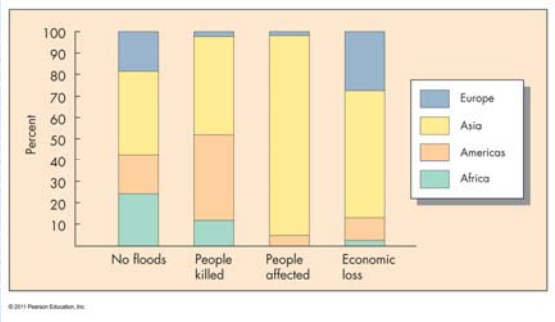
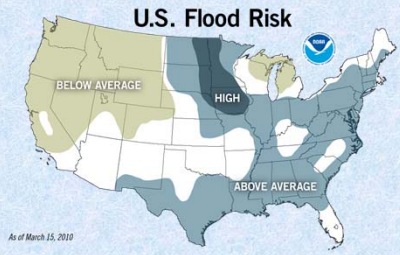
CHAPTER 6

RIVERS AND FLOODING

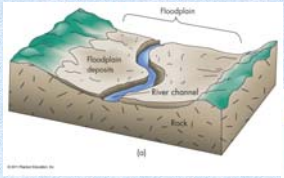
Global View of the Flood Hazard



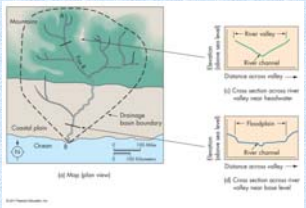
National View of the Flood Hazard

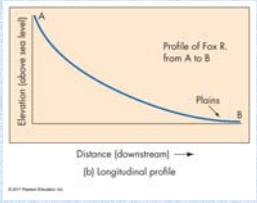


Floodplains

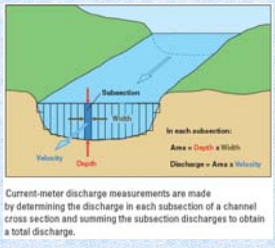


Drainage Basins and Longitudinal Profiles





Discharge



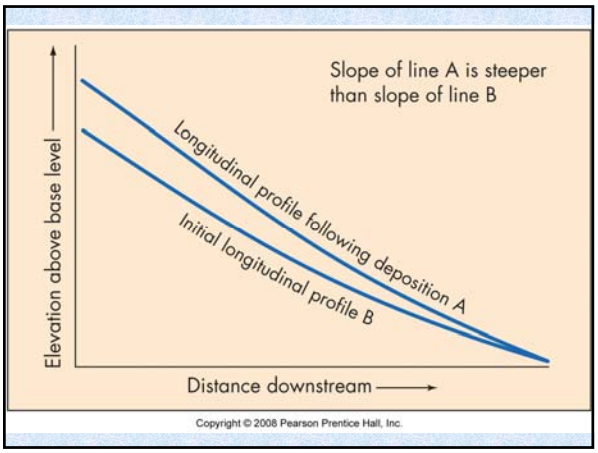
Current-meter discharge measurements are made by determining the discharge in each subsection of a channel cross section and summing the subsection discharges to obtain a total discharge.

Q = W x D x V

http://ga.water.usgs.gov/edu/streamflow2.html

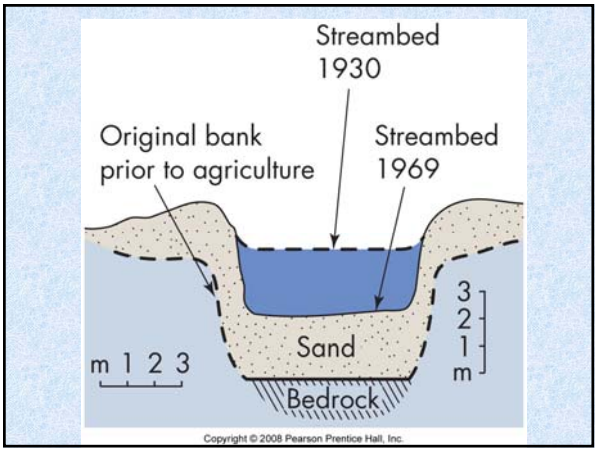
Effects of Land-Use Changes (1)

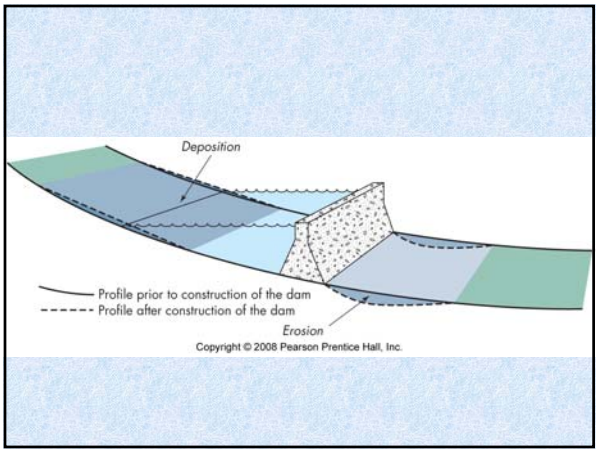
- Changes in infiltration rate: Change of the amount of water flowing into a river
- Soil erosion: Change in the amount of sediments in a river
- Amount of water and sediments in river: Changes in the velocity of water flow
- **Changes in river's velocity:** Leading the change in river dynamics



Effects of Land-Use Changes (2)

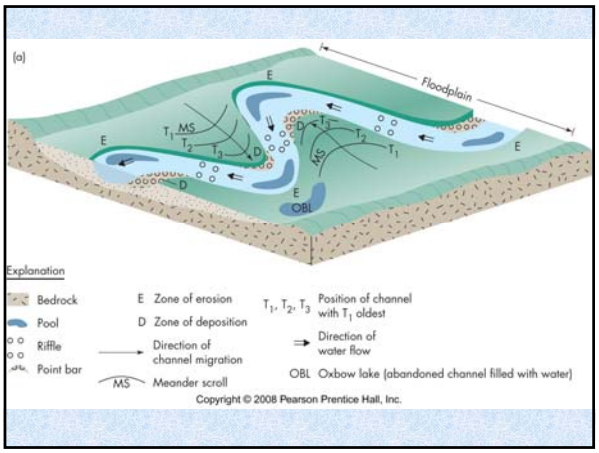
- Forest to farmland
  - Increases soil erosion, stream deposition
  - Increases gradient and velocity
  - Increases river-channel erosion
- Urban buildup
  - Increases impervious cover
  - Increases lower-magnitude flood frequency
  - Reduces the lag time of flood





Dynamics of River Erosion and Deposition

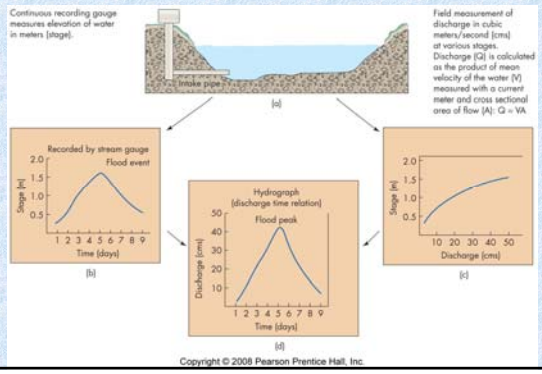
- Ever-changing processes: Time and rate of erosion and deposition
- Reasons for the changes—Complex, but related to
  - Changes in river channel (width, depth, and slope)
  - Composition of channel bed and banks
  - Vegetation cover
  - Variations of weather and climate pattern
  - Human activities, particularly land-use changes



Flooding

- Flooding: Overbank flow condition, discharge greater than channel's holding capacity
- Stage: The height of the water level in a river at a given location at a given time
- Hydrograph: Graphic representation of a river's discharge over time
- Lag time: The amount of time between the occurrence of peak rainfall and the onset of flooding

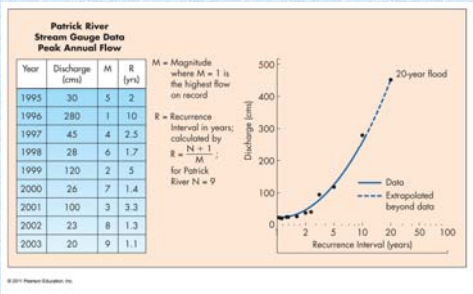
Flooding Data Measurement



Frequency and Magnitude of Flood

- Recurrence interval
  $R = (N + 1)/M$
  N is the number of years of record, M is the rank of individual flow within the recorded years
- The probability of a given magnitude flood
  $P = 1/R$
- Statistical probability versus reality
  Probability: One 25-year flood, on average, once every 25 years – a 4% chance per year.
  Reality: Two 25-year floods two consecutive years

Flooding Data Measurement



Patrick River Stream Gauge Data Peak Annual Flow

Year	Discharge (cms)	M	R (yrs)
1995	30	5	2
1996	280	1	10
1997	45	4	2.5
1998	28	6	1.7
1999	120	2	5
2000	26	7	1.4
2001	100	3	3.3
2002	23	8	1.3
2003	20	9	1.1

M = Magnitude where M = 1 is the highest flow on record

R = Recurrence Interval in years; calculated by $R = \frac{N+1}{M}$; for Patrick River N = 9

Frequency and Magnitude of Flood

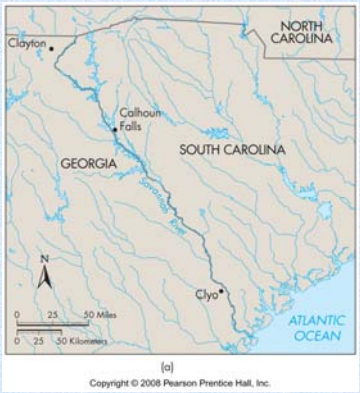
- Recurrence interval method needed improvement; assumes normal distribution.
- The USGS uses a statistical model based upon the "log-Pearson" distribution

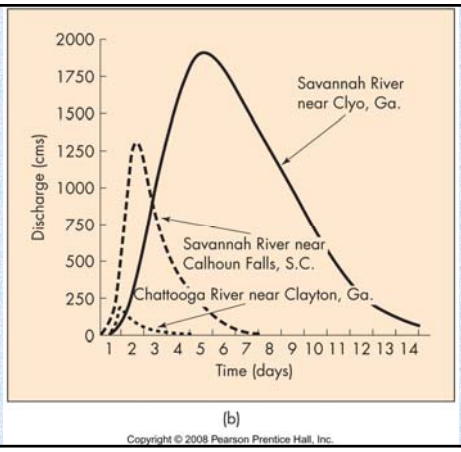
$$X = \bar{X} + K\sigma$$

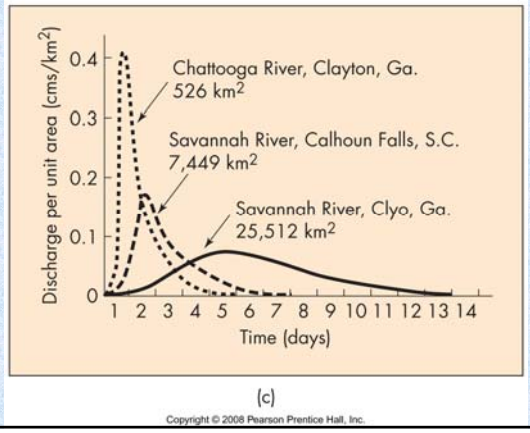
Where:
X = peak discharge at a particular flow frequency
$\bar{X}$ = mean discharge
K = a frequency factor related to R
σ = standard deviation of the annual peak flows

Types of Flooding

- By stream location
  - Upstream flood: Shorter duration, smaller area
  - Downstream flood: Longer duration, greater magnitude, larger area
- By duration
  - Flash flood: High volume of flooding water in very short duration, characteristic short lag time, usually in upstream
  - Non-flash flood
- By magnitude/recurrence interval
  - 100-year, 50-year, 25-year, 10-year floods





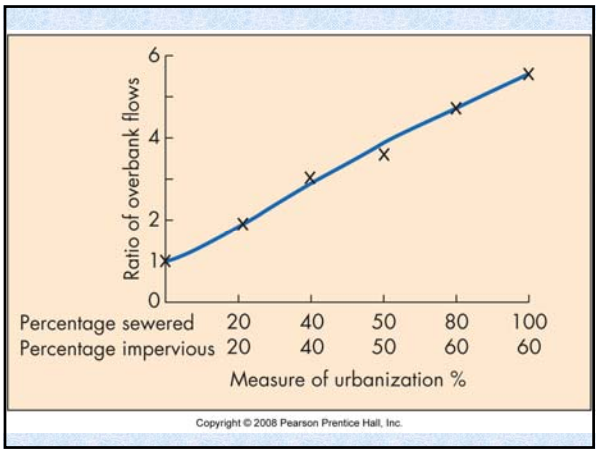


Factors Affecting Flood Damage

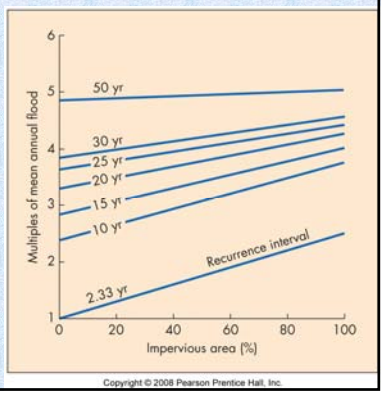
- Regional land-use changes, such as urban development, deforestation, soil erosion, etc.
- Land use on the floodplain
- Frequency and magnitude of flooding
- Lag time and duration of flooding
- Sediment load
- Effectiveness of forecasting, warning, and emergency management

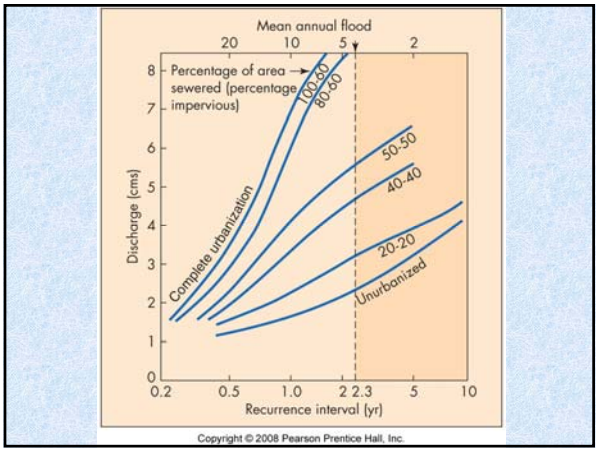
Urbanization and Flooding

- Impact on frequency and magnitude
  - Increase in both frequency and magnitude, especially in small drainage basins
- Impact on a river's discharge
  - Increase in runoff, without an increase in precipitation
- Significant reduction in lag time or *flashy discharge*

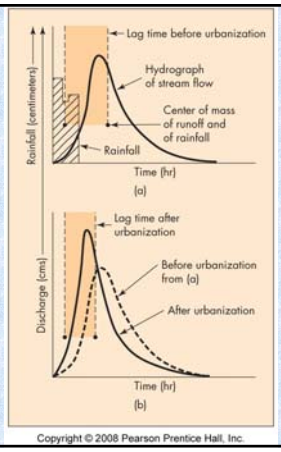


Urbanization and Flooding





Urbanization and Flooding



Nature and Extent of Flood Hazard

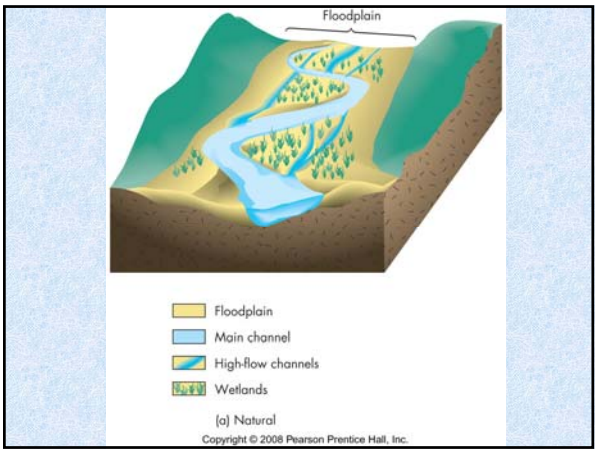
- Factors affecting flood damage
  - Type of land use on the floodplain
  - Magnitude and frequency of flood
  - Rate and duration of flood
  - Season of the flood
  - Population density
  - Public awareness
  - Effectiveness of forecasting, warning, and emergency planning

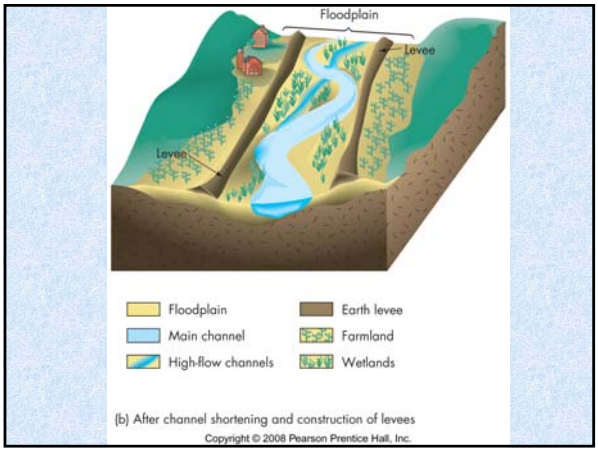
Impact Effects of Flooding

- Primary effects
  - Injury and loss of life, damage and destruction of property, erosion and deposition of sediments
- Secondary effects
  - Water pollution
  - Fire
  - Diseases
  - Displacement of people
  - Interruption of social and economic activities

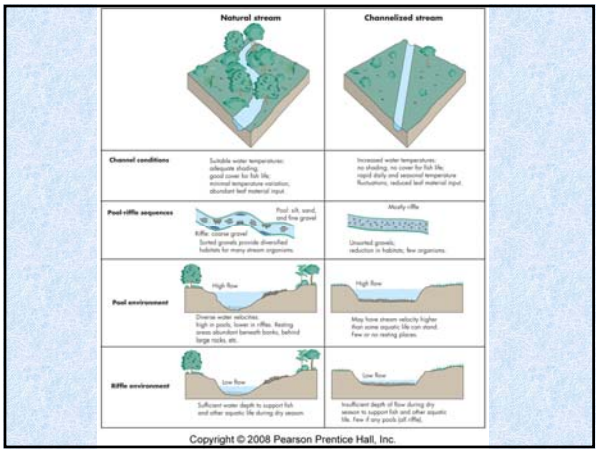
Adjustments to Flood Hazards (1)

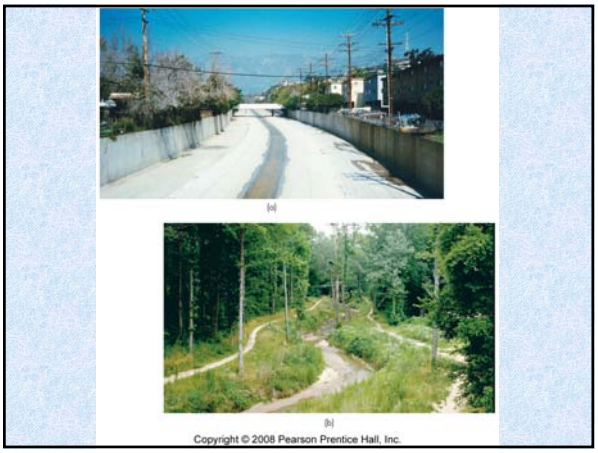
- The structural approach
  - Engineering barriers: Levee augmentation
  - Channelization
  - River-channel restoration
- Flood insurance: Shared responsibility and accountability
- Flood-proofing: Raised foundation, floodwalls, waterproof doors and windows, pumps

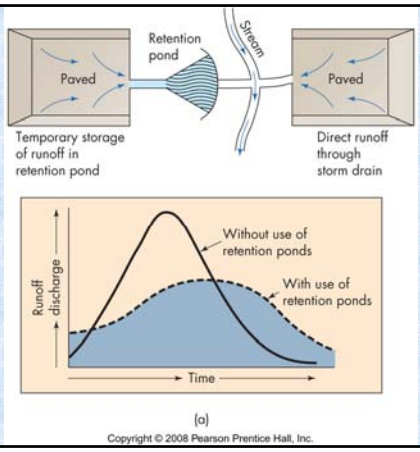


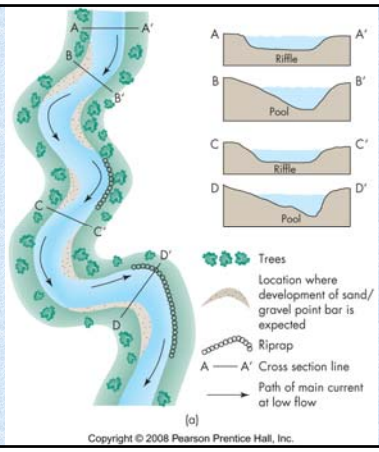


Levees on the Mississippi



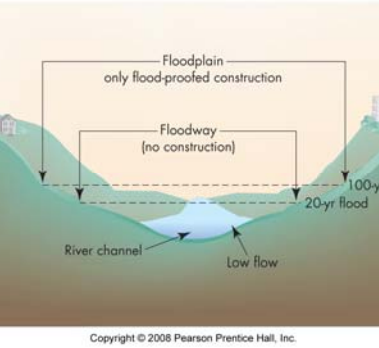


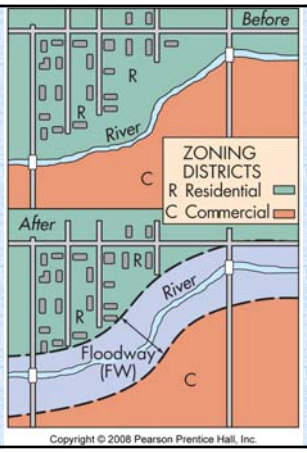




Adjustments to Flood Hazards (2)

- Floodplain regulation: Obtaining the most beneficial use of floodplains
  - Flood-hazard mapping
  - Floodplain zoning
- Government buyout and relocating people from floodplain
- Personal adjustments





Perception of Flooding

- Individual level: Variable (see p.169)
- Local and state level: Mitigation plans
- Federal government level
  - Mapping of flood-prone areas
  - Floodplain management plans
  - Public outreach