

The Human Population and The Environment

Env107

Housekeeping

- Textbook

Question

- What is the greatest human generated threat to the environment?

Lecture Outline

- The scope of human population growth
- The effect of population, affluence and technology on the environment
- Fundamentals of demography
- The demographic transition
- Factors that affect population growth



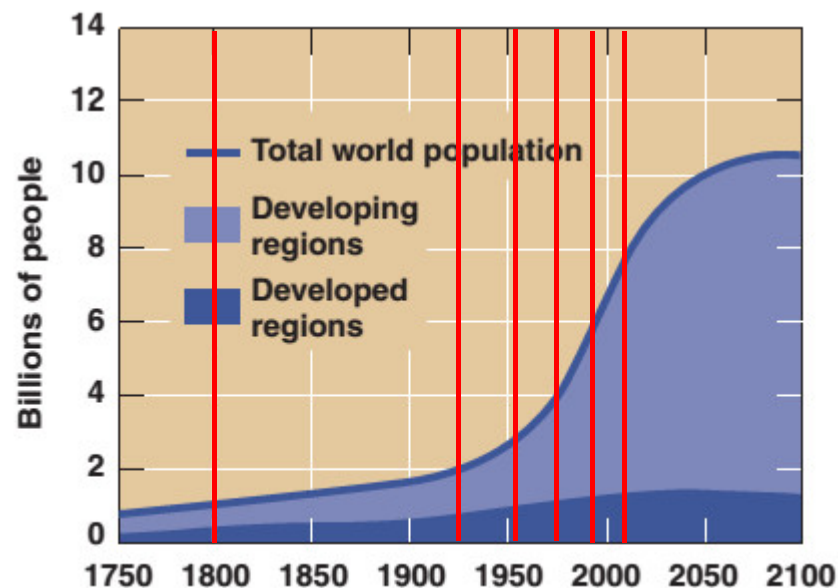
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Human Population Growth

- Human population grew at a rate unprecedented in history in the 20th century.
- Although rate of growth is slowing, absolute numbers still increasing
- **Population growth is the underlying environmental problem**

The human population is still growing rapidly

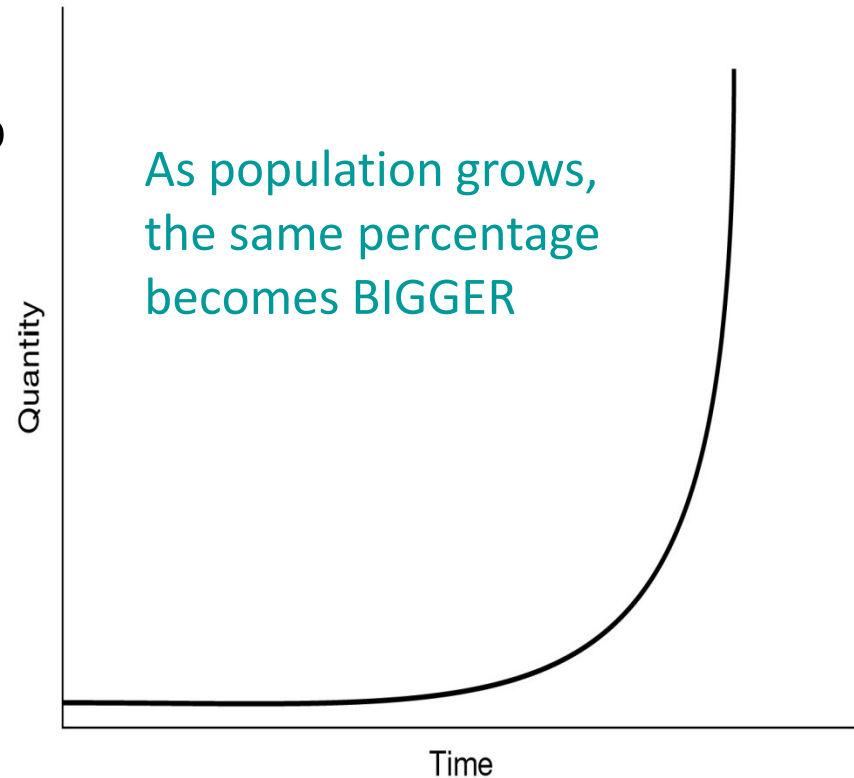
- It took until after 1800 to reach 1 billion
- In 1930, 130 years later, we reached 2 billion
- The most recent billion was added in 12 years



*Due to **exponential growth**, even if the growth rate remains steady, population will continue to grow*

Exponential Growth

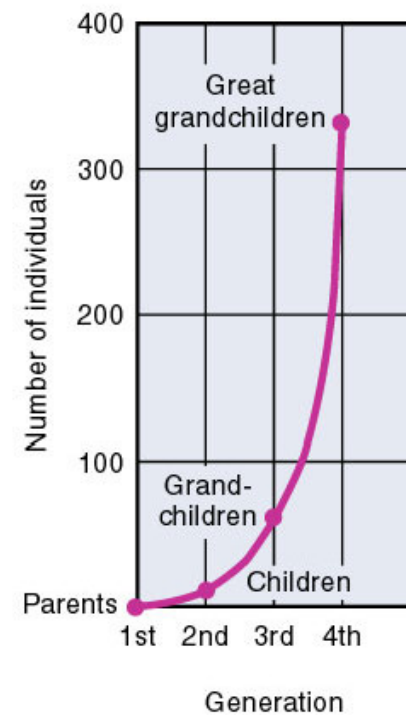
- Exponential growth:
- Growth by a fixed percentage, where the increase is added to the principal:
- $P = P_0 e^{rt}$
 - P_0 = initial population
 - r = growth rate (in decimals)
 - t = time
 - e = base of natural logarithms (2.71828)
- If growth rate is 1.3%:
 $r = 0.013$



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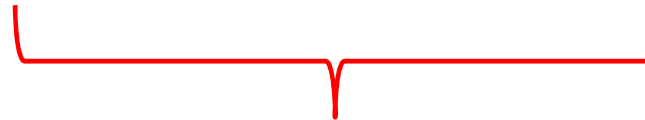


(b)

- Exponential growth cannot be sustained indefinitely
- It occurs in nature with a small population and ideal conditions

Forecasting Population Change

$$P_2 = P_1 + (B - D) + (I - E)$$



Population Growth Rate

B= births

D = deaths

I= immigration

E=emigration

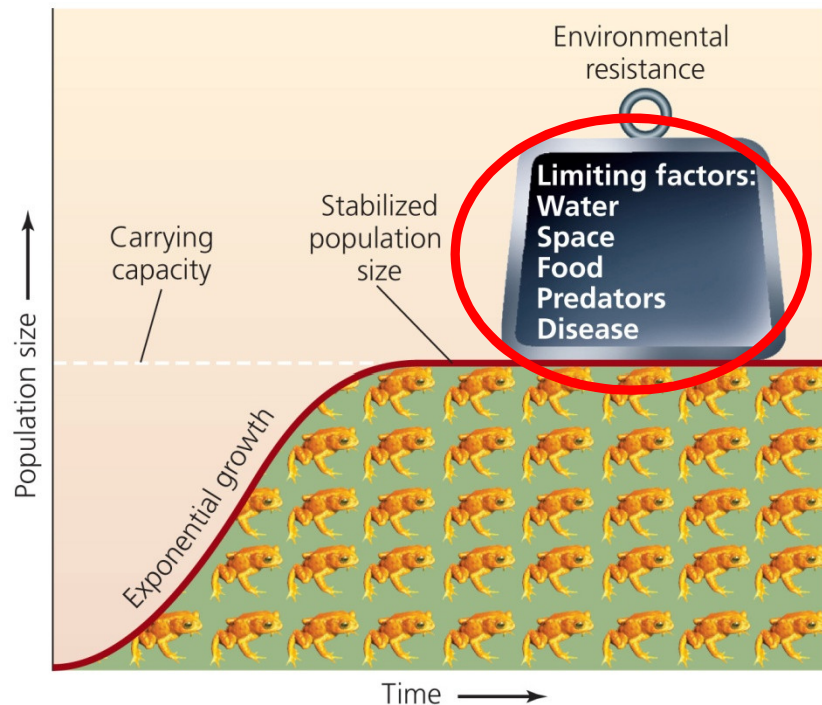
P1=pop at Time 1

P2=pop at Time 2

Exponential Growth

- *Population growth rate* remains the same, but the number of individuals increases rapidly
- Exponential growth cannot be maintained indefinitely... eventually the population will feel the environmental resistance and growth will slow or stop completely

Carrying capacity



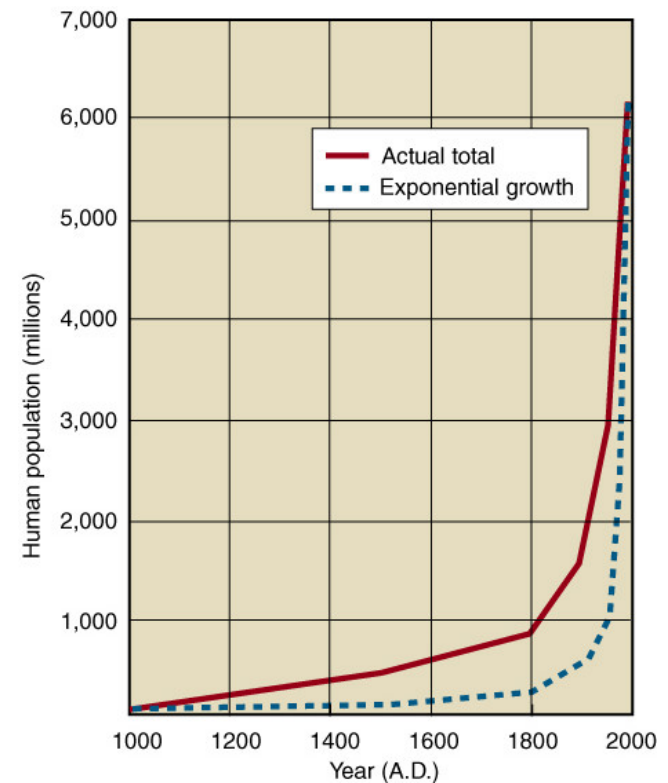
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- **Carrying capacity** = the maximum population size of a species that its environment can sustain
 - An S-shaped **logistic growth curve**
 - Limiting factors slow and stop exponential growth
- Carrying capacity changes

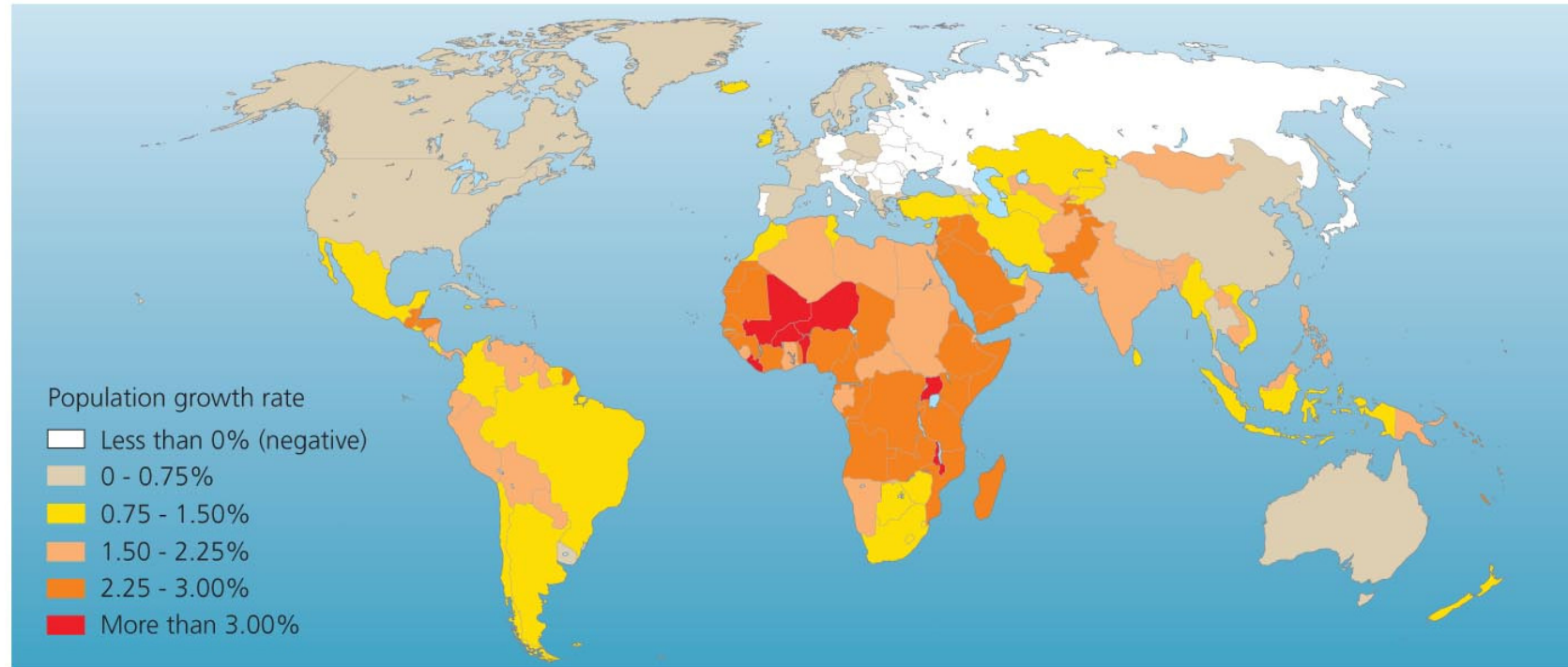
Humans have raised their carrying capacity by decreasing the carrying capacity for other species

Exponential Growth & Doubling Time

- Exponential growth:
 - Growth occurs at a constant rate per time period
- Doubling time
 - The time necessary for the quantity being measured to double.
 - Approximately equal to 70 divided by the annual percentage growth rate



Rates of growth vary from region to



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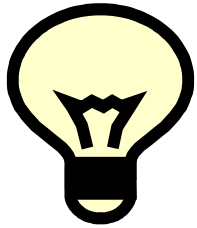
- At today's 1.2% global growth rate, the population will **double** in **58 years** ($70/1.2 = 58$)
- 2068 global population = 14 billion people

The World's 10 Largest Countries in Population

2015

Rank	Country	Population
1	China	1,362
2	India	1,252
3	United States	321
4	Indonesia	256
5	Brazil	204
6	Pakistan	199
7	Nigeria	182
8	Bangladesh	169
9	Russia	146
10	Japan	127

Population Reference Bureau
www.prb.org



- What will the population breakdown look like in 2050?

The World's 10 Largest Countries in Population

2006

Country	Population (millions)
China	1,311
India	1,122
United States	299
Indonesia	225
Brazil	187
Pakistan	166
Bangladesh	147
Russia	142
Nigeria	135
Japan	128

2050

Country	Population (millions)
India	1,628
China	1,437
United States	420
Nigeria	299
Pakistan	295
Indonesia	285
Brazil	260
Bangladesh	231
Dem. Rep. of Congo	183
Ethiopia	145

Projections

~5.18 billion

2008

Country	Population (millions)
China	1,324.7
India	1,149.3
United States	304.5
Indonesia	239.9
Brazil	195.1
Pakistan	172.8
Nigeria	148.1
Bangladesh	147.3
Russia	141.9
Japan	127.7

2050

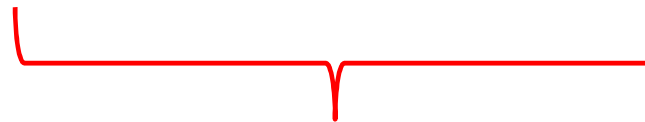
Country	Population (millions)
India	1,755.2
China	1,437.0
United States	438.2
Indonesia	343.1
Pakistan	295.2
Nigeria	282.2
Brazil	259.8
Bangladesh	215.1
Congo, Dem. Rep.	189.3
Philippines	150.1

~5.37 billion

Difference =
~200 million

Forecasting Population Change

$$P_2 = P_1 + (B - D) + (I - E)$$



Population Growth Rate-
different for each population/country,
differs through time

B= births

P1=pop at Time 1

D = deaths

P2=pop at Time 2

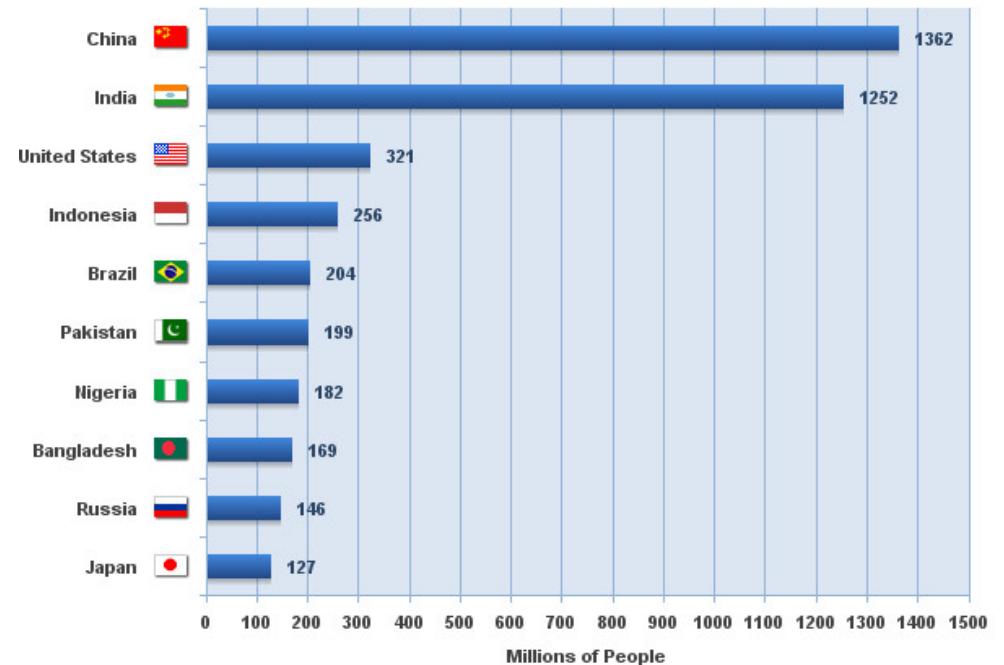
I= immigration

E=emigration

Demography

- **Population Ecology** = the study of how individuals of a species interact
- **Demography** = the application of population ecology to the study of humans
 - Population size
 - Density and distribution
 - Age structure & sex ratio
 - Birth, death, immigration, & emigration rates

10 Most Populated Countries in the World
Population in Millions - November 30, 2015

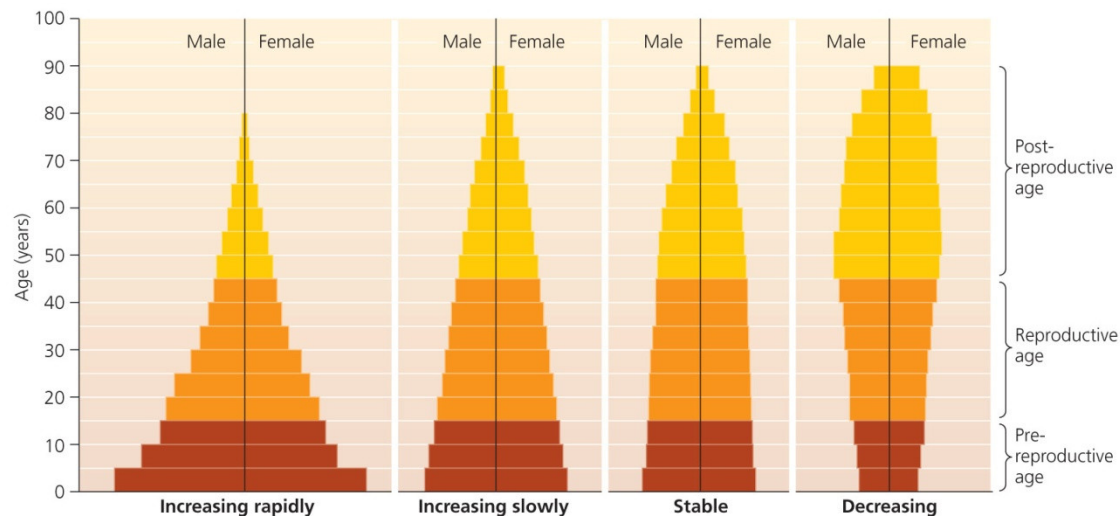


Source: Internet World Stats - www.internetworldstats.com/stats8.htm
7,259,902,243 world population estimated for November 30, 2015
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Age Structure

Population age structure:

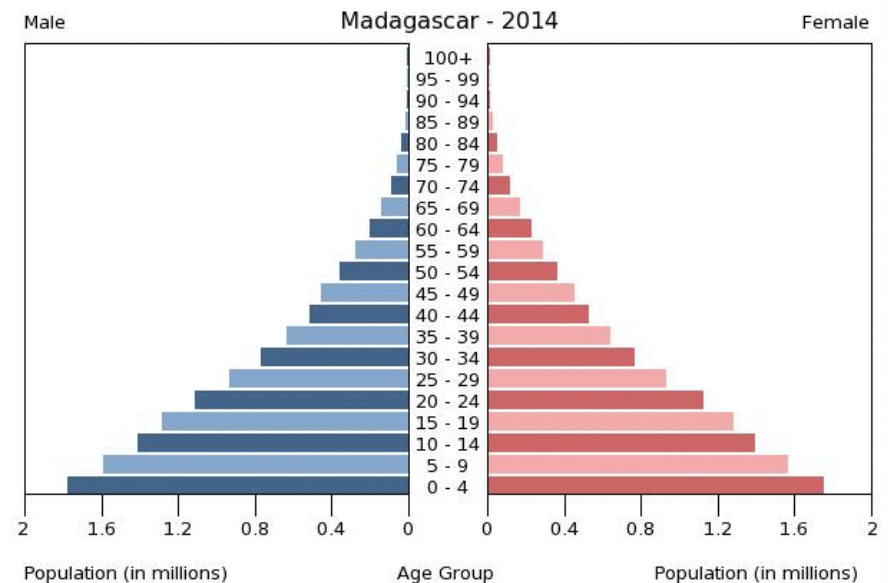
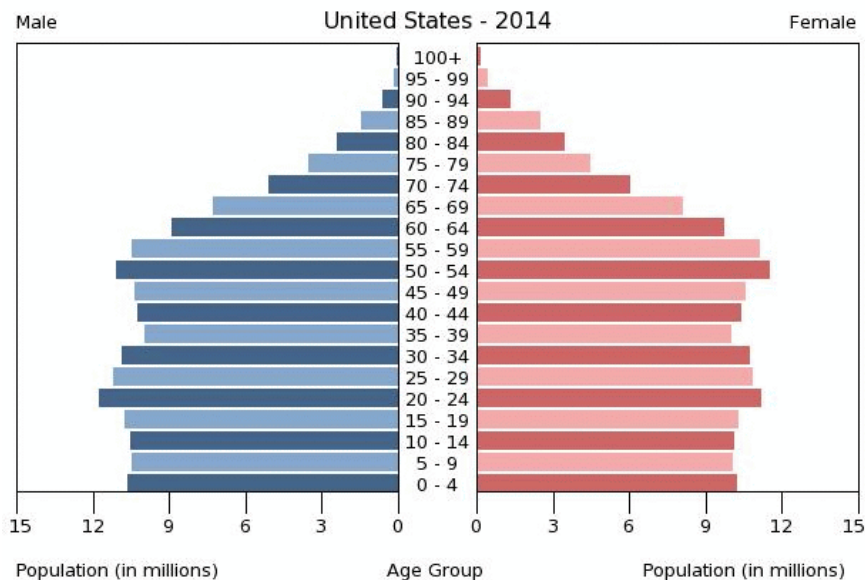
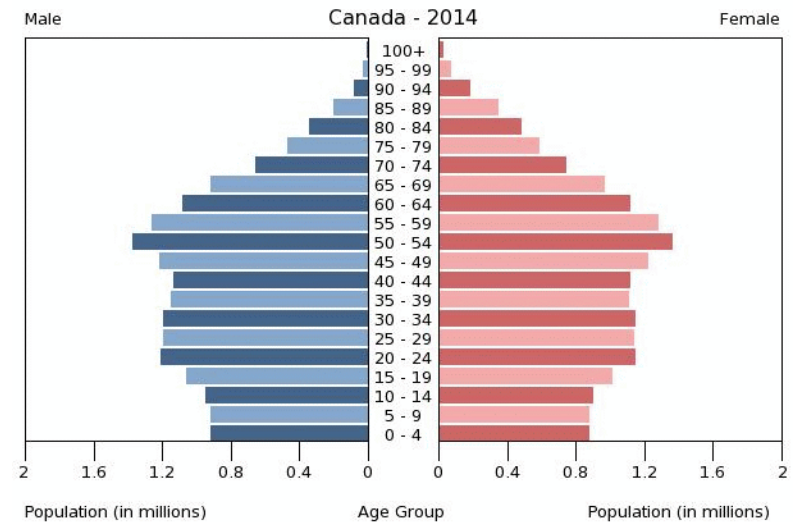
- The proportion of the population in each age class
- Affects current and future birth rates, death rates and growth rates
- Has an impact on the environment
- Has complications for current and future social and economic status.



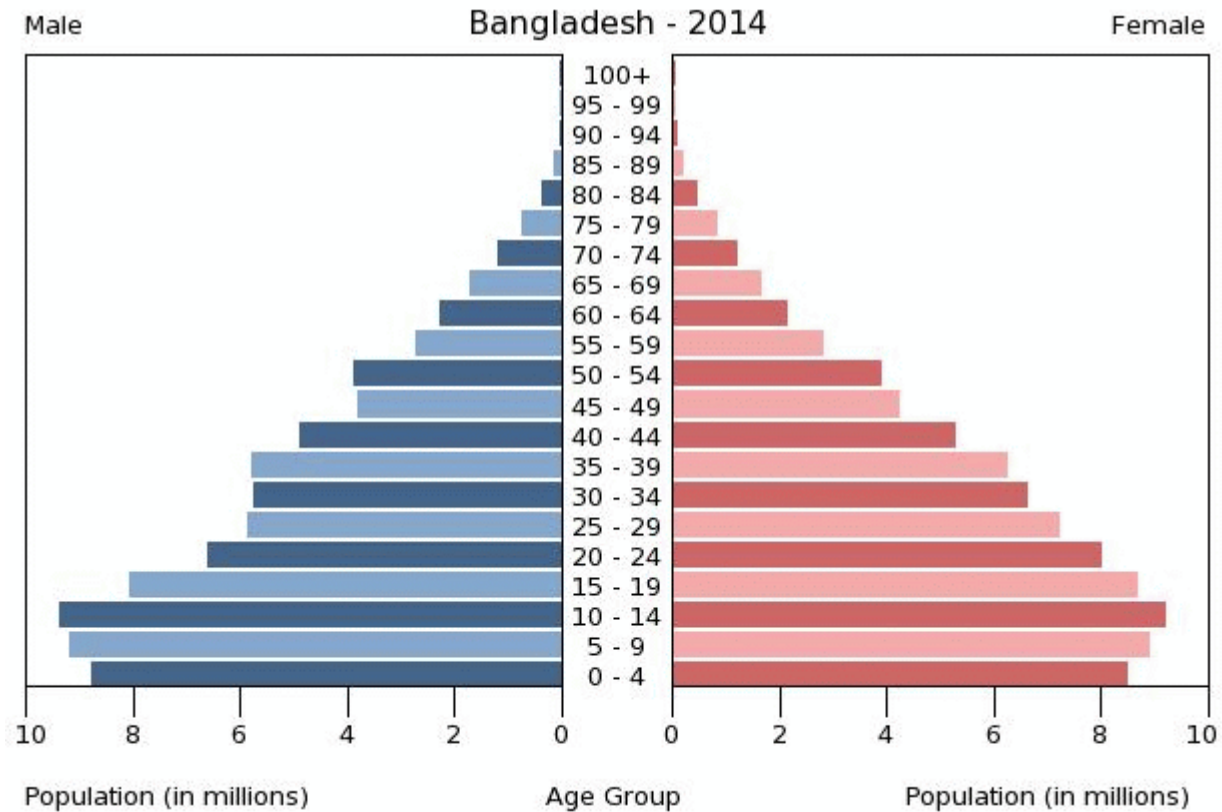
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Age structure affects future population size

- Having many individuals in young age groups results in high reproduction and rapid population growth



Age structure of Bangladesh in 2014



A Brief History of Human Population Growth

Hunters and gatherers

- The world's population was probably less than a few million

Early, pre-industrial agriculture

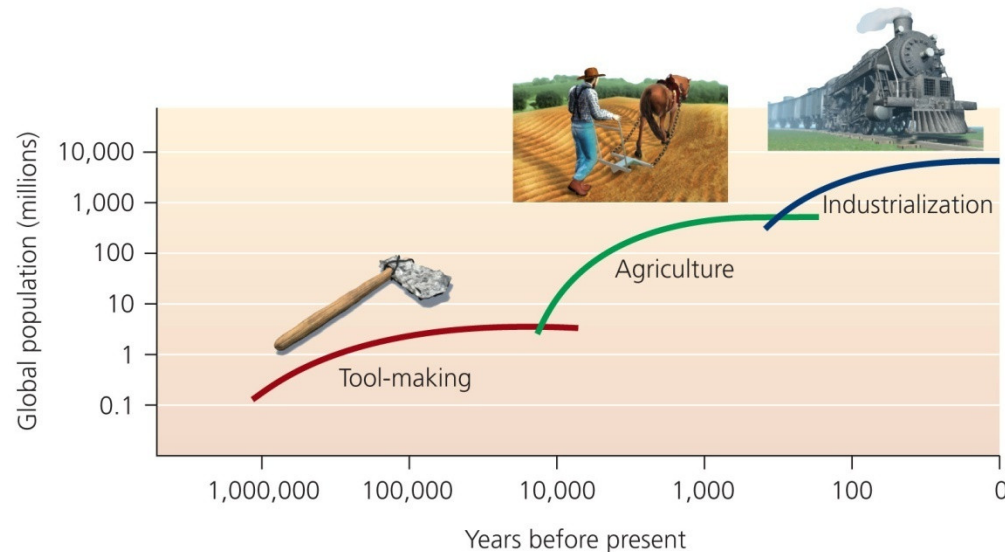
- Allowed a much greater density of people
- The first major increase in human population

Machine age

- Industrial revolution (~1800s) led to rapid increase in human population

The Modern era

- Rate of population has slowed in wealthy nations but continues to increase rapidly in poorer, less developed nations.



The demographic transition

- **Demographic transition** = a model of economic and cultural change to explain the declining death and birth rates in industrializing nations
- Moves from stable preindustrial state of high birth and death rates change to a stable post-industrial state of low birth and death rates

The Demographic Transition

- Demographic transition:
 - Three-stage pattern of change in birth rates and death rates.
 - Occurred during the process of industrial and economic development of Western nations.
 - Leads to a decline in population growth.

Stage I: Pre-Industrial: Birth rate & death rate high

Stage II: Decline in death rate

Stage III: Birth rate remains high, High growth rate

Stage IV: Birth rate drops toward the death rate, leading to low or zero growth rate.

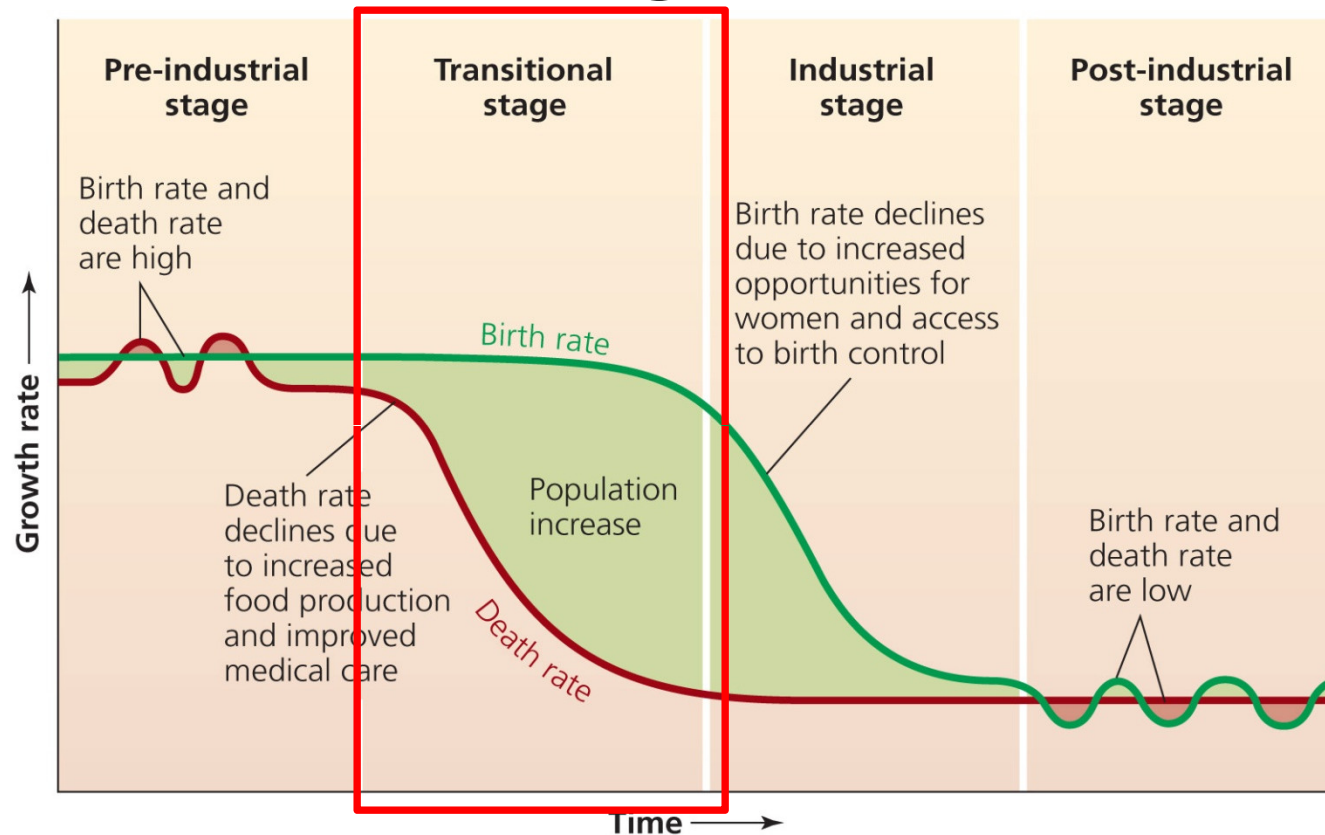
The demographic transition's four stages

Stage 1:
Preindustrial

Stage 2:
Increasing population

Stage 3:
Population continues to increase, but growth rate reduced

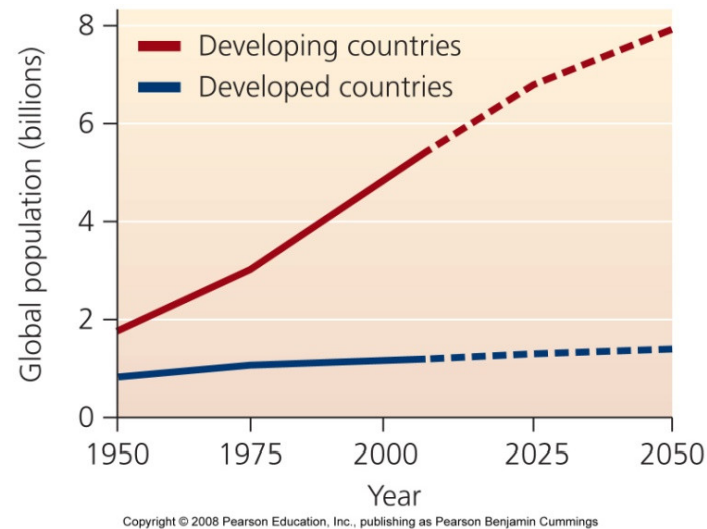
Stage 4:
Population stable, but overall size larger



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- As mortality decreases, there is less need for large families
 - Parents invest in quality of life

Poverty and population growth are correlated

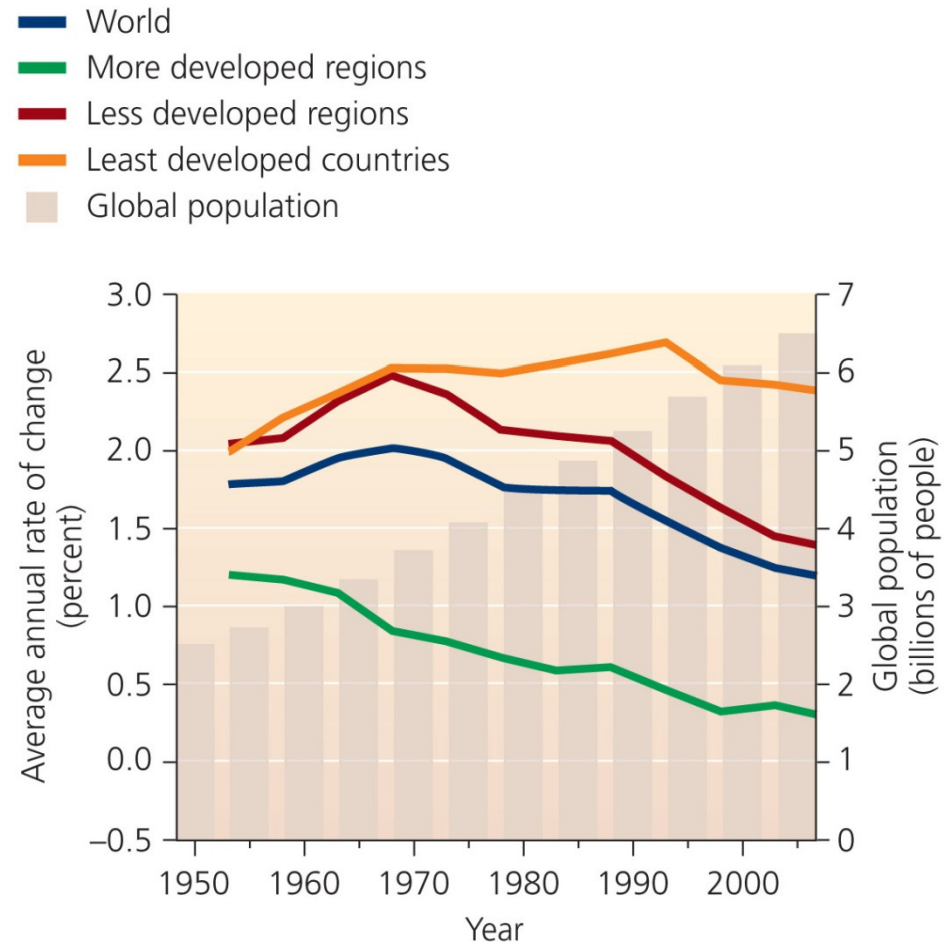


- Poorer societies have higher growth rates than wealthier societies
 - Consistent with the demographic transition theory
 - They have higher fertility and growth rates, with lower contraceptive use

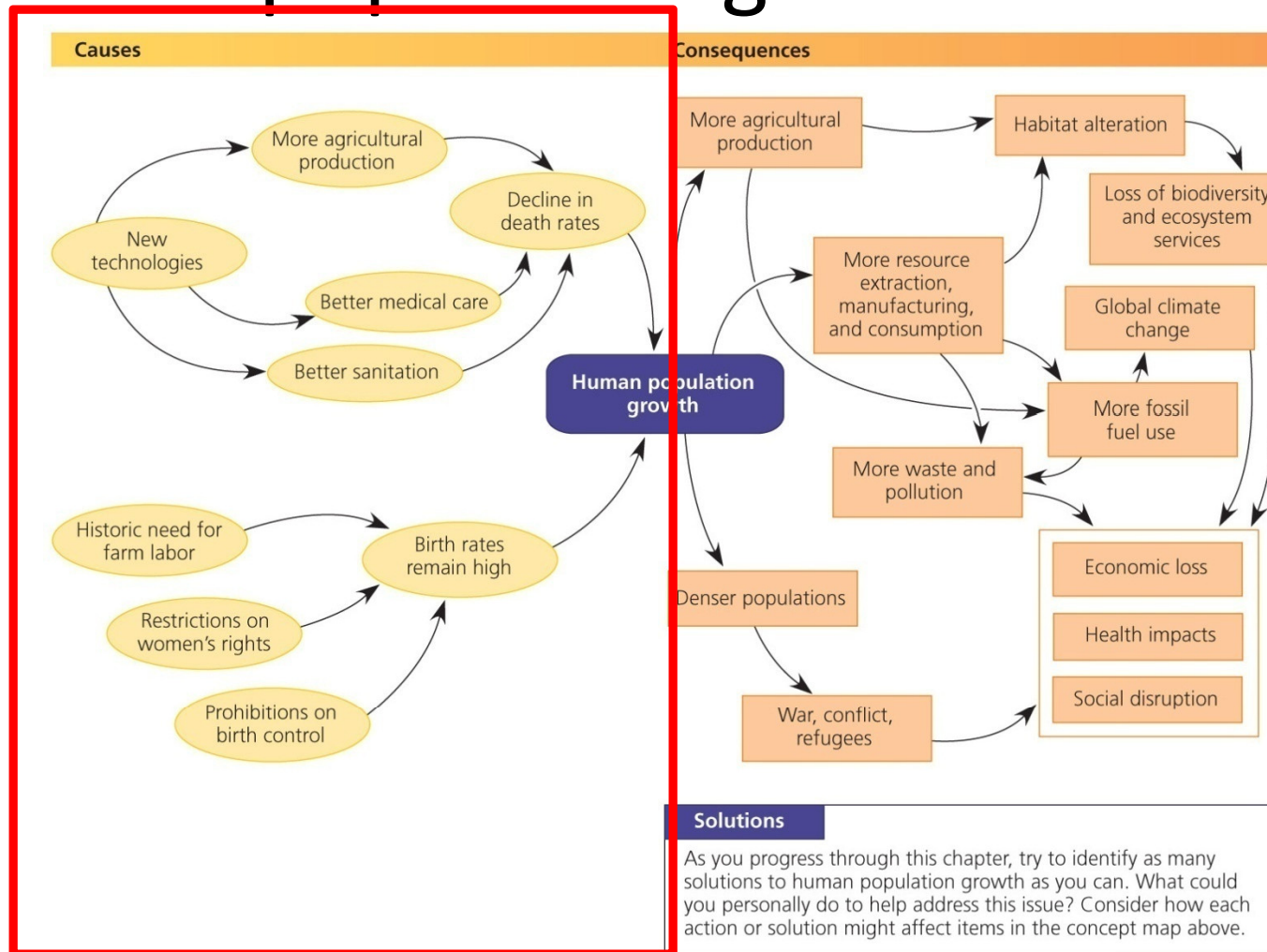
99% of the next billion people added will be born in poor, less developed regions that are least able to support them

Falling growth rates do not mean fewer people

Falling rates of growth do not mean a decreasing population, but only that rates of increase are slowing



Causes and consequences of population growth

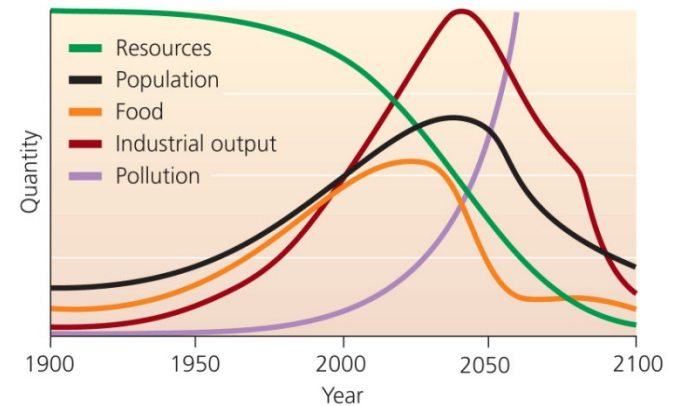


Population growth affects the environment

- The IPAT model: $I = P \times A \times T \times S$
 - Total impact (I) on the environment results from the interaction of:
 - Population (P) = individuals need space and resources
 - Affluence (A) = greater per capita resource use
 - Technology (T) = increased exploitation of resources
 - Sensitivity (S) = how sensitive an area is to human pressure

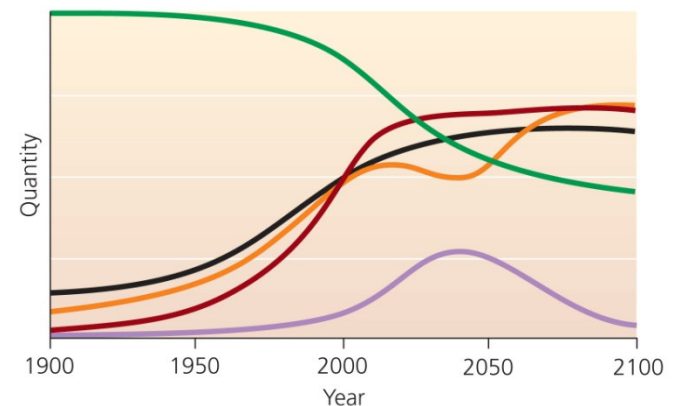
Computer simulations predict the future

- Simulations project trends in population, food, pollution, and resource availability
- If the world does not change, population and production will suddenly decrease
- In a sustainable world, population levels off, production and resources stabilize, and pollution declines



(a) Projection based on status quo policies

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(b) Projection based on policies for sustainability

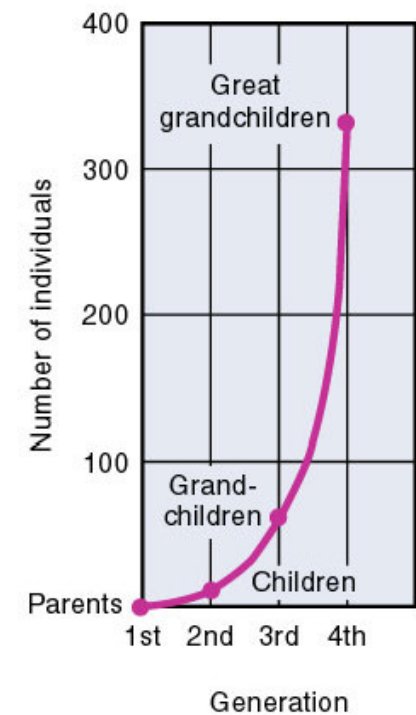
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How to curb population growth?

- **Reduce TFR**
 - **Total fertility rate (TFR)** = the average number of children born per female
 - Increasing urbanization decreases TFR
 - Children go to school, and increase costs
 - With social security, elderly parents need fewer children to support them
 - Greater education allows women to enter the labor force, with less emphasis on child rearing
- **Delay age of first reproduction**
 - China laws on age of marriage
 - Between 1950 and 1985 when laws raising age first to 18 and then 20 went into effect. Fertility rate fell from 5.7 to 2.1 from 1972-1985.



(a)



(b)

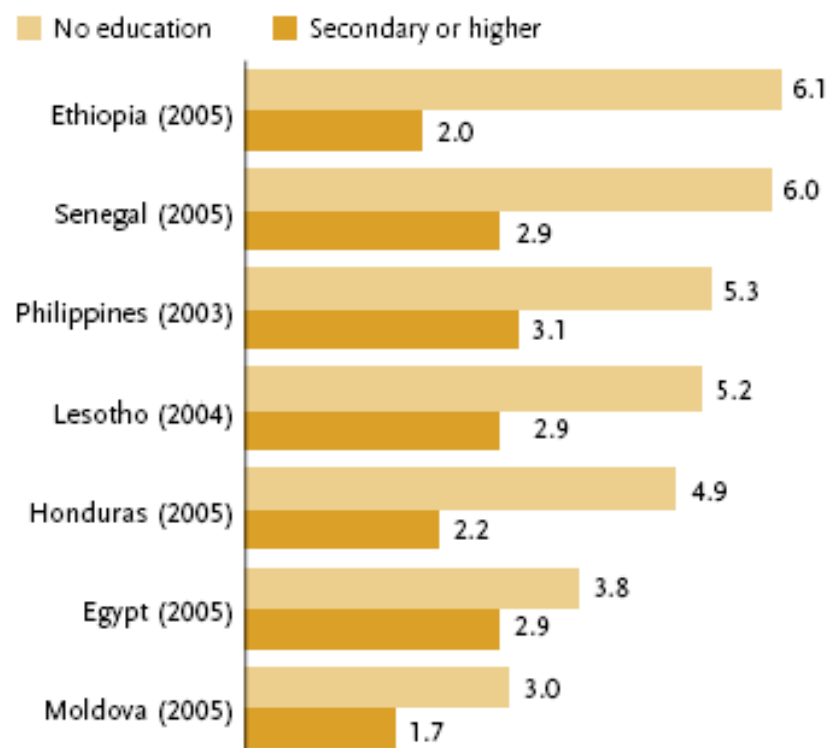
Consider the difference between the parents having their first kids at age 18 vs. having them at 26?

Among Women in Developing Countries, More Education Often Leads to Lower Fertility.

A large body of research over the years has linked higher education for women and girls with reduced fertility levels. Indeed, recent data from many countries have shown that women with at least a secondary-level education eventually give birth to one-third to one-half as many children as women with no formal education. In some of these countries, the fertility of these well-educated women approaches replacement level. Better-educated women are able to delay marriage and exercise more control over their reproductive lives, including decisions about childbearing.

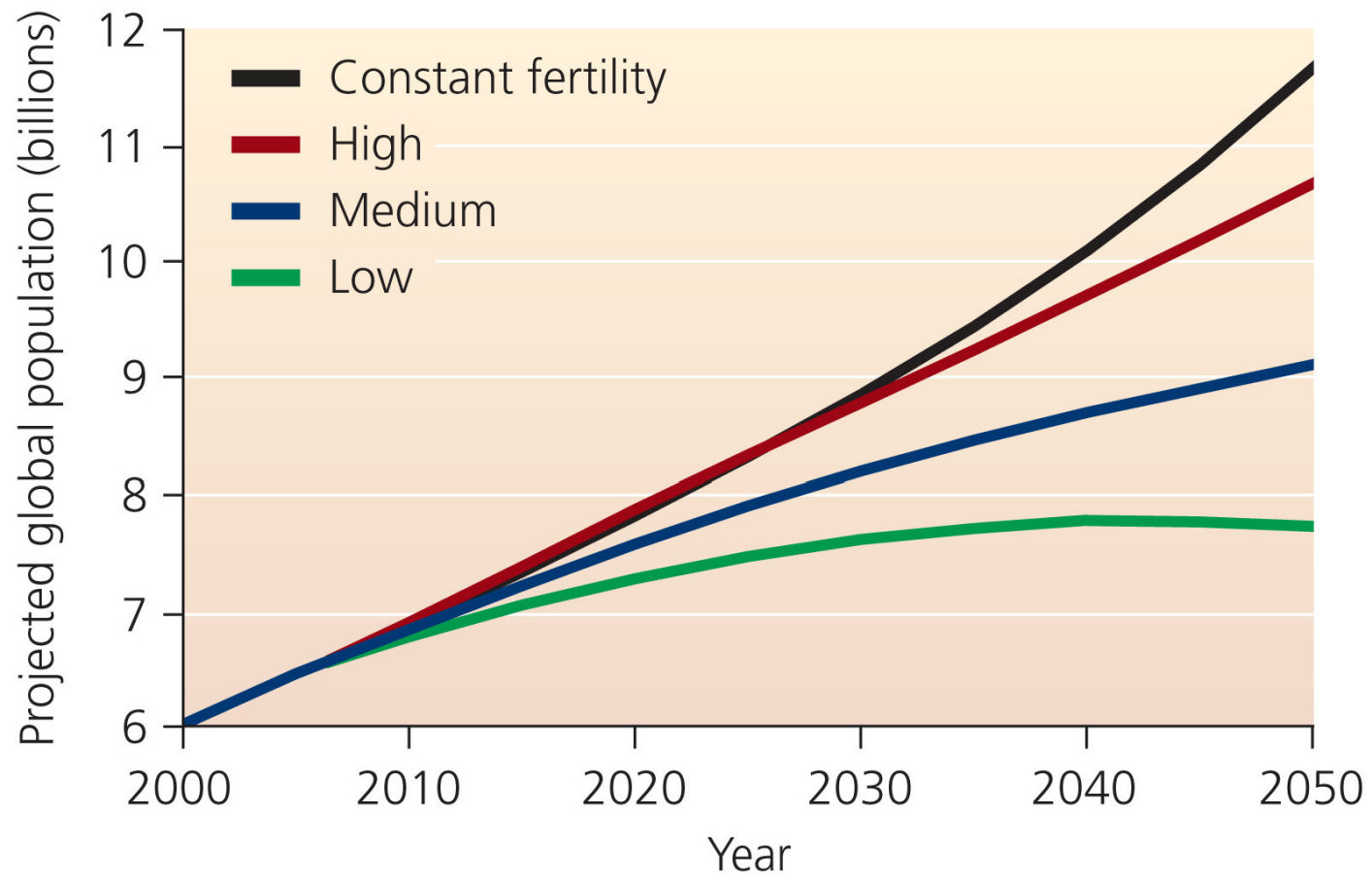
SOURCE: ORC Macro, MEASURE DHS STATcompiler (www.measuredhs.com, accessed June 15, 2007).

Lifetime births per woman by highest level of education



China's "one child policy"

- In 1970, China's 790 million people faced starvation
- Introduced in 1979, extended to 2015
- Limits couples to one child
- Fines, abortion pressure, forced sterilization can be consequences for second child
- Restricted to couples living in urban areas (~36% of population)
- Controversial- led to abortion, neglect, abandonment, and infanticide in female infants, black market trade in teenage girls
- New provisions for parents without siblings (many born out of this policy)
- TFR in China has dropped from over 5 in the early 1970s to 1.8 in 2008

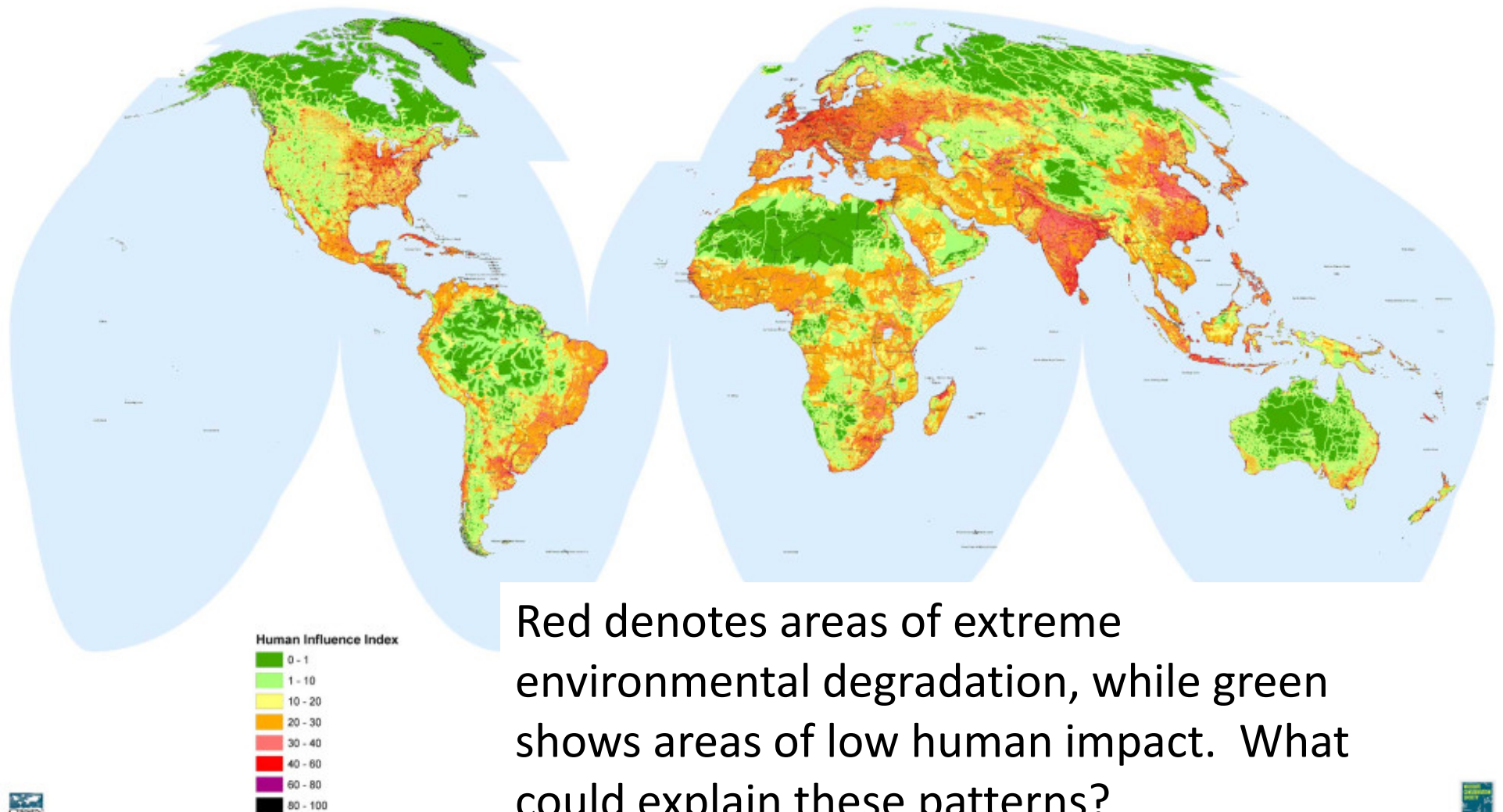


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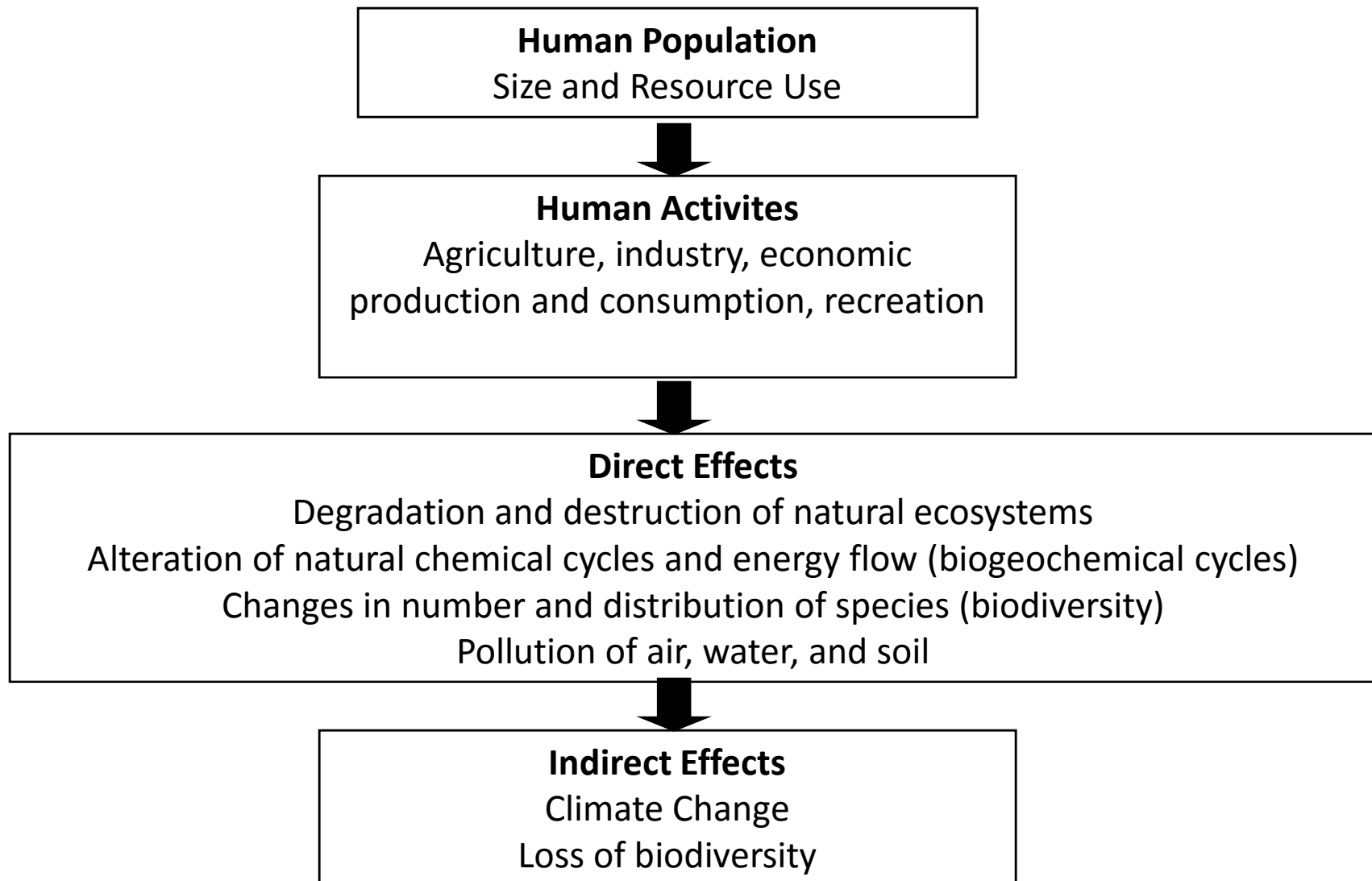
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Human Impacts on Environment



Humans have both direct and indirect impacts on the environment



Wealth also produces severe environmental impacts

- The population problem does not exist only within poor countries
- Affluent societies have enormous resource consumption and waste production
 - People use resources from other areas, as well as from their own
 - Individuals' ecological footprints are huge

One American has as much environmental impact as 6 Chinese or 12 Indians or Ethiopians

The wealth gap and population growth cause conflict

- The stark contrast between affluent and poor societies causes social and environmental stress
- The richest 20% use 86% of the world's resources
 - Leaves 14% of the resources for 80% of the world's people to share
- Tensions between “haves” and “have-not’s” are increasing



(a) A family living in the United States

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(b) A family living in Egypt

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Human Carrying Capacity

- The maximum number of people the Earth can sustain without decreasing its capability to sustain same number in future.



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How to maintain
populations, provide
adequate standard of
living and not destroy
the environment. THIS
IS THE QUESTION



The Precautionary Principle

- Take precautionary steps rather than wait for solid scientific evidence that actions/policies are not sustainable
- Proactive, not reactive
- Socioeconomic implications

Human Population Growth - You should know:

- ✓ **Impact of birth rate and death rate on population growth projections**
- ✓ **Concept of doubling time**
- ✓ **Where most population growth is and will be occurring**
- ✓ **Logistic growth curve (lag, exponential, and equilibrium phases)**
- ✓ **Age structure of developing, developed, and mature/decreasing populations**
- ✓ **Demographic transition**
- ✓ **Factors influencing carrying capacity**
- ✓ **Ways to limit population growth**
- ✓ **Relationship between pop. size and population impact**