Human Population Growth and Environmental Consequences

(Various Sources)

Case study: China's one-child policy

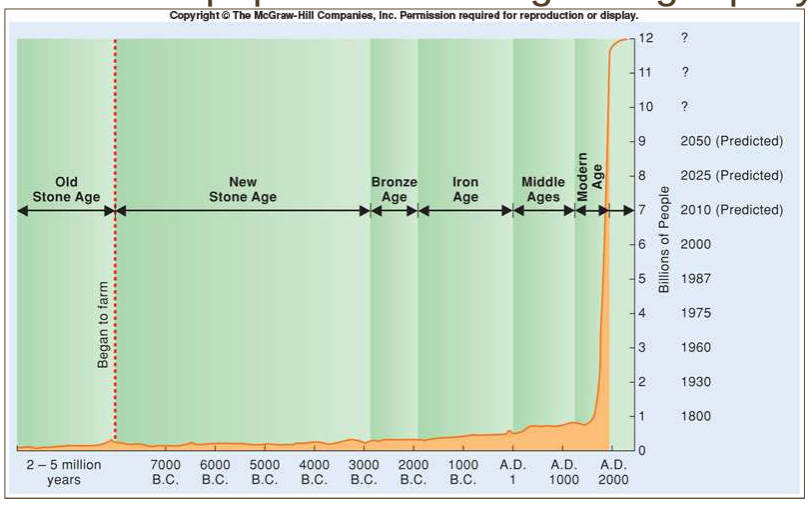
- In 1970, China's 790 million people faced starvation.
  - The average Chinese woman gave birth to 5.8 children.
- The government instituted a one-child policy.
  - China's growth rate plummeted.
  - The government first used education and outreach and later instituted rewards and punishments.
  - In 1984, the policy exempted ethnic minorities and farmers.
- The program has been both successful and controversial.
  - The low growth rate makes it easier to deal with challenges.
  - It has produced unintended consequences: killing female infants and a black-market trade in teenage girls.

Human population: 6.75 billion

- Populations continue to rise in most countries.
  - Particularly in poverty-stricken developing nations
- Although the rate of growth is slowing, we are still increasing in absolute numbers.

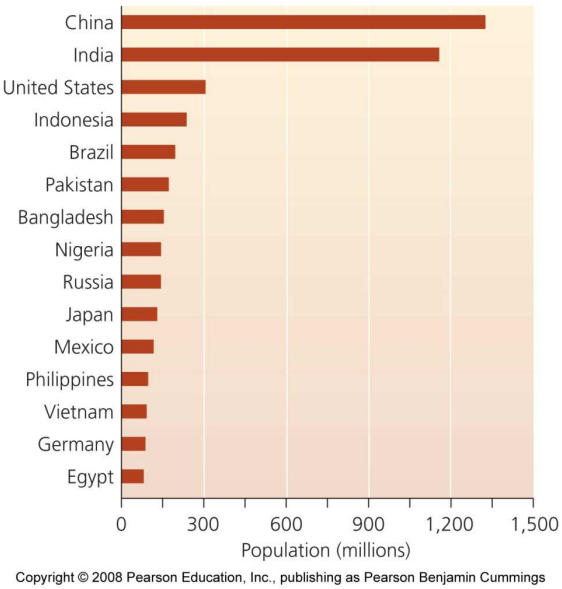
It would take 30 years, counting once each second, to count to a billion!

The human population is still growing rapidly



- It took all of human history to reach 1 billion.
- In 1930, 130 years later, we reached 2 billion, and added the most recent billion in 12 years. We add 80 million people each year (2.5 people/second).

Population by Country



Reasons for the population boom

- Late 1800s – discoveries from Louis Pasteur and others led to germ theory:
  - diseases were caused by “germs” including bacteria, viruses, and parasites transmitted by food, water, insects, and rodents
- Vaccines were developed for many diseases and populations were immunized against many diseases like smallpox, diphtheria, and typhoid

Lowering the death rate

- Cities and towns treat drinking water and sewage
- 1930s penicillin discovered, the first in a long line of antibiotics that could cure pneumonia, blood poisoning, and other illnesses caused by bacteria
- More productive agriculture, refrigeration, transport and shipping all helped improve nutrition

Major causes of population growth

- Better sanitation
- Medicine
- Improved nutrition

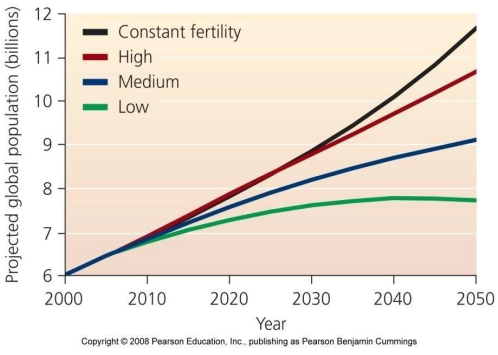
- These factors greatly decreased mortality (death rate)
- Helped produce the exponential population growth seen since the 1800s

Population growth affects the environment

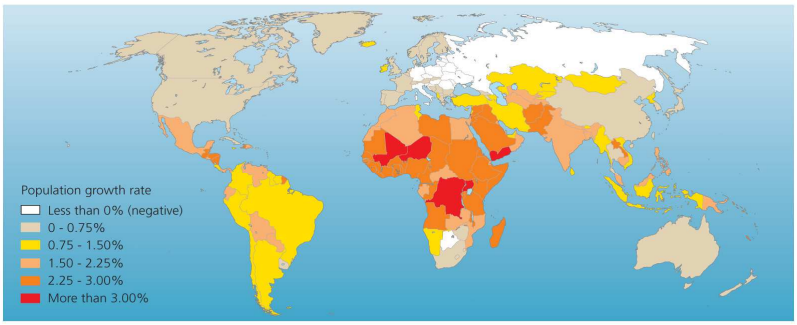
- The IPAT model: I = P x A x T
  - Our total impact (I) on the environment results from the interaction of population (P), affluence (A), and technology (T).
  - Population: individuals need space and resources and produce waste
  - Affluence: per capita resource use
  - Technology: allows increased exploitation of resources
    - But can also reduce our impact (e.g., decrease emissions)
  - Further model refinements include: sensitivity of the environment to impacts, education, laws, ethics

Demography

- All population principles apply to humans.
  - Environmental factors limit population growth.
  - The environment has a carrying capacity for humans.
- Humans can raise the environment's carrying capacity through technology.
  - How many humans can the world sustain?
    - 1–33 billion
  - Quality of Life?
  - What will nature look like?

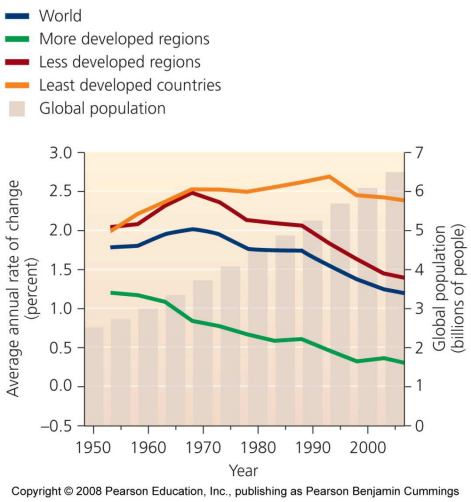


Rates of growth vary from region to region



- At today's 1.2% global growth rate, the population will double in 58 years (70/1.2 = 58).
- If China's rate continued at 2.8%, it would have had 2 billion people in 2004.

Growth rates are decreasing, but…

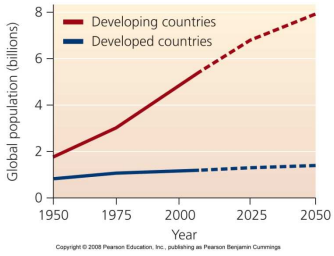


Falling growth rates do not mean a decreasing population, but only that rates of increase are slowing.

Poverty and population growth are correlated

- Poorer societies have higher growth rates than wealthier societies.
  - They have higher fertility and growth rates, with lower contraceptive use.
- Poverty results in environmental degradation.

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

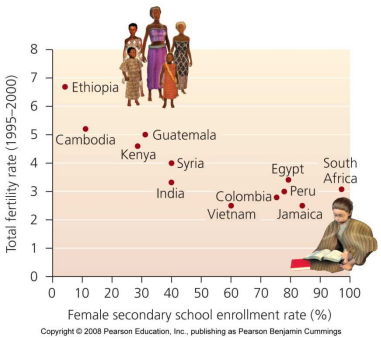


Factors affecting total fertility rate

- **Total fertility rate (TFR)**: the average number of children born per female
- **Replacement fertility**: TFR that keeps the size of a population stable
  - For humans, replacement fertility = 2.1
- Urbanization decreases TFR.
  - Access to medical care
  - Children attend school and impose economic 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.

Empowering women reduces growth rates

- Fertility rates drop when women gain access to contraceptives, family planning programs, and better educational opportunities.
- In 2007, 54% of married women worldwide used contraception.
  - China = 86%; the U.S. = 68%; 20 African nations < 10%



Women with little power have unintended pregnancies.

Population policies and family planning work

- Many countries provide incentives, education, contraception, and reproductive health care.
- Funding and policies that encourage family planning lower population growth rates in all nations.
  - Thailand has an educational based approach to family planning and its growth rate fell from 2.3% to 0.7%.
  - Brazil, Mexico, Iran, Cuba, and other developing countries have active programs.

The wealth gap and population growth cause conflict

- The stark contrast between affluent and poor societies causes social and environmental stress.
- Tensions between “haves” and “have-nots” are increasing.

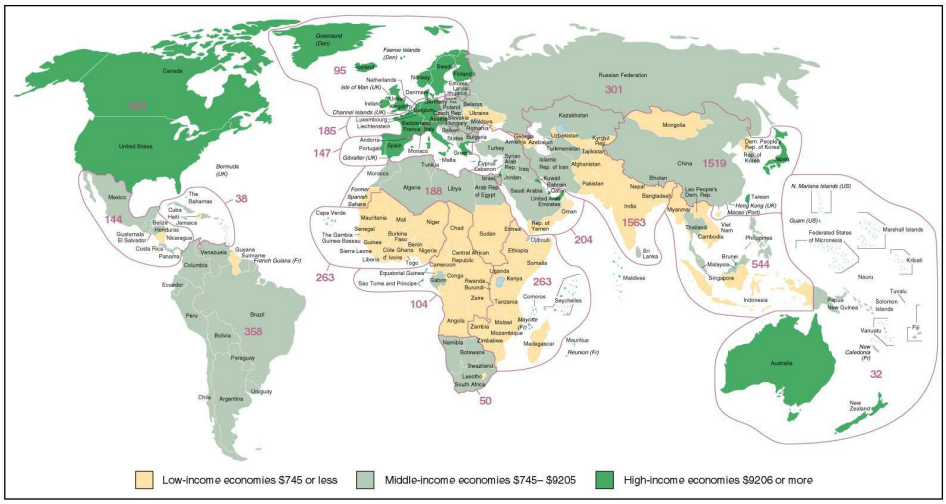
(a) A family living in the United States

(b) A family living in Egypt

Rich Nations, Poor Nations

- The World Bank, part of the United Nations, divides countries into 3 main categories
  - High income, highly developed, industrial
    - 964 million people total
  - Middle income, moderately developed
    - 2.7 billion people total
  - Low income, developing countries
    - 2.65 billion people total

Income disparity among nations



Disparities

- Developed countries are 16% of the population yet control 81% of the wealth (using gross national income)
- Low-income developing countries control 3.4% of the wealth but have 41% of the population
- Distribution of wealth within countries is also disproportionate – poor people in poor countries face dire circumstances
  - E.g., the recent talk of the “99 percent” in our country highlighting the fact that 1% of the US population controls about 40% of the wealth

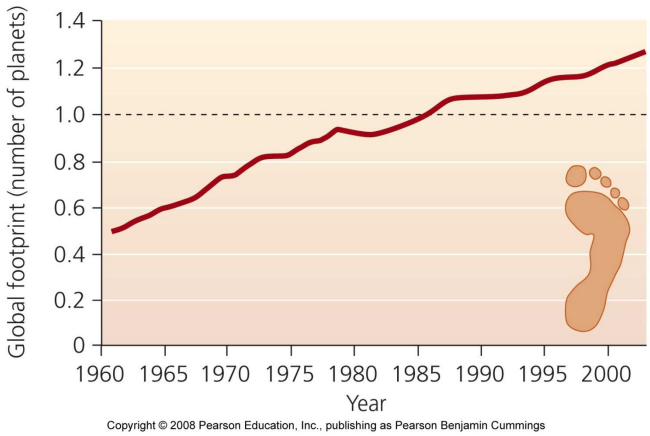
Growth in Rich and Poor Nations

- Developed nations: 965 million growing at a rate of 0.1% per year = <1 million/year
- Developing nations: 5.35 billion growing at a rate of 1.6% per year = >76 million/year
- 98% of the population growth is occurring in developing countries that already have trouble providing for their citizens
- Other interesting facts about nations can be found at http://hdr.undp.org/hdr2006/summaries.cfm

Consequences of Growth

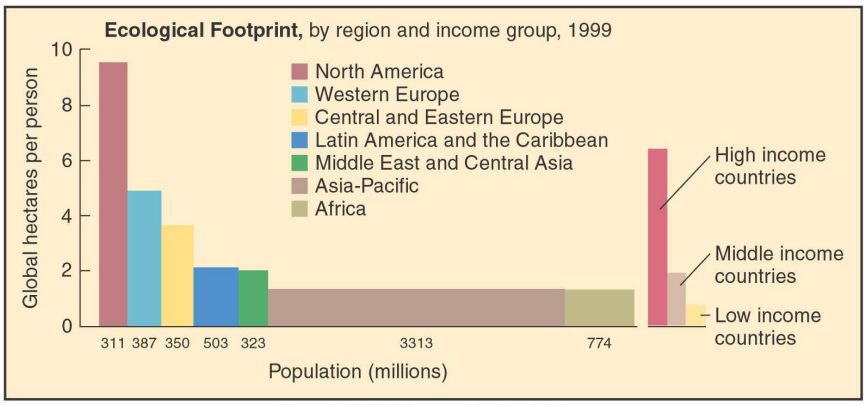
- Prior to the industrial revolution, most of the world survived through subsistence agriculture, the land they lived on provided enough food for their own consumption and for barter
  - i.e., people lived on “current sunlight”
- Forests provided firewood, timber, and game
- Rivers, lakes, and rain provided water
- All of this changed with the industrial revolution
  - Switched to dependency on “ancient sunlight”

The Earth can't support our consuming lifestyle



Humanity's global ecological footprint surpassed Earth's capacity to support us in 1987.

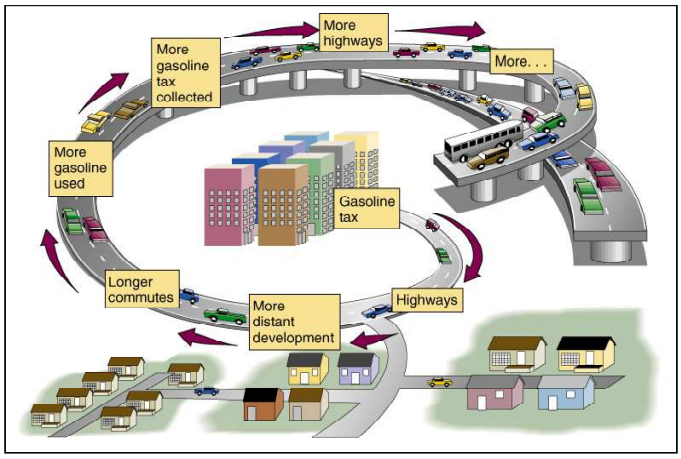
Comparison of Ecological Footprints



Urban Sprawl

- Sprawl: is unplanned, low-density housing and commercial development outside of cities, often with no real idea of where it is going or where it will stop.
- Sprawl encouraged by
  - Post–World War II demand for consumer goods: cheap cars and gas
  - Housing boom with low mortgage rates
  - Highway Trust Fund

Impact of Highway Trust Fund



Characteristics of Sprawl

- Excessive land consumption.
- Low densities in comparison with older centers.
- Lack of choice in ways to travel.
- Fragmented open space, wide gaps in development, and a scattered appearance.
- Lack of choice in housing types and prices.
- Separation of uses into distinct areas.
- Repetitive one-story development.
- Commercial buildings surrounded by large parking areas.
- Lack of public spaces and community centers.

Measuring Sprawl

- Residential density
- Neighborhood mix of homes, stores, and workplaces
- Accessibility of the street networks
- Strength of activity centers and downtowns
- Visit, www.priceofsprawl.com

table 23-2 Ten Most Sprawling Metropolitan Regions

Metropolitan Region	Overall Sprawl Index Score	Rank
Riverside–San Bernardino, CA	14.2	1
Greensboro–Winston-Salem–High Point, NC	46.8	2
Raleigh–Durham, NC	54.2	3
Atlanta, GA	57.7	4
Greenville–Spartanburg, SC	58.6	5
West Palm Beach–Boca Raton–Delray Beach, FL	67.7	6
Bridgeport–Stamford–Danbury, CT	68.4	7
Knoxville, TN	68.7	8
Oxnard–Ventura, CA	75.1	9
Forth Worth–Arlington, TX	77.2	10

(*Source*: Ewing, Reid, Pendall, Rolf, and Chen, Don. *Measuring Sprawl and Its Impact*. Smart Growth America, 2002)

Factors That Contribute to Sprawl

- Planning and Policy
  - Historically, there was little coordination of effort as to how cities should develop.
    - Large cities have a huge number of political jurisdictions, so coordination is difficult.
  - Zoning ordinances prohibit land-use mixing.
    - Ordinances specify minimum lot and house sizes.
  - Government subsidizes the development of decentralized cities.
    - Local governments pay some costs of extending services into new areas; costs are not passed on to builders.

Problems Associated with Unplanned Growth

- Transportation
  - As cities grew, little thought was given to transportation corridors.
  - Establishment of new corridors stimulates growth in nearby areas, and the new corridors soon become inadequate.
    - Reliance on automobiles has required constant road building.
    - In Los Angeles, 70% of city's surface area dedicated to automobiles.
    - The average person in the U.S. spends 9 hrs/week in an automobile.

Problems Associated with Unplanned Growth

- Air Pollution
  - As traffic increases, so does air pollution.
  - A centralized, efficient public transportation system solves this problem, but it is difficult to achieve with a highly dispersed population.
- Low Energy Efficiency
  - Automobiles are inefficient transportation.
  - Separation of homes and businesses requires additional driving.
  - Stop-and-go traffic patterns.
  - Single-family homes are less efficient than multifamily dwellings.

Problems Associated with Unplanned Growth

- Loss of Sense of Community
  - In many areas, people do not routinely walk through their neighborhood, leaving them feeling isolated.
- **Death of the Central City**
  - Currently less than 10% of people work in the central city.
    - There is less income to support public services.
- Higher Infrastructure Costs
  - Extension of municipal services is more costly than supplying services to areas already in the city.

table 23-1 Decline in Population of American Cities, 1950–2000

City	Population (thousands)				Percent Change,
	1950	1970	1990	2000	1950–2000
Baltimore, MD	950	905	736	651	−31
Boston, MA	801	641	574	589	−26
Buffalo, NY	580	463	328	293	−49
Cleveland, OH	915	751	505	478	−48
Detroit, MI	1,850	1,514	1,028	951	−49
Louisville, KY	369	362	270	256	−31
Minneapolis, MN	522	434	368	383	−27
Philadelphia, PA	2,072	1,949	1,586	1,517	−27
St. Louis, MO	857	662	396	348	−59
Washington, DC	802	757	607	572	−29
U.S. population (millions)	151	218	249	281	+86

(*Source:* Data from Population Division, U.S. Bureau of the Census, 2003.)

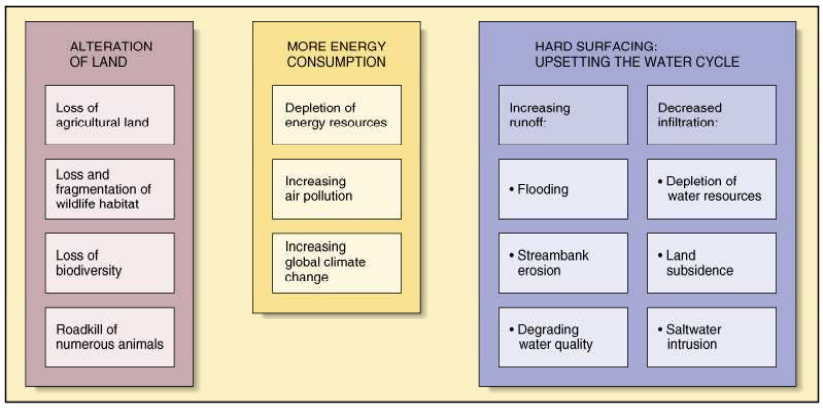
Problems Associated with Unplanned Growth

- Loss of Open Space
  - Oftentimes open space planning is left out of development plans.
- Loss of Farmland
  - Flat, well-drained land is ideal for both farmland and urban development.
  - Several states have established programs that provide protection to farmers who do not want to sell their land to developers.
    - These programs may require farmers to put their land in a conservation easement.

Problems Associated with Unplanned Growth

- Water Pollution Problems
  - Large impervious surface areas lead to high runoff and potential flooding.
- Floodplain Problems
  - Many cities are located on floodplains because they were originally established along waterways.
    - The flat land is attractive to developers but would be better put to use as open space or recreation.
  - Development increases economic losses.
    - Many communities have enacted floodplain zoning ordinances.

Impacts of Urban Sprawl: Environmental



Environmental Impacts of Urban Sprawl: Simplify and Destabilize Habitats

Photos by C. E. Adams

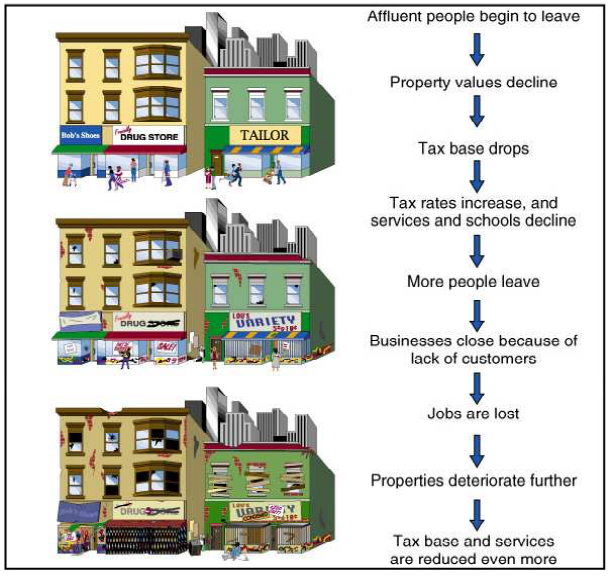
Impacts of Urban Sprawl: Quality of Life

- Higher vehicle ownership and driving mileage
- **Greater risk of fatal accidents!**
- Lower rates of walking and lessened use of mass-transit facilities
- No change in congestion delays (or they get worse)
- Higher costs for municipal services
- Higher incidence of obesity and high blood pressure

Indicators of Urban Decay

- Economic and ethnic segregation
- Eroding tax base
- Loss of social services
- Lowered property values
- Higher property taxes
- Deterioration of central city infrastructure

Economic Exclusion of the Inner City



Segregation by Exurban Migration

(a)

(b)

Urban Blight in Developing Countries

- Slum communities
  - No utility services
  - No land ownership
  - Crime and disease are endemic
  - Expected to continue growing into middle of century
  - Continually overwhelmed by influx of rural immigrants
  - Severe problems just miles away in Haiti

Controlling Urban Sprawl: Smart Growth

- "Smart Growth": forces communities to purposely choose to develop in more environmentally sustainable ways.

Land-Use Planning Principles

- **Land-use planning** is a process of evaluating the needs and wants of a population, the land characteristics and value, and various alternative solutions to land uses before changes are made.
  - A basic rule should be to make as few changes as possible.
- When changes are needed:
  - Evaluate and record unique geological, geographic, and biologic features.
  - Preserve unique cultural or historical features.
  - Conserve open space and environmental features.
  - Recognize and calculate the cost of additional changes required to accommodate altered land use.

Land-Use Planning Principles

- Plan for mixed uses in close proximity.
- Plan for a variety of transportation options.
- Set limits and require managed growth patterns with compact development.
- Encourage development in areas with existing infrastructure.
- Comprehensive toolbox of solutions for Florida:
  - http://www.cues.fau.edu/toolbox/

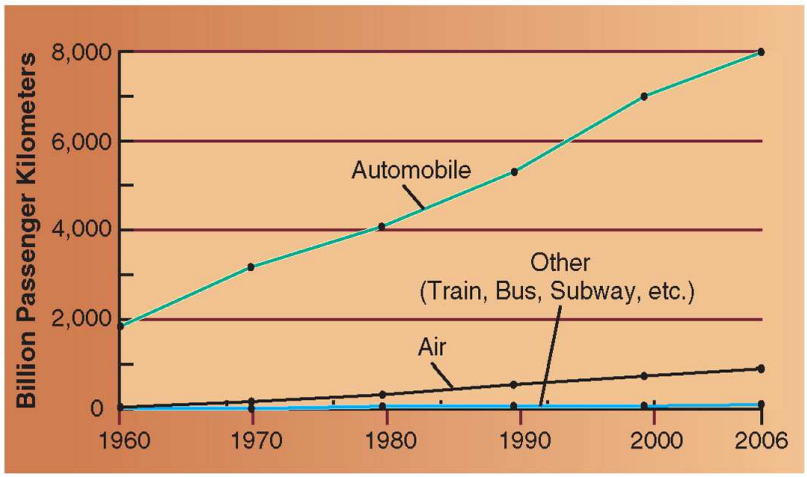
Special Urban Planning Issues

- Urban Transportation Planning
  - Urban transportation planning usually involves four goals:
    - Conserve energy and land resources.
    - Provide efficient and inexpensive transportation, particularly to those who are unable to drive.
    - Provide efficient transportation opportunities to suburban residents.
    - Reduce urban pollution.

Special Urban Planning Issues

- Mass transit in the U.S. is often underfunded and difficult to establish because:
  - It is only economical along heavily populated routes.
  - It is less convenient than the automobile.
  - It is extremely expensive to build / operate.
  - Existing examples are often crowded and uncomfortable.
- The U.S. government encourages personal autos by financing highways, maintaining cheap energy policy, and not funding mass-transit projects (these are all hidden subsidies).

Special Urban Planning Issues



Source: Data from U.S. Department of Transportation, *National Transportation Statistics* 2008.

Decline of mass transportation

Special Urban Planning Issues

- Special efforts must be made to revitalize the inner city.
- Abandoned industrial and commercial sites remain vacant because they are expensive to clean up and renovate.
  - **Brownfield development** matches the degree of cleanup required to the intended use of the site.
- Another important focus is remodeling abandoned commercial buildings into shopping centers, cultural facilities, and high-density housing.

Special Urban Planning Issues

- One aspect of smart growth is the building of “green buildings.”
- Green buildings often are built using a standard, e.g, the Leadership in Energy and Environmental Design (LEED) or Green Globes.
- The guidelines call for using recycled materials, ensuring better ventilation in buildings, reducing water and energy use, and other goals.

Special Urban Planning Issues

- **Smart Growth** Principles:
  - Mix land uses.
  - Take advantage of compact building designs.
  - Create range of housing opportunities and choices.
  - Create walk-able neighborhoods.
  - Foster distinctive, attractive communities with a strong sense of place.
  - Sets boundaries on urban sprawl

Special Urban Planning Issues

- Preserve open space, farmland, natural beauty, and critical environmental areas.
- Strengthen and direct development of existing areas.
- Provide a variety of transportation choices.
- Make fair, predictable, cost-effective development decisions.
- Encourage community and stakeholder collaboration in development decisions.
- Sustainability! For both the environment and human quality of life.