Visualizing Environmental Science

Human Population Change and the Environment

Chapter 7

Population Ecology

- Population
  - Individuals of a particular species living in a defined area
- Population ecology
  - Branch of biology that studies individuals of a particular species in a defined area
  - Concerned with how and why population increases or decreases over time as a result of competition, disease, predation, and other environmental pressures

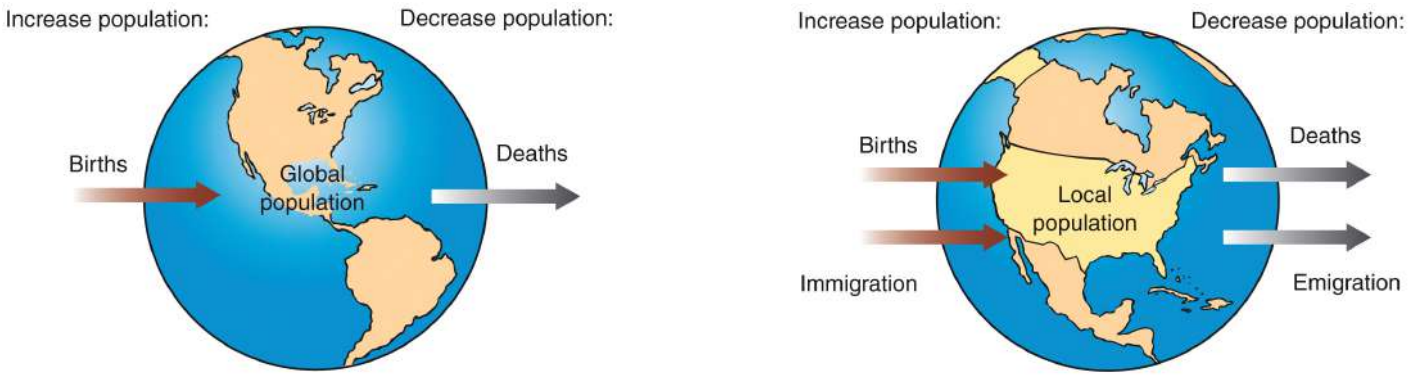
How Do Populations Change in Size?

- Growth rate (*r*)
  - Birth rate (*b*) minus death rate (*d*) gives you growth rate (*r*)
    - $r = b - d$
- Dispersal
  - Movement of individuals from one region to another
  - Affects local populations
  - Immigration (*i*)
    - Individuals enter a population and increase its size
  - Emigration (*e*)
    - Individuals leave a population and decrease its size

How Do Populations Change in Size?

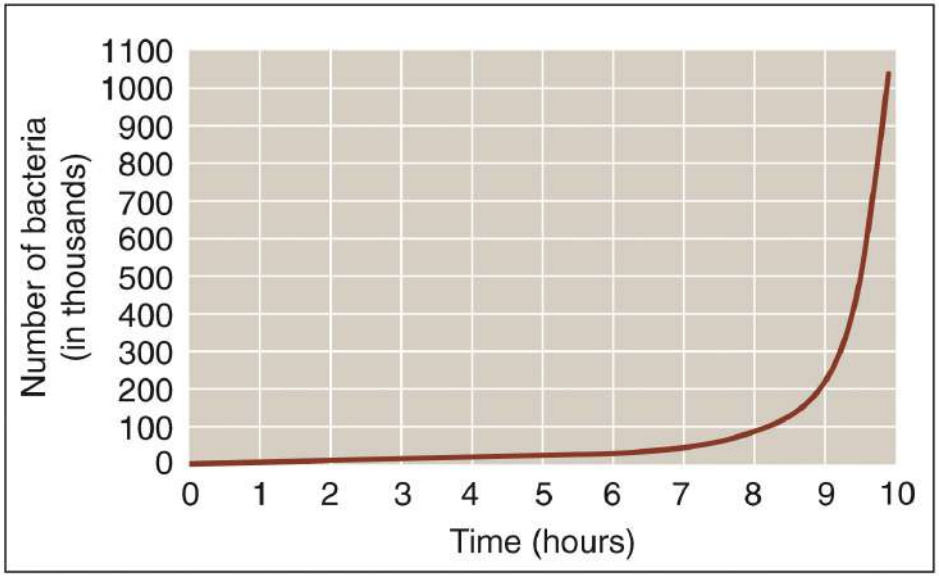
- In humans
  - Birth rate (b) is expressed as number of births per 1000 people per year
  - Death rate (d) is expressed as number of deaths per 1000 people per year
  - Growth rate is also referred to as natural increase

Factors that interact to change population size



Maximum Population Growth

- Exponential population growth occurs when optimal conditions enable organisms to maintain a constant reproductive rate (J shaped curve)



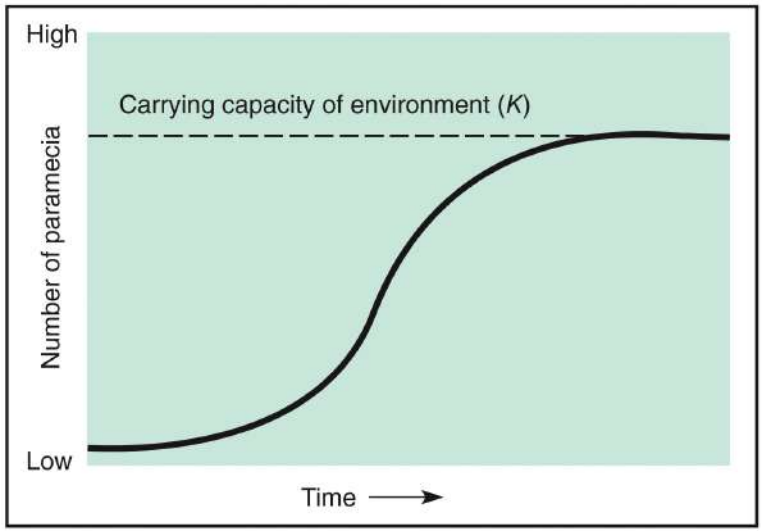
When bacterial numbers are graphed, the curve of exponential population growth has a characteristic J shape.

Environmental Resistance and Carrying Capacity

- Environmental resistance
  - Environmental limits placed on exponential growth
    - Exponential population growth results in increases in competition, predation, and disease
    - Availability of food, water, shelter, and other resources decline
  - Environmental resistance increases as population grows
    - Over time, environmental resistance may reduce population growth to near zero

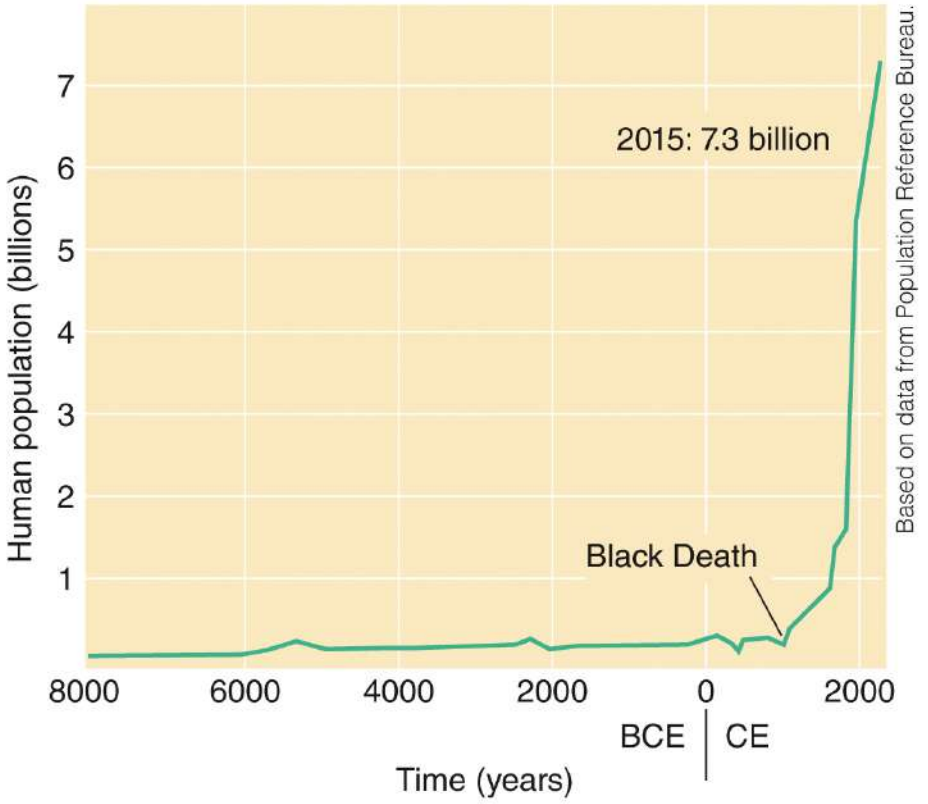
Environmental Resistance and Carrying Capacity

- Carrying capacity
  - the largest population a particular environment can support long term if there are no changes in that environment
    - Carrying capacity changes in response to environmental changes
    - At carrying capacity, growth rate is nearly zero as population size levels off
    - Graphing this growth pattern produces an S-shaped curve



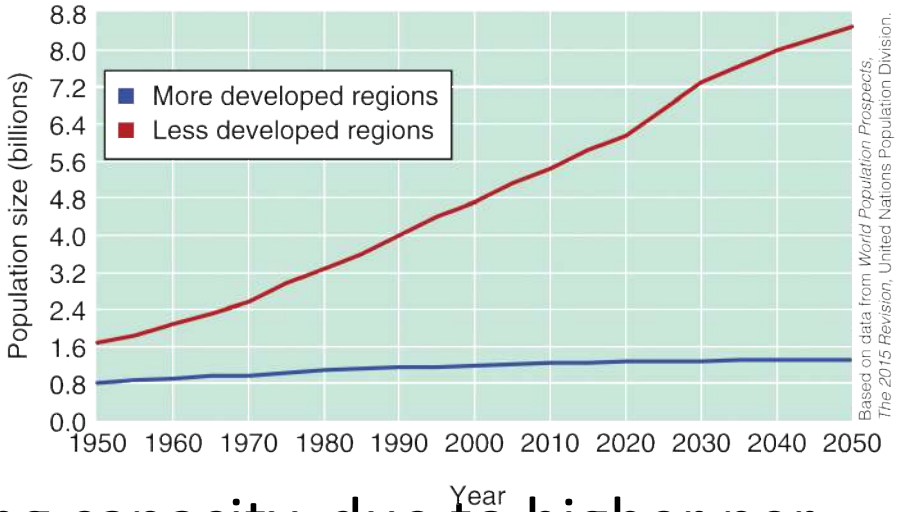
Human Population Patterns

- Advances in global health result in a decrease in death rate
  - Greater food production
  - Better and more accessible medical care
  - Improved water quality
  - Improved sanitation



Projecting Future Population Numbers

- Human population continues to increase
- Growth rate (*r*) has declined over the last few decades
- Global average of number of children born to each woman is 2.5
  - Earth's carrying capacity *is* estimated to range from 4 billion to 16 billion
  - The more highly developed countries have lower carrying capacity, due to higher per-capita resource use



Projecting Future Population Numbers

- What will happen to the human population as it approaches Earth's carrying capacity?
  - Optimists suggest a decrease in birth rate (*b*) will stabilize human population
  - Pessimistic experts predict widespread environmental degradation

    - Earth becomes uninhabitable for humans and other species
    - Massive wave of suffering and death
    - Extinction of humans unlikely, but severe hardship for most will ensue
    - Some experts think humans have already exceeded the carrying capacity of the environment

Demographics of Countries

- Countries are classified into two main groups:
  - Highly developed countries
  - Developing countries
- These classifications are based on
  - Population growth rates
  - Degree of industrialization
  - Relative prosperity

The world's 10 most populous countries • Table 7.1

Country	2015 Population (in millions)	Population density (per square kilometer)
China	1372	143
India	1314	400
United States	321	33
Indonesia	256	133
Brazil	205	24
Pakistan	199	250
Nigeria	182	197
Bangladesh	160	1081
Russia	144	8
Mexico	127	64

Population Reference Bureau

Demographics of Countries

- Highly developed countries
  - USA, Canada, France, Germany, Sweden, Australia, Japan
  - Lowest birth rates in the world
  - Low infant mortality rates
  - Longer life expectancies
  - Higher per person income

Demographics of Countries

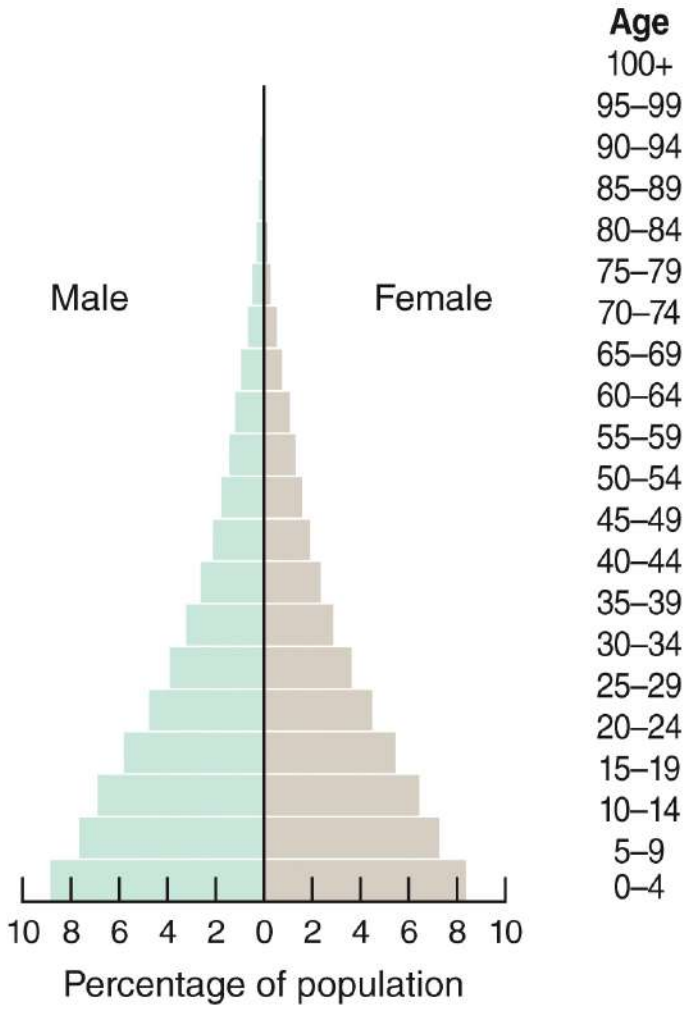
- Moderately developed countries
  - Bangladesh, Afghanistan, Niger, Ethiopia, Laos, Cambodia
  - Birth rates higher than highly developed countries, but are declining
  - Medium level of industrialization
  - Average per person incomes lower than in highly developed countries

Demographics of Countries

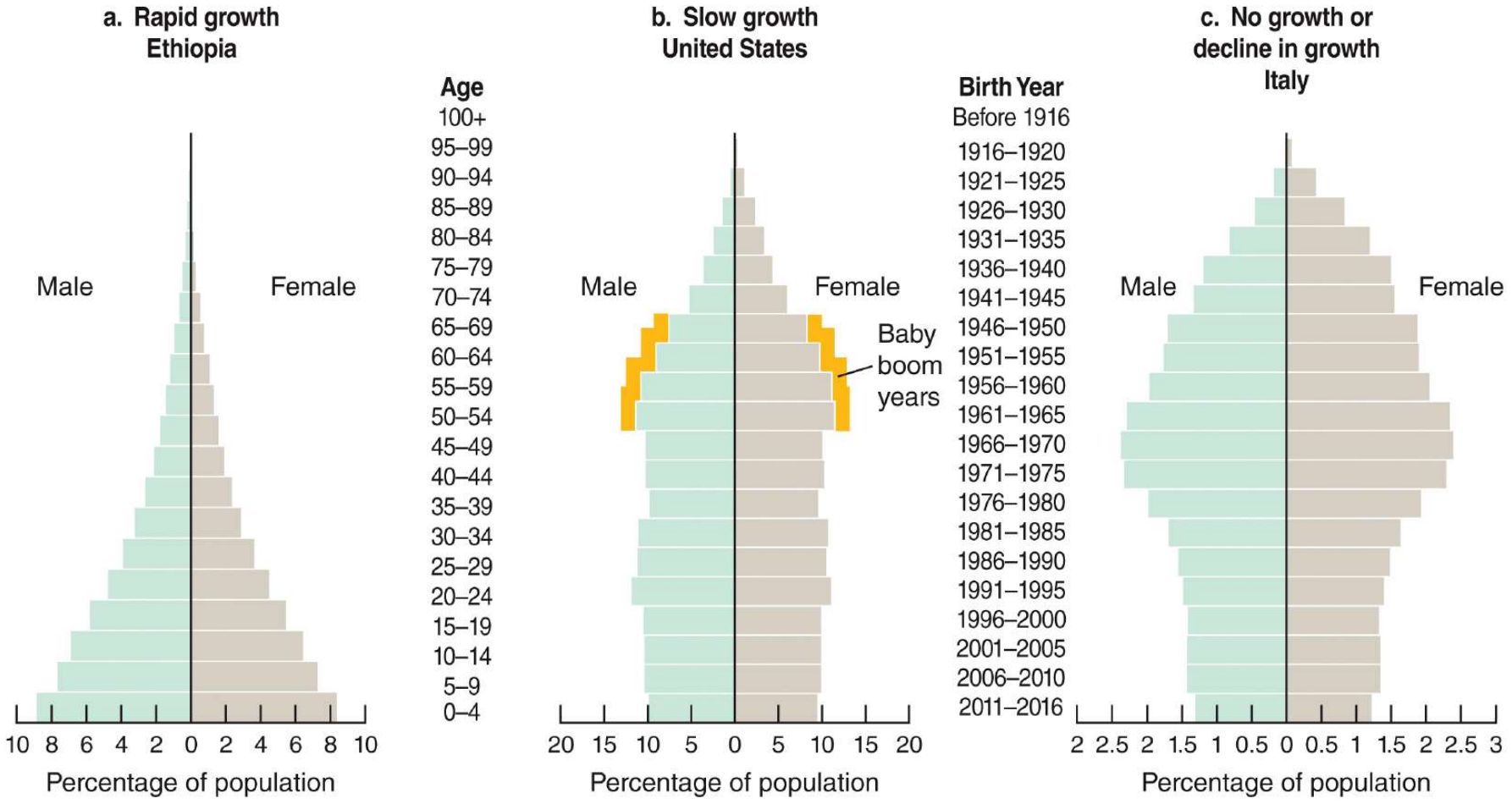
- Less developed countries
  - Mexico, Turkey, Thailand, most South American countries
  - Highest birth rates
  - Highest infant mortality rates
  - Shortest life expectancies
  - Lowest average per person incomes

Age Structure of Countries

- Age structure diagram:
  - Left side of an age structure diagram represents males in the population, and the right side the females
    - Bottom third of each diagram = pre-reproductive humans (0 – 14 years old)
    - Middle third = reproductive humans (15 – 44)
    - Top third = post-reproductive humans (45+)
  - Segment widths are proportional to the population sizes



Age Structure of Countries



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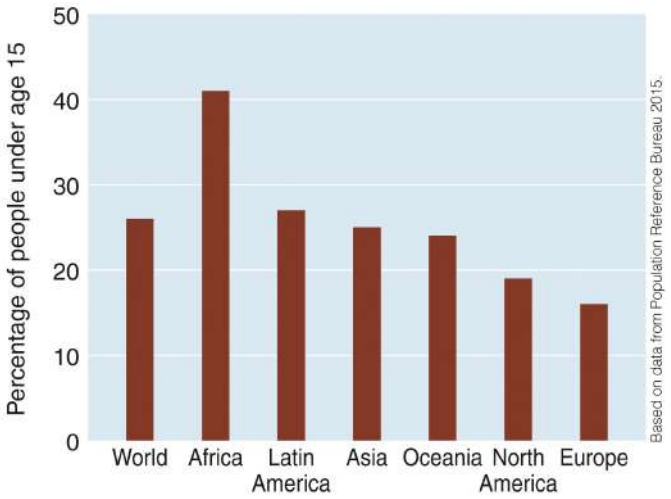
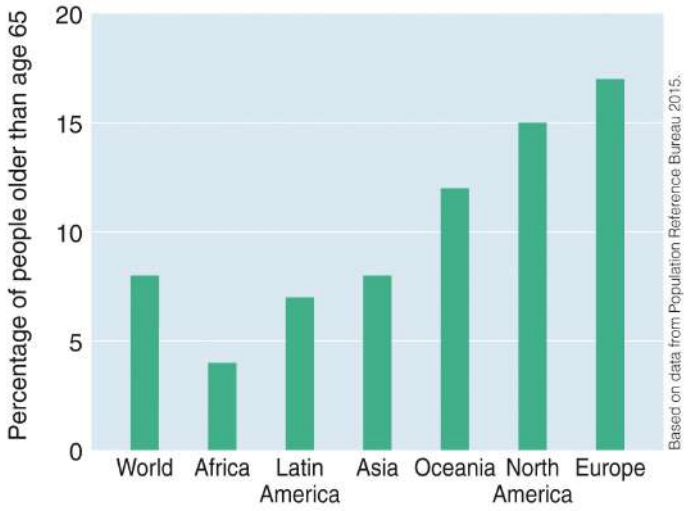
Original data from U.N. Population Division.

Age Structure of Countries

- Population growth momentum
  - Both positive and negative growth momentum can have significant social an economic implications in their countries
    - Rapid and significant population growth can stress food supplies, housing, the environment, employment, and infrastructure
    - Conversely, a population with two few young people and many elderly have too few workers to meet the needs of the overall population and help both care for the infirm and provide a large enough tax base to support the costs of the population as a whole





Culture and Fertility

- Culture
  - The values and norms of a society
  - What is considered right from wrong
  - Language, beliefs and spirituality
- Gender roles
  - The varying roles men and women are expected to fill
  - Different societies have different gender expectations
  - A couple is expected to have the number of children traditional in their society

Culture and Fertility

- High total fertility rates (TFRs)
  - Are traditional in many cultures to offset high infant mortality rates
  - Are traditional in some developing countries as children work, contributing to the family's livelihood
    - 168 million children between the ages of 5 and 14 worked full time in 2012, mostly in developing countries
    - Almost 85 million child laborers do hazardous work such as mining and construction
- Some cultures place higher value on male children and women who bear many sons achieve a higher status, leading to a higher (TFR)

The Social and Economic Status of Women

- Gender inequality exists in most societies
  - Women don't have the same rights, opportunities, or privileges as men
  - Women have lower political, social and economic status
  - More women than men live in poverty
  - In most countries, women are not guaranteed equality in legal rights, education, employment or earnings, or political participation
  - Sons often go to school, girls are kept home to work
  - In most developing countries, more women are illiterate than men, although progress is being made in this area

The Social and Economic Status of Women

- The low status of women in many societies is the biggest factor influencing high TFRs
- Marriage age also affects TFR
  - The earlier a woman marries, the more children she is likely to have
- Education affects TFR
  - Less education leads to earlier marriages
  - More education leads to later marriages and fewer children
  - Education improves women's health awareness
    - Understanding of fertility and how to control it
    - Decreases in infant and child mortality

Family Planning Services

- Health and family planning services availability is necessary if TFRs are to be reduced
- These services have lowered TFRs in developing countries, when available
- Increased availability of prenatal care has lowered TFR
- Information on contraceptive use and access to contraceptives have lowered TFR

Population and Urbanization

- Urbanization
  - Movement of people from rural areas to densely populated cities
- Approximately 81% of people in US live in cities, as of 2015
- Cities have grown due to:
  - Fewer farms and farmers exist today, resulting in reduced employment opportunities in rural areas
- Cities are sites of industry, education, and cultural, economic and technological centers

Population and Urbanization

- Cities are urban ecosystems
  - Certain characteristics are common to cities
    - City populations have far greater heterogeneity than those in rural areas
    - City residents tend to be younger than those in rural areas
    - Cities in developing nations have a higher ratio of males to females
    - Cities in highly developed nations have a higher ratio of females to males

Environmental Problems of Urban Areas

- Suburban sprawl
  - Most US urban workers commute to the city from suburbs
  - Suburbs expand around a city, encroaching onto natural areas and farmland
  - Because development is spread out in the suburbs, having an automobile is a necessity to accomplish chores
    - Our heavy dependence on motor vehicles for transportation increases air pollution and other environmental problems

Environmental Problems of Urban Areas

- Urban air and water problems
  - High density of commercial enterprises in urban areas causes buildup of airborne emissions
  - Urban areas in developing nations have the worst air pollution in the world
  - Cities affect water flow because rainfall-absorbing soil is covered with pavement and buildings
  - Urban runoff can contain multiple pollutants, and sometimes remains untreated, potentially contaminating waterways distant from the city

Case Study: Urban Planning in Curitiba, Brazil

- Example of compact development
- Home to 3.5 million
- Efficient mass transit system and traffic management
  - Two million people use Curitiba's mass transportation system daily
- Instead of vehicular traffic, the center of Curitiba is a big sidewalk that consists of 49 blocks of pedestrian walkways connected to bus stations, parks and bicycle paths
- First city in Brazil to use low-polluting fuel that burns cleanly
- Labor-intensive garbage purchase program
  - Poor people exchange garbage for bus tokens, food and school notebooks