World Population: Growth & Trends

Take away concepts

Why is population growth so central to environmental problems?
What is the current population? What will it be in 2050?
What factors affect population growth rates?
How do growth rates compare in developed vs. developing countries?
What is a "demographic transition? What are its stages?
Interpreting Population Pyramids.
Understanding modern demographic trends.

Why Population is so important

Thomas Malthus (1798)
Organism populations increase exponentially, whereas the "environment" is "fixed" (actually decreases).

Factually correct, but a complex problem...
Modern example: high populations AND high quality of life
Malthus’ 1st Axiom

“The power of population is indefinitely greater than the power in the earth to produce subsistence for man.”

“Population, when unchecked, increases in a geometrical ratio (exponentially). Subsistence increases only in an arithmetical ratio (linearly).”

World Population: 7.3 billion

As of Sept., 2014

(Super)exponential growth

Some observations...

Pre-19th century growth rates were ~0.2%/yr
<1 billion people.
Pop. doubled in 300 yr.
140 million died of plague: 6th, 14th, and 17th centuries.
Replaced in a few centuries.

Population increased after Renaissance

Modern era population explosion: post-1960
More...

Population growth after 1800’s ranged 1.2-1.9%!
– Super-exponential growth

Post-1960 was first time EVER that population doubled within a generation

 Likely population by 2050: 9 billion

Toward “logistic growth”
Factors affecting Growth Rate

Growth rate = Birth Rate - Death Rate
1.1% = 1.9% - 0.8% (as of 2012)

Of these the Birth Rate is the most important contributor, specifically the Fertility Rate (#children/woman)

Why? Because death rates have stabilized...

Calculating Growth Rates (r)

• \( N_t = N_o \exp(r \cdot t) \)
  
  where \( N_o \) = pop. at time t, \( N_t \) = pop at later time (t),
  
  and \( r \) is the growth rate, and \( t \) is time in years.

• Rearranging to solve for \( r \):
  
  \( \frac{N_t}{N_o} = \exp(r \cdot t) \)

  \( r = \ln(N_t/N_o) / t \)

Example: with current population of 7 billion, 1% growth rate = 70 million new people/year.
(equiv. to Turkey or Malaysia)

Factors affecting Birth Rate

Global BR = 1.9% (95% in developing countries).

Lessons on population control from Thailand, South Korea, Japan, India, and China:

– Invest in Family Planning
– Reduce poverty
– Elevate the status of women
Factors affecting Death Rate

Global DR = 0.8% (equal between developing and developed countries)

Low death rates due to:
– medical treatments,
– better food supplies and nutrition,
– improvements in sanitation, and
– access to clean water

Lower DR is the main reason for the global population increase

Population Projections

Current ~7.3 billion (and rising), growth rate: 1.1% (and falling…).

Projected 2050 population: 9 billion

Using modern growth rate:
Calculated pop. by 2050: ~11 billion.

Calculating Doubling Times

The “Rule of 70”:
– Doubling time = 70/percentage growth rate
– (… comes from ln(2) = 0.69)

Example:
– Current growth rate is 1.1%, so doubling time is 70/1.1 = 64 years (ca. 2075).
– Projected pop at 2078 would be ~14 billion
– But this won’t be the case… why?
Global growth rate values are falling

At the heart of this issue is the concept of Carrying Capacity (K) – the maximum number of individuals that the environmental resources of a given region can support.

Population growth and Carrying Capacity co-evolve.
Factors: Technology, social, political, economic institutions, physical & ecological environment.

Carrying Capacity

Physical carrying capacity = “packing density”, limited only by space and resources

Cultural carrying capacity is always less

Still there is a large difference of opinion regarding how many people the earth can support.

Accepted range for K is 10-20 billion people
Demographic Transition

Refers to the impact of economic development on birth and death rates. Responsible for the gradual reduction in population growth rates during the late-20th century. First noted by demographers for changes in 19th-century Europe, the DT is a critical shift in population growth and age structures that differentiate developed nations from developing nations.

Four stages of DT

1. The Preindustrial Stage, when there is little population growth because harsh social conditions lead to both high death and high birth rates.
2. The Transitional Stage, when industrialization begins and health care improves, resulting in lowered death rates, but birth rates remain high. Most of the developing world here.
3. The Industrial Stage, when the birth rate drops due to modernization (and its accompanying social changes). Many developed countries and a few developing countries here.
4. Finally, the Postindustrial Stage is recognized by further reductions in birth rates, approaching or even below zero population growth. Approximately 13% of the world population (mostly European countries) is in this stage. A complete DT exhibits both declining birth and death rates.

When is the period of maximum population growth rate?
Demographic Transition

Stage 1: Death rates and birth rates both high.
Stage 2: Fall in death rates, Population increases.
Stage 3. Decline in birth rate stabilizes population.
Stage 4. Birth and death rates both low, population stable.
Stage 5 (new). Higher death rates than birth rates, populations contract.

Population Pyramid

2) Transitional Stage

2.9% growth rate; 4.8 births/woman; 43% population under 15 yrs
Why is this group so important?

Largest segment of population today..
“bottom billion” - world’s poorest
Will be even larger in near future because
most of population is under childbearing
age (<15 yrs).

Population Momentum
(also population lag effect)

Phenomenon that population will continue to
grow for decades even after total fertility rates
equal only the replacement rate...
Due to weighting of age structure towards the
young…
So, work toward zero population growth...

3) Industrial Stage

1.9% growth rate
4) Early Postindustrial

- 0.1% growth rate; 1.8 births/woman; 18% of population under 15 yrs

4) Late Postindustrial

- 0.1% growth rate; 1.2 births/woman; 14% of population under 15 yrs

Population Pyramids for the four demographic transition phases

[Diagram showing population pyramids for different stages]

- Stage 1: Expanding
  - High birth rate, low death rate; each age group has a high proportion of the population
  - High birth rates, mortality rates are low
  - High birth rates, high death rates; mortality rates are low

- Stage 2: Expanding
  - Moderate birth rates, low death rates; mortality rates are low
  - Moderate birth rates, low death rates; mortality rates are low
  - Moderate birth rates, low death rates; mortality rates are low

- Stage 3: stationary
  - Low birth rates, low death rates; mortality rates are low
  - Low birth rates, low death rates; mortality rates are low
  - Low birth rates, low death rates; mortality rates are low

- Stage 4: Contracting
  - Low birth rates, decreasing death rates; mortality rates are low
  - Low birth rates, decreasing death rates; mortality rates are low
  - Low birth rates, decreasing death rates; mortality rates are low
China’s past and future population pyramid

Post-industrial woes of low fertility

Fewer young support increasing old
Reduced workforce
Population decline

Significant socioeconomic impacts.

Reducing population growth

Successful efforts to reduce population growth by Japan, China, South Korea, Thailand, and Iran.

These countries were able to achieve replacement-level fertility (enough children born to replace death of parents) within 15-30 years - this is good news.

Key Factors were:
- Invest in Family Planning
- Reduce poverty
- Elevate the status of women

1. Make a bigger pie: Increase human productive capacities through technology and innovation.
2. Put fewer forks on the table: Reduce numbers and expectations of people through such means as family planning and vegetarian diets.
3. Teach better manners: Change the terms of people’s interactions through improved planning and government to enhance social justice.

Google’s GapMinder

http://tools.google.com/gapminder

A world in transition

1. Developed vs. developing world
2. Demographic transitions (1960-2003)
3. Health or Wealth first for prosperity?
4. Demographic impact of HIV-AIDS
What should this graph look like for the world in 1950?

A. Positive slope  
B. Negative slope  
C. No significant trend

What does this graph look like today?
Demographic Impact of HIV/AIDS

Impact on life expectancy

HIV infection rates

UN Millennium Development Goals

UN Millennium Declaration, Sept. 2000
Adopted by 189 countries

By 2015:
1. Eradicate extreme poverty & hunger
2. Universal primary education
3. Gender equality, empower women
4. Reduce child mortality
5. Improve maternal health
6. Combat HIV/AIDS and other diseases
7. Environmental sustainability
8. Global partnership for development