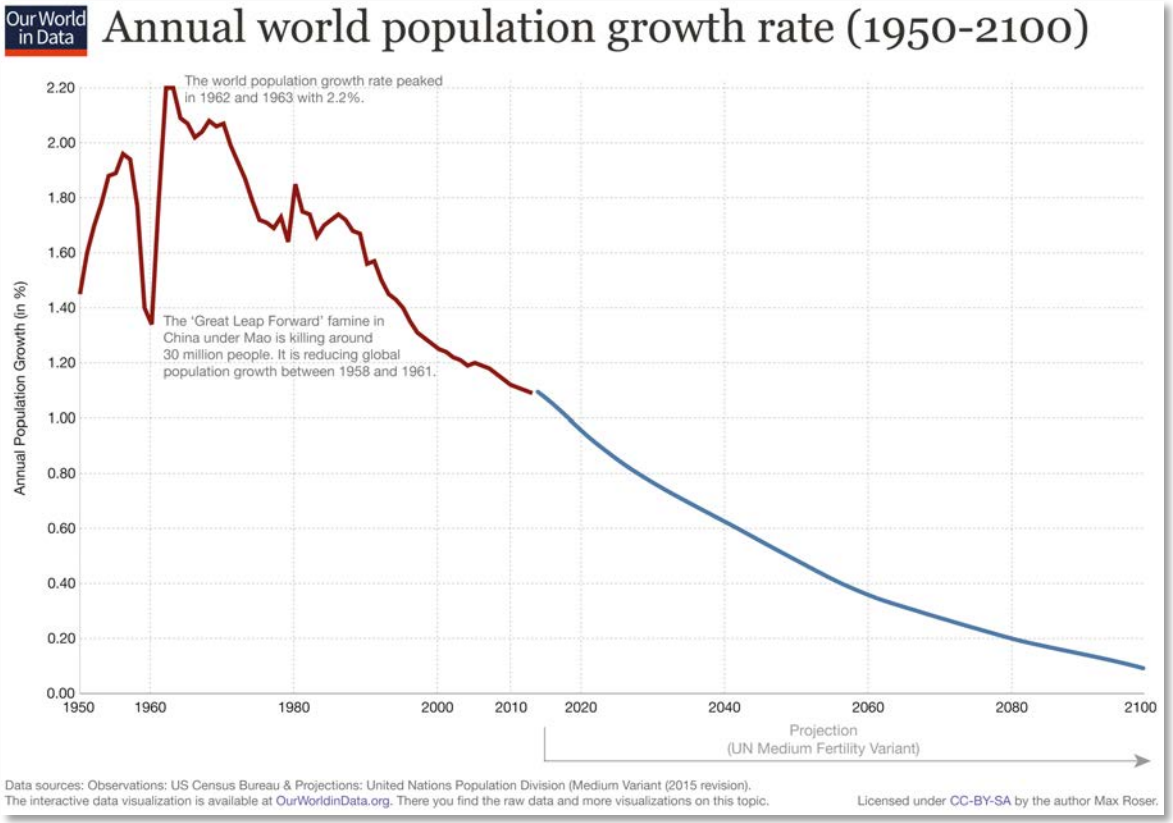








The higher the growth rate, the more quickly a population will double

Less Developed Countries (LDCs) generally have high growth rates

Highly Developed Countries (HDCs) generally have low growth rates

Rule of 70

Doubling Time for World Population = (70 / annual growth rate)

At our current rate of growth, in what year should we expect the world population to double in size?

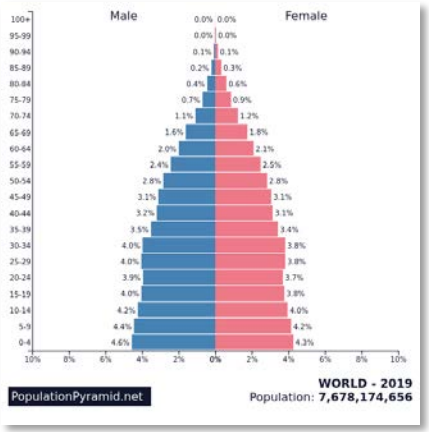
Population doubling time = $\frac{70}{annual\ growth\ rate}$

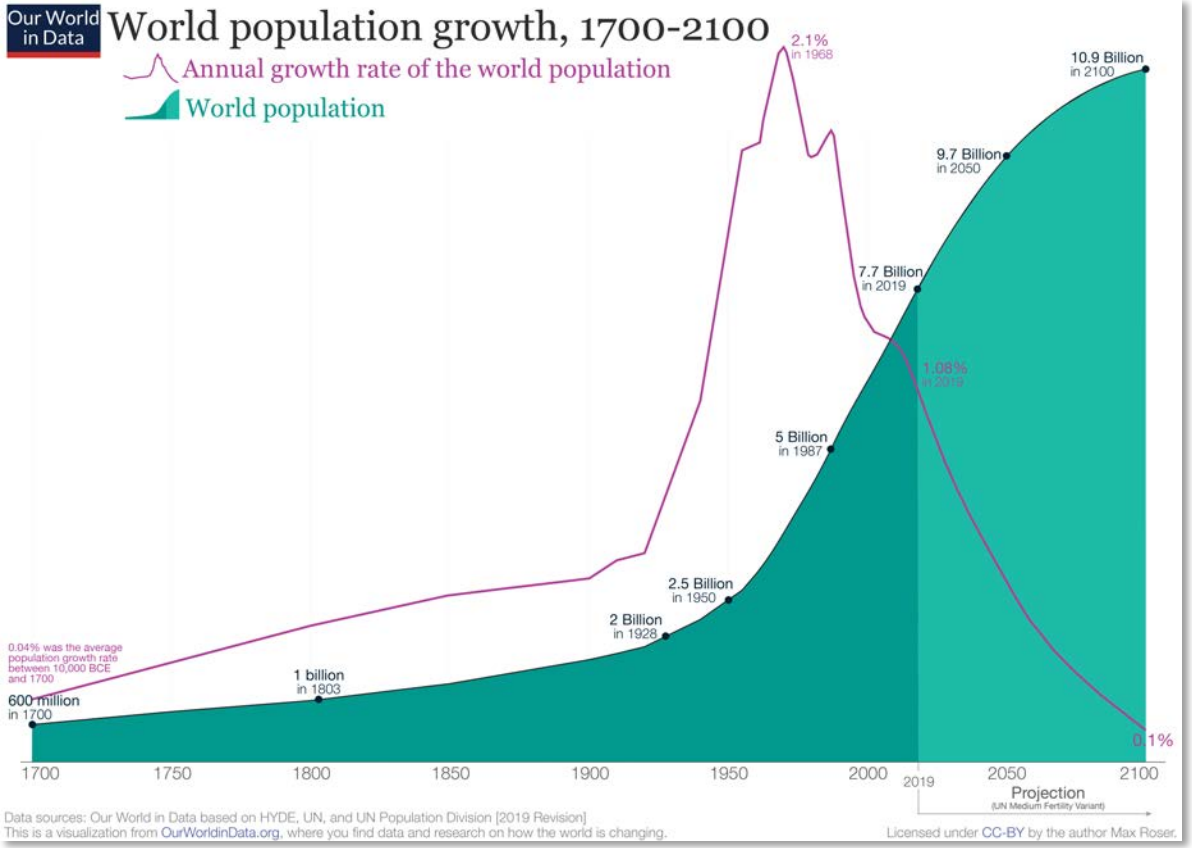
Annual growth rate = 1.08%

$$Population\ doubling\ time = \frac{70}{1.08} = 64.8\ years\ (+2020) = 2085$$

Therefore, at our current rate of population growth of 1.08%, the human population will double to 15.4 billion people by the year 2085.

Worldwide, population growth rates are declining, but the overall number is still greater than zero, so the world population is still growing.





Identify and explain strategies that influence population growth and why influencing human population growth is important.

Reaching zero population growth takes two steps:

1. Identifying why birth rates are high
2. Taking steps to reduce them

Image by Robert Schediwy from Wikimedia Commons

Top-Down approach to Population Planning

- 1959-1961 – Great Chinese Famine (starvation deaths = tens of millions)
- 1970's – shortage of consumer goods (i.e. soap, eggs, sugar, cotton)
- Government blamed overpopulation and so initiated the One-Child Policy (1979)

The Chinese Government claims that the policy prevented 400 million Chinese births.

Officials enforced the policy with controversial methods – forced sterilization and abortions, infanticide, and restriction of health care for unsanctioned children.

Experts except that due to demographic transition, the birth rates would have declined without the One-Child Policy.

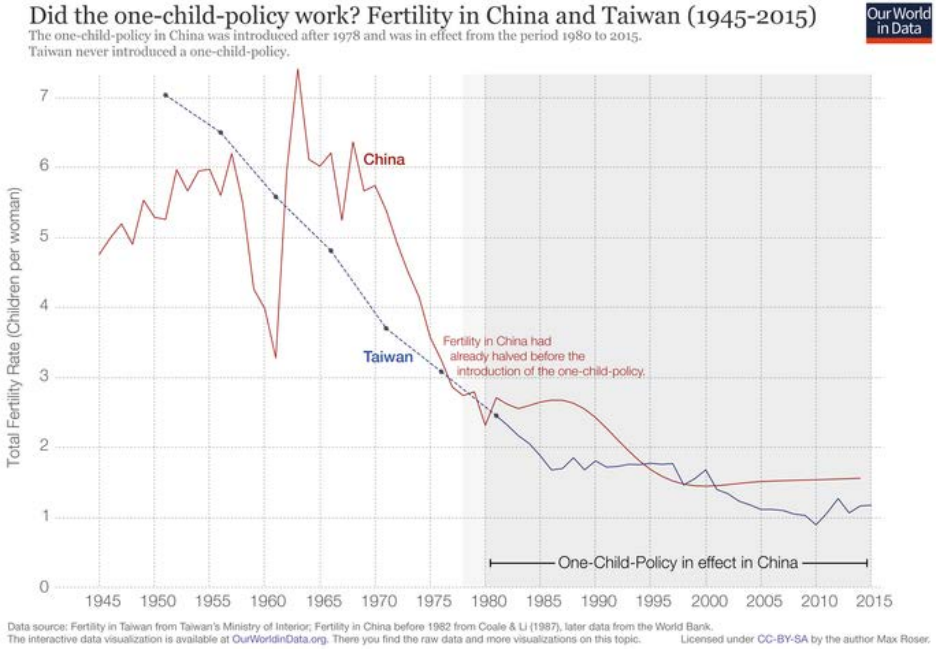


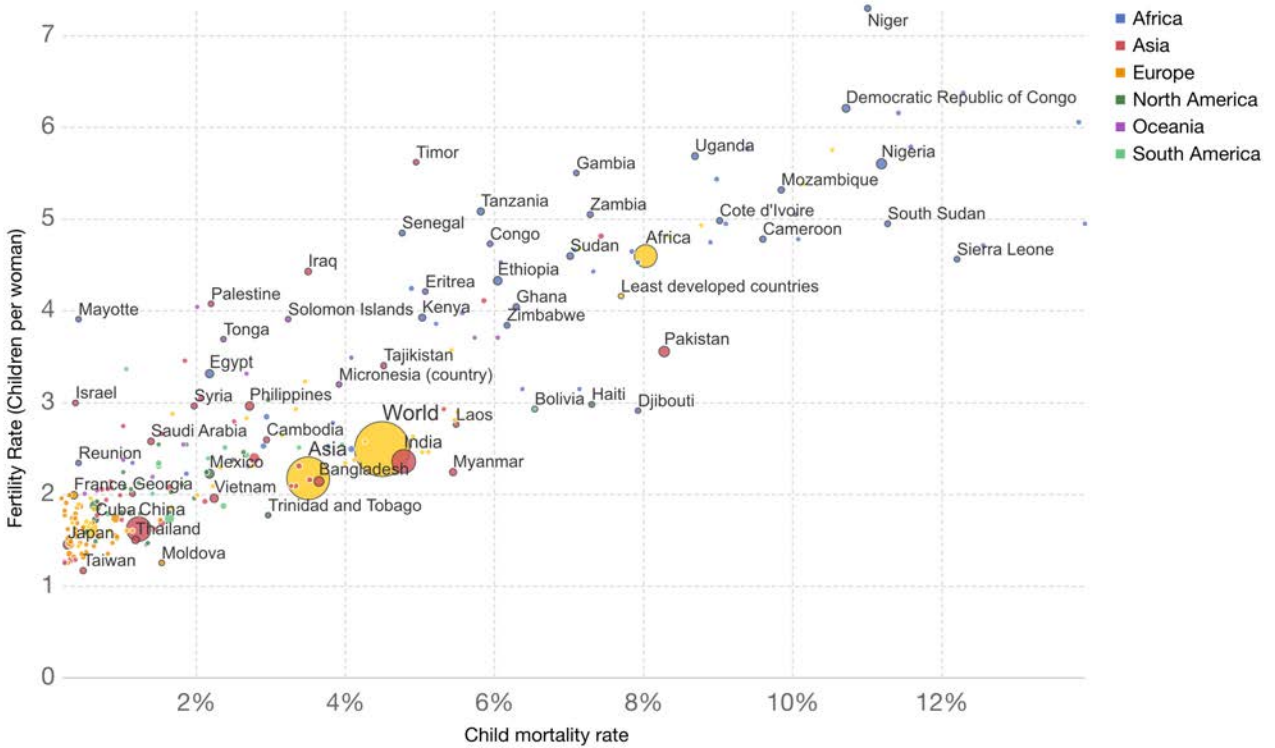
Image by WikiImages from Pixabay

Bottom-up approach to Population Planning

- Factors that decrease the death rate can also decrease overall population growth rates.
- Programs that address the needs of a population and work within cultural and religious traditions are the most successful for reducing pronatal pressures.
- Social justice issues associated with overpopulation must be resolved.

Average number of children vs child mortality, 2015

Child mortality measures the share of children that die before their fifth birthday.



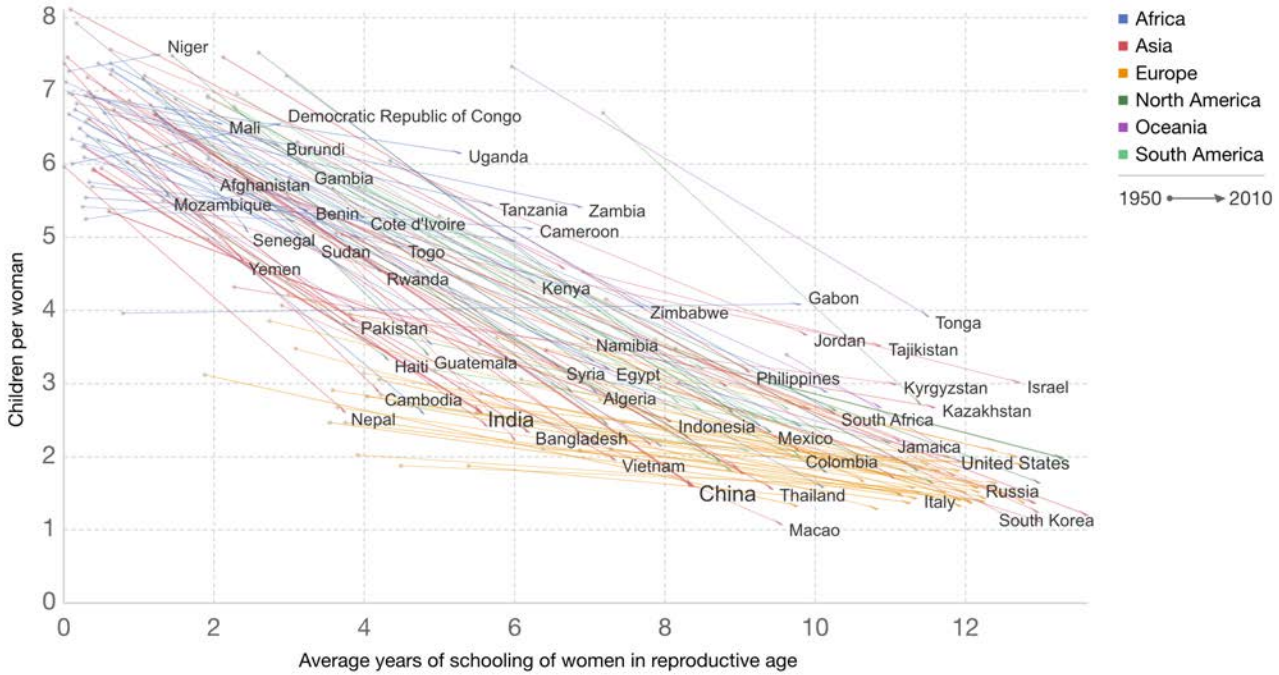
Source: UN Population Division (2017 Revision), Population (Gapminder, HYDE(2016) & UN (2019))

OurWorldInData.org/fertility-rate • CC BY

Women's educational attainment vs. number of children per woman, 1950 to 2010

Our World in Data

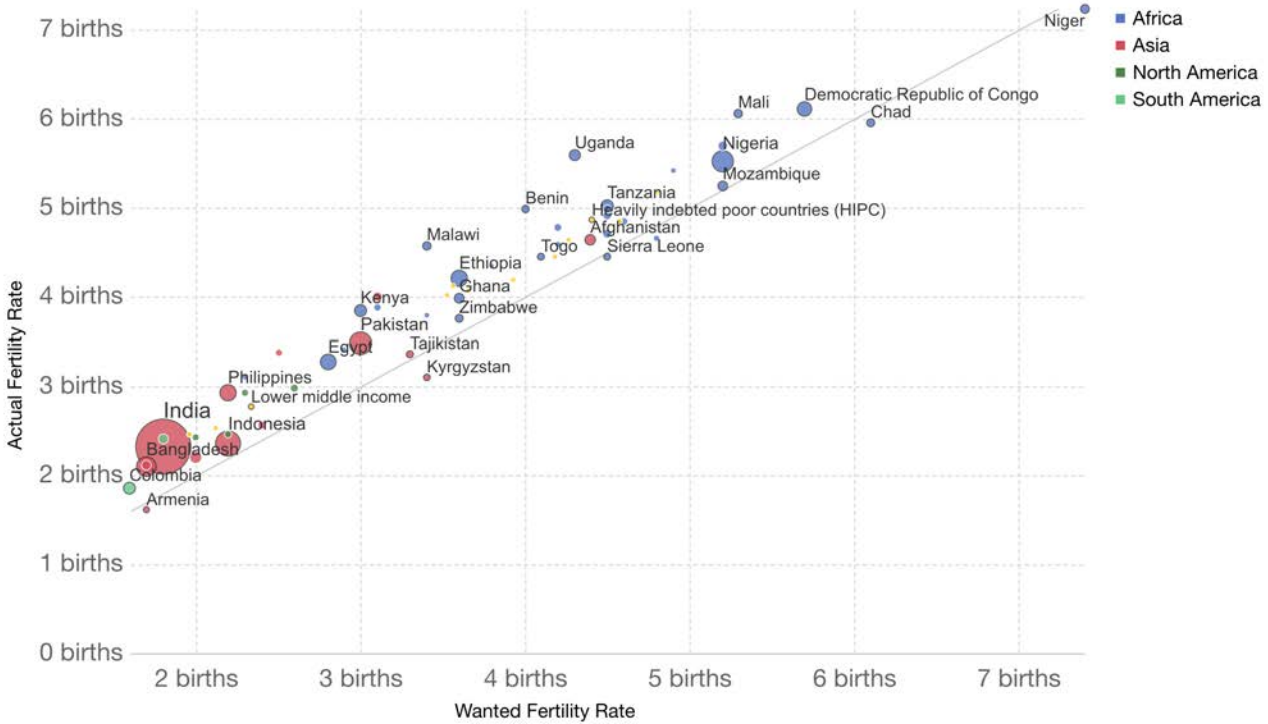
Shown on the x-axis is the average number of years of schooling of women in the reproductive age (15 to 49 years). On the y-axis you find the 'total fertility rate' – the number of live births per woman in reproductive age.



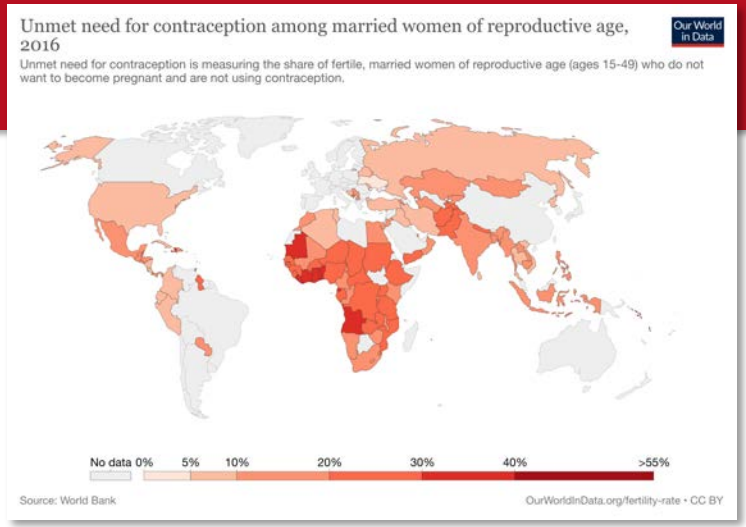
Source: Our World In Data (2017), UN Population Division (2017 Revision), Population (Gapminder, HYDE(2016) & UN (2019))
OurWorldInData.org/fertility-rate • CC BY

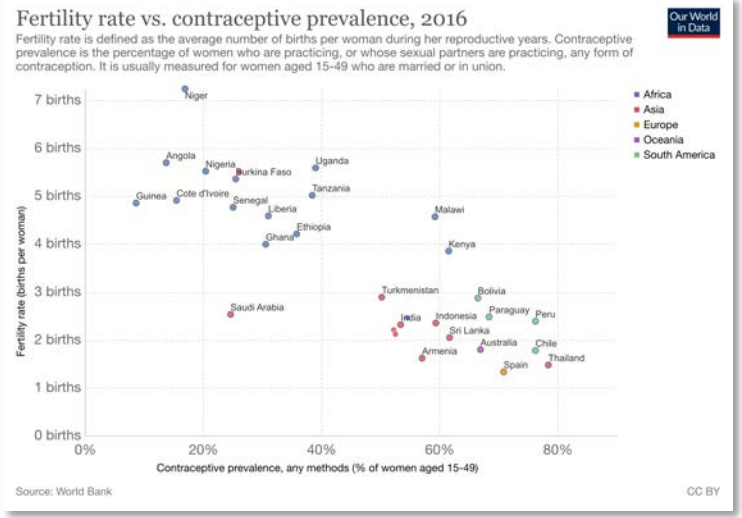
Fertility vs wanted fertility, 2016

The wanted fertility rate is an estimate – based on survey data – of what the total fertility rate would be if all unwanted births were avoided.

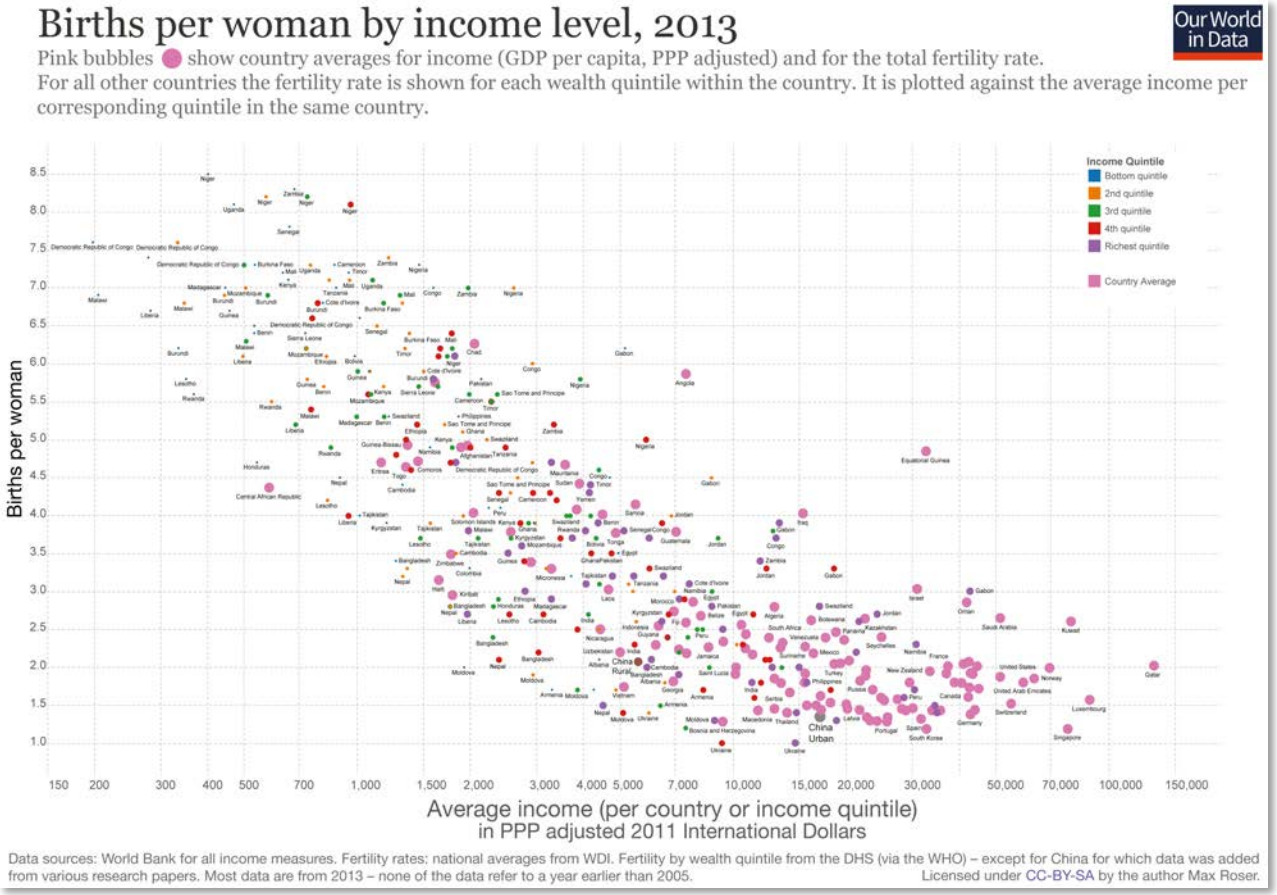


Source: World Bank, Population (Gapminder, HYDE(2016) & UN (2019))





Family planning programs have been effective in many areas of the world. However, in countries where the desired fertility rates are high – such as Niger – providing contraceptives may have little impact on total fertility rates.



Helping low-income countries develop economically may spur a demographic transition similar to that experienced by many industrialized nations.

Many demographers believe addressing social justice issues, especially improving the health and well-being of women and children, will reduce total fertility rates.

Image by bdcbethebest from Pixabay

Resource Use – Changing Demand for Goods

As nations industrialize and incomes increase, the demand for resources also increases. However, the price that we pay for various goods does not reflect their true costs. The environmental and social costs are often left out of the ticket price.

Solutions: buy less, buy only from socially and environmentally responsible companies, purchase quality made items with long functional lives, buy second hand

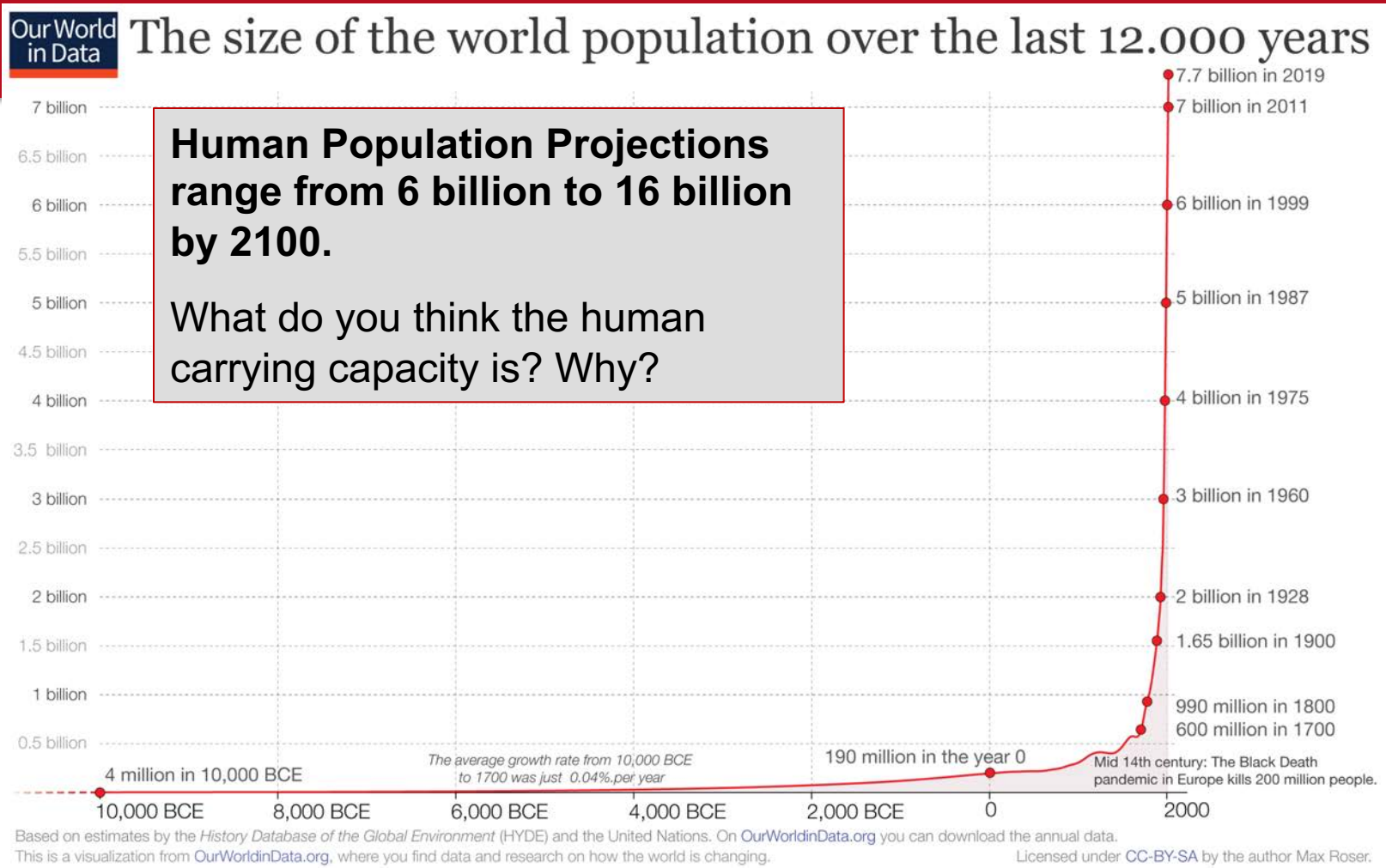
Image by Timpo from Pixbay

Resource Use – Changing Diets

Higher incomes and urbanization are associated with an increased demand for meat and animal proteins. While the global meat industry provides food and a livelihood for billions of people, it also has significant environmental and health consequences for the planet.

Solutions: Reduce the amount of meat and other animal products that you consume. Ideally this means a vegan or vegetarian diet, but cutting meat out of even one meal/day a week will reduce your ecological footprint.

OECD (2016), Meat consumption (indicator). doi: 10.1787/fa290fd0-en (Accessed on 21 June 2016)


Our World in Data
The size of the world population over the last 12.000 years
Human Population Projections range from 6 billion to 16 billion by 2100.
What do you think the human carrying capacity is? Why?
7 billion
6.5 billion
6 billion
5.5 billion
5 billion
4.5 billion
4 billion
3.5 billion
3 billion
2.5 billion
2 billion
1.5 billion
1 billion
0.5 billion
7.7 billion in 2019
7 billion in 2011
6 billion in 1999
5 billion in 1987
4 billion in 1975
3 billion in 1960
2 billion in 1928
1.65 billion in 1900
990 million in 1800
600 million in 1700
4 million in 10,000 BCE
The average growth rate from 10,000 BCE to 1700 was just 0.04% per year
190 million in the year 0
Mid 14th century: The Black Death pandemic in Europe kills 200 million people.
10,000 BCE
8,000 BCE
6,000 BCE
4,000 BCE
2,000 BCE
0
2000
Based on estimates by the History Database of the Global Environment (HYDE) and the United Nations. On OurWorldinData.org you can download the annual data.
This is a visualization from OurWorldinData.org, where you find data and research on how the world is changing.
Licensed under CC-BY-SA by the author Max Roser.