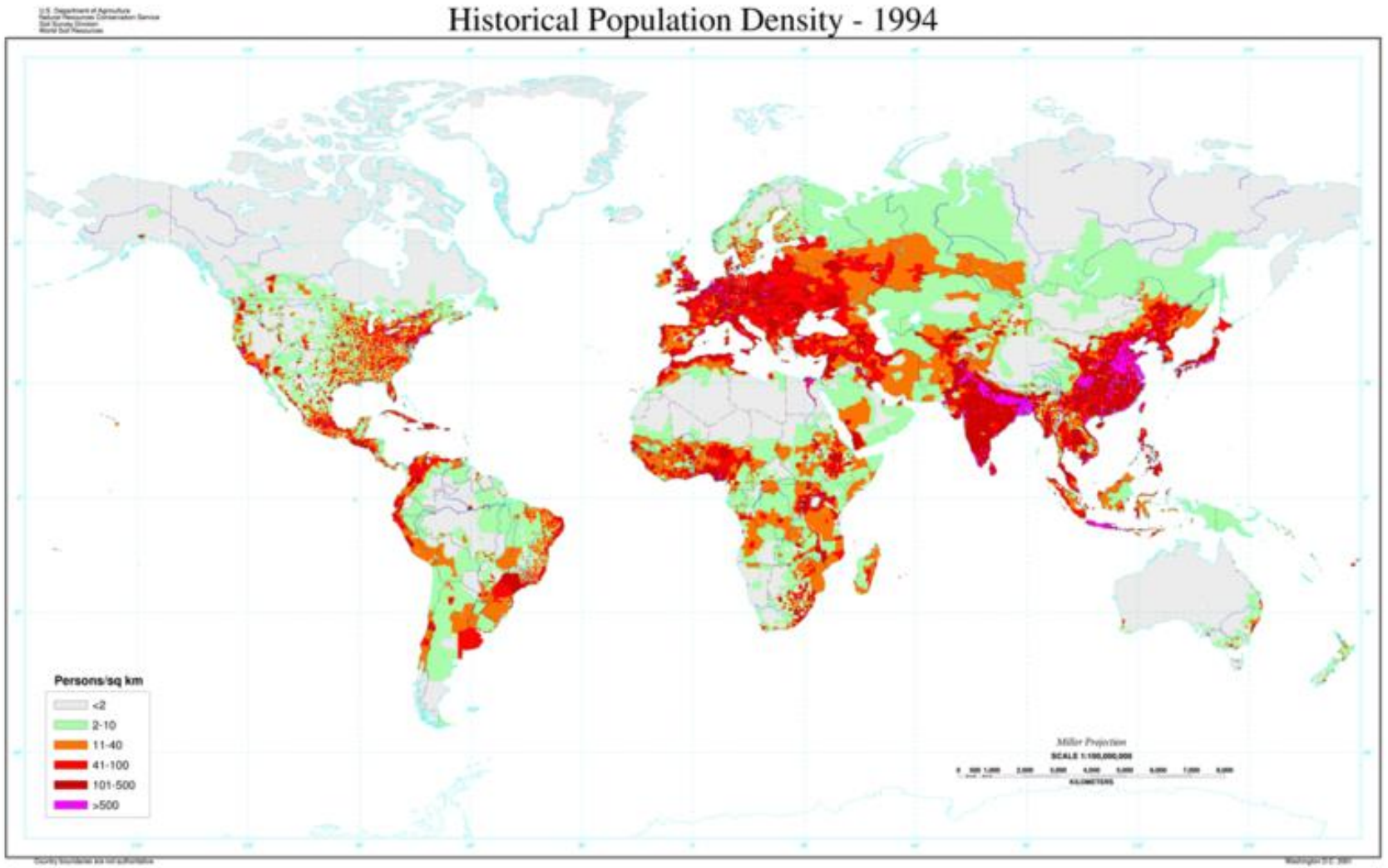
# Lecture 5: Basic Population Dynamics

CE 107: Introduction to Civil and Environmental Engineering

# Population Density



# The Demographic Divide: Developed and Developing Nations

- **A. Rich Nations**

**1.** Decreased birth rates
**2.** Low to negative growth rates
**3.** Increased consumption rates per person
**4.** Negative environmental impact due not to numbers but affluence.
**5.** Consequences of affluence
**a.** Greater contribution per person to global pollutants  carbon dioxide, ozone depletion chemicals
**b.** Food consumption high on biomass pyramid  fewer people can be supported
**c.** Waste production high  fuel inefficient transportation, throwaway consumer goods.

# Developed and Developing countries

- **B. Poor Nations**

**1.** Moderate birth rates (these rates have decreased in the last 20 years)
**2.** Moderate to high growth rates
**3.** Low consumption rates per person
**4.** Negative environmental impact due to numbers not affluence
**5.** Consequences of population size
**a.** Subdividing farms and intensifying cultivation
**b.** Opening up new lands for agriculture
**c.** Migration to cities
**d.** Illicit activities
**e.** Emigration and immigration
**f.** Impoverishment of women and children

# Developed and Developing countries

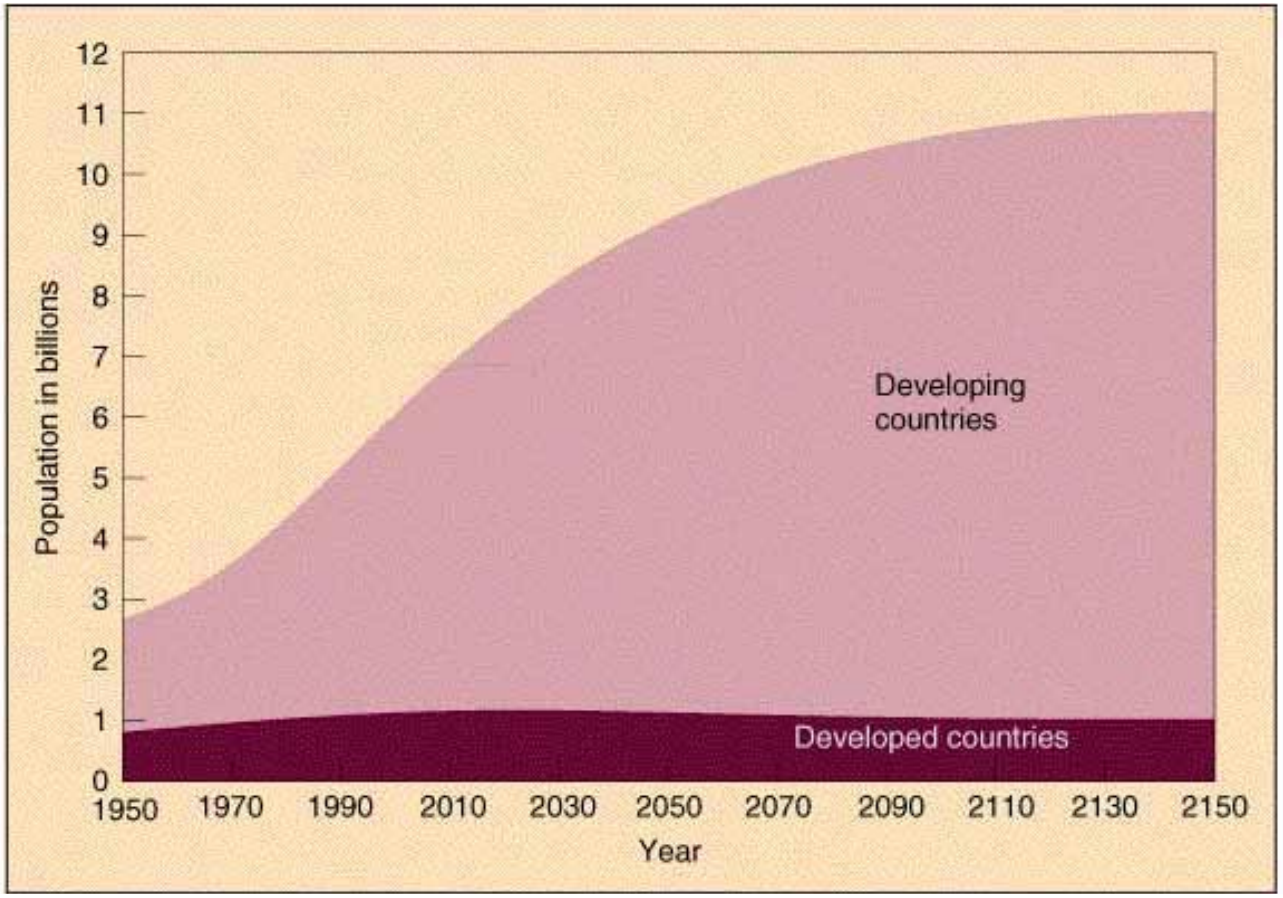



**Fig.** Developing countries represent a larger and larger share of world population because of higher populations and higher birth rates.

# Population Explosion

**A.** Current world population: 6 billion people (October 1999)

**B.** Putting the numbers in perspective:

- Each time your heart beats, 3 more people are added to the world
- Each time a person dies, 2.8 babies are born Every **day** a quarter of a million are added.
- Every **year**, about 87 million people (about the population of Mexico, or 3x the population of California, or the combined populations of the Philippines and South Korea) are added to the world.
- During the next **2.5 years**, the equivalent of the U.S. population will be added to the planet.
- During the coming **decade** the increased population of one billion people is the equivalent of adding an extra China to the world's population

**C.** Causes of population growth:

**a.** Better recruitment resulted from declining infant mortality rates

**b.** Mortality rates decline:

· Improvement in agriculture  increased production and better food

distribution and storage

· Public health measures  improved sanitation practices, clean drinking water, mass inoculations

# World Population: The Reality

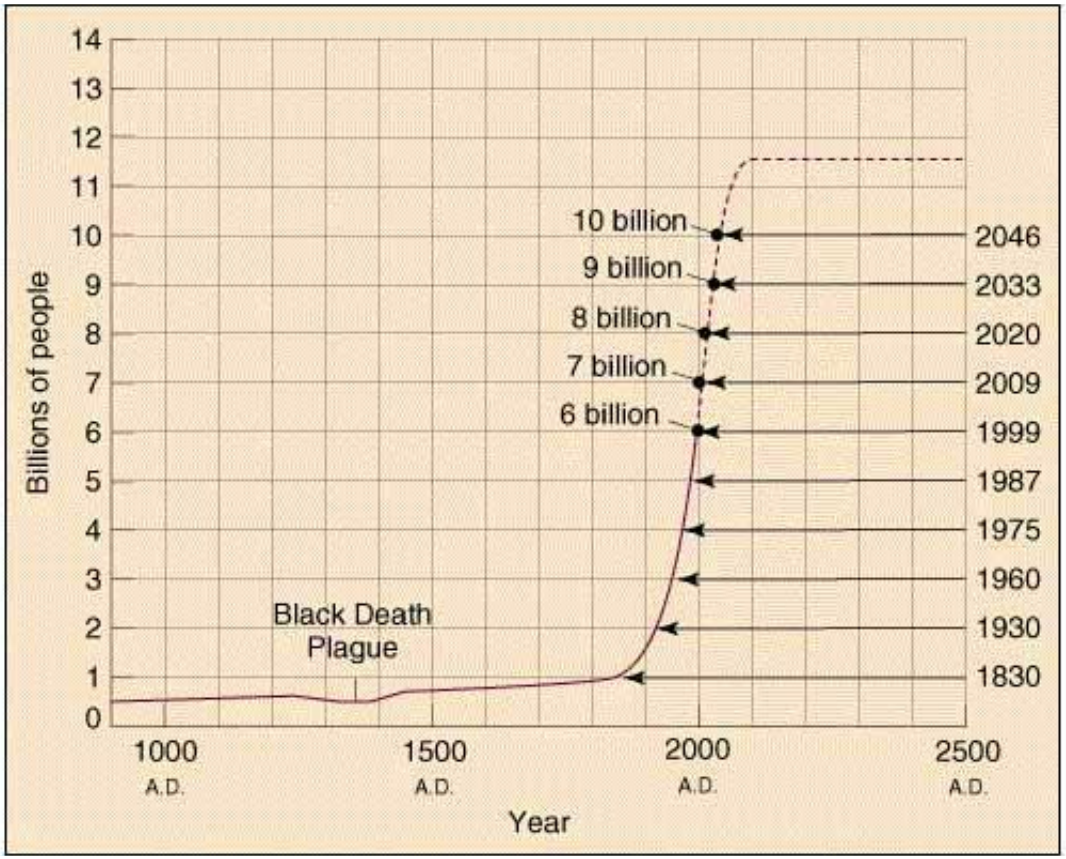
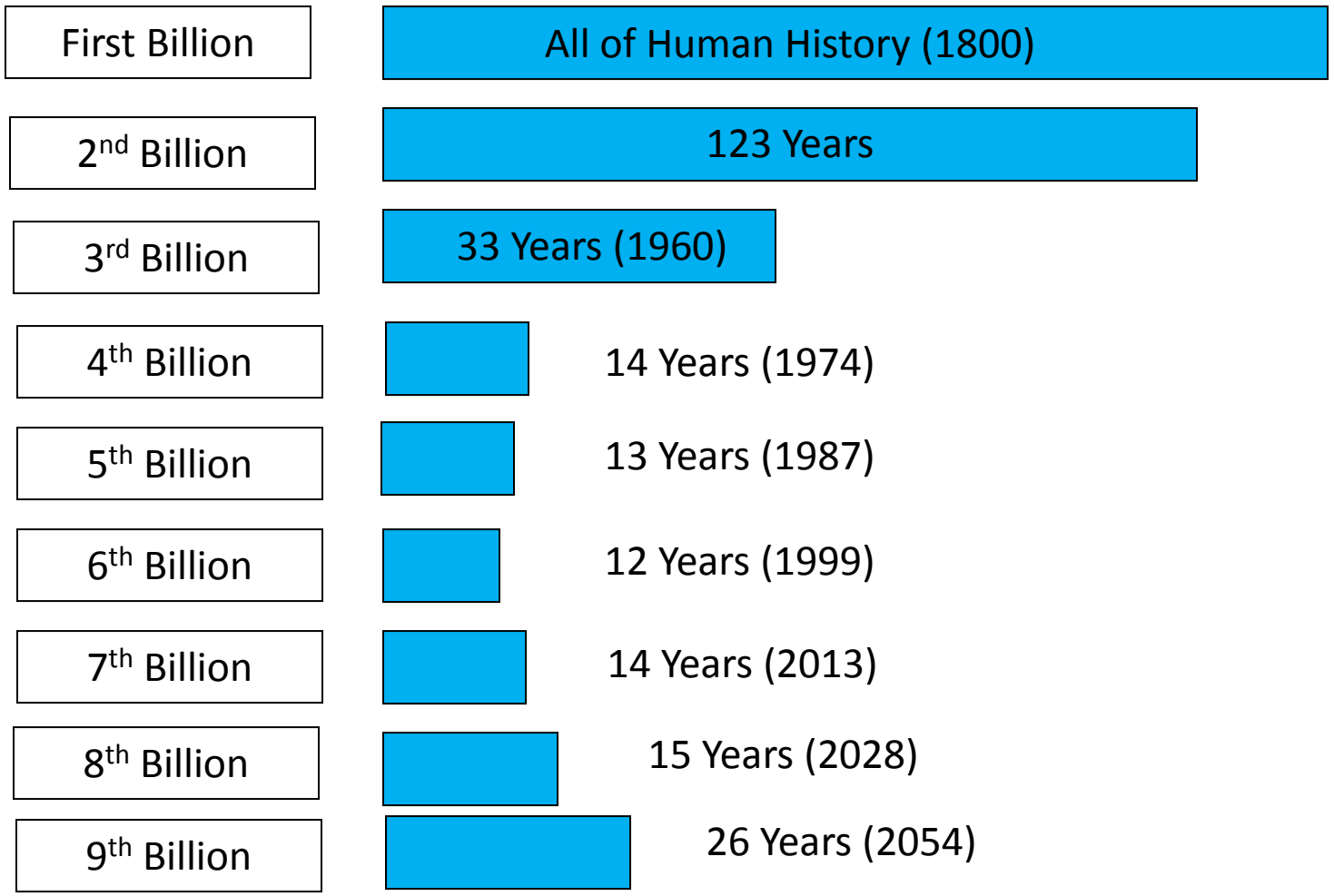



**Fig.** For most of human history, population grew slowly, but in modern times it has suddenly "exploded. World population started a rapid growth phase in the early 1800s and has grown sixfold in the last 200 years. It continues to grow by nearly 88 million people per year ”

# World Population: The Reality and Projections

| World population (millions) | | | | |
|---|---|---|---|---|
| # | Top ten most populous countries | 1990 | 2008 | 2025* |
| 1 | China | 1,141 | 1,333 | 1,458 |
| 2 | India | 849 | 1,140 | 1,398 |
| 3 | US | 250 | 304 | 352 |
| 4 | Indonesia | 178 | 228 | 273 |
| 5 | Brazil | 150 | 192 | 223 |
| 6 | Pakistan | 108 | 166 | 226 |
| 7 | Bangladesh | 116 | 160 | 198 |
| 8 | Nigeria | 94 | 151 | 208 |
| 9 | Russia | 148 | 142 | 137 |
| 10 | Japan | 124 | 128 | 126 |
| | World total | 5,265 | 6,688 | 8,004 |

# World Population growth



# Carrying capacity of the Earth environment

- Definition: A concept related to sustainability which is usually defined as the maximum number of individuals of a species that can be sustained by an environment without decreasing the capacity of the environment to sustain that same amount in the future.
- What is the maximum number of people that Earth can sustain?

# How many people can Earth Support?

May vary from 2.5 billion to 40 billion.

2.5 bill: if everybody eat like Americans

40 bill: if all flat lands are cultivated

Factors need to be considered

- **Food supply**
  - Support 6 billion if vegetarian. Agriculture production is not increasing much since 1984.
- **Land and Soil Resources**
  - Almost all usable land areas for agriculture used. 13% increase is possible, but extremely costly.
- **Water Resources**
  - Consumption ~ 1000 liters/day, rural ~ 5 liters/day. Only 1% freshwater is available for effective human use
- **Net primary productions**
  - Human uses 4% of land and 2% of oceans production. Since 1950, NPP of the planet decreased by around 13%.
- **Population density**
  - Bangladesh has 915 people /$km^2$
- **Technology**
  - 1 American = 35 Indian = 140 Bangladeshi (??)

# Population and Consumption

**The "ecological footprint"**

• The environmental impact of a person or population

- Amount of biologically productive land + water

- For resources and to dispose/recycle waste

• Overshoot: humans have surpassed the Earth's capacity to support us

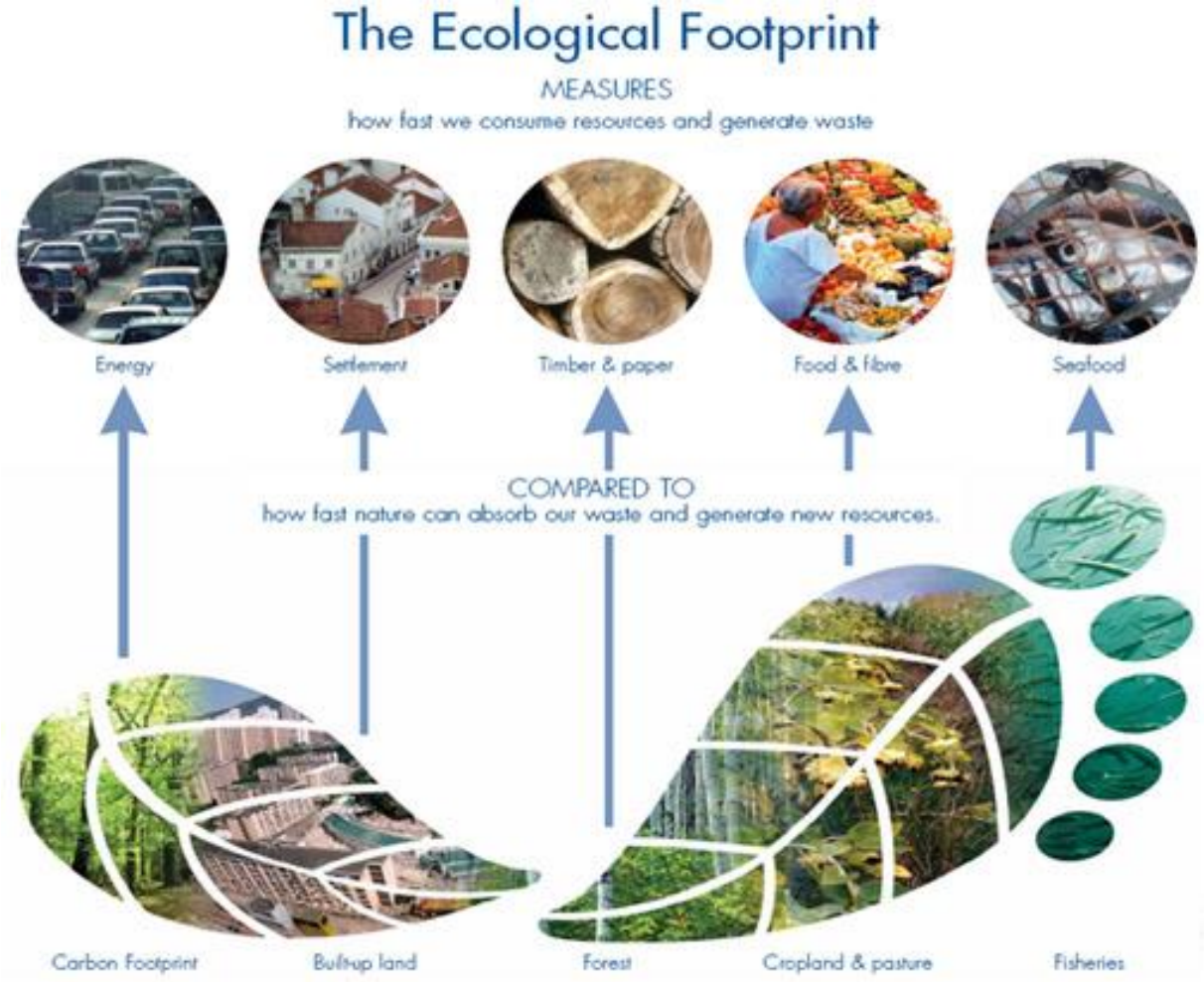
**Ecological footprints are not all equal**

• The ecological footprints of countries vary greatly.

- The U.S. footprint is much greater than the world's average.

- Developing countries have much smaller footprints than developed countries.

# Population and Consumption



# Your Footprint : Example ..food

- Vegetarian: Food footprint 0.2 hectares
- Eat meat now and then: Food footprint 0.6 hectares
- Eat meat a few times a week: Food footprint 1.3 hectares
- Eat meat most days: Food footprint 2.1 hectares
- Eat meat once or twice a day: Food footprint 2.8 hectares
- Eat meat almost every meal: Food footprint 3.5 hectares

# We are increasing the burden on our planet

- • Human population growth amplifies all environmental problems
  - The growth rate has slowed, but we still add over 200,000 people to the planet each day.
- • Our consumption of resources has risen even faster.
  - - Life has become more pleasant for us so far.
  - - However, rising consumption increases the demands we make on our environment.
  - - The rise in affluence has not been equal. The gap between rich and poor has doubled in the past 40 years.

# Consequences of a Population Explosion in Developing Countries

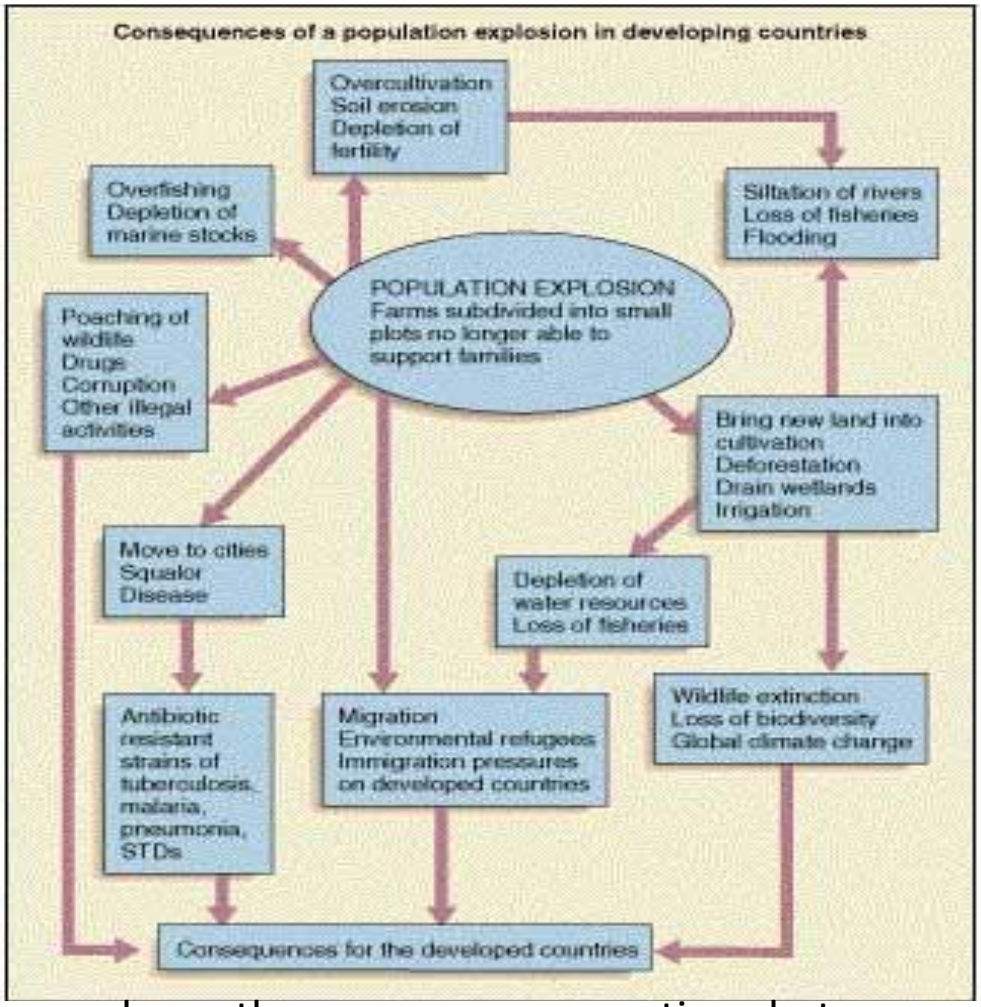



**Fig.** The diagram shows the numerous connections between unchecked population growth and social and environmental problems.

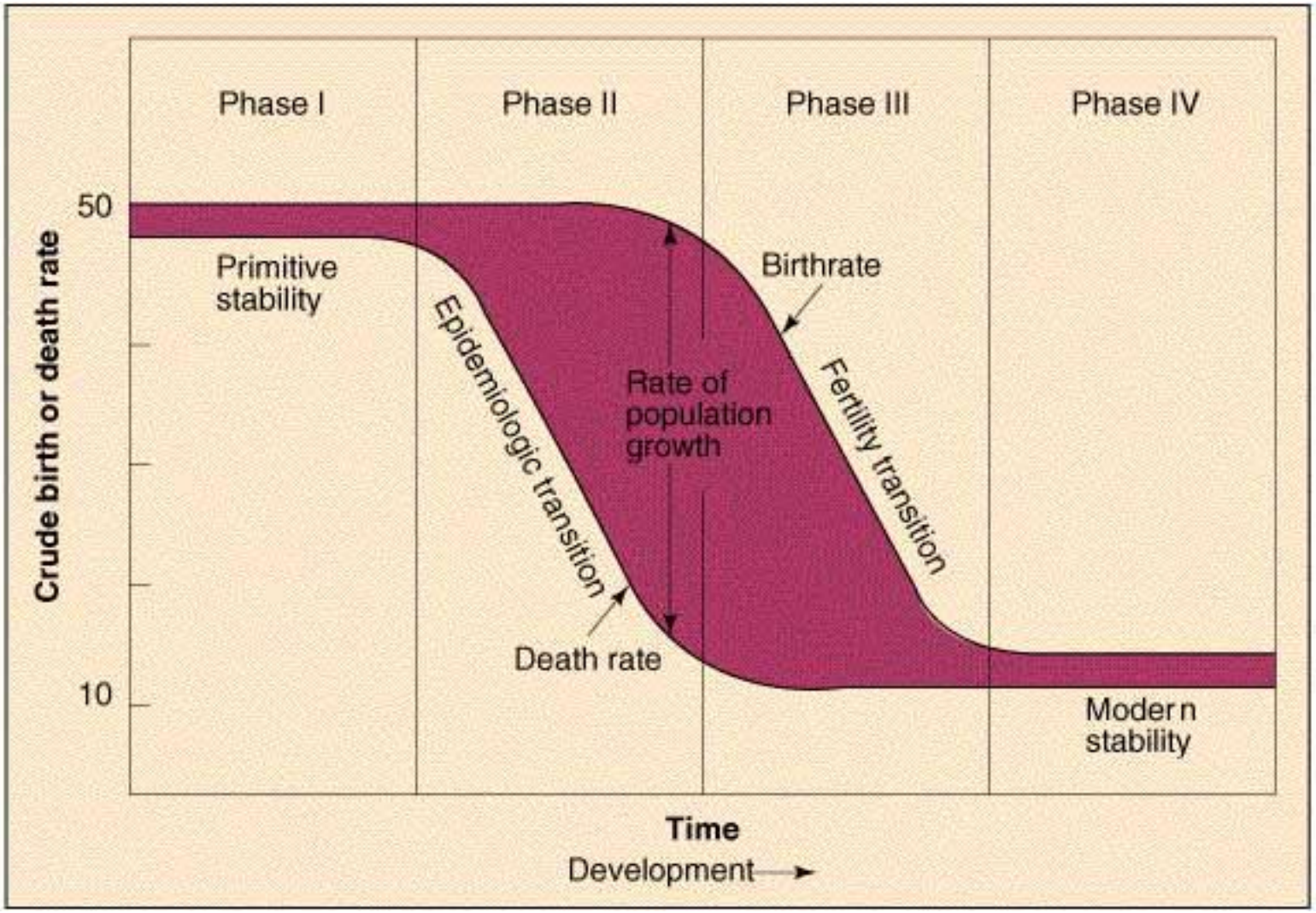
# The Demographic Transition

**1. Epidemiologic transition**
**a.** Pattern of change in mortality factors
**b.** Decline in death rates

**2. Fertility transition**
**a.** Pattern of change in crude birth rates
**b.** Decline in birth rates worldwide

**3. Phases of demographic transition**
**a.** The demographic transition is a description of the correlation observed in developed countries between economic development and decreased fertility rates. There may be other, equally effective means of reducing fertility rates.

# The Demographic Transition



# The Demographic Transition

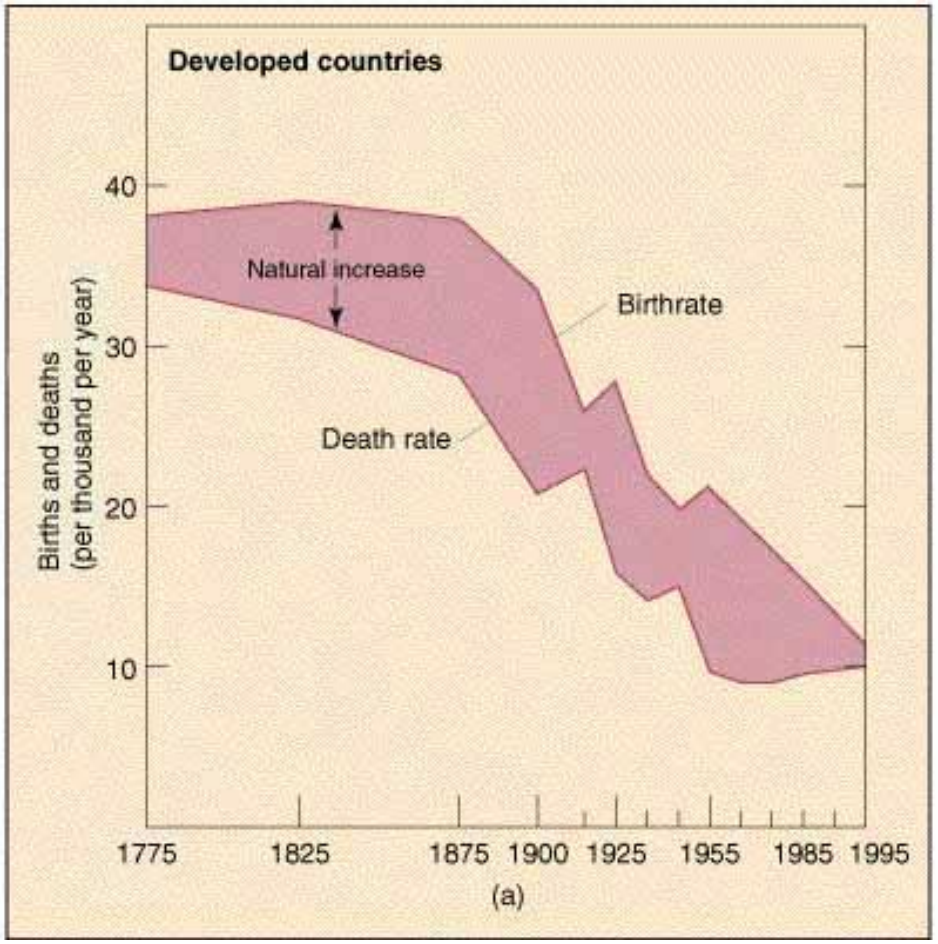



**Fig. 7.8** In developed countries, the decrease in birth rates proceeded soon after and along with the decrease in death rates, so very rapid population growth never occurred.

# The Demographic Transition

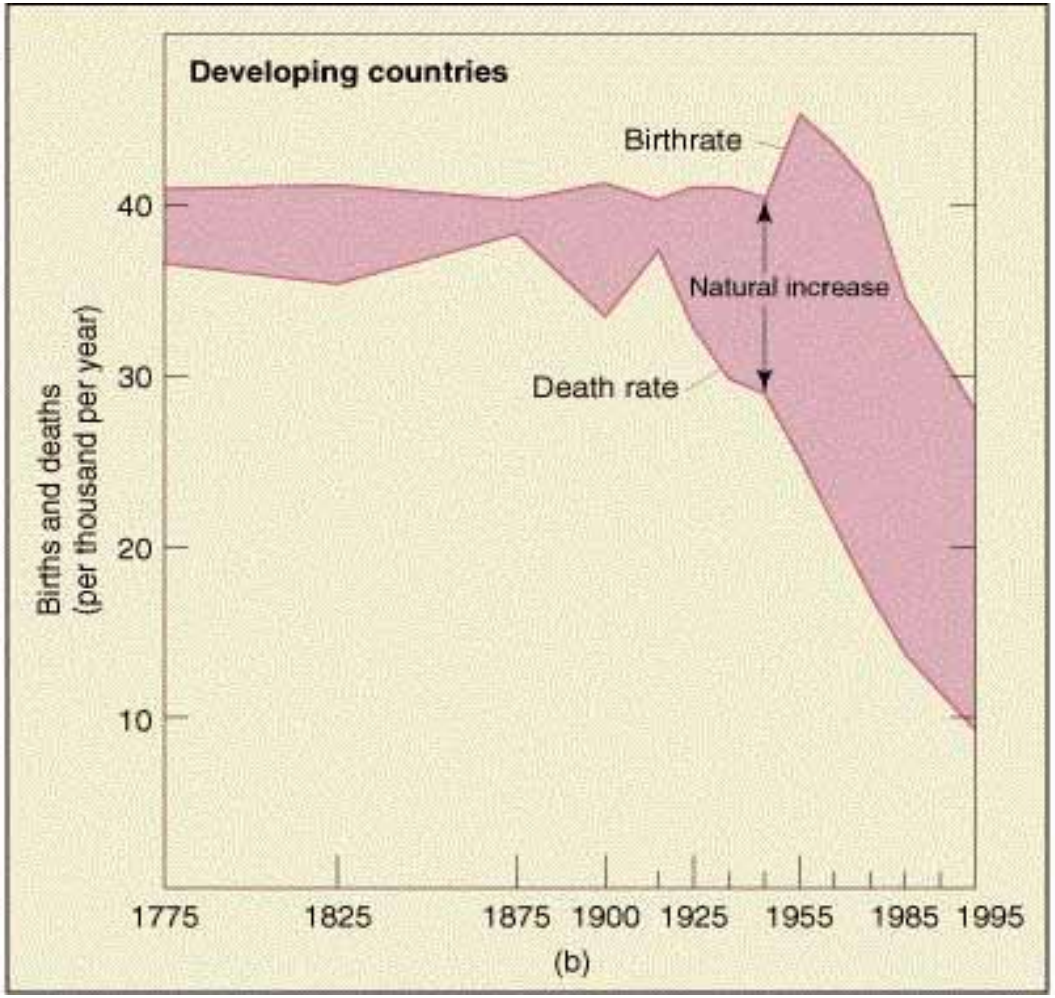


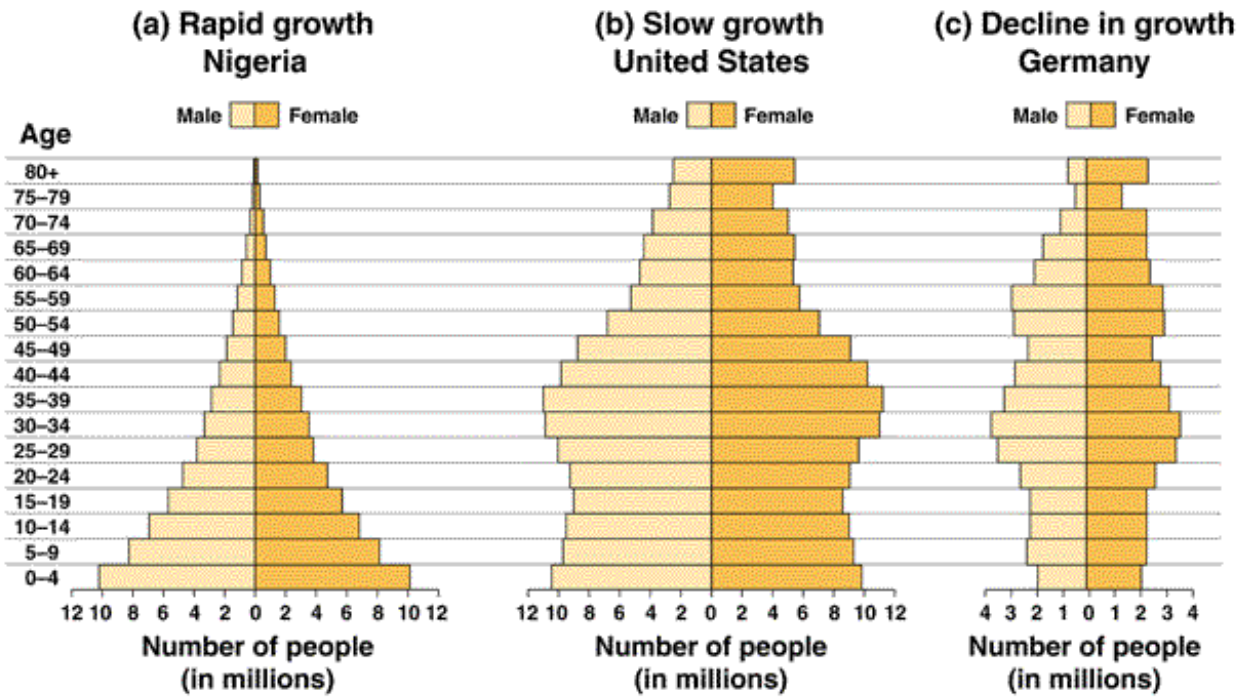

**Fig. 7.8b** In developing countries, both birth and death rates remained high until the mid 1900s. Then a steep decline in death rates was caused by the rapid introduction of modern medicine, whereas birth rates remained high, causing very rapid population growth.

# Age Structure

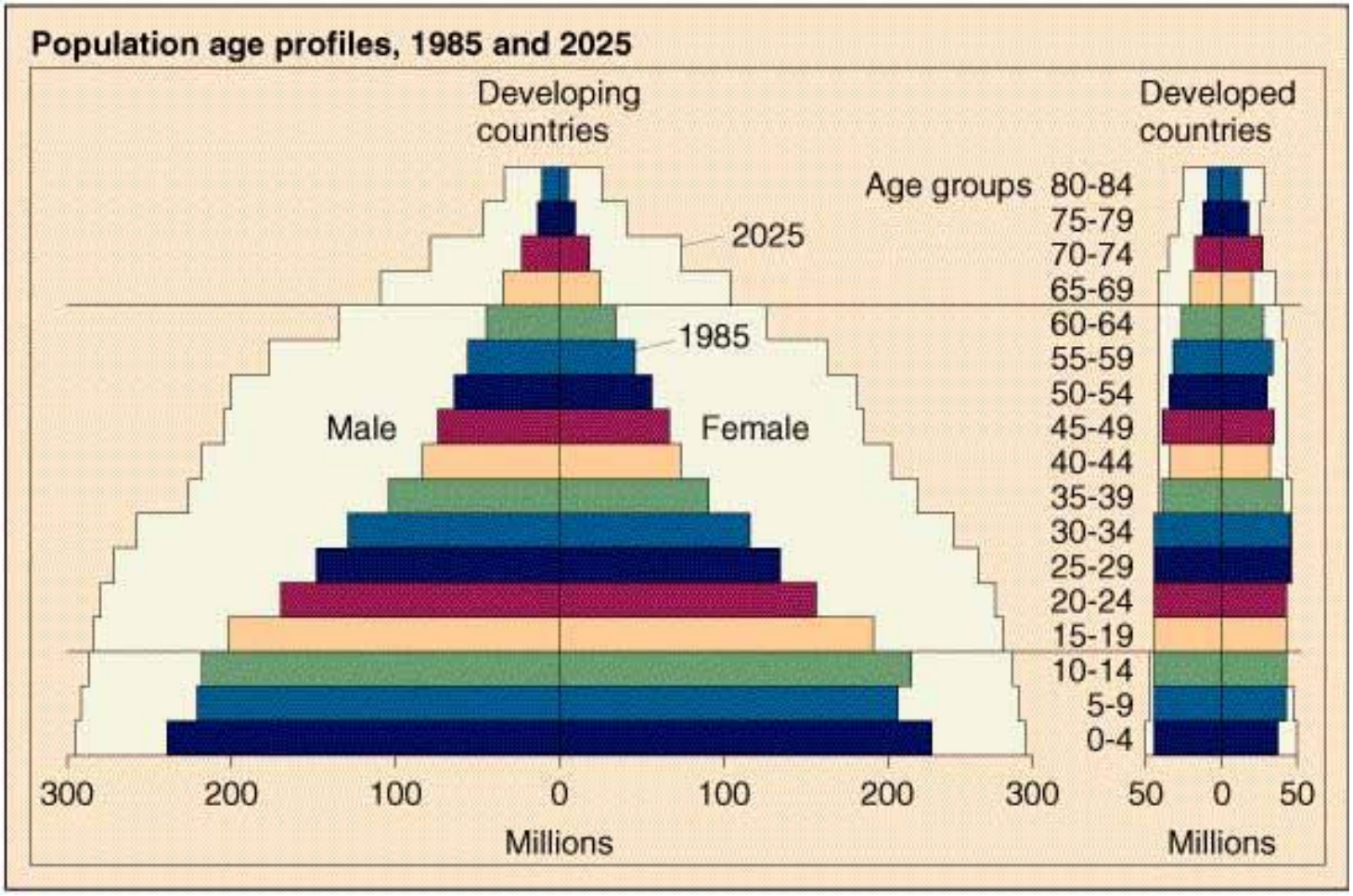
- The proportion of the population in each age class. Age structure provide insight into a population's history.
- The age structure of a population affect current and future birth rates, death rates; and growth rates.
- Rapidly growing nation has shape like pyramids.
- In developing country 37% population are under 15.
- Slow growing nation has eye shape.

# Age Structure

Raven/Berg, Environment, 3/e
Figure 8.14



# Age Structure



# Projected Future Trends

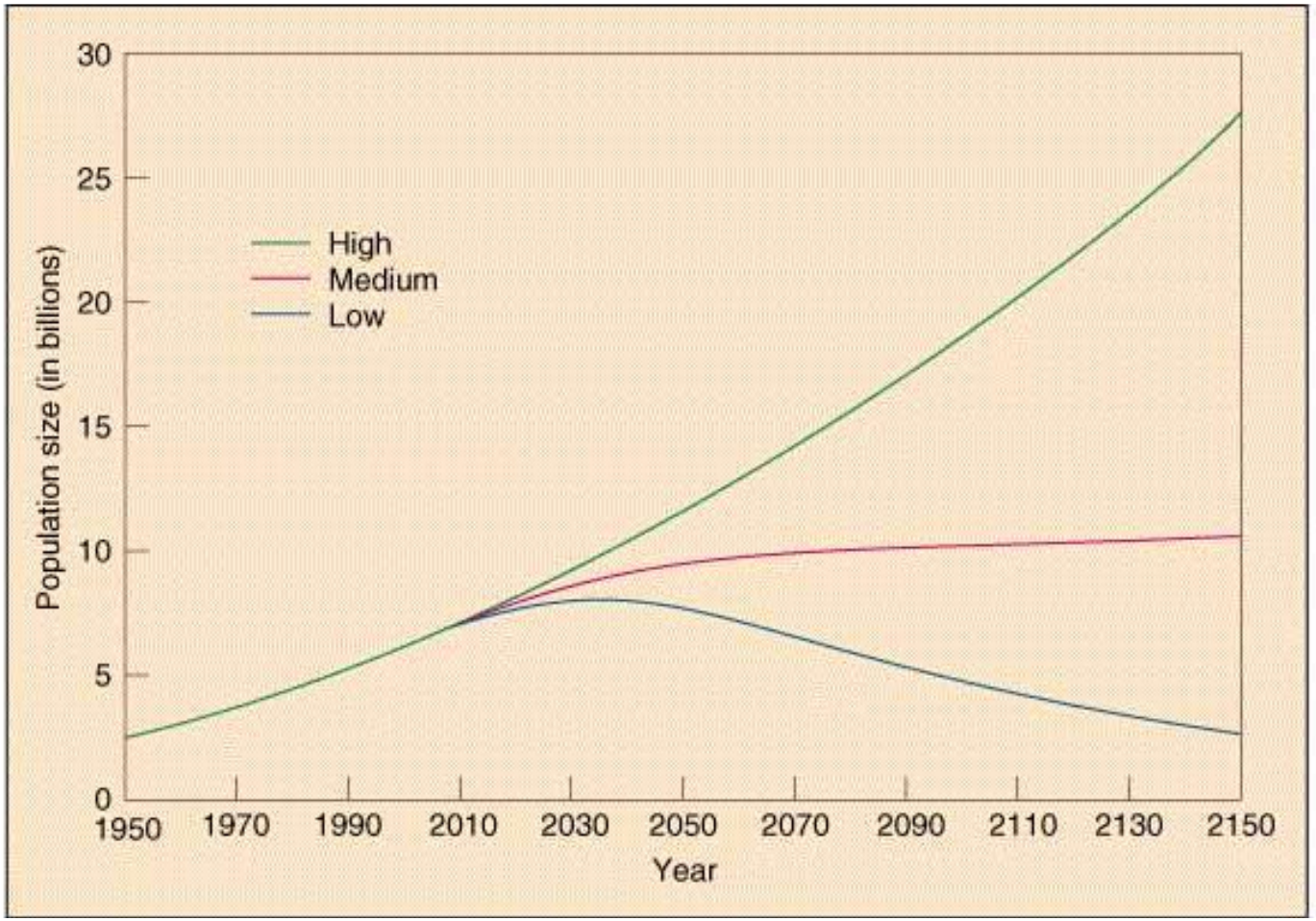



**Fig.** This figure shows projected world population according to three different fertility scenarios. UN projections of the future world population, using different total fertility rates.

# Reality of the problem

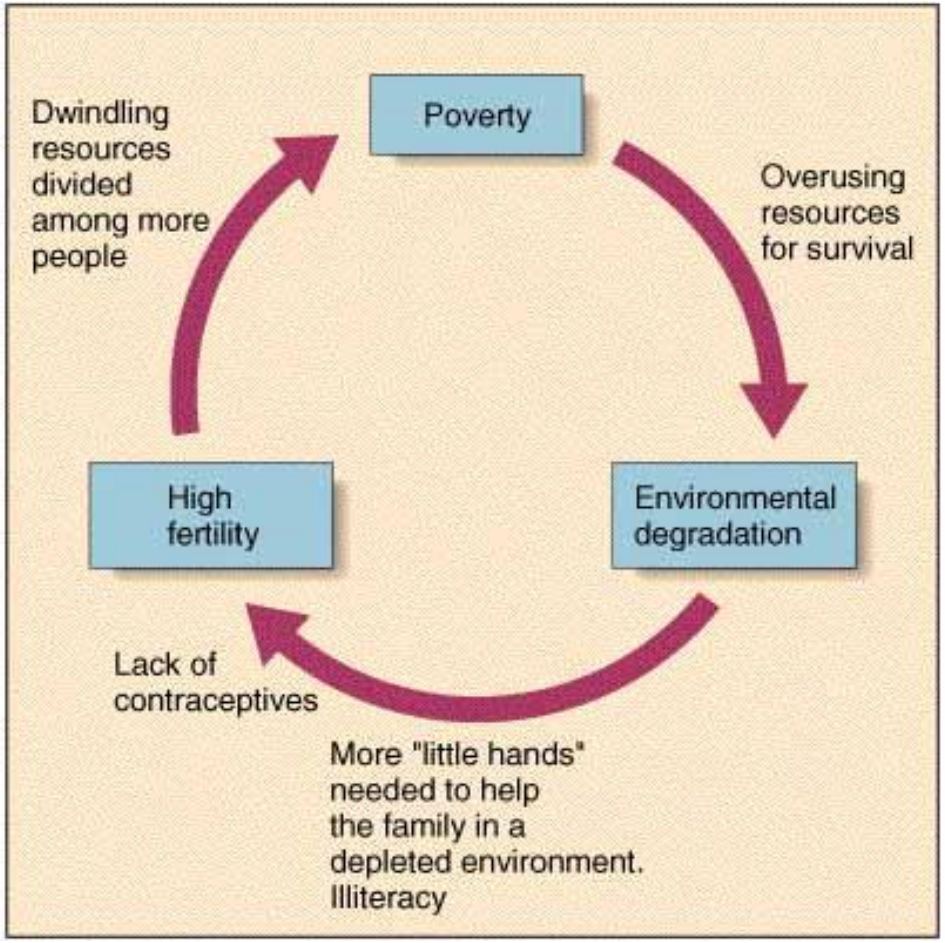



**Fig.** Poverty, environmental degradation, and high fertility rates become locked in a self-perpetuating vicious cycle.

# Population Impact on the Environment

- Environmental Impact (EI)

  = Population (P)

  X Per Capita Resource Consumption (A)

  X Technological Impact (T)