

Lesson 1. Natural Hazards & Natural Disasters

*Natural hazards are
inevitable but natural
disasters are not.*

Geological Hazards

- Definition: A geological hazard is an *interaction* between human society and extreme or rare natural phenomena that is harmful to humans or their property.

Geological Hazards

- Geologic and natural hazards can be associated with different Earth systems.
 - hydrosphere
 - atmosphere
 - pedosphere
 - biosphere
 - lithosphere

Geological Hazards

- Geologic and natural hazards associated with the atmosphere/hydrosphere include:
 - hurricanes/cyclones/typhoons tornados/windstorms
 - thunderstorms/lighting
 - rain, hail, freezing rain, blizzard, snow, sleet, whiteout
 - floods
 - storm surges
 - heat wave/cold spell
 - frost fog
 - coastal erosion/extreme wave actions
 - sea ice
 - sea level rise (low catastrophic potential)
 - Drought

Geological Hazards

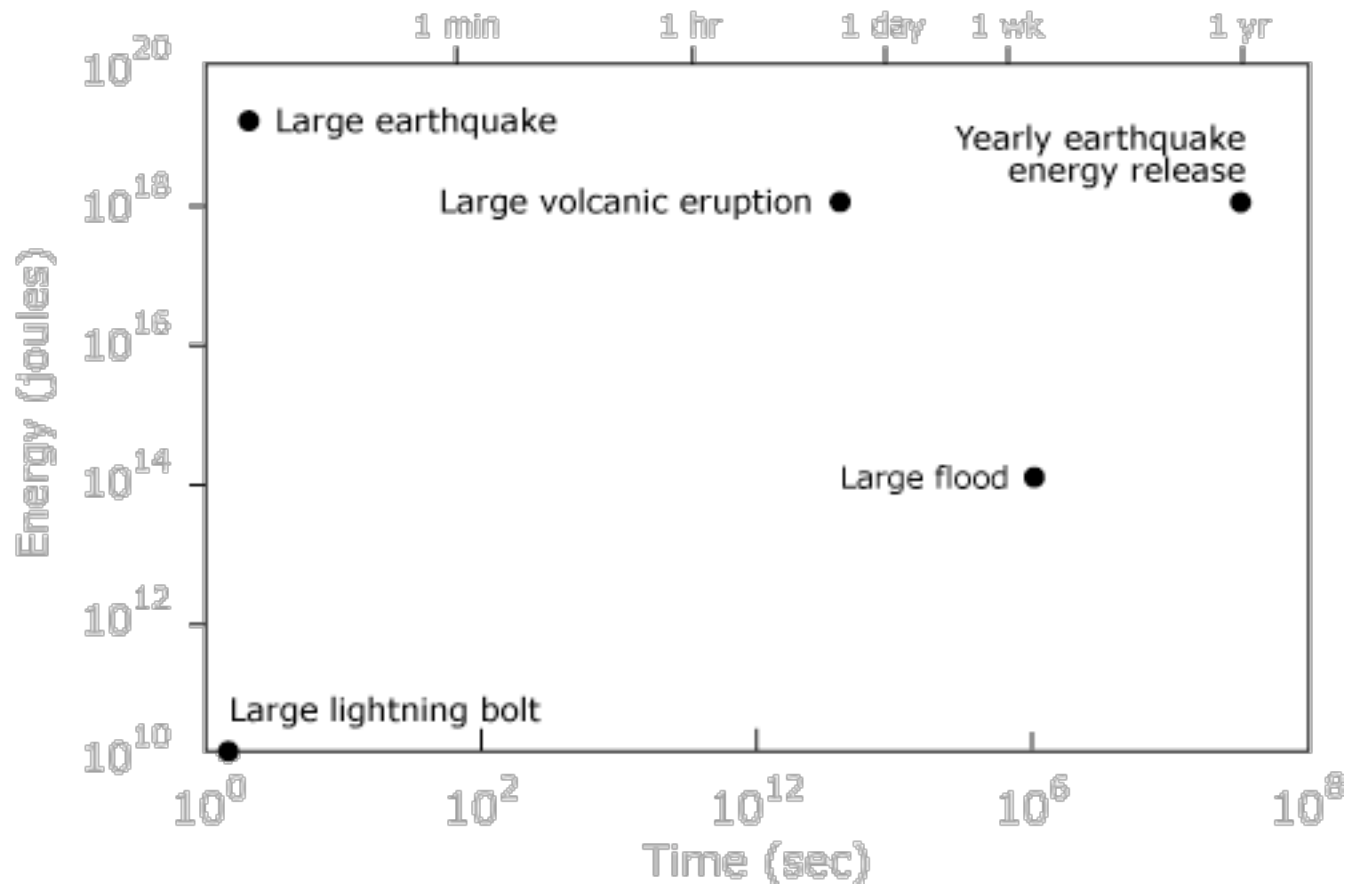
- Hazards associated with the lithosphere are:
 - earthquake (ground rupture, fault displacement, fault scarp movement, soil liquefaction, ground shaking)
 - volcano (explosion, lava flow, tephra fall, ballistic projectiles, pyroclastic flows)
 - mass movement/wasting (mudflow, soil creep, avalanche, debris flow, rockfall, landslide)
 - tsunami (produced by earthquake, volcanic eruption, landslide)
 - duststorm
 - swelling soils (low catastrophic potential)
 - sand drift (low catastrophic potential)

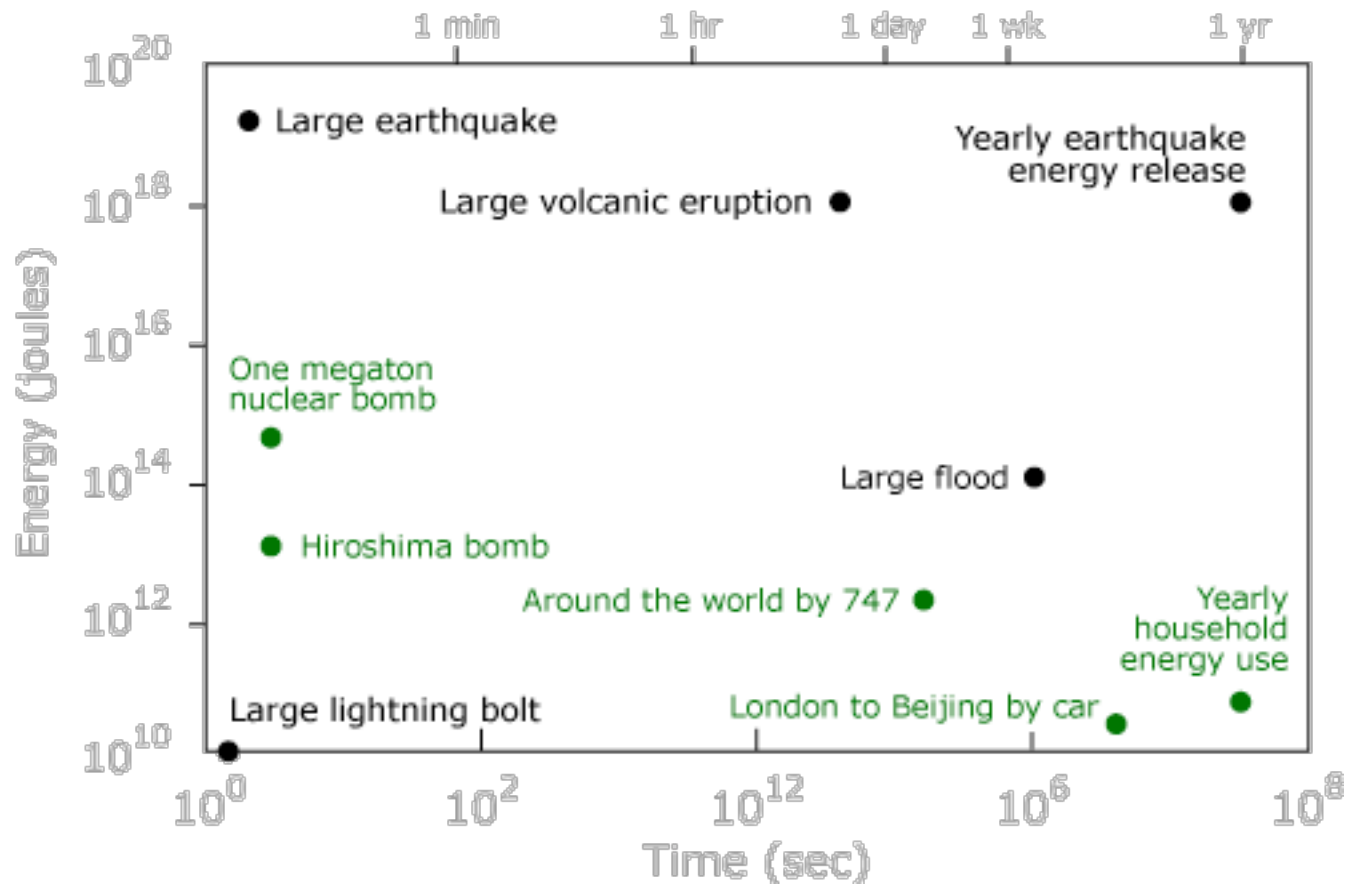
Geological Hazards

- Hazards associated with the biosphere are:
 - wildfire
 - Bacterial
- Hazards associated with the space are:
 - Impacts

Geological Hazards

- Different geologic hazards occur over different time intervals and release vastly different amounts of energy.





Geological Hazards

- When planning for geologic hazards, it is necessary to determine the magnitude of a potential event and its likelihood of occurring again.
- Scientifically, these quantities can be determined by studying historical records and, for long time periods, the geological record as recorded in rocks.
- What is done with this information is the result of economic, political, social and religious interactions. To make good decisions, it is important to understand, however, the relation between frequency, magnitude and recurrence interval of geologic events.

Geological Hazards

- The **magnitude** of an event is a measurement of its size. This can be expressed in a number of different ways and varies depending upon the event under consideration.
- Magnitude scales have been defined for
 - earthquakes
 - volcanic eruptions
 - hurricanes
 - tornados
- Ideally, a magnitude scale should yield a single size for a given event regardless of who did the measurements.
- In reality, there is variation in magnitude calculations because the quantities being measured often have large errors associated with them.
- In addition for earthquakes, different magnitude scales have been defined. Thus, a given earthquake will have different magnitudes depending upon which scale is used.
- In general, the larger the magnitude of an event, the greater the impact on humans and their structures.

Geological Hazards

- **Frequency** is the number of times a particular type of event, e.g. earthquake, flood, etc., of a certain magnitude occurs in a given time interval.
- The frequency of a process is determined by studying the historical record as well as the geologic record of a given area.
- The further back the historical record stretches, the better estimate of the frequency.
- The frequency of different geologic events varies greatly. Floods have a much higher frequency than earthquakes.
- the greater the frequency of an event the more likely it is to cause damage.

Geological Hazards

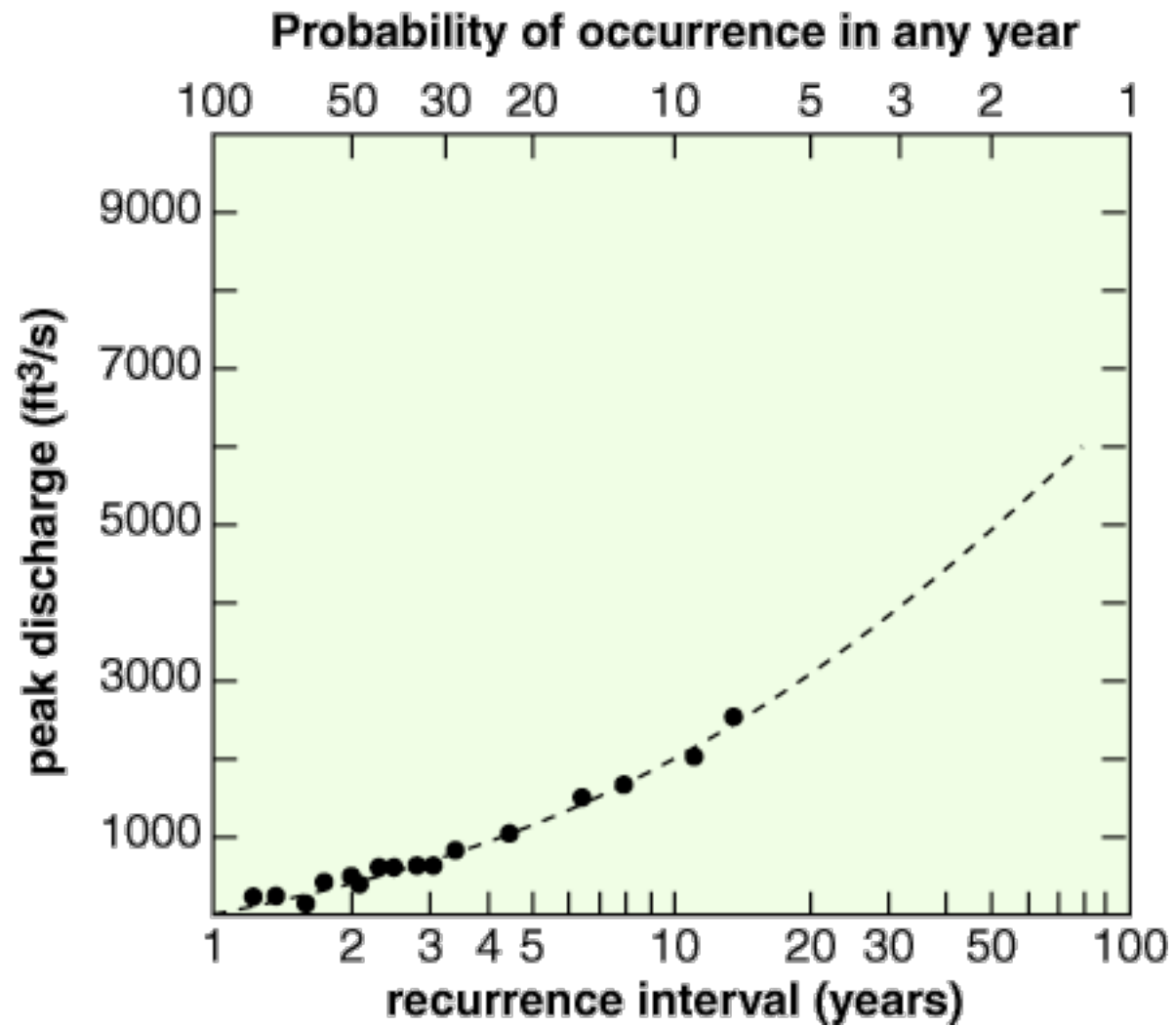
- As the magnitude of an event increases, its frequency decreases. Thus, large events, e.g. truly big earthquakes or volcanic eruptions, occur only rarely. In contrast, small-sized events such as minor floods occur very often. For example, it is not unknown for a river to experience small floods almost every year.

Geological Hazards

- Magnitude, frequency and recurrence interval are key factors in determining public policy with regards to hazard planning. Thus, it is critical that policy makers, politicians and the general public understand how scientists use their terms and the errors associated with their calculation.

Geological Hazards

- The **recurrence interval** is the average time interval between events of similar magnitude.
- It generally applies to floods and earthquakes, but could potentially be applied to other geologic events as well.
- A major problem with the recurrence interval is the public's misinterpretation of what it means. Calculating recurrence interval requires long and accurate historical data on the occurrence of particular events in an area, e.g. stream flow. Because a region's physical characteristics may have changed during the time period represented by a historic record, e.g. urbanization of a stream's drainage basin.

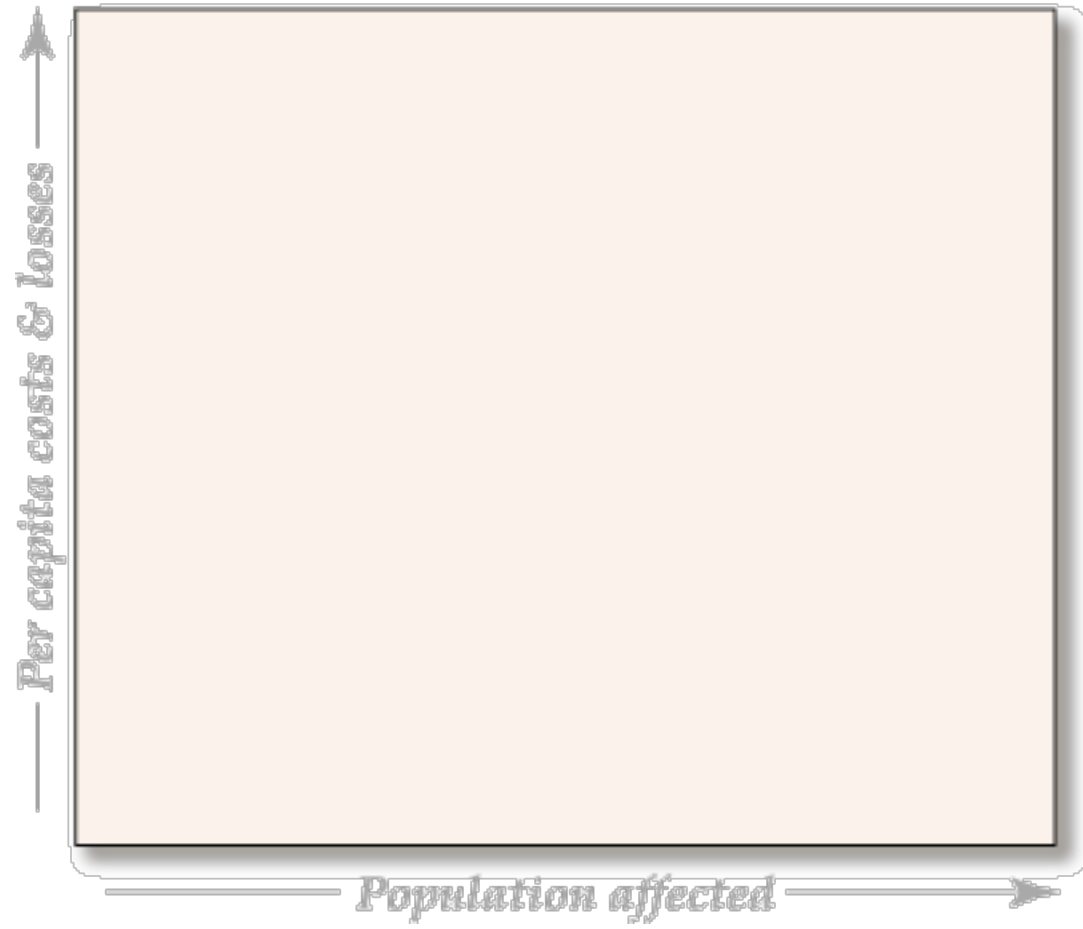


Natural Disasters

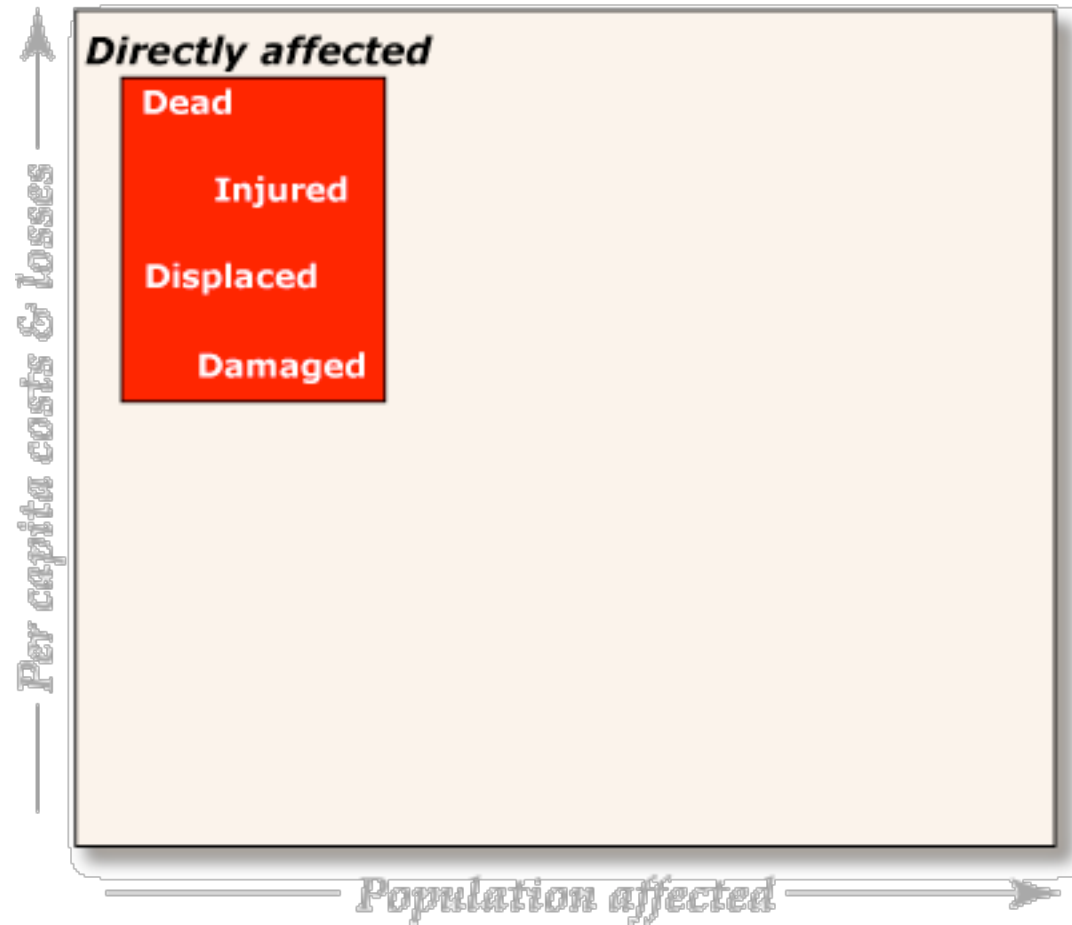
- Geologic hazards are in essence natural processes. To change them from a process to a disaster what is needed? *People*. With over 6 billion people on planet Earth today and geologic processes widespread there are lots of potential for natural disasters.

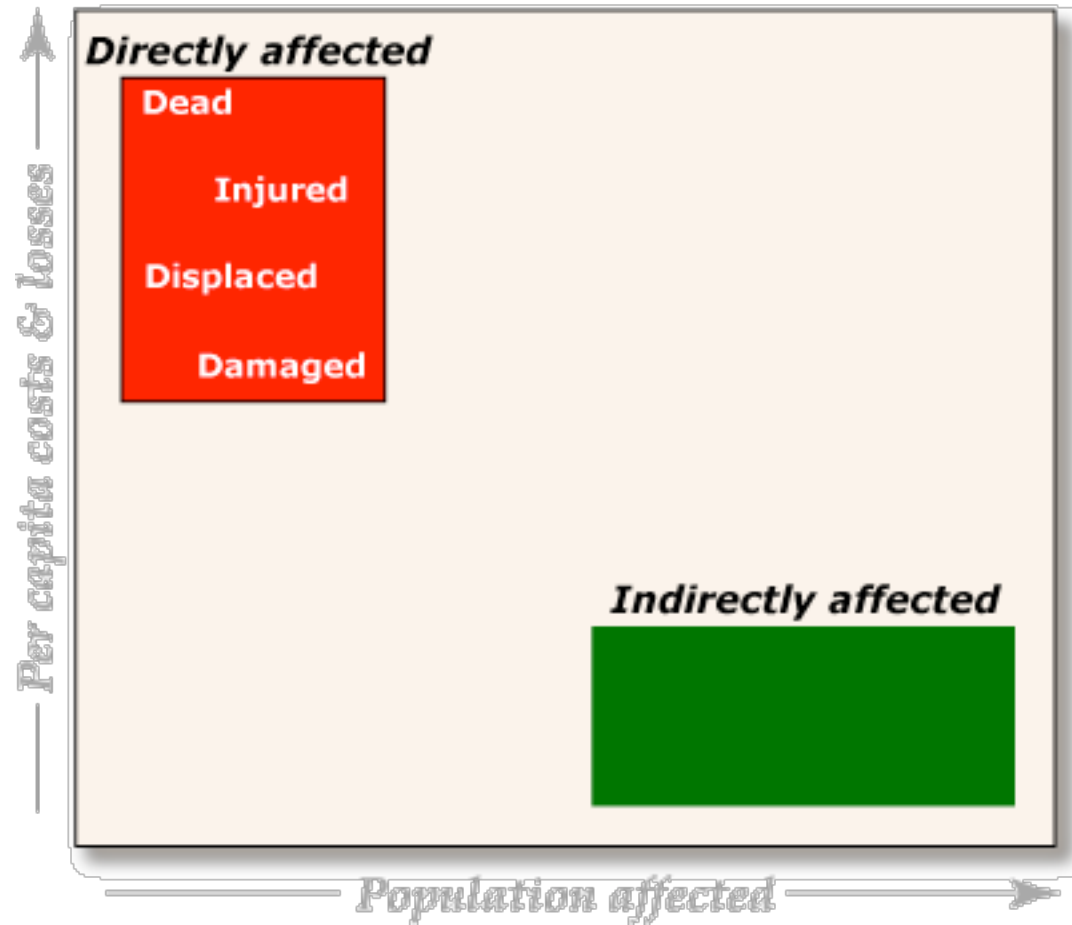
Natural Disasters

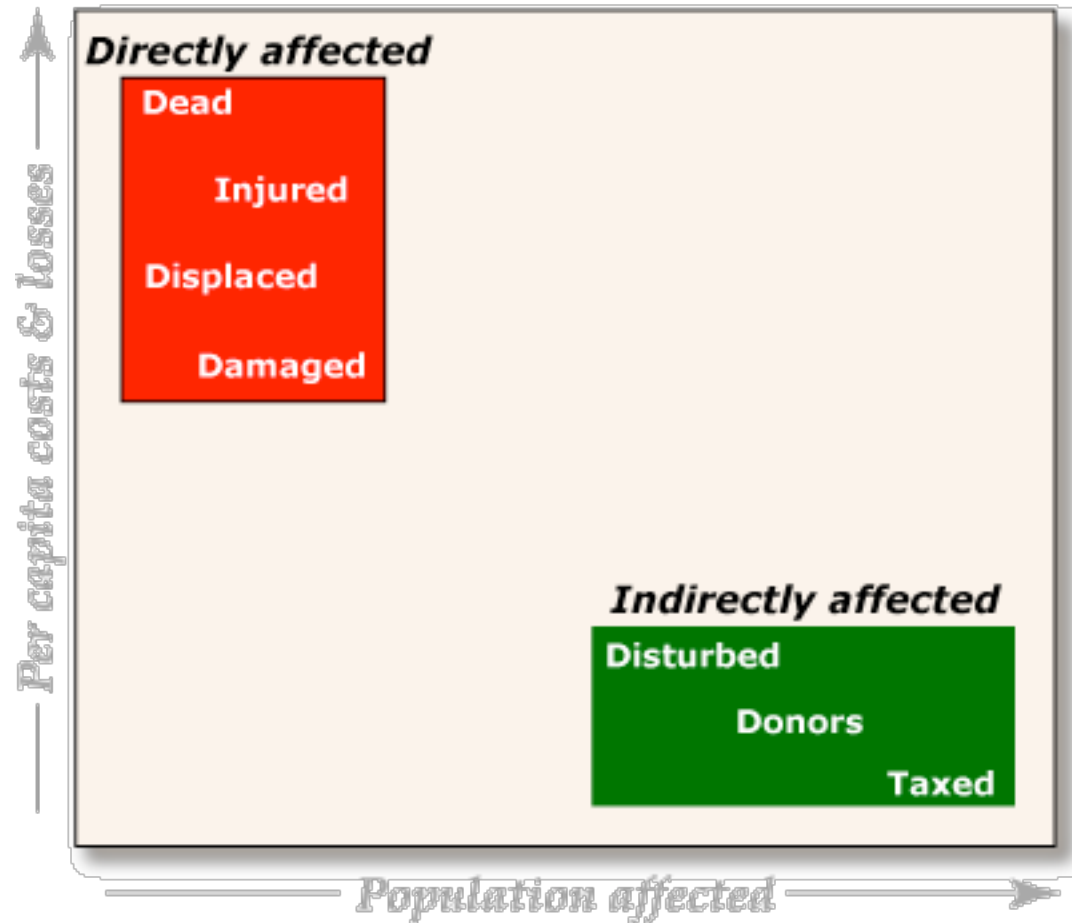
- Individuals affected by a geologic hazard can be grouped into one of two basic classes with several differently affected subgroups in each class.

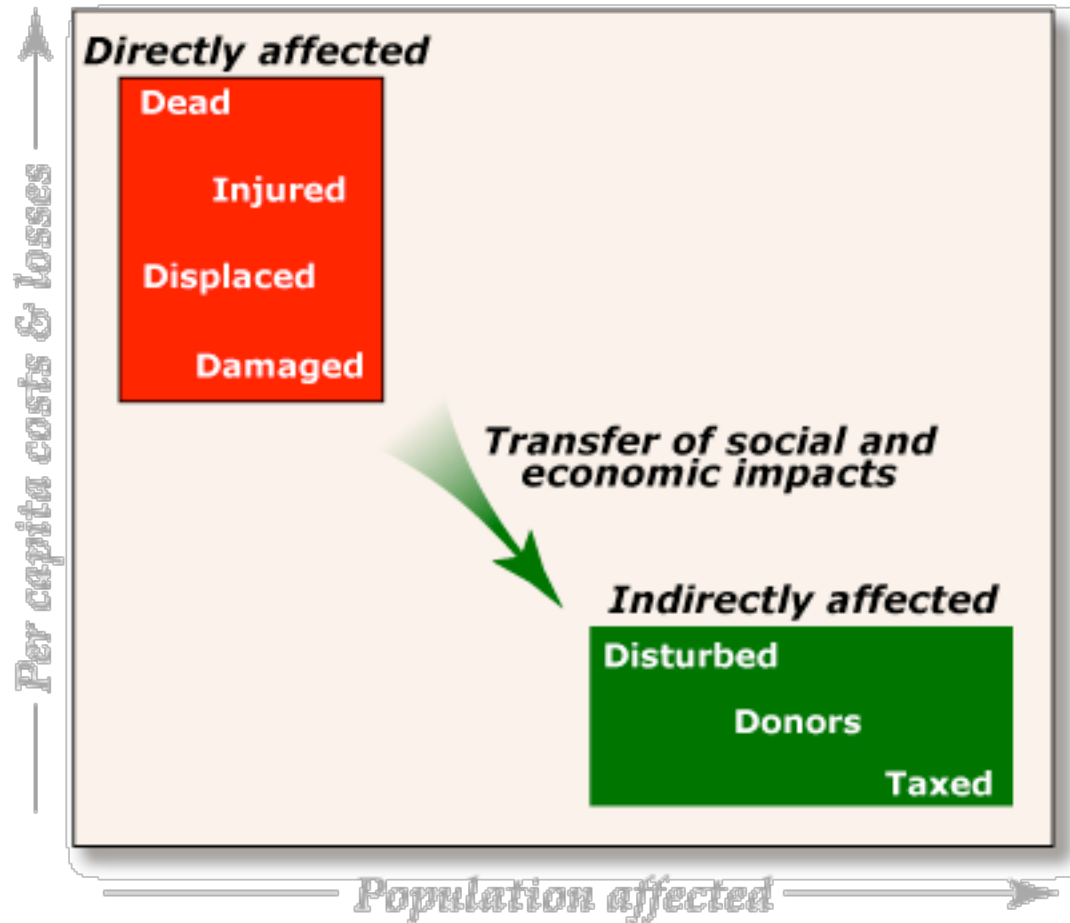










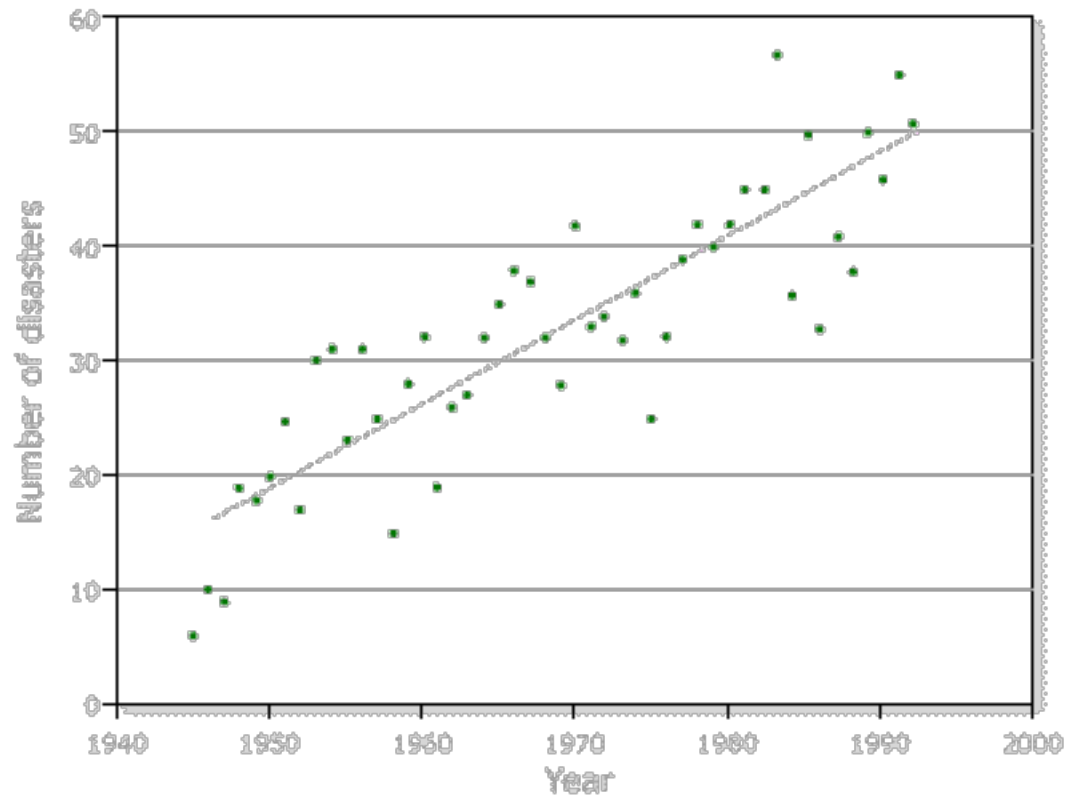


Natural Disasters

- In an age of modern communication and travel, the social and economic impacts of a geologic hazard event are transmitted from the directly affected population to the larger population.

Natural Disasters

- Trend in reporting natural disasters: the number of natural disasters reported since 1940 with deaths equal to or greater than 25 has steadily risen.

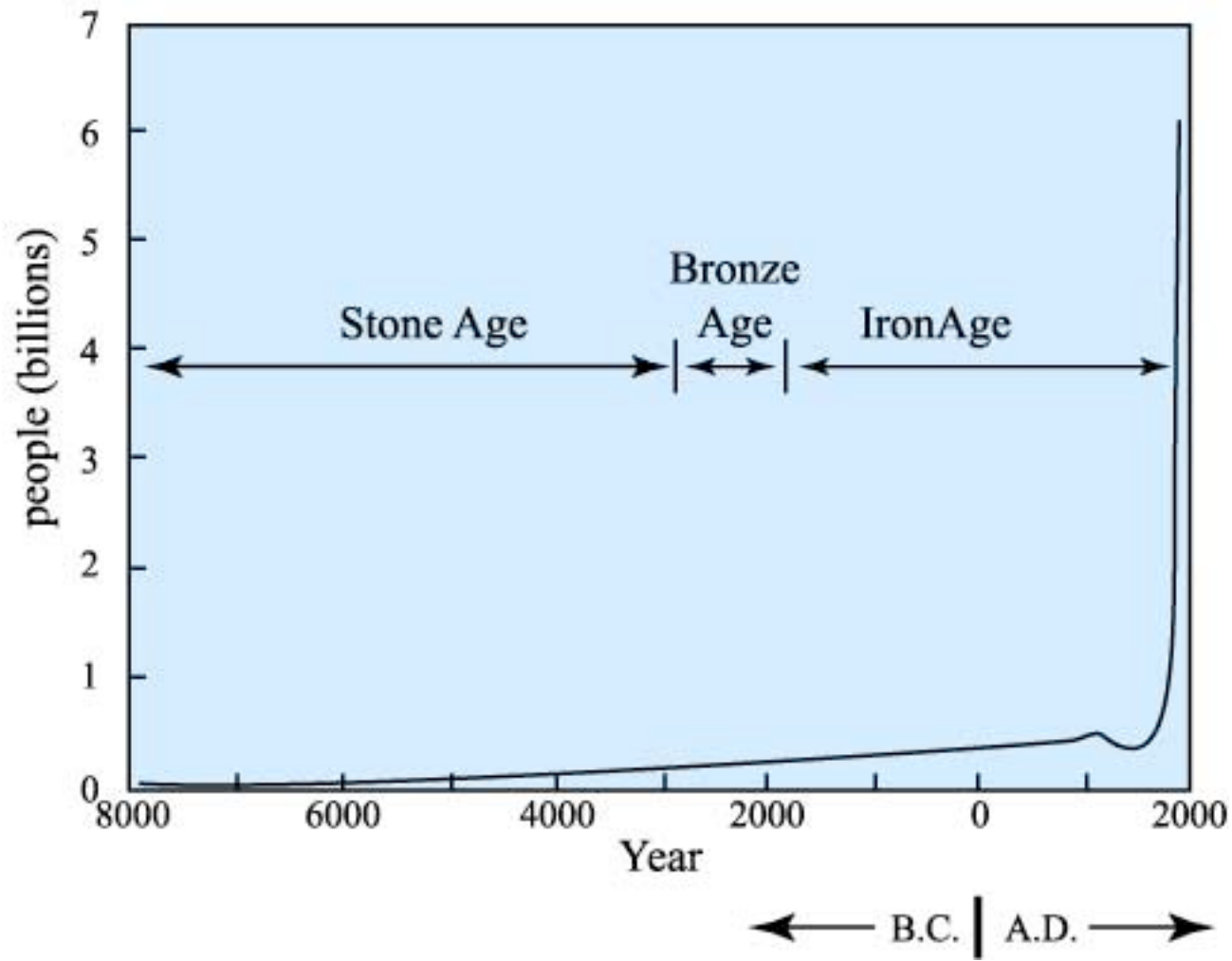


Natural Disasters

- Why?
 - increased global population;
 - increased population density;
 - improved reporting of small events in remote regions;
 - improved communications in general;
 - human-induced effects on the environment

Population

- For most of human history, there has been zero population growth. Only in the last 350 years has the population actually grown.

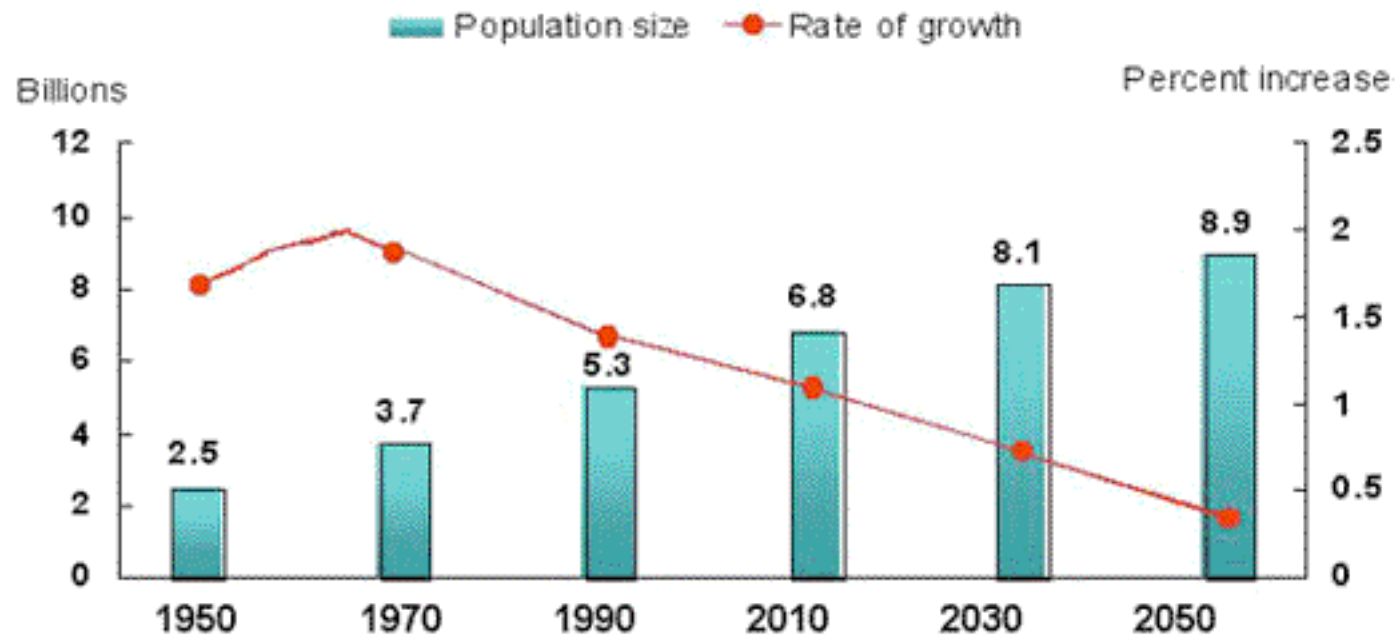


Population

- In 1950, the world's population stood at only 2.5 billion and the growth rate was nearly 8 %.
- Since then, the population has climbed to over 6 billion but the growth rate has fallen dramatically, i.e. less than 2 %.
- Because this is a global average, there is wide variation in national population growth rates.

Population Size and Rate of Growth

Worldwide, 1950-2050












Source: UN, *World Population Prospects: The 1998 Revision*, 1998 (medium scenario).



Population

- Although the population growth rate for the world is projected to fall even more by 2050, the large population base means that globally population will still continue to climb.
- Conservative estimates place it at 8.9 billion whereas more radical estimates project a world population of 15 billion in 2050.
- In 2009, the UN estimated the world's population to be 6,780,000,000.

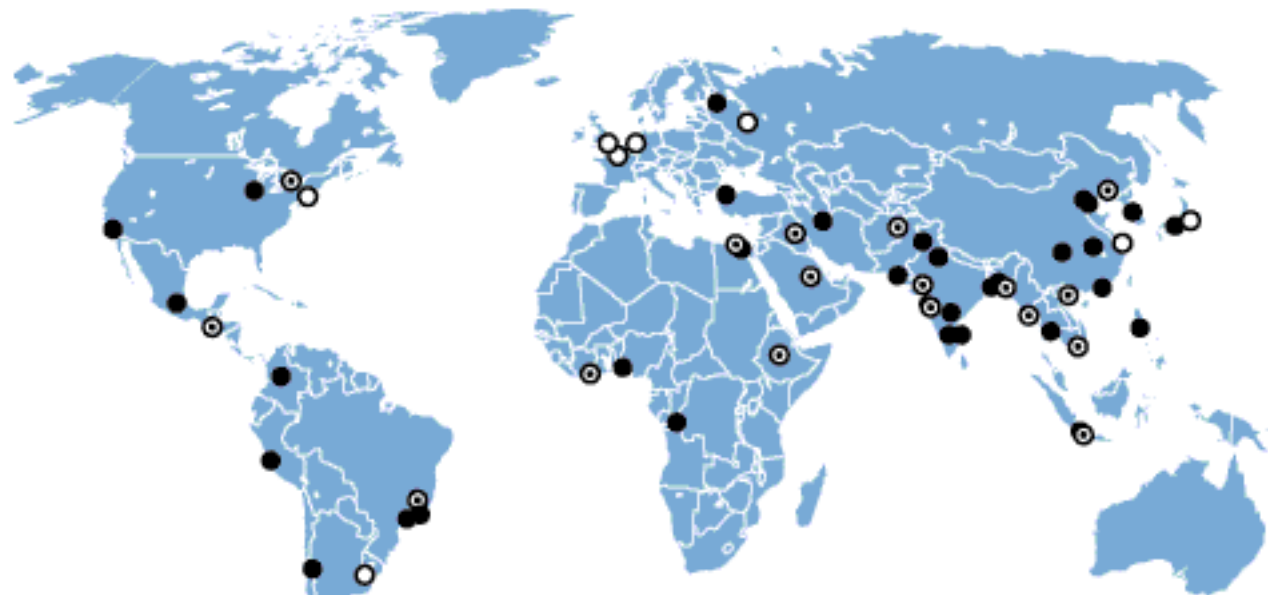
Rank	Country	Population	% World Population
1	 People's Republic of China	1,332,600,000	19.65
2	 India	1,168,120,000	17.23
3	 United States	307,238,000	4.53
4	 Indonesia	229,965,000	3.39
5	 Brazil	191,757,000	2.83
6	 Pakistan	167,268,000	2.47
7	 Bangladesh	162,221,000	2.39
8	 Nigeria	154,729,000	2.28
9	 Russia	141,864,000	2.09
10	 Japan	127,580,000	1.88

Population

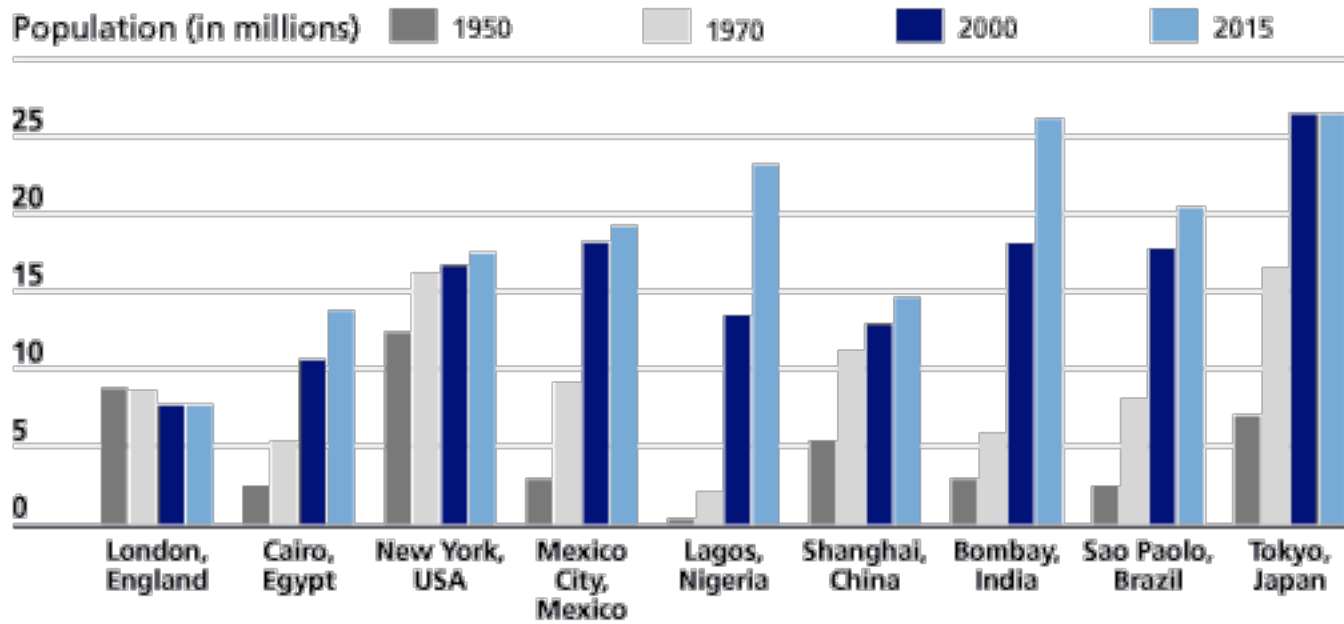
- Some of these nations, have low growth rates but large population bases, e.g. China.
- Others have low birth rates but large numbers of immigrants, e.g. the United States.
- Still others, e.g. Nigeria, have rapidly growing populations.

Population

- Most of the world's population growth is occurring in urban environments.
- Concentration of population into large urban areas has important and severe impacts for environment, resource issues and hazard mitigation.



Size of Urban Population
○ 5 million and over since 1950
● 5 million and over since 2000
⊙ 5 million and over in 2015 (projected)



Population

- Before 2000, the young always outnumbered the old. After 2000, the number of old people will always outnumber the young ones.
- Beginning in about 2007, the number of people living in urban areas exceeded those in rural areas. Humankind has steadily moved from a rural to a urban creature and this trend will not reverse in the foreseeable future.
- From 2003 on, women worldwide typically are having less than 2.1 children each. This is the rate necessary to maintain human population at current levels. If this trend continues, human population may start to decrease in the future.

Urbanization

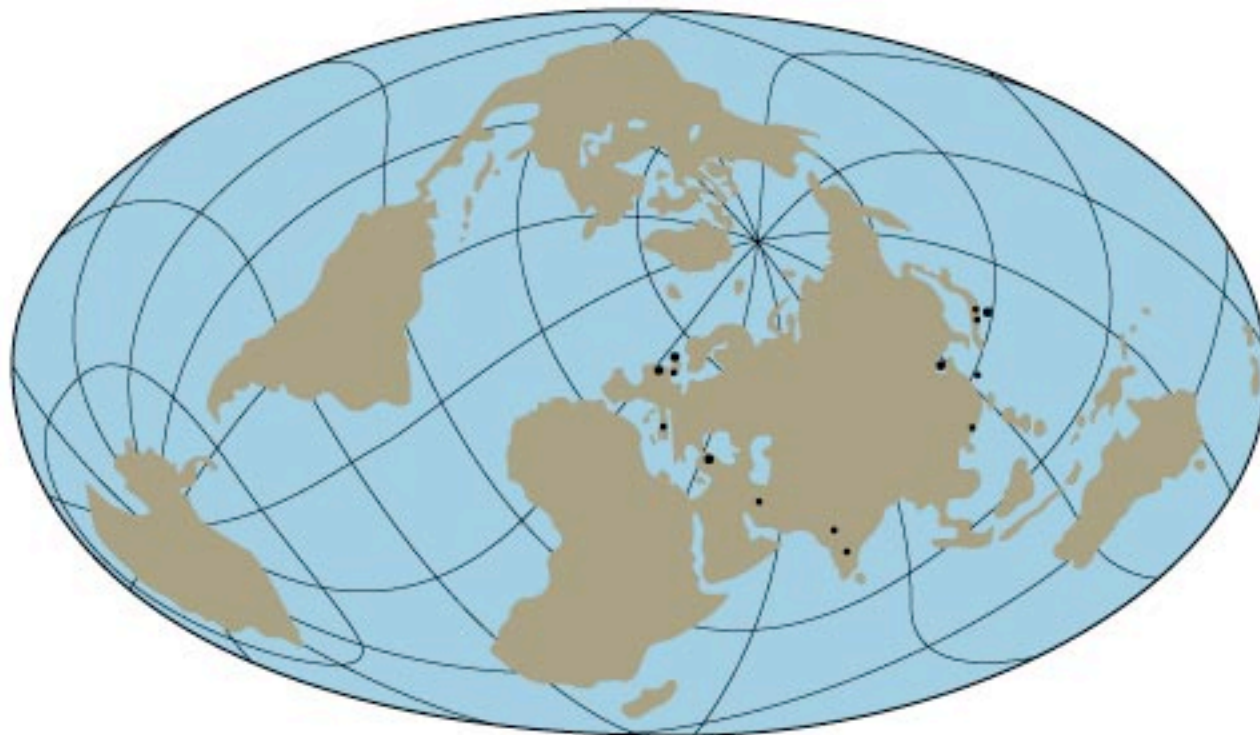
- Until the middle of the 20th, most people lived in a rural setting. Hence, their impact on the environment was limited and mostly local in extent.
- In 1900, there were only 16 cities with populations greater than 1,000,000 and only 43 with more than half a million.
- However, since 1950 the number of large cities has increased markedly. There are now over 400 cities with populations of a million or more.
- This marked shift in population has important environmental ramifications as well as relevance for hazard evaluation.

Urbanization

- The past 300 years has seen a dramatic growth in the world's urban population.
- This growth is reflected in a marked increase in the number of cities as well as increases in their sizes.

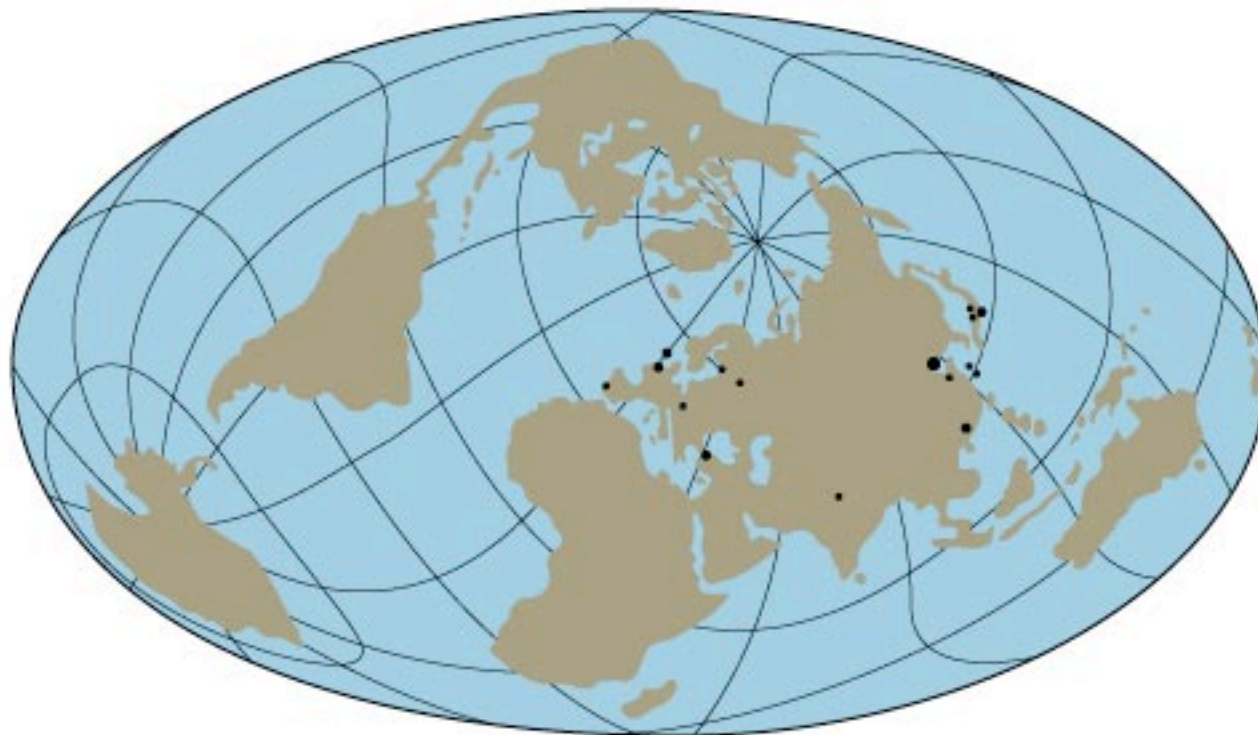
Sizes of World Cities, A.D. 1700

- 200,000 - 500,000
- 500,000 - 1,000,000



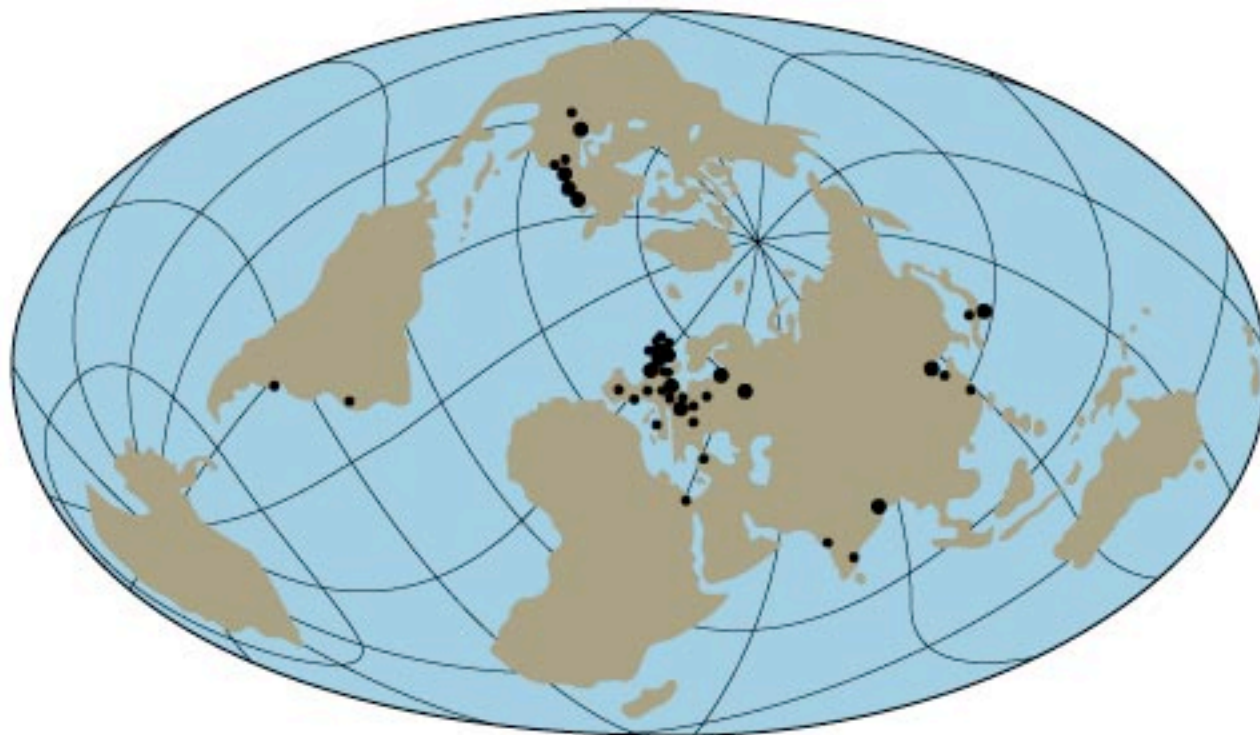
Sizes of World Cities, A.D. 1800

- 200,000 - 500,000
- 500,000 - 1,000,000
- 1,000,000 - 10,000,000



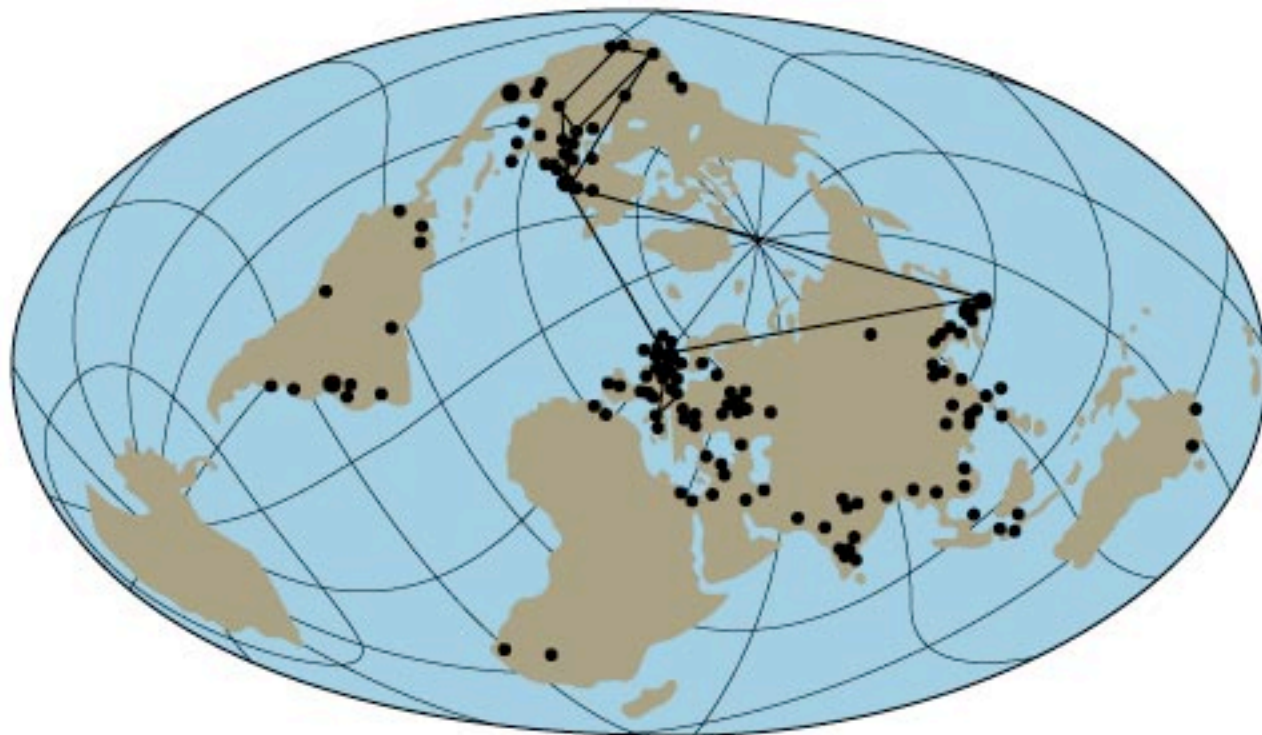
Sizes of World Cities, A.D. 1900

- 500,000 - 1,000,000
- 1,000,000 - 10,000,000



Sizes of World Cities, A.D. 1985

- 1,000,000 - 10,000,000
- >10,000,000
- The polycenter



Urbanization

- **Urbanization** is the process of population concentration. Thus, it is the movement from one state to another.
- It occurs in two parts:
 - increase in number of population centers
 - increase in size of these population centers
- The growth in a city's population occurs in two ways:
 - natural increase
 - net migration

Urbanization

- Economists suggest urbanization is tied to economic development and occurs on a 55-year cycle.
- For each cycle, a key innovation starts the growth.
- This produces rapid expansion until the market is saturated and there is a downturn followed by a recession.
- Ultimately, a new technology comes along to start the cycle again.

Urbanization

- Three important cycles:
 - late 18th-century in Britain - water-powered textile industries
 - introduction of coal-based and steam-powered in Britain (mechanization of textile factories, initial development of railroads and iron industry start)
 - coal-based steam power in U.S. produced steel rails and ships and growth of chemical industry (later energy sources were gas and electricity)

Urbanization

- Last stage very important driving force of urbanization producing:
 - increasing city size
 - greater population densities
 - more heterogeneous immigrant populations

Urbanization

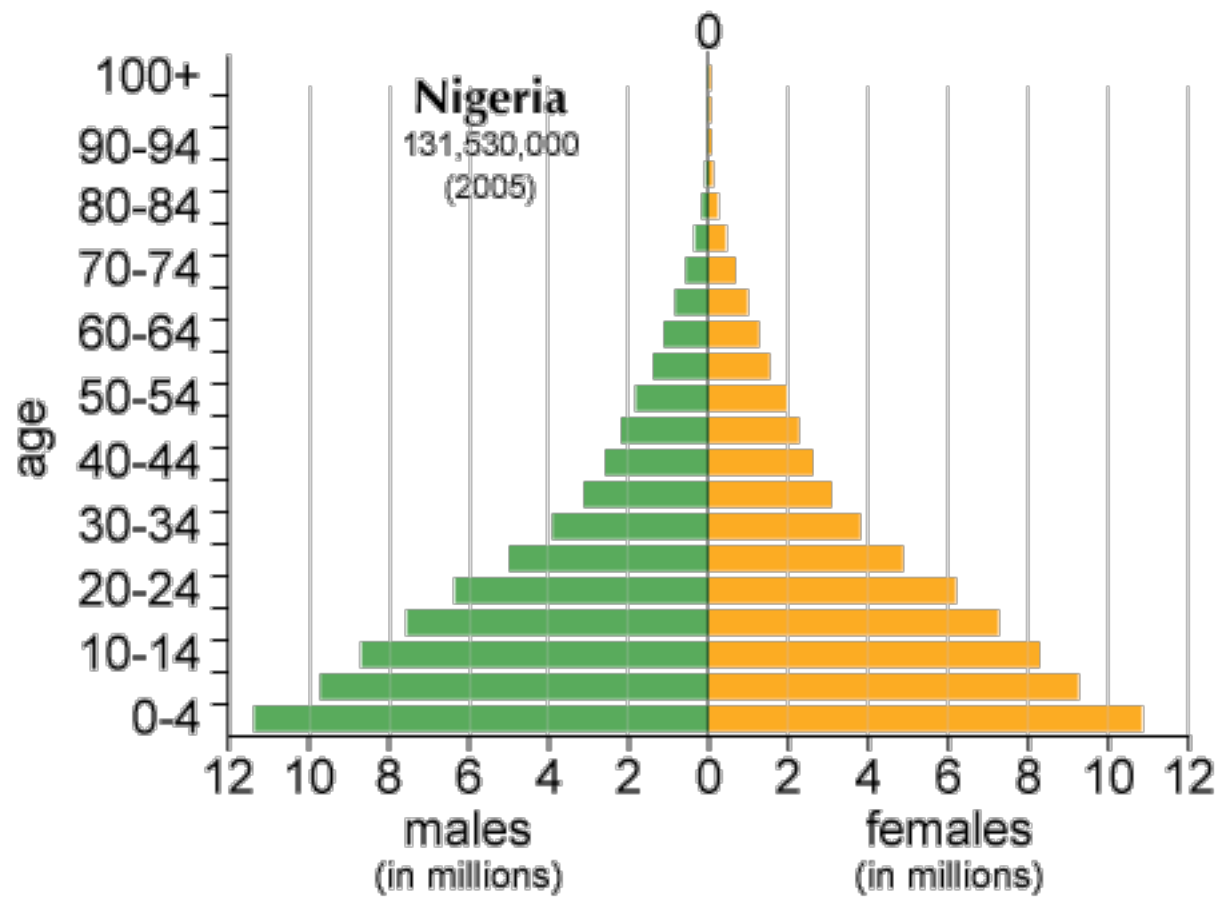
- Urban growth has major impacts on surroundings.
- Impacts grow as size of urban center grows.
- The changes are:
 - alteration of hydrology by replacing natural surface with impermeable one
 - generation of large amounts of heat (heat island) and alteration of atmosphere composition
 - global contributions to greenhouse gas through emission of CO₂ and sulfur

Urbanization

- The current process of urbanization will continue in the developing world.
- However, a new process is emerging in the developed world. This process is a decrease in population concentration and has been called *counterurbanization*, *polarization reversal* or *urban turnaround*. Its characteristics are:
 - decreasing size
 - decreasing population density
 - decreasing heterogeneity
- This trend results from increased ability to communicate which allows separation of control and production and the increase in the disadvantages of urban growth.

Population Structure

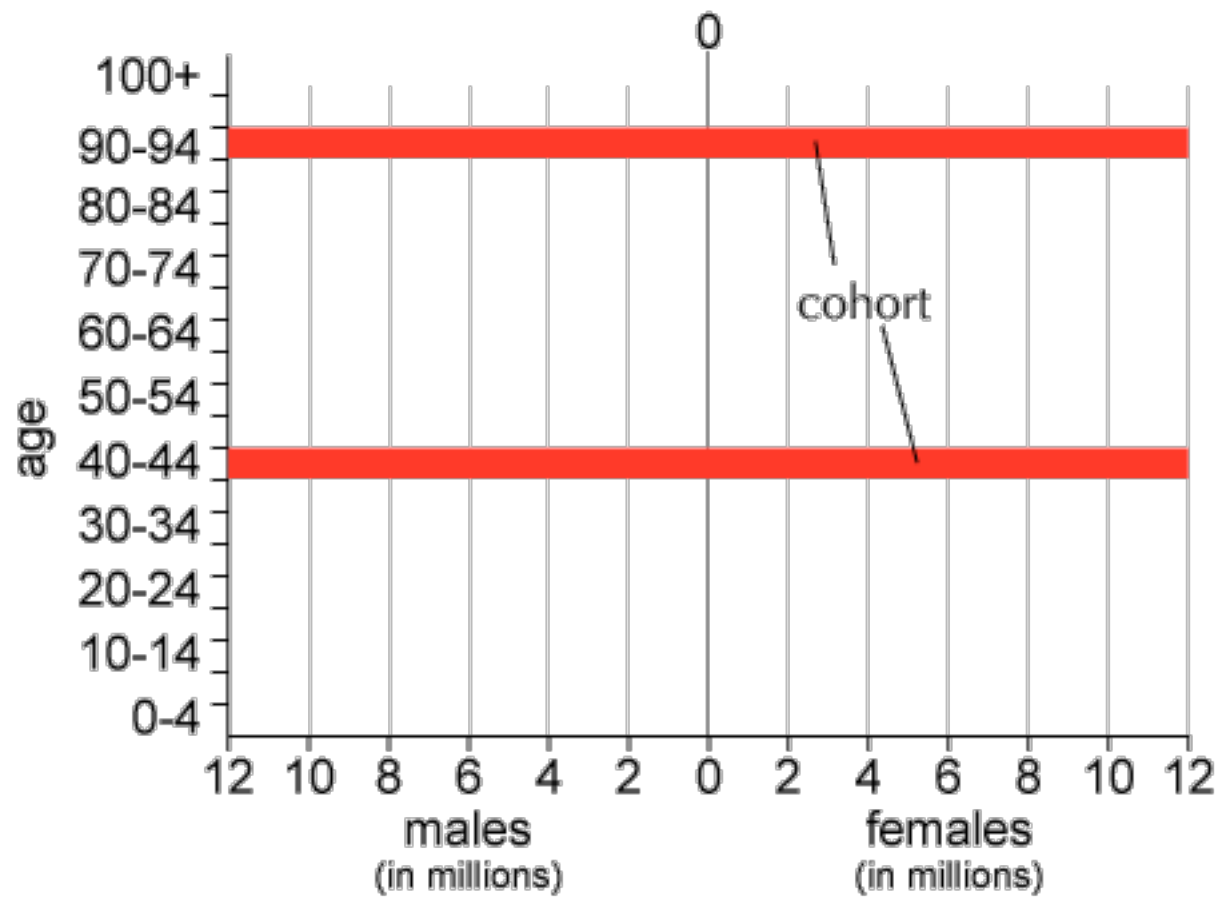
- The structure of a population, **demographics**, in terms of age and sex make-up is very important for predicting future population growth and assessing future economic impacts.
- Population structure can focus on a local region, a nation or a regional area.
- It also reflects a wide range of shifts and changes in population and population movement.



source: U.N. World Population Division

Population Structure

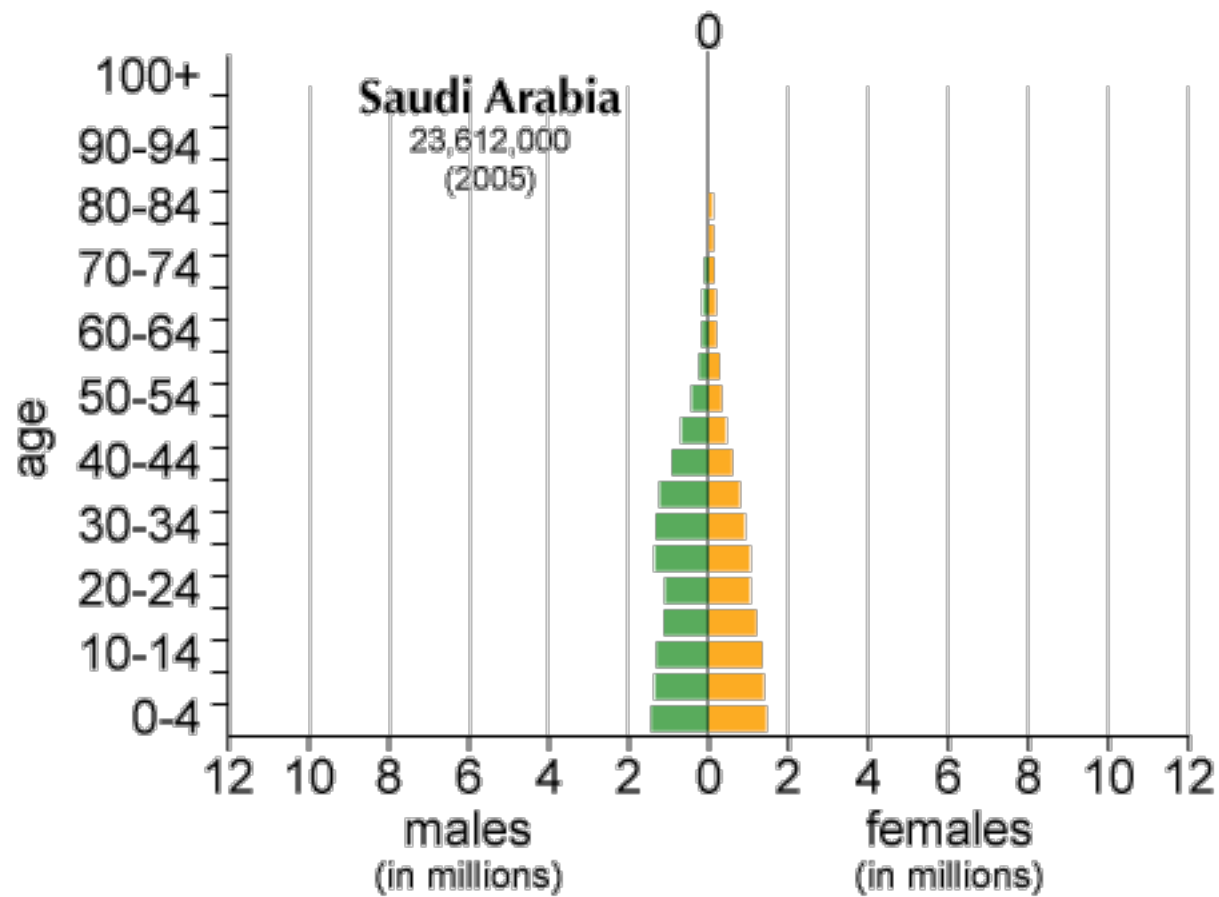
- A **cohort** is a segment of a population that shares one or more common characteristics. For the age-sex pyramid, the cohort is an age cohort. That is, all the individuals within a certain age range. In most cases, this age range is a 5 year span.
- The age distribution and female/male make-up of a nation is readily displayed using an **age-sex pyramid**. This type of diagram plots age on the vertical axis and number or percent on the horizontal. On this type of diagram, a cohort plots as a horizontal bar stretching across the diagram.
- These diagrams are useful because they visual indicate the likely future trends in a nation's population.



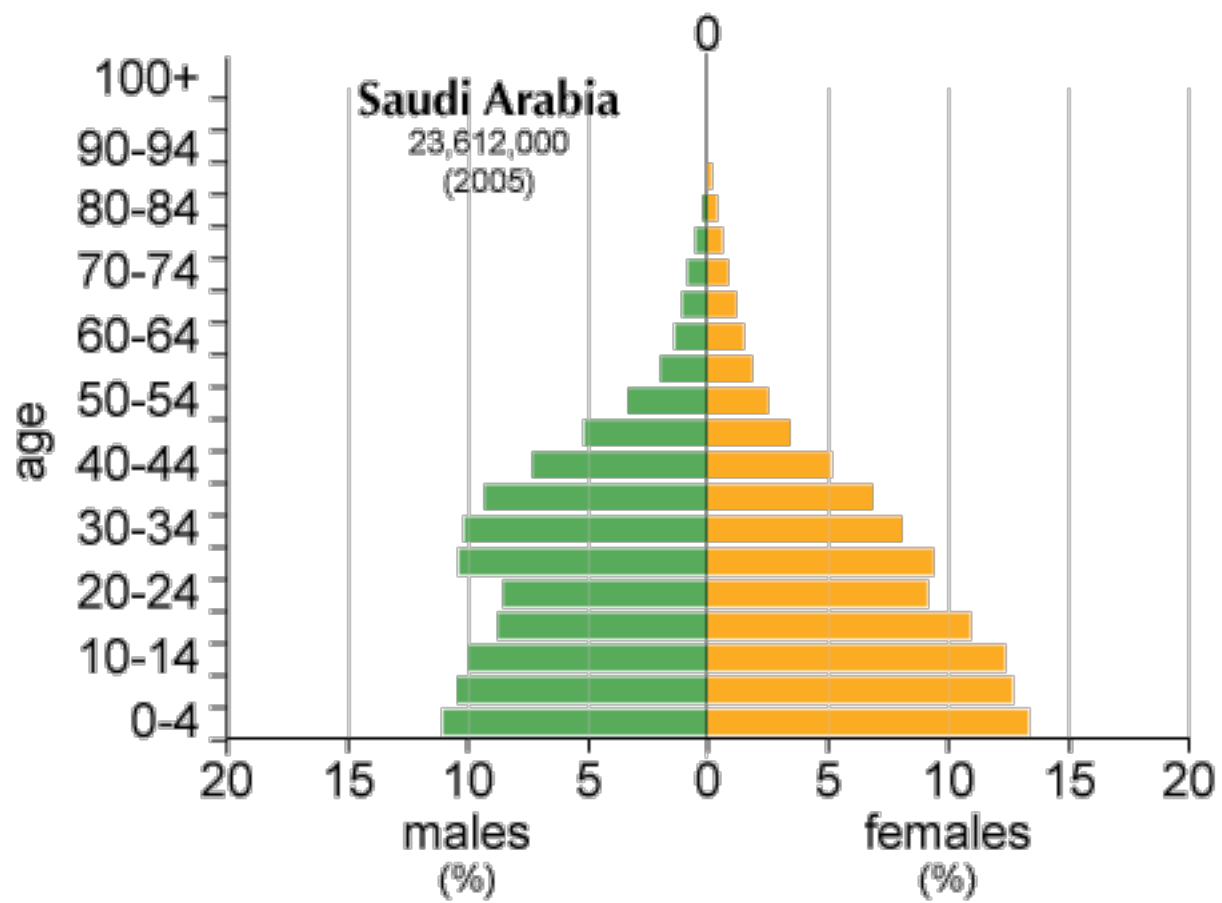
source: U.N. World Population Division

Population Structure

- The horizontal axis of an age-sex pyramid can be expressed in numbers (typically millions) or in percent. Each choice gives a different view of the population structure.



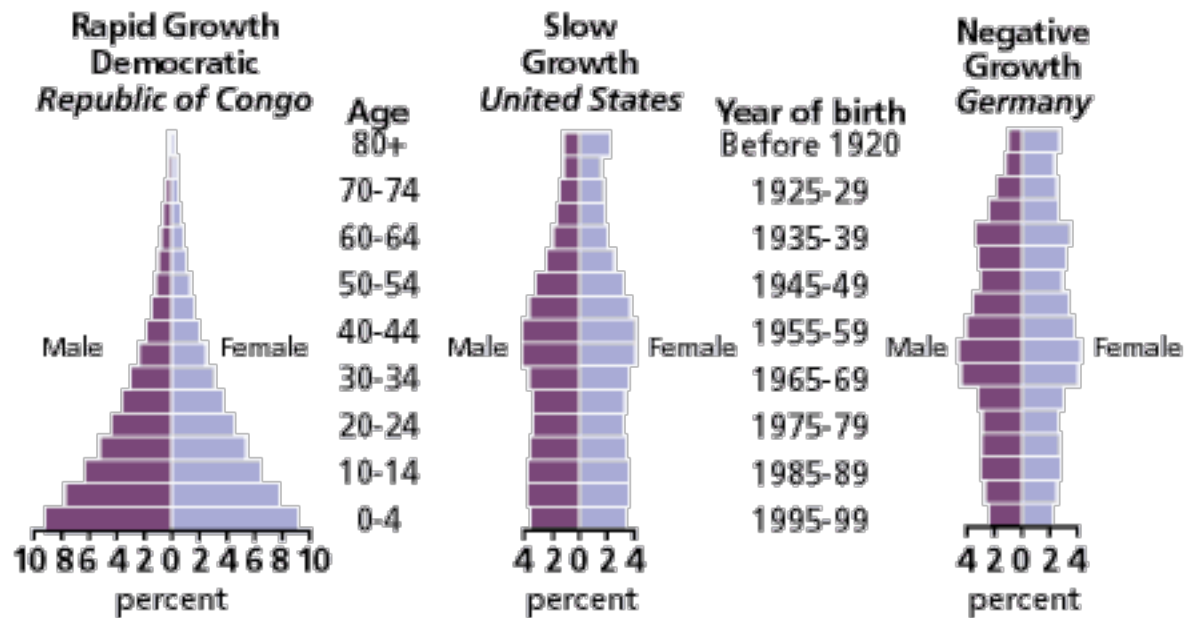
source: U.N. World Population Division



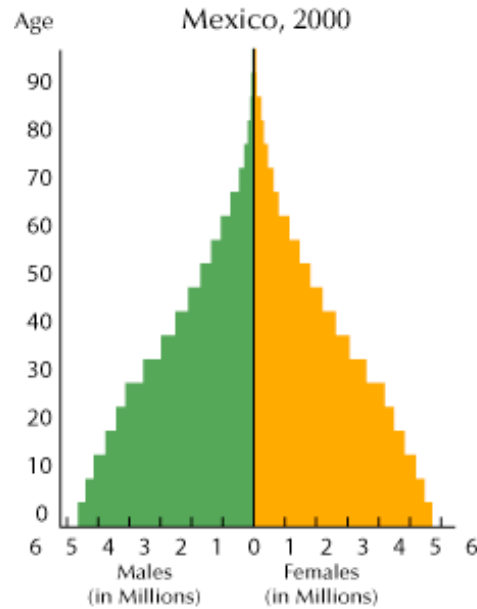
source: U.N. World Population Division

Population Structure

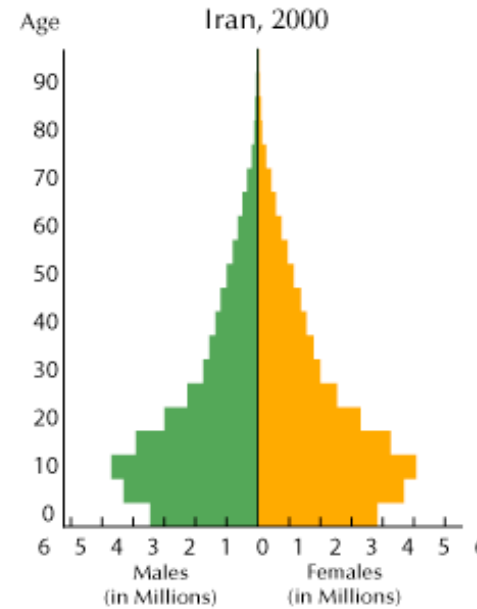
- The three types of population growth are shown by the age-sex pyramids below:
 - **rapid growth**: birth rate + immigration \gg death rate + emigration, population is dominated by young people, pyramid looks like a triangle;
 - **static or slow growth**: birth rate + immigration \sim death rate + emigration, population is not dominated by anyone age group, pyramid looks like a column;
 - **negative growth**: birth + immigration \ll death rate + emigration, population is dominated by older people, pyramid looks like an inverted triangle.



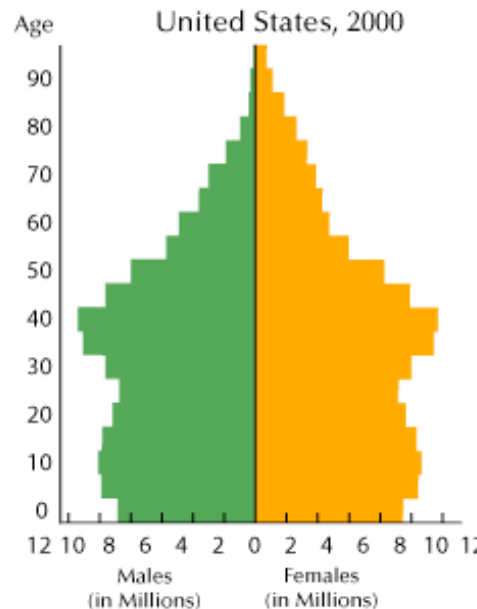
Mexico's pyramid shows a young growing population that will need jobs and education.



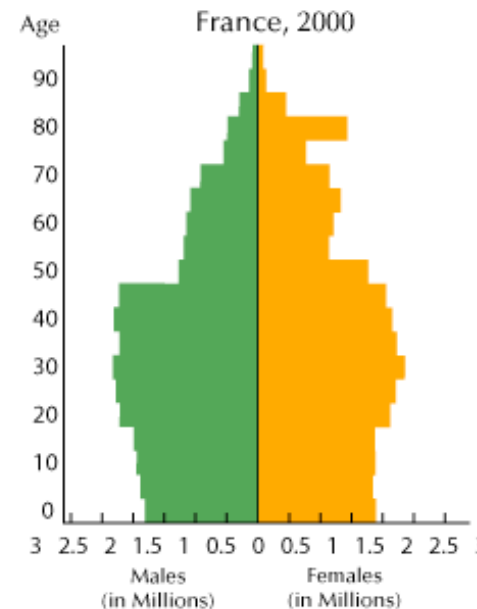
Iran's population has undergone a dramatic change in population. The diagram indicates the birth rate dramatically declined recently.



The U.S. pyramid depicts a switch to a stable, but aging population in which births barely replace deaths.



France has a population structure that reflects the impact of two World Wars, i.e. significant drop in the number of older males, and a declining birth rate.



SOURCE: Weeks, 2002; UNAIDS/WHO, 2000.

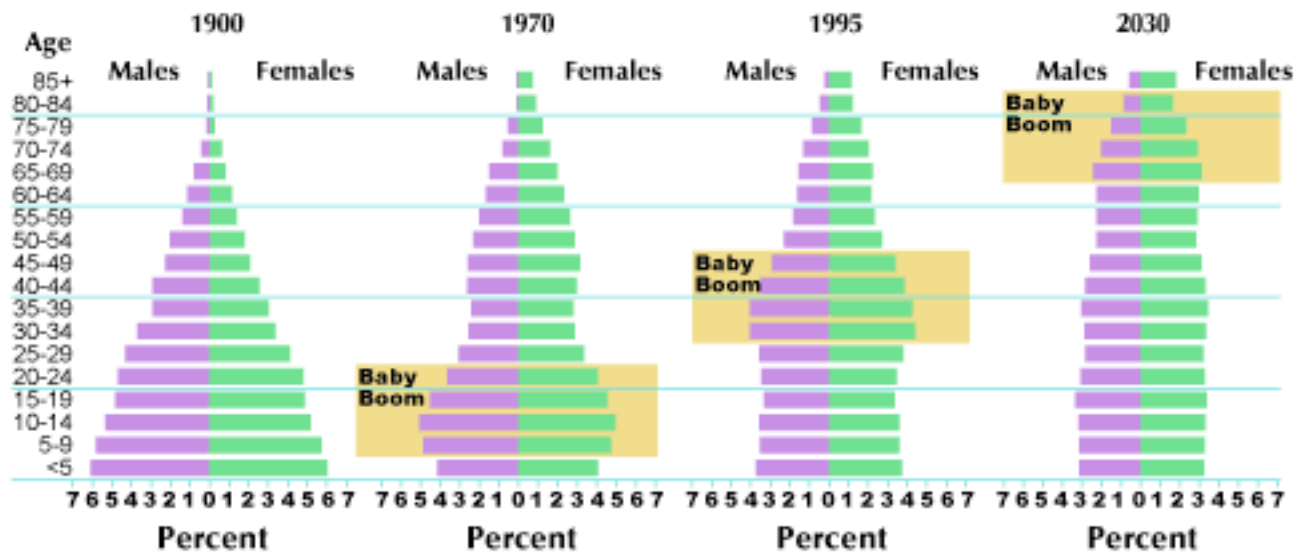
Population Pyramids for Mexico, Iran, the United States and France

Population Structure

- These four age-sex pyramids illustrate four very different types of population structures.
- Note that the four pyramids have different horizontal scales. The different nature of the pyramids means different nations will have different concerns about future national issues.

Population Structure

- A series of age-sex pyramids constructed at different times provides a quick, visual picture about how the population structure will change over time.



SOURCE: U.S. Census Bureau. 2002. *Statistical Abstract of the United States*. 2001. Washington, DC: U.S. Government Printing Office.

reflect the aging of the U.S. population and the emergence of the baby boom generation (1900-1970). Later years also show an aging of the country's population as a whole.

Population Structure

- In 1900, the population is growing so jobs are important.
- With the emergence of the baby boomers in 1970, policies supporting education and families will be important.
- In 2030, the major issues will be issues revolving around the older generation, e.g. health care, retirement and medical costs. The question of how to support this large old population with a shrinking base of workers.

Population Migration

- **Migration** is the movement of people from one residence to another.
- Humans have been on the move since the earliest times and continue to move today.
- This movement has profound impacts for the regions people leave as well as their destinations.



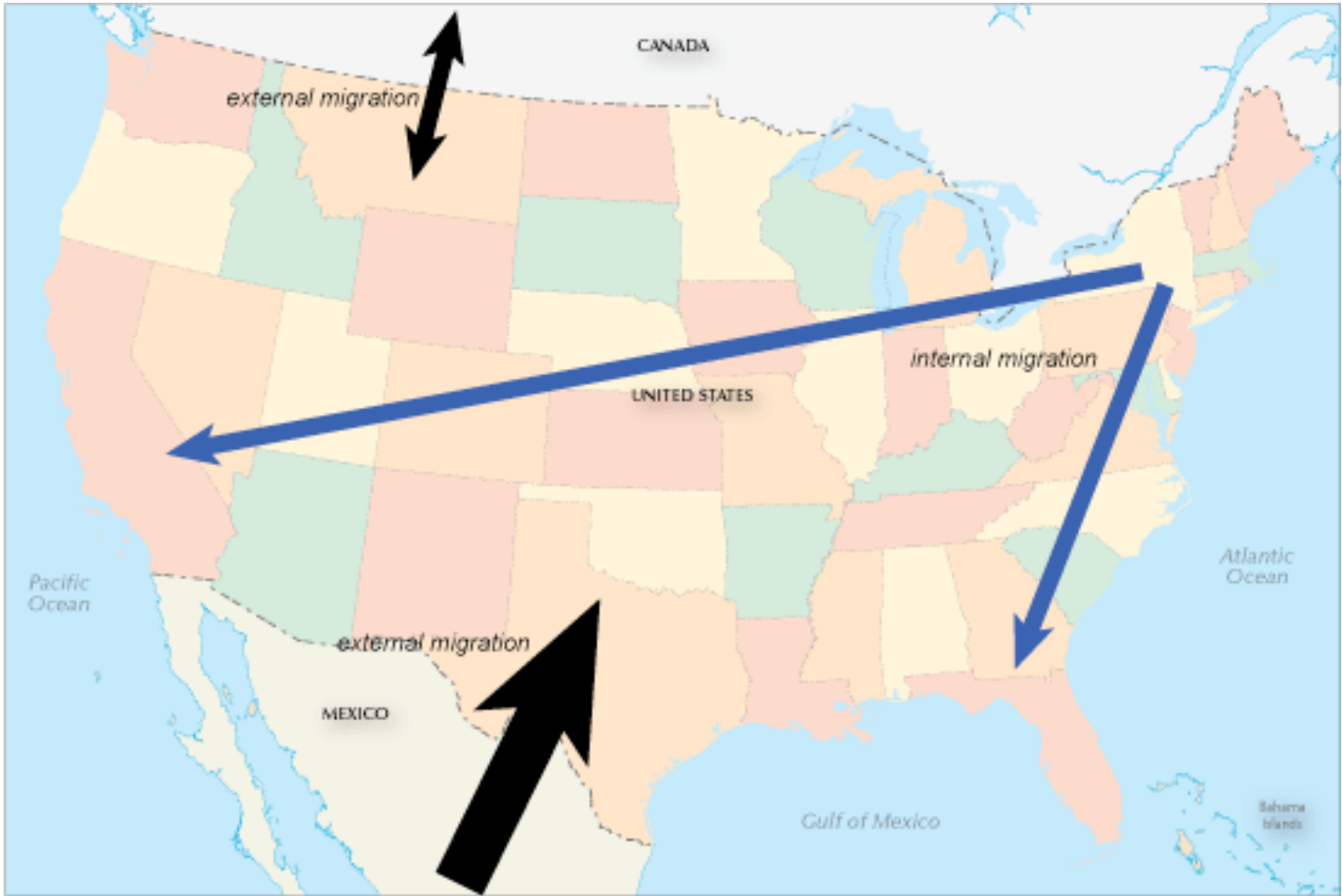
Migration has been important in West Africa.

Population Migration

- Depending upon the distance of the move and the region of interest, migration can have three effects on a region's population:
 - add to it;
 - cause no change;
 - subtract from it.

Population Migration

- There are two types of migration:
 - **influx**: movement of people into a region
 - **outflux**: movement of people out of a region
- Depending upon whether or not movement crosses national boundaries two types of migration can be defined:
 - **international**: migration involving movement crosses national boundaries
 - immigration: movement into a country
 - emigration: movement out of a country
 - **internal**: migration involving movement within a country's boundaries
 - in-migration: movement in a region
 - out-migration: movement out of a region



Population Migration

- Migration rate is the difference between the inflow and outflow of people.

$$\text{migration rate} = \frac{(\text{influx} - \text{outflux})}{\text{region's population}} \times 1000$$

Population Migration

- Migration is the result of two different sets of factors. These are:
 - **push factors:** encourage people to leave a region
 - persecution (religious, political)
 - Discrimination
 - depletion of natural resources
 - natural disasters (drought, flood, earthquakes, volcanic eruptions, etc.)
 - ethnic cleansing
 - **pull factors:** encourage people to move to an area
 - employment opportunities
 - climate
 - tolerance

Population Migration

- Historically, there have been three major migrations.
 - Europeans to North and South America, Asia and Africa
 - often displaced native populations
 - led to establishment of new, independent nations, e.g. Argentina, Australia, Brazil, Canada, New Zealand, South Africa, United States
 - Asian immigrants to East Africa and the U.S.
 - relatively small number of people involved
 - Africans to North and South America and Caribbean
 - force migration due to slave trade
 - very large population affected - 11 million