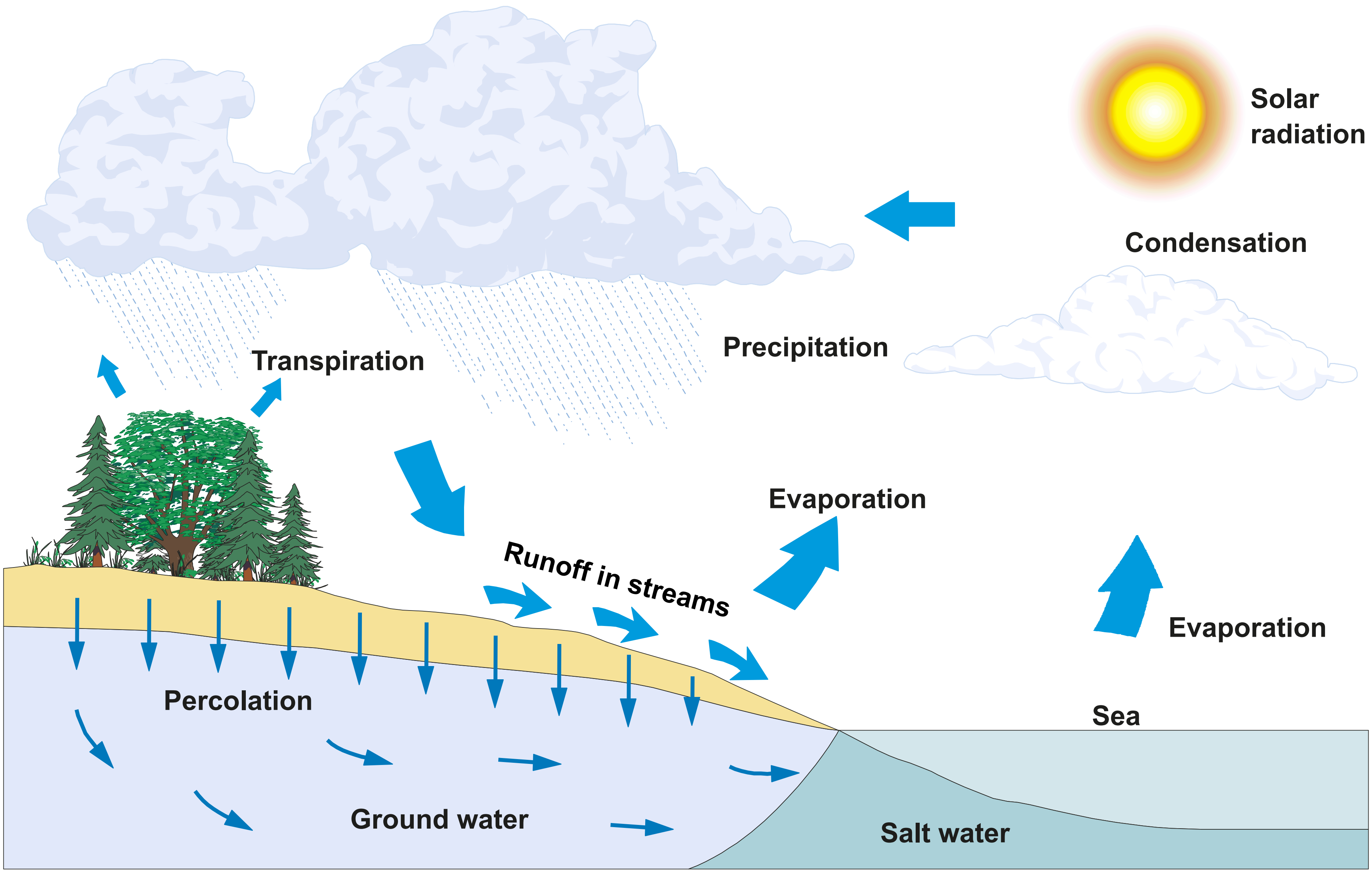
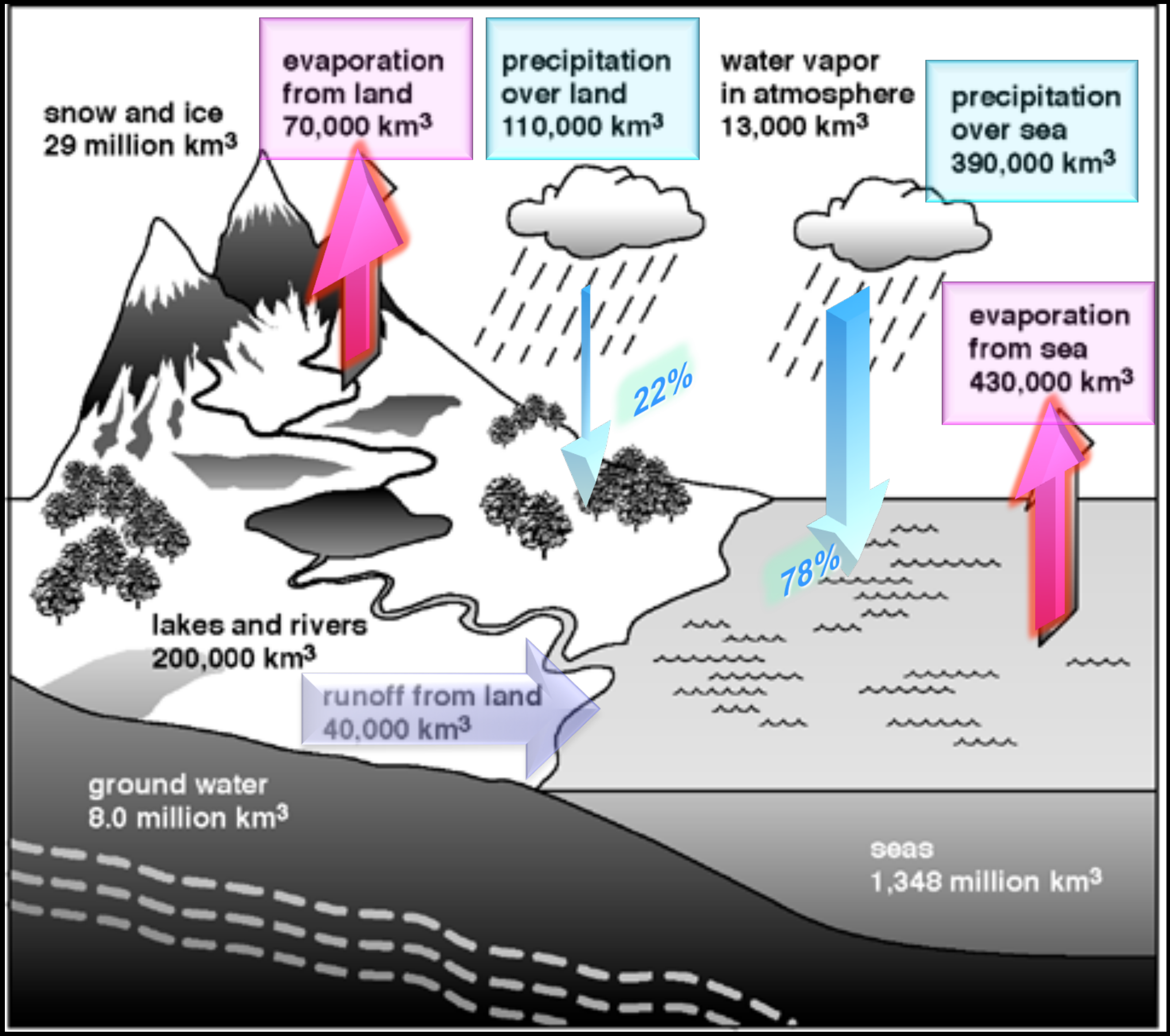

The Hydrologic Cycle
Streams
Flooding
http://ngs.woc.noaa.gov/storms/katrina/

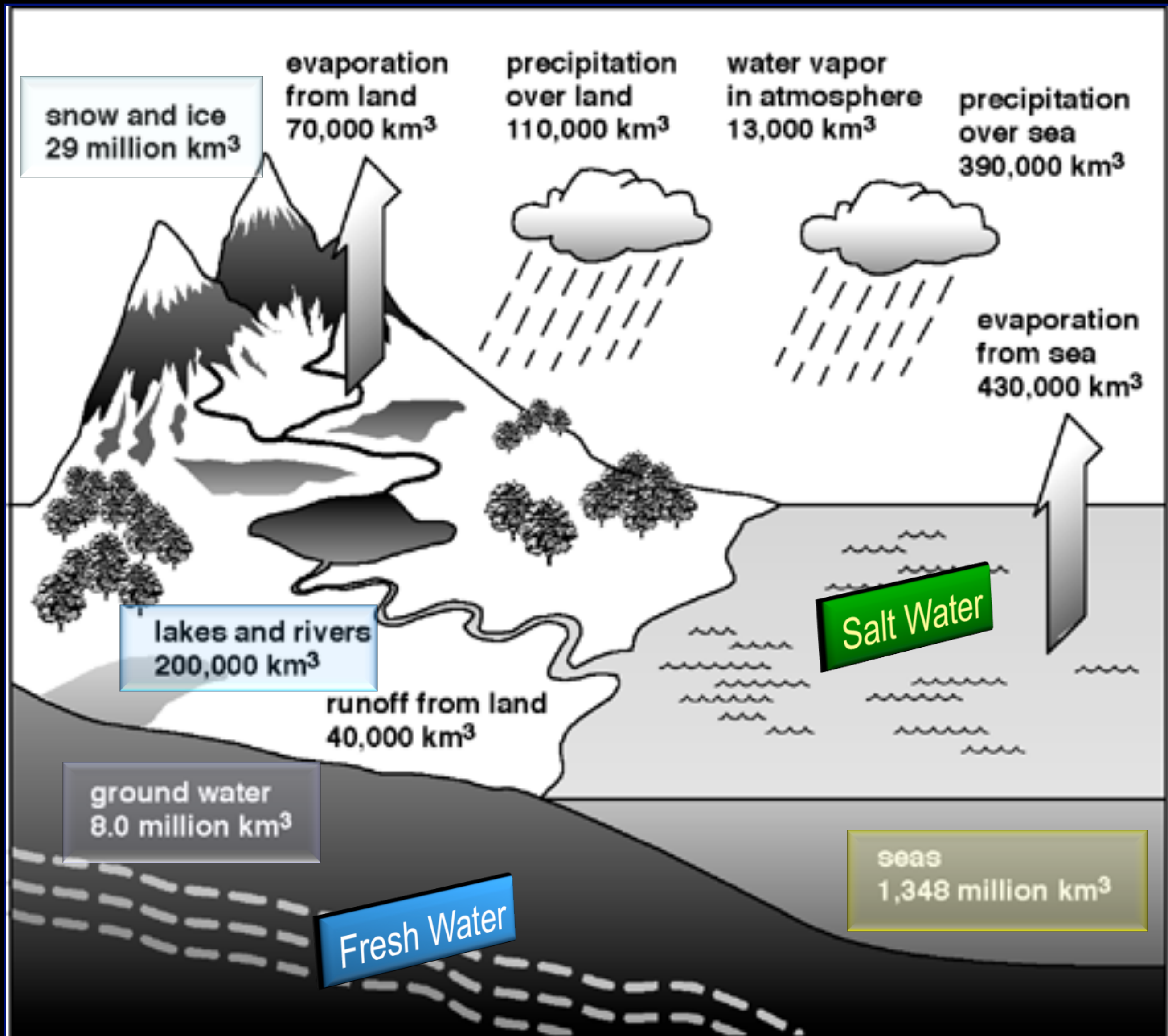

Solar
radiation
Condensation
Precipitation
Transpiration
Evaporation
Runoff in streams
Evaporation
Percolation
Sea
Ground water
Salt water

Total Evaporation = Total Precipitation = 500,000 km³/yr



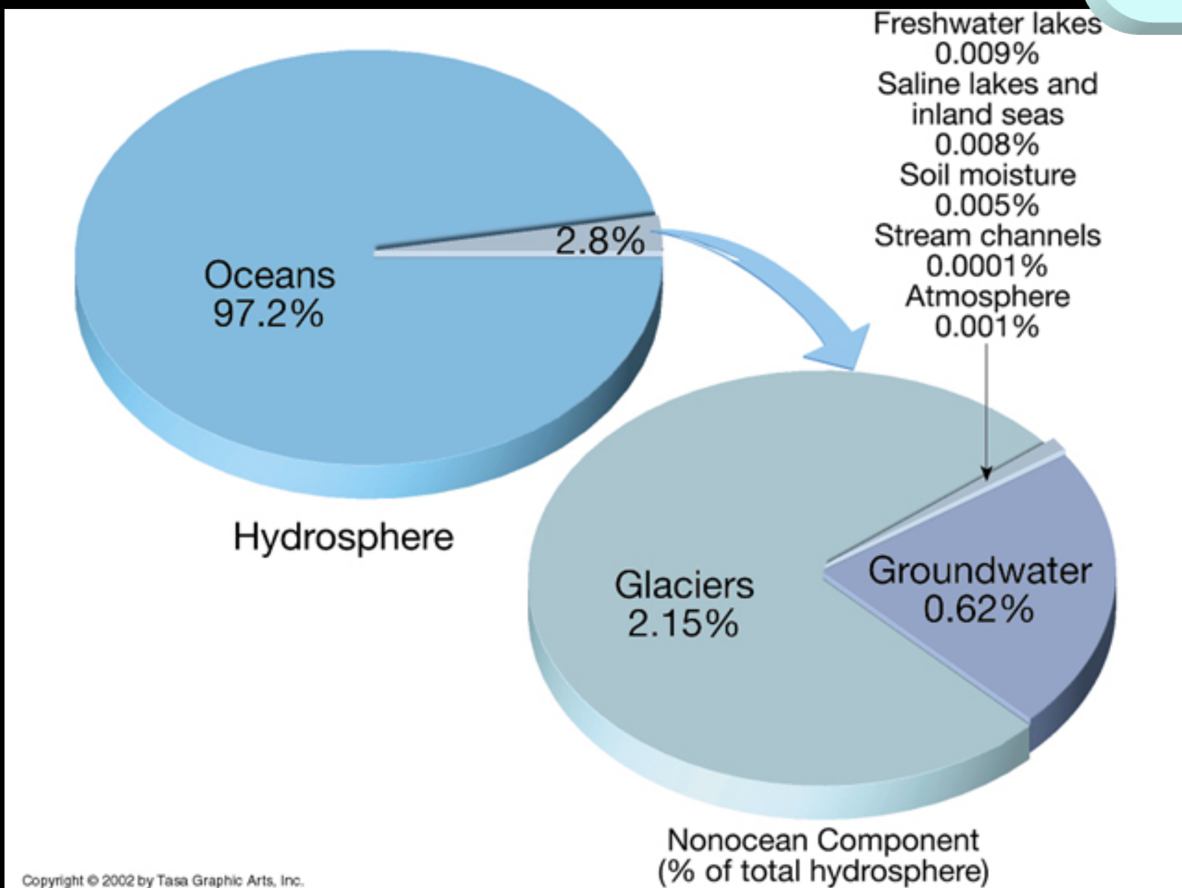
http://www.jhuccp.org/pr/m14/m14figs.stm

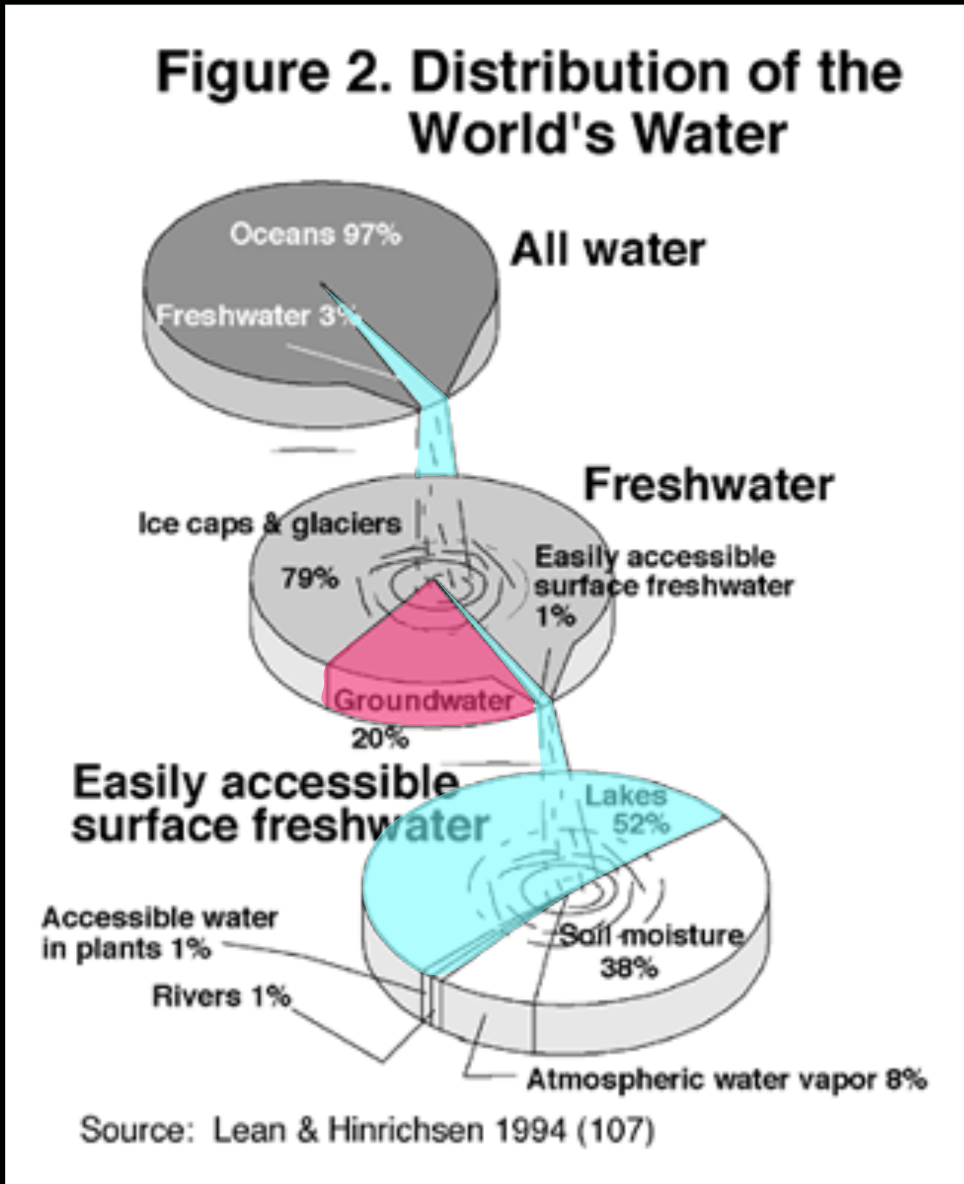
Water Reserves



http://www.jhuccp.org/pr/m14/m14figs.stm

- Most of the Earth's water is saline (salt water)
- Of the remaining, most is locked up in glacial ice

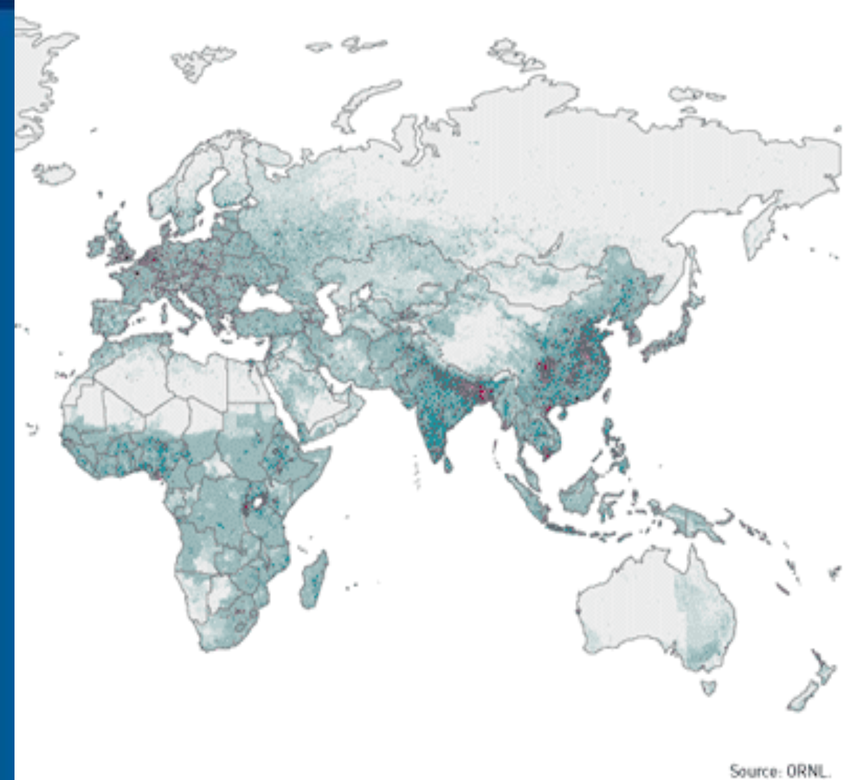




- Less than 1% of the Earth's freshwater is on the surface at any time.
- 20% of the freshwater flows through the ground – groundwater.

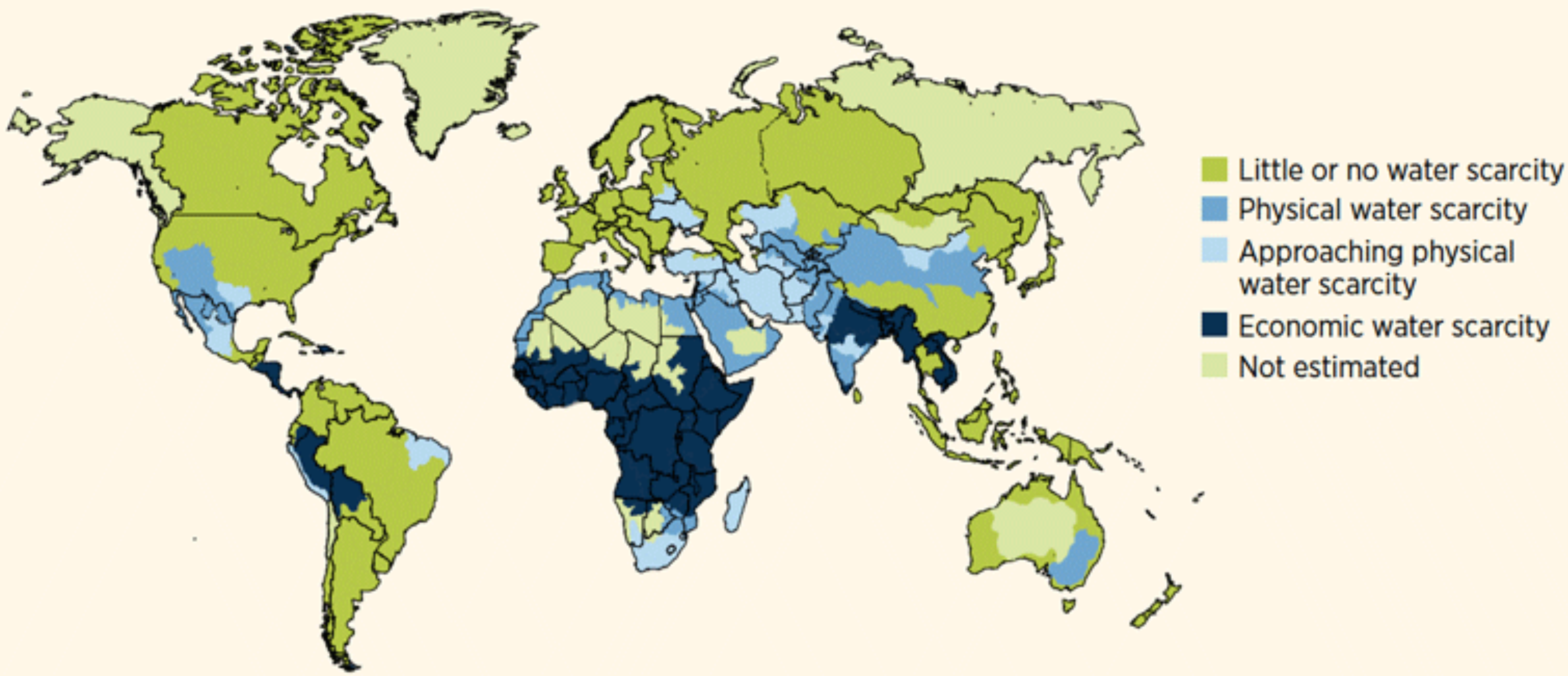
http://www.jhuccp.org/pr/m14/m14figs.stm

http://blogs.salon.com/0002007/2007/11/08.html

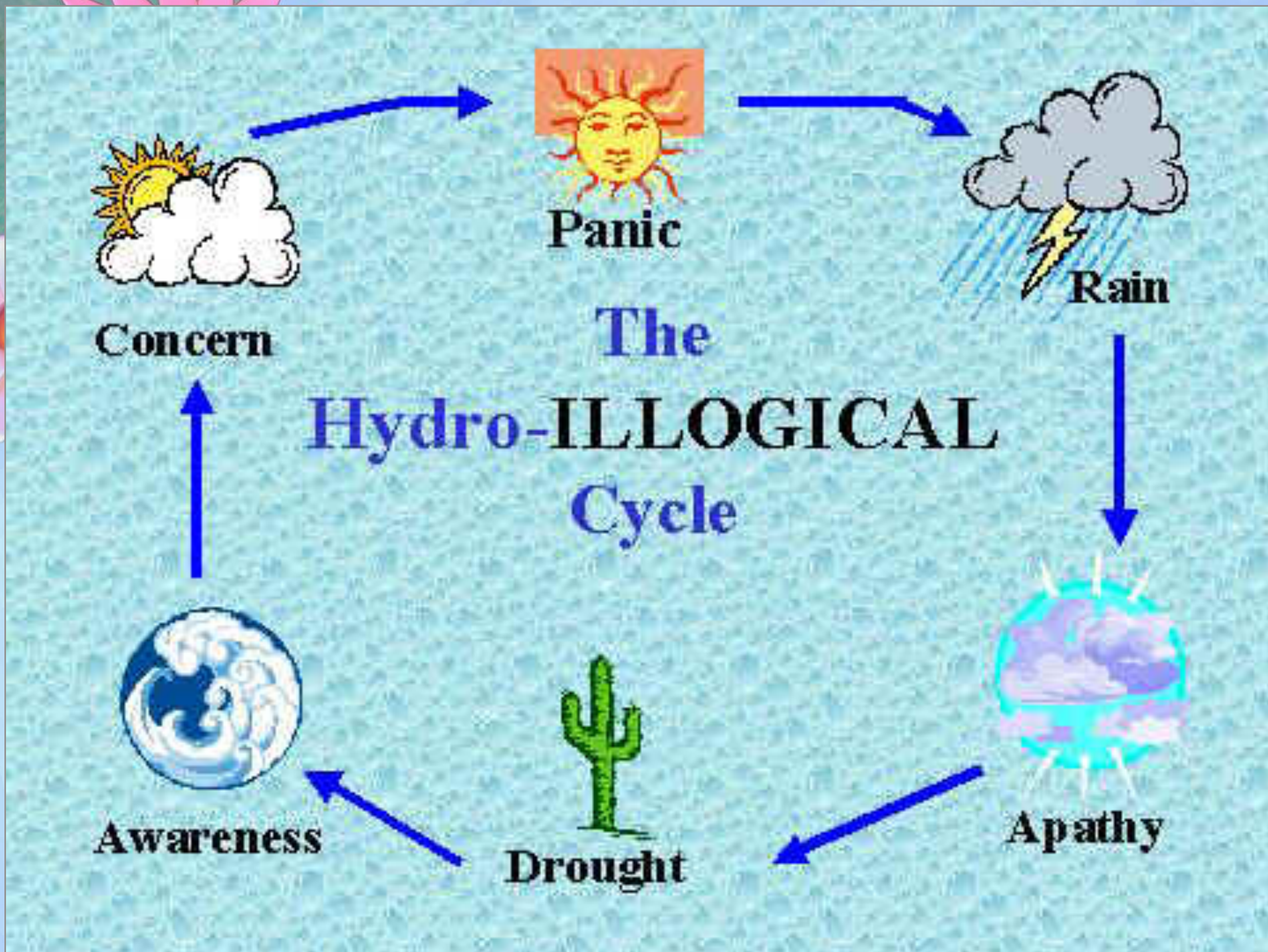


http://atlas.aaas.org/

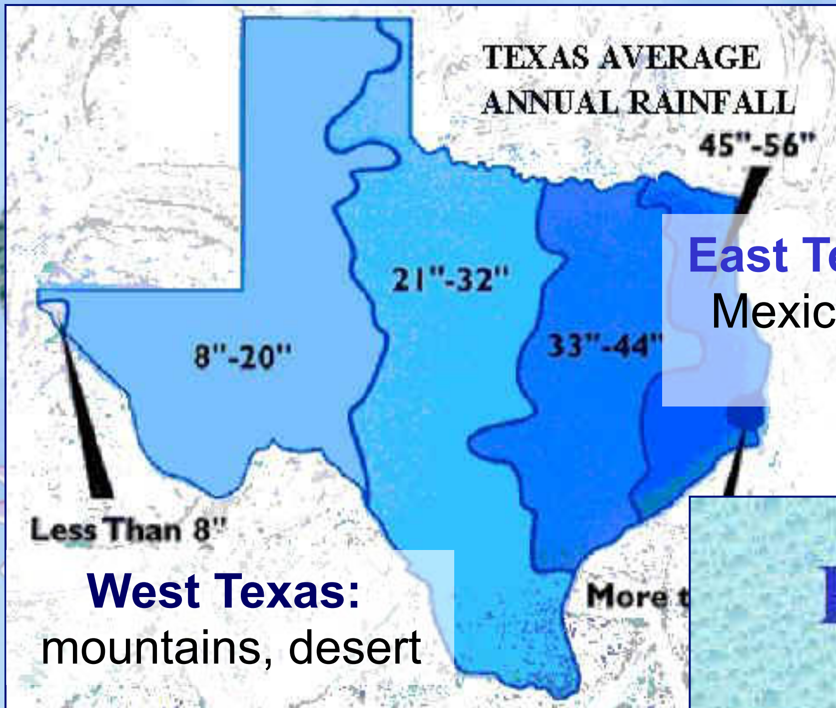
Global physical and economic water scarcity



Source: World Water Development Report 4. World Water Assessment Programme (WWAP), March 2012.

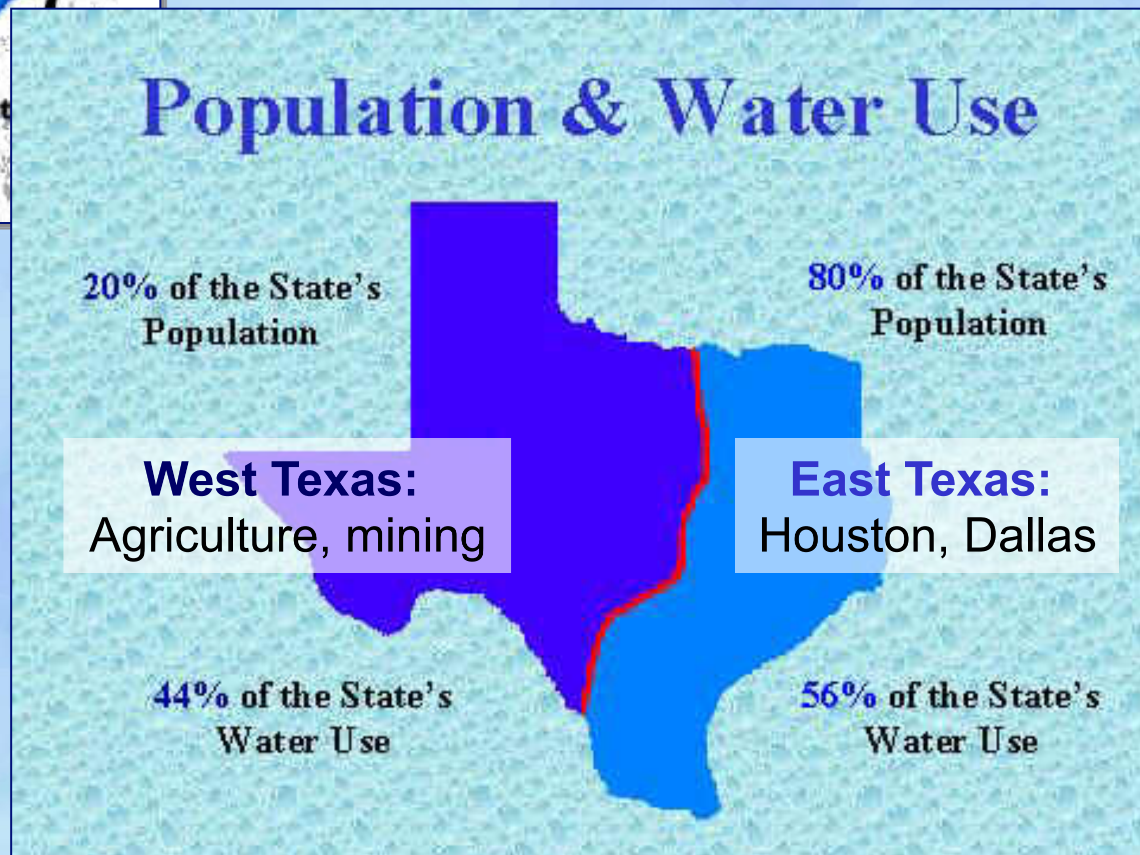


http://www.waterwisetexas.org/understanding_our_water_supply.htm



East Texas: Gulf of Mexico influence, soggy

West Texas: mountains, desert



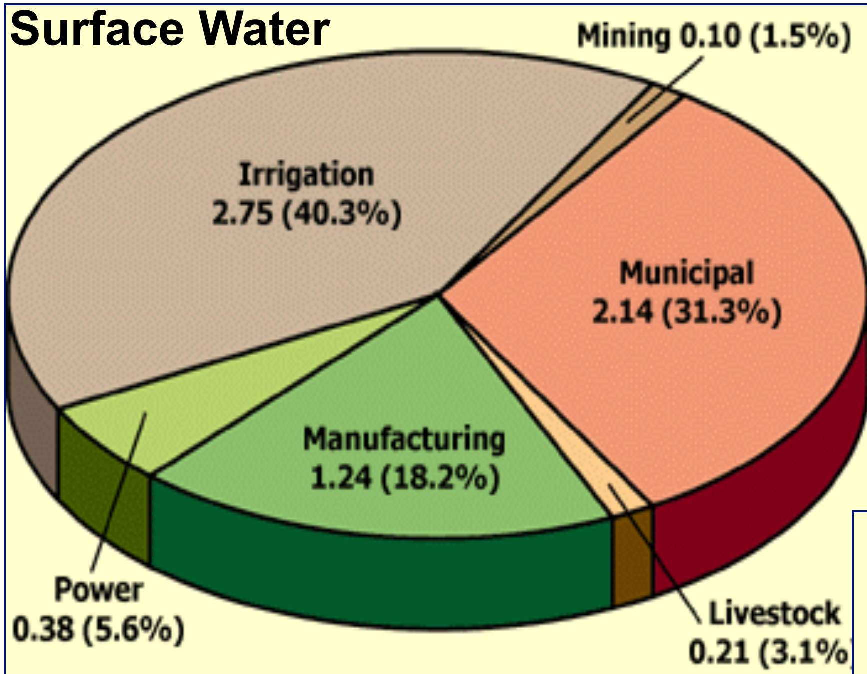
West Texas: Agriculture, mining

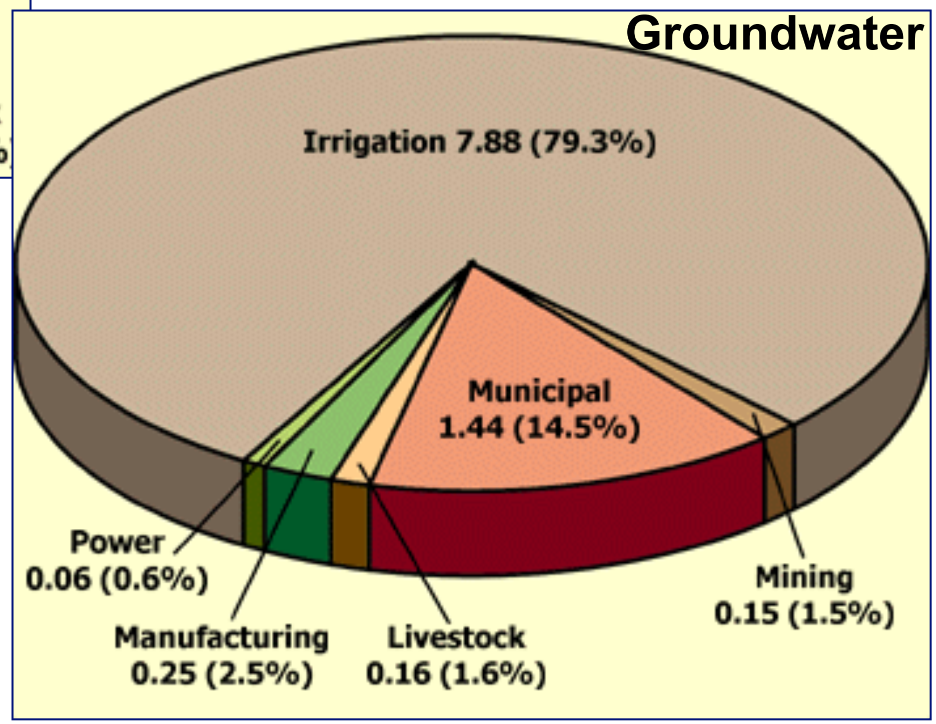
East Texas: Houston, Dallas

Texas Water Use

http://www.waterwisetexas.org/understanding_our_water_supply.htm

Texas Water Use





Most water for agriculture is drawn from the ground.

If the rate of withdrawal exceeds aquifer recharge, the resource becomes depleted

http://www.texasep.orgl

Stream: body of running water that is confined to a **channel** and moves downhill due to gravity

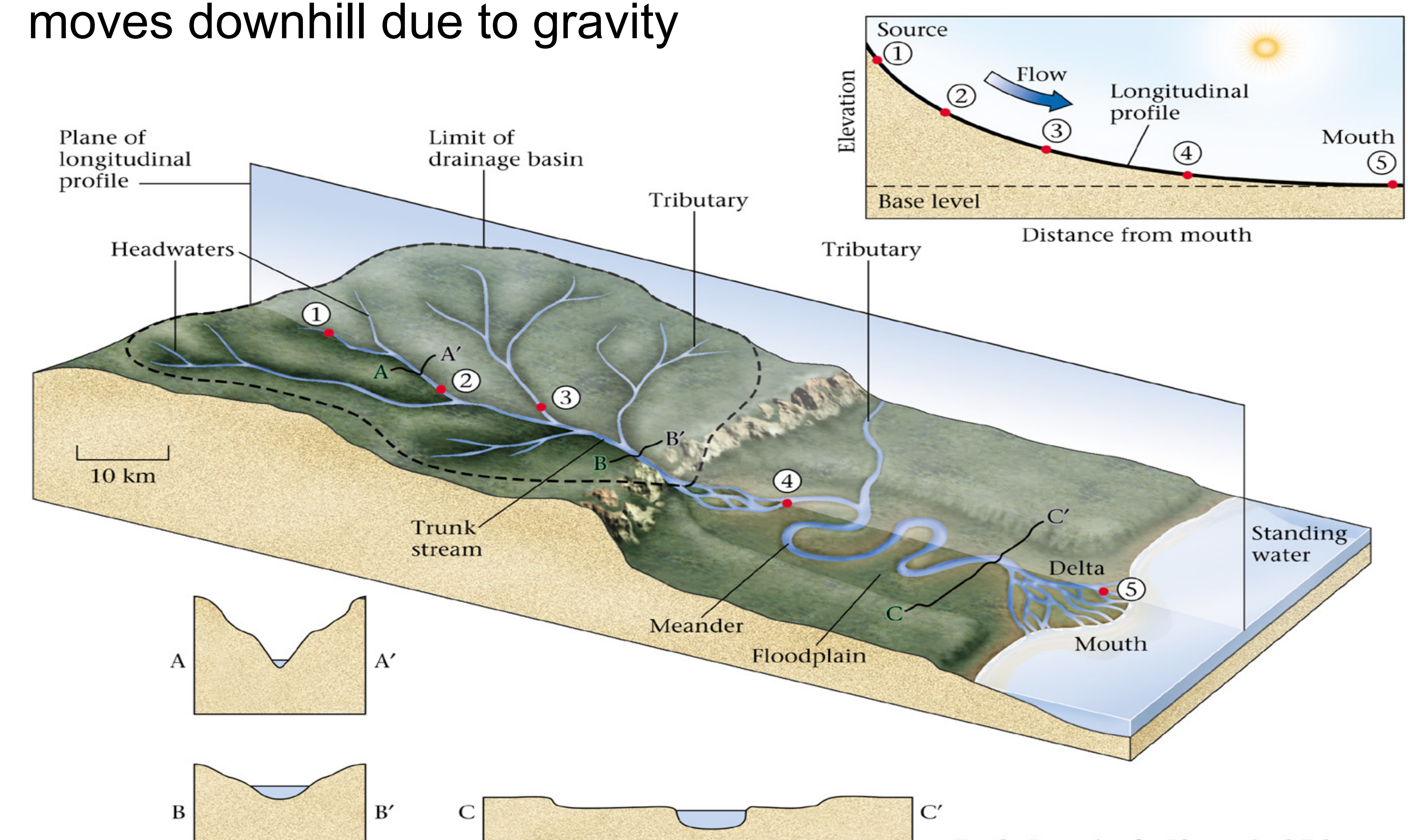


FIGURE 17.13

Earth: Portrait of a Planet, 2nd Edition

Drainage Basin: total area drained by a stream. Larger streams have larger drainage basins.

The size and composition of the sediment carried by the stream depends on the nature of the drainage basin.

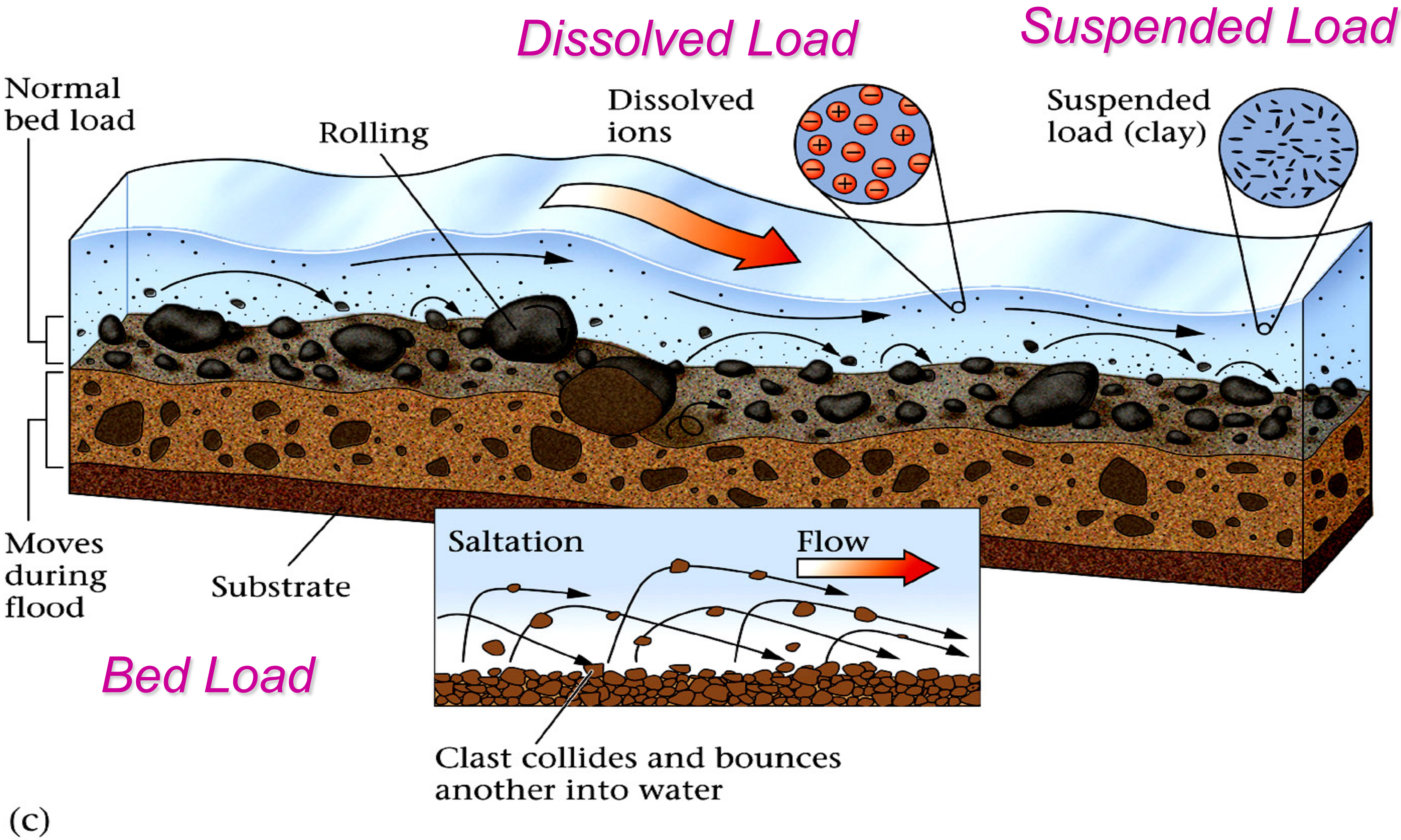


FIGURE 17.11

Earth: Portrait of a Planet, 2nd Edition

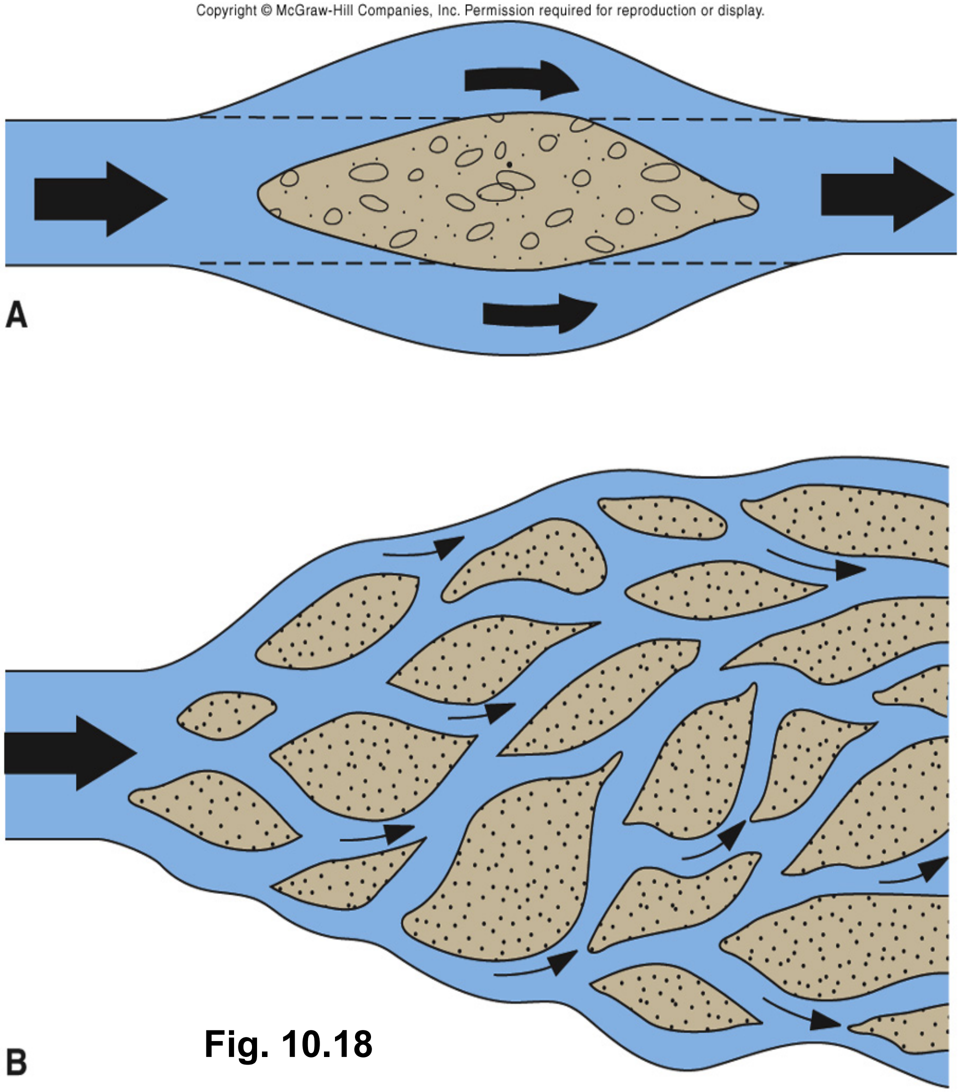


Fig. 10.18

Braided Streams

Streams with high sediment loads deposit lots of channel bars. The stream moves around the bars, wending through the barriers.

Usually found near sediment source areas and/or areas with easily eroded substrate.

Braided stream fed by a glacier in Alaska. The sediment load is very high, and the substrate is loose sediment.

(b)

FIGURE 17.21

Earth: Portrait of a Planet, 2nd Edition

Meandering Stream

Deposition occurs on point bars, where stream velocity is low

Erosion occurs on cutbanks, where stream velocity is high

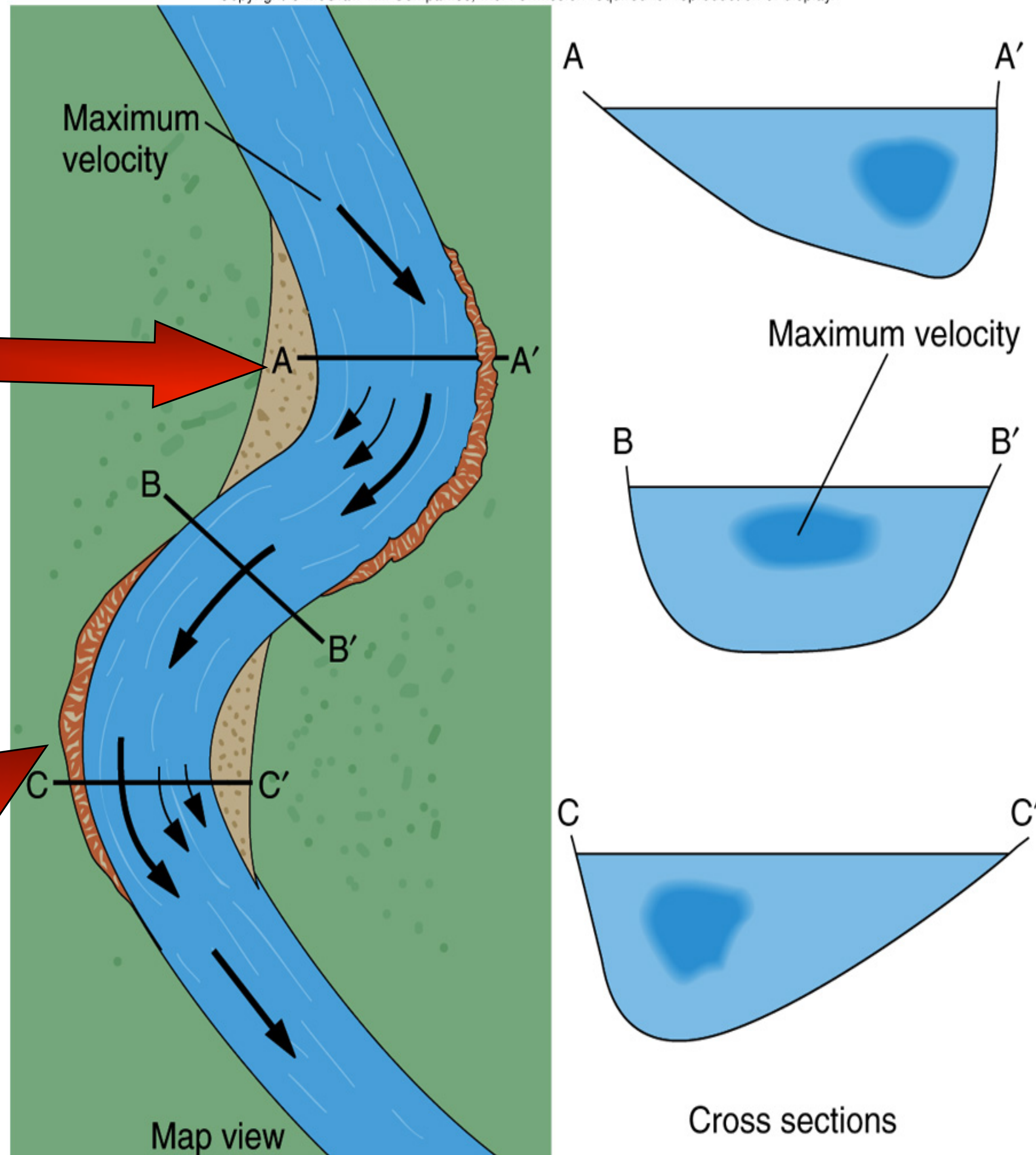
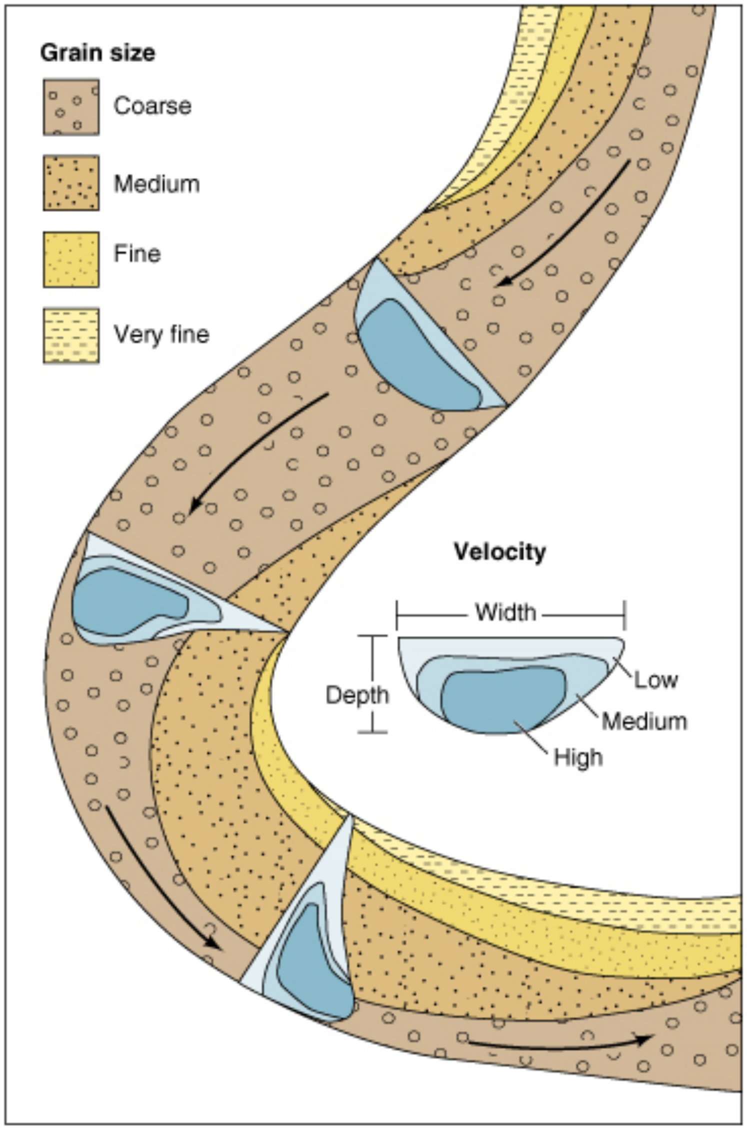


Fig. 10.06

Meandering Stream



http://www.usd.edu/esci/figures/

Fine-grain sediment is usually deposited in:

point bars - sediment deposited on the banks of a stream

channel bars - sediment deposited within the stream channel

Coarse-grain sediment is usually found in the stream channel. The largest clasts move only during floods

Meandering Streams

Once started, a meander tends to become more pronounced through lateral erosion.

The cutbank at the start of the meander frequently cuts through the meander neck, diverting the flow of water.

New sediment deposition isolates the old meander from the stream, forming an oxbow lake.

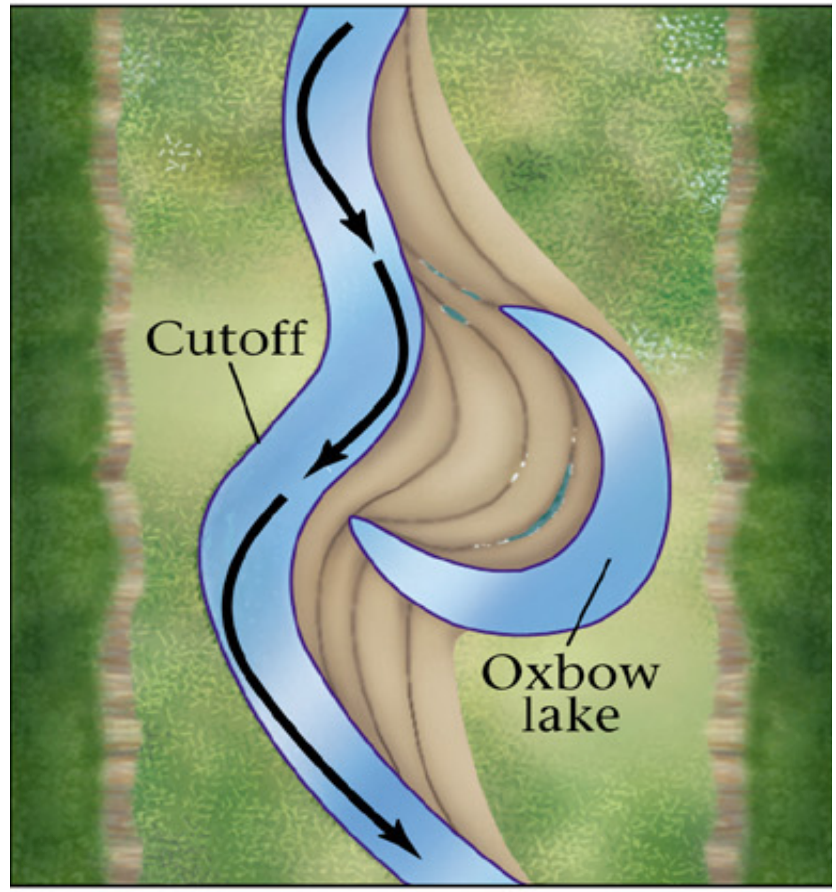
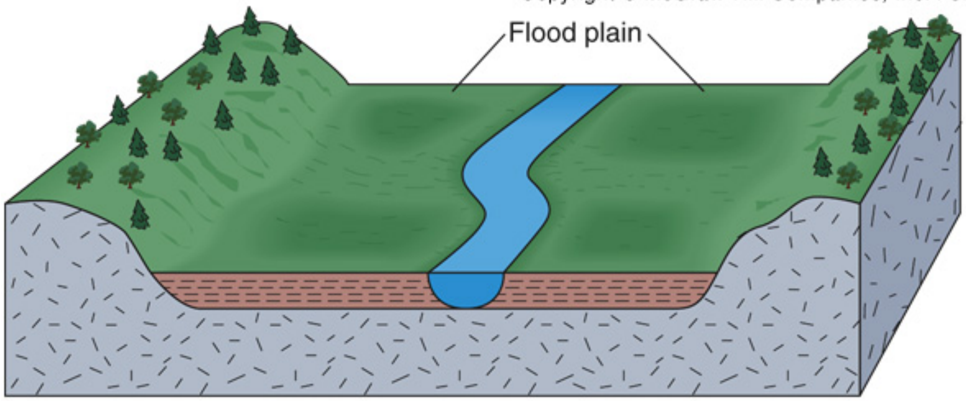


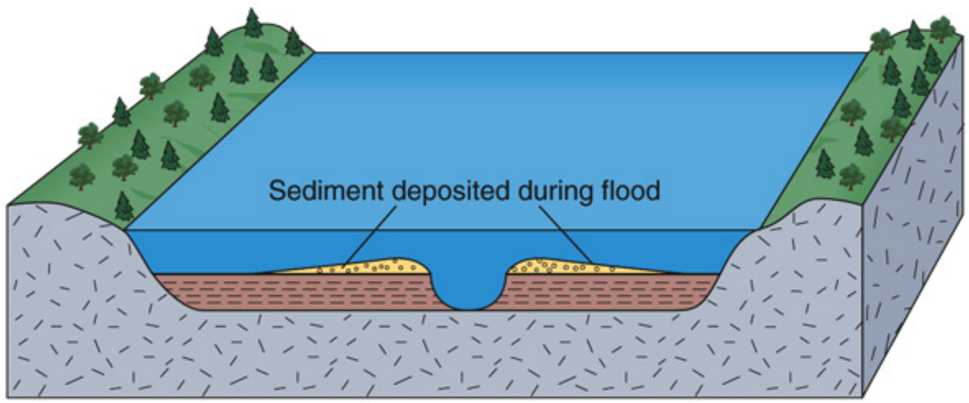
Fig. 10.24

Photo by W. R. Hansen, U.S. Geological Survey



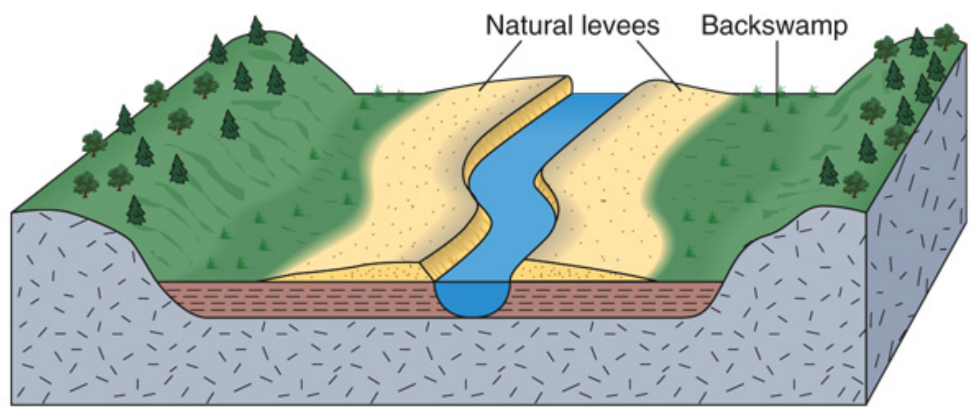
A

Flood Plain: area habitually flooded by a stream at high water. Contains fine-grain sediment deposited during flooding



B

Natural levee: low ridges formed along sides of main stream channel during flooding.



C

Fig. 10.27

Stream Budget

Water In (Inflow)

Discharge from upstream

Surface runoff

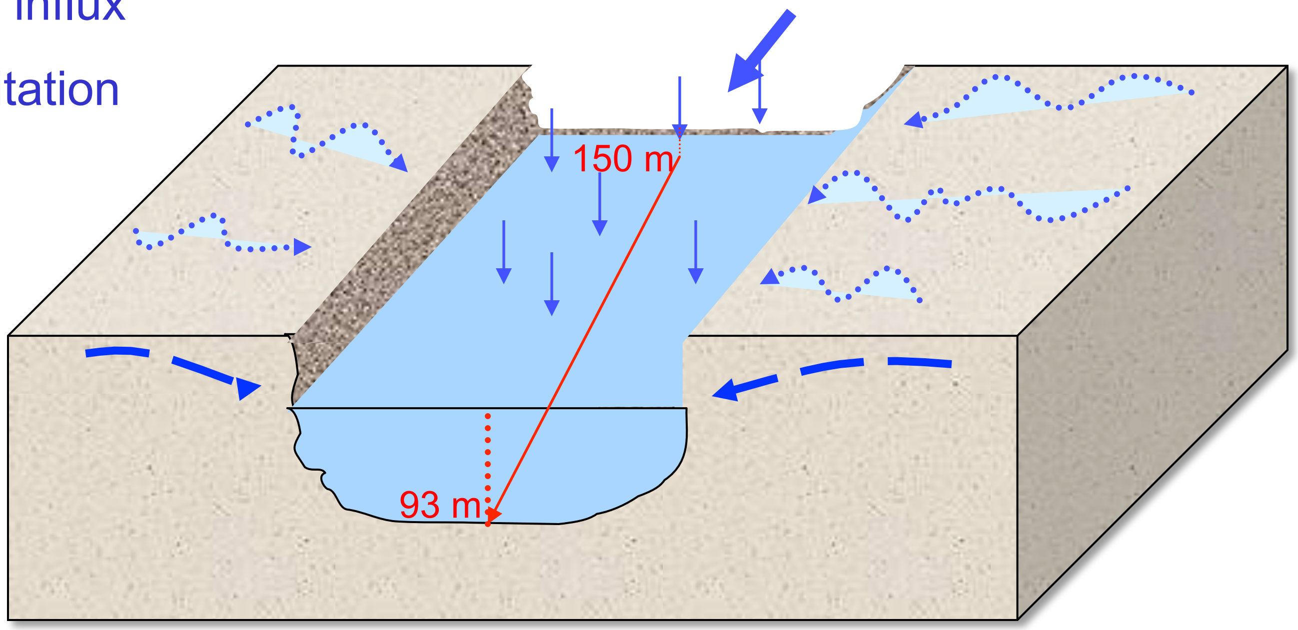
Groundwater influx

Direct precipitation

Water Out (Outflow)

Rate (slope-dependent)

Capacity (shape-dependent)



I <=> O normally

I > O channel fills

If channel fills completely, river can overflow banks and flood

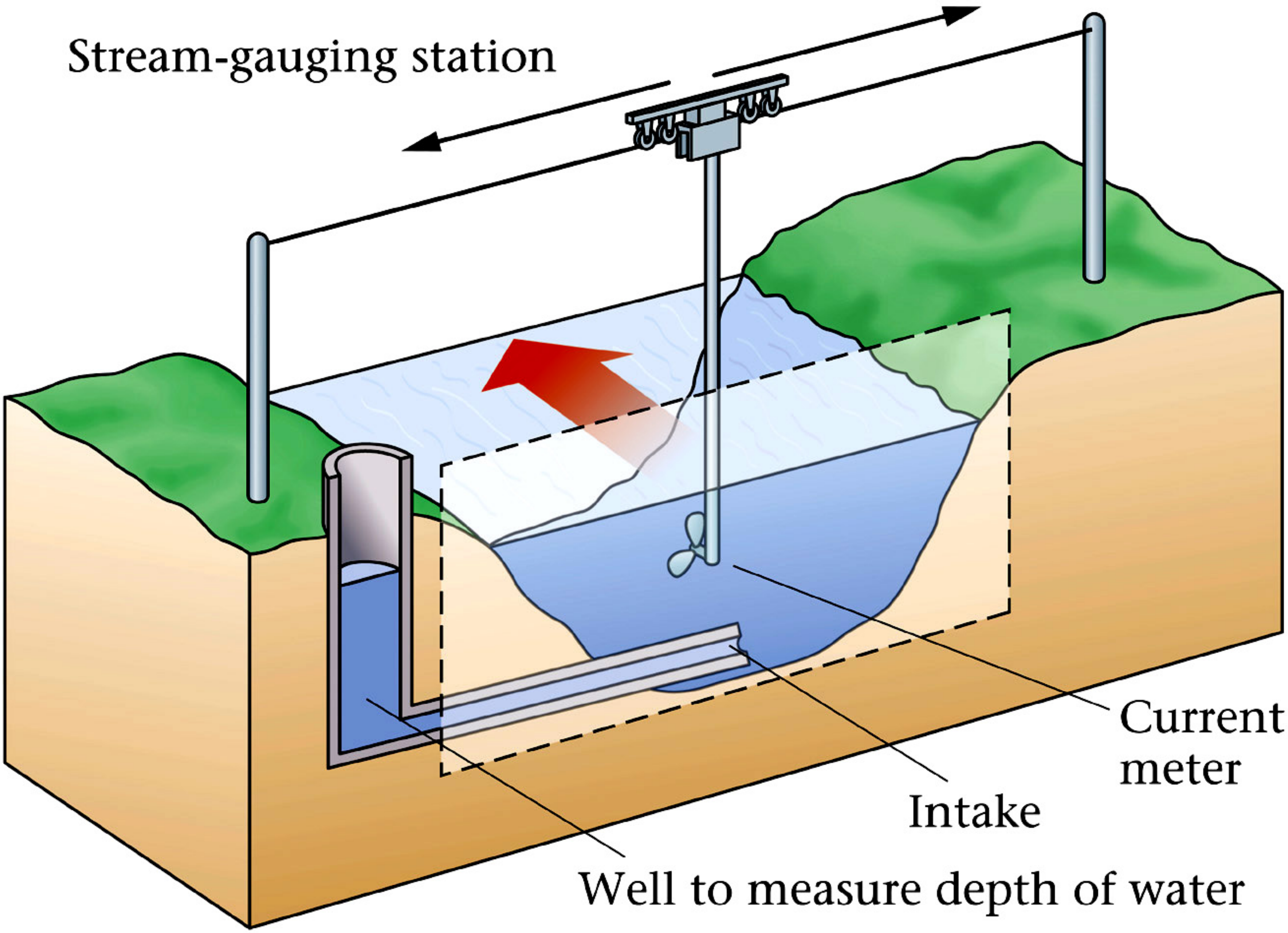
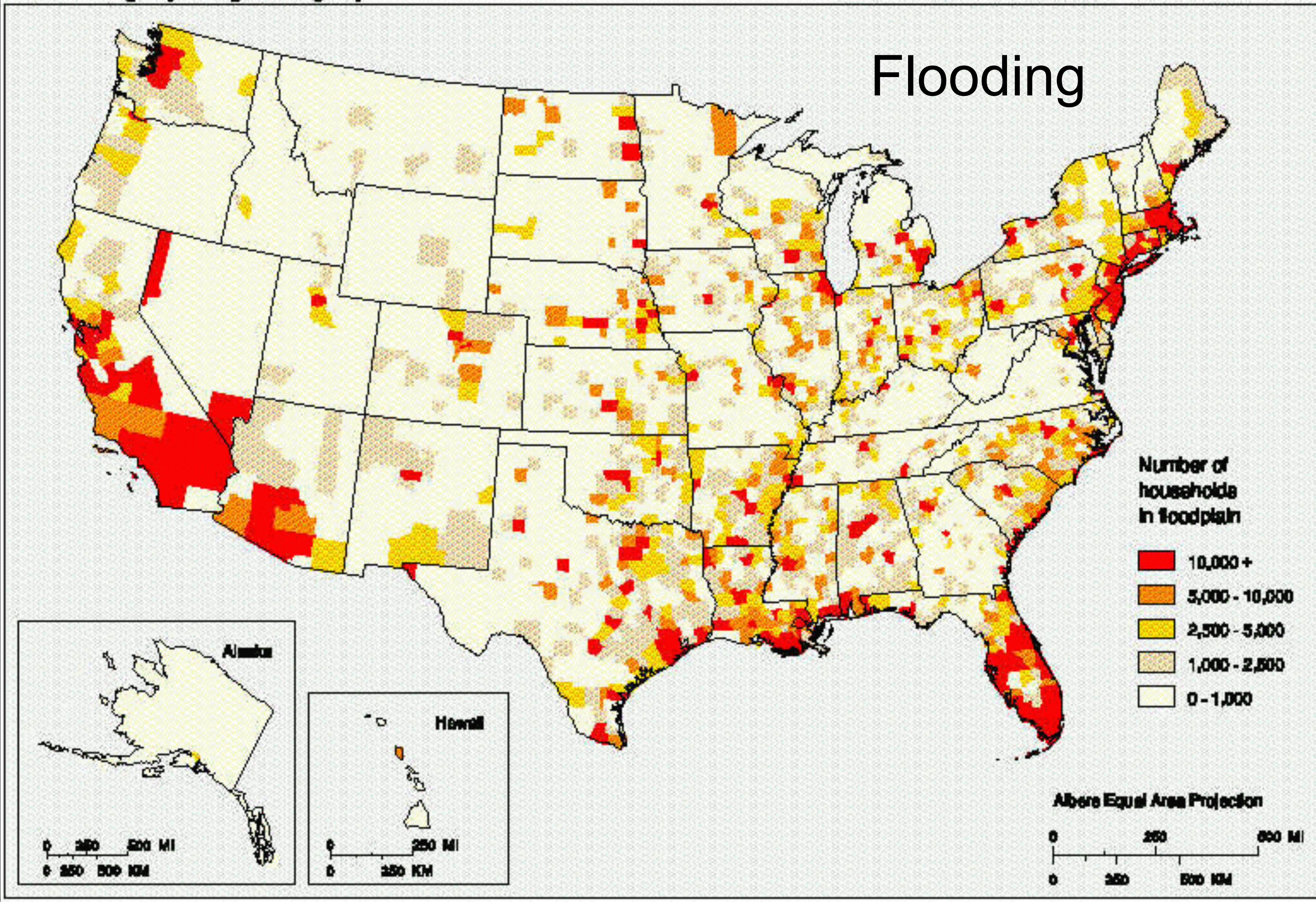

Stream-gauging station
Current meter
Intake
Well to measure depth of water

FIGURE 17.8

Federal Emergency Management Agency

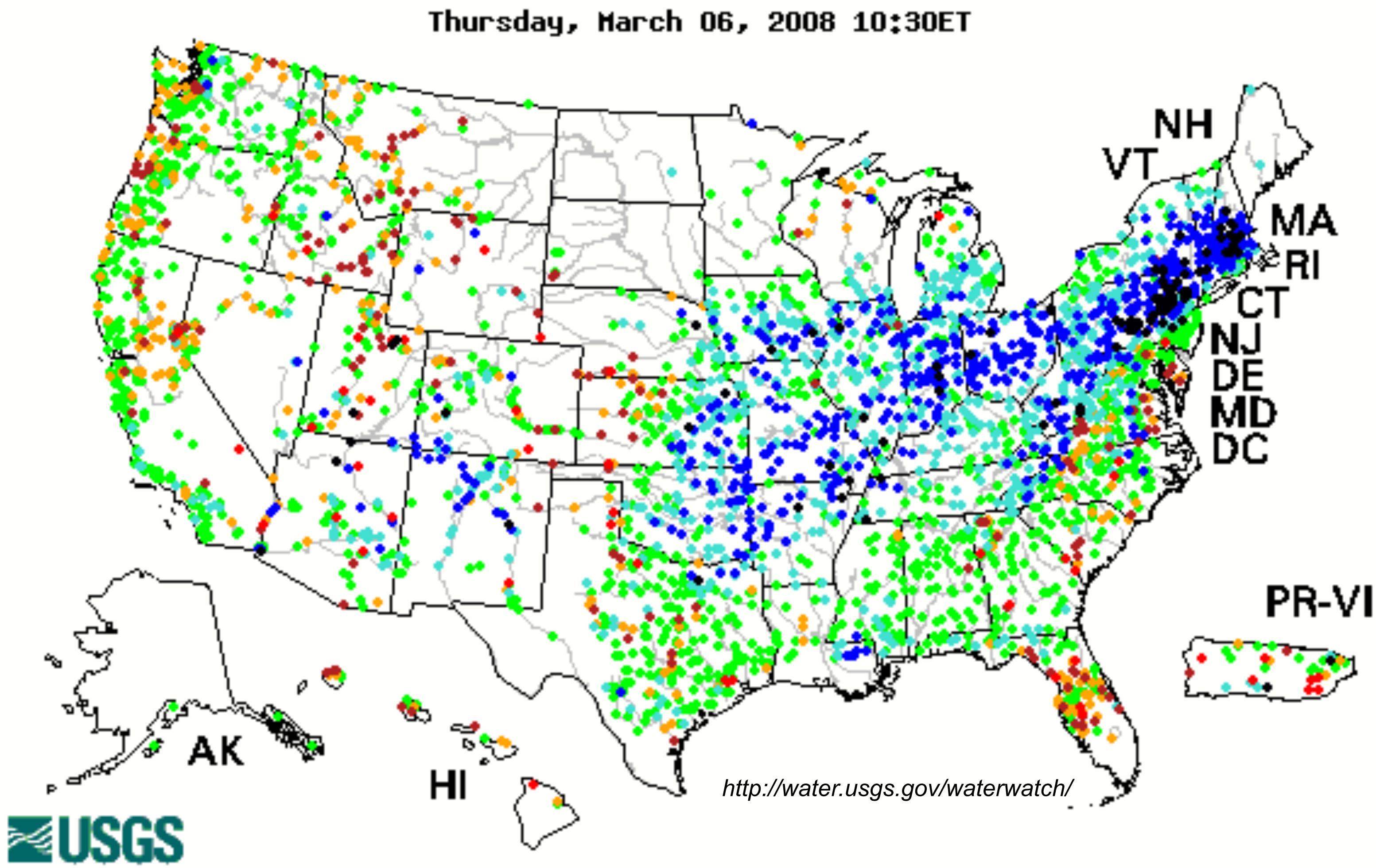
Multi Hazard Identification and Risk Assessment - 1995

Flooding



Map 12-1 Geographic distribution by county of households in the United States in the special flood hazard area.
Data not available for Puerto Rico, U.S. Virgin Islands, and Pacific Territories
(Source: FEMA, 1995)

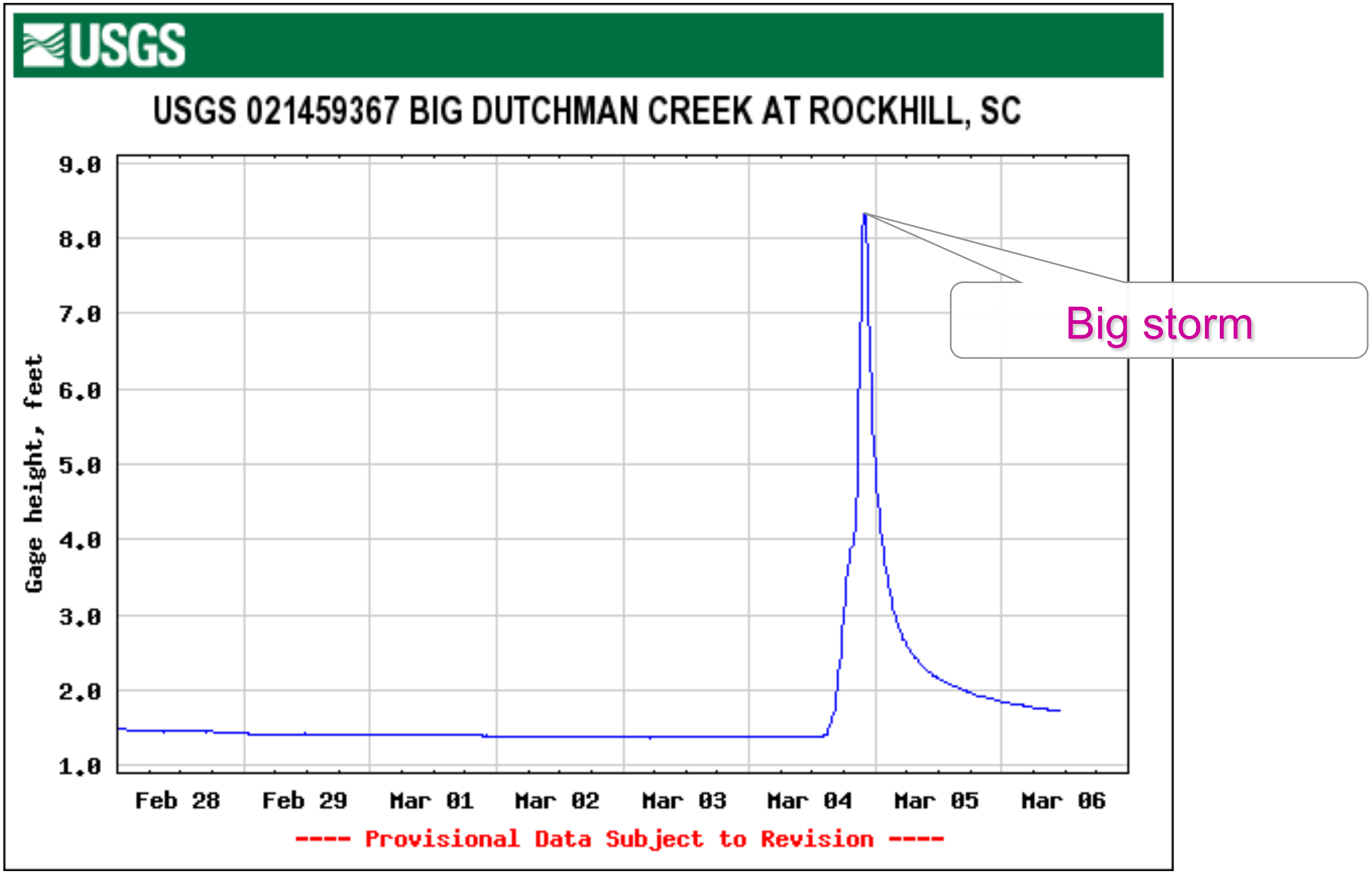
WaterWatch



Current water resources conditions. Map of real-time streamflow compared to historical streamflow for the day of the year (United States).

Blue and black dots indicate high relative percentages, green is normal, orange and red are low values

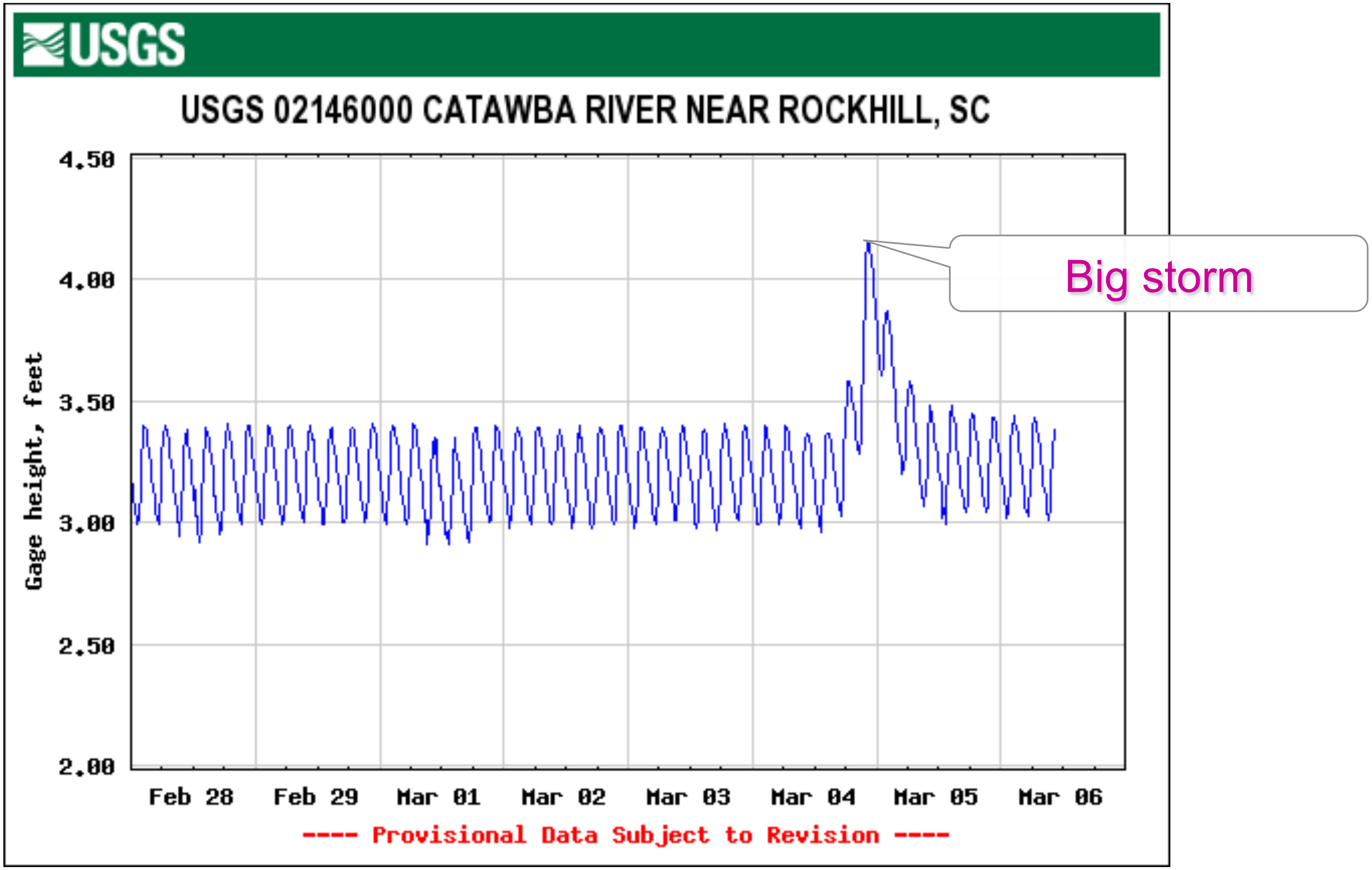
WaterWatch



The WaterWatch system allows you to download data from individual monitoring stations. This is the data from earlier this year for the gauge hanging over the Mount Gallant Rd. bridge over Big Dutchman Creek.

http://waterdata.usgs.gov/

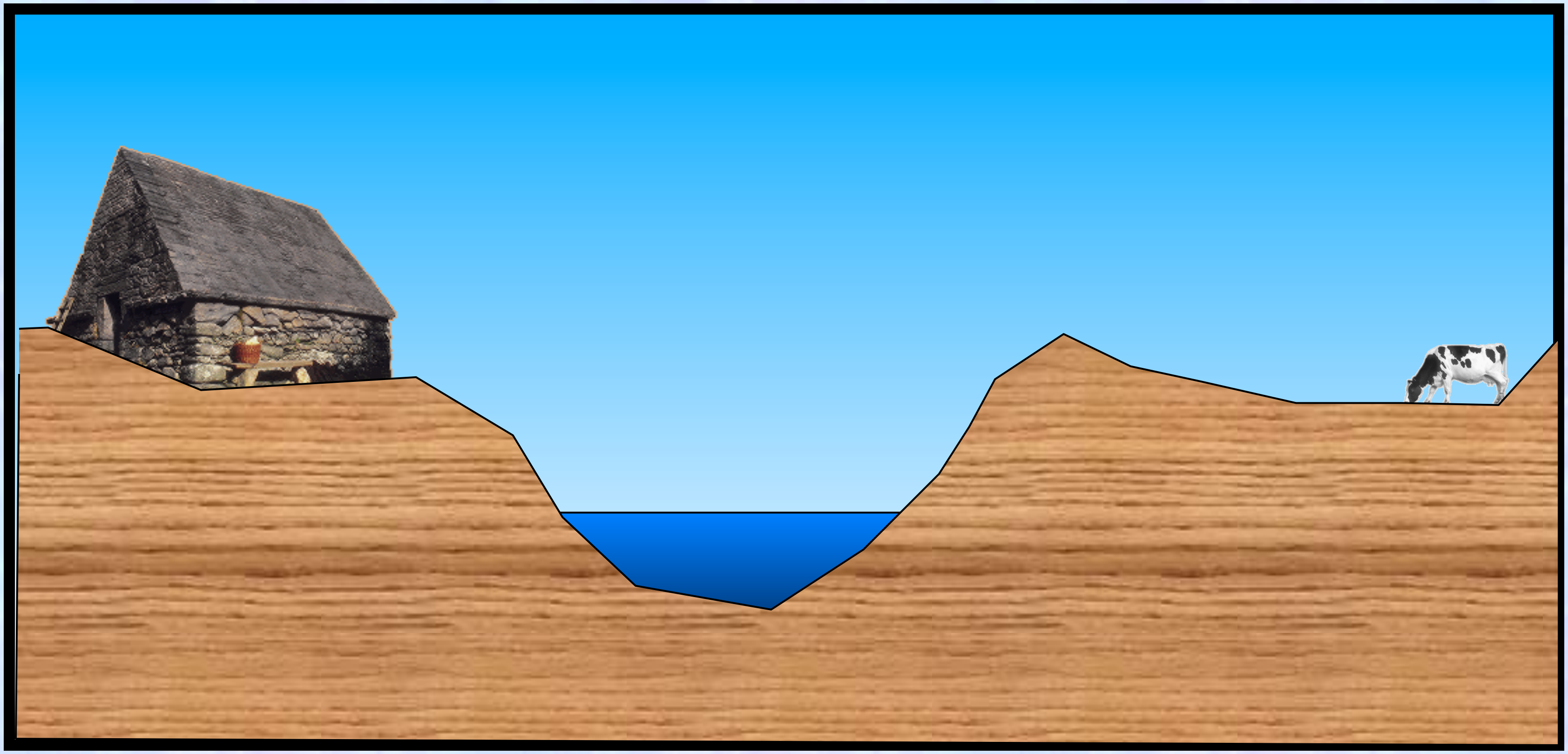
WaterWatch



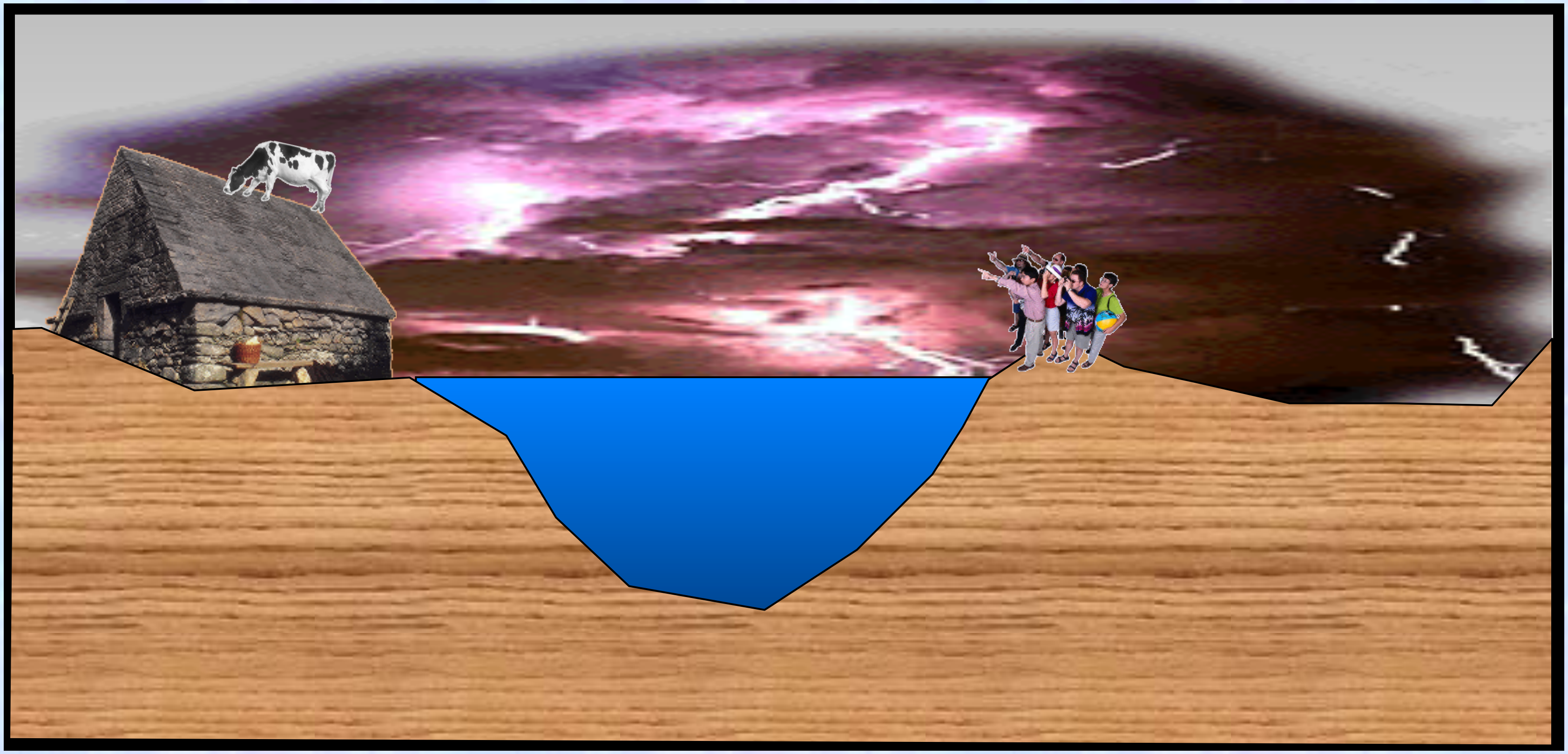
This is from a gauge from below one of the dams on the Catawba river. The weird pattern is caused by controlling outflow from a hydroelectric dam.

http://waterdata.usgs.gov/

Normal Stage



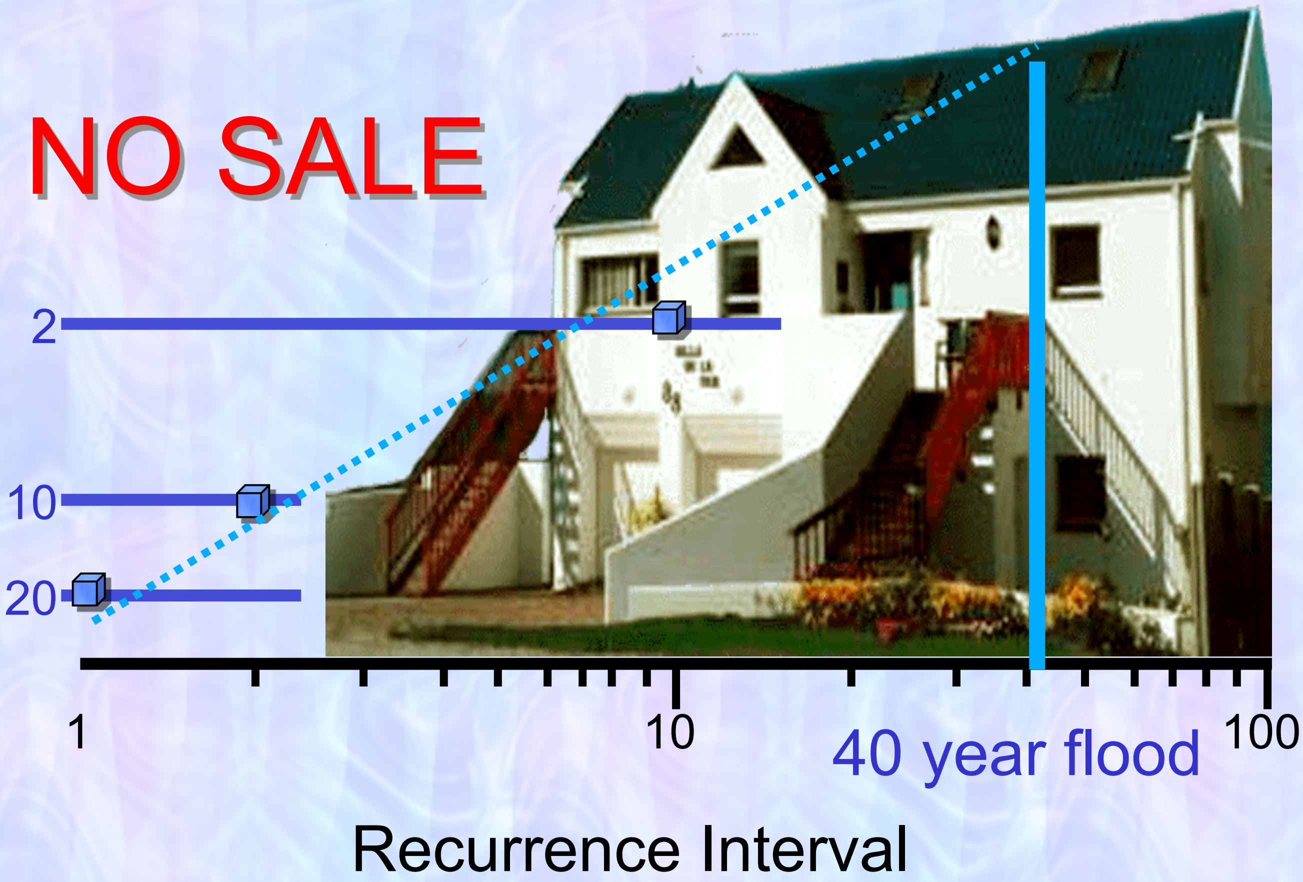
Bankfull Stage



http://www.globalsecurity.org/military/facility/html/new-orleans_050908_1234579.htm

Dream Home?

20 Year Flood Record



Dream Home?

What is the probability of this house drowning while you own it?

$$\text{Probability} = 1 - (1 - (1 / \text{return interval}))^{\text{elapsed interval}}$$

$$\text{Probability} = 1 - (1 - (1 / 40))^{20 \text{ years}} = 40\%$$

Elapsed Interval (yrs)	Flood Probability
5	12%
10	22%
15	32%
20	40%
40	64%
60	78%
100	92%
120	95%

Discharge

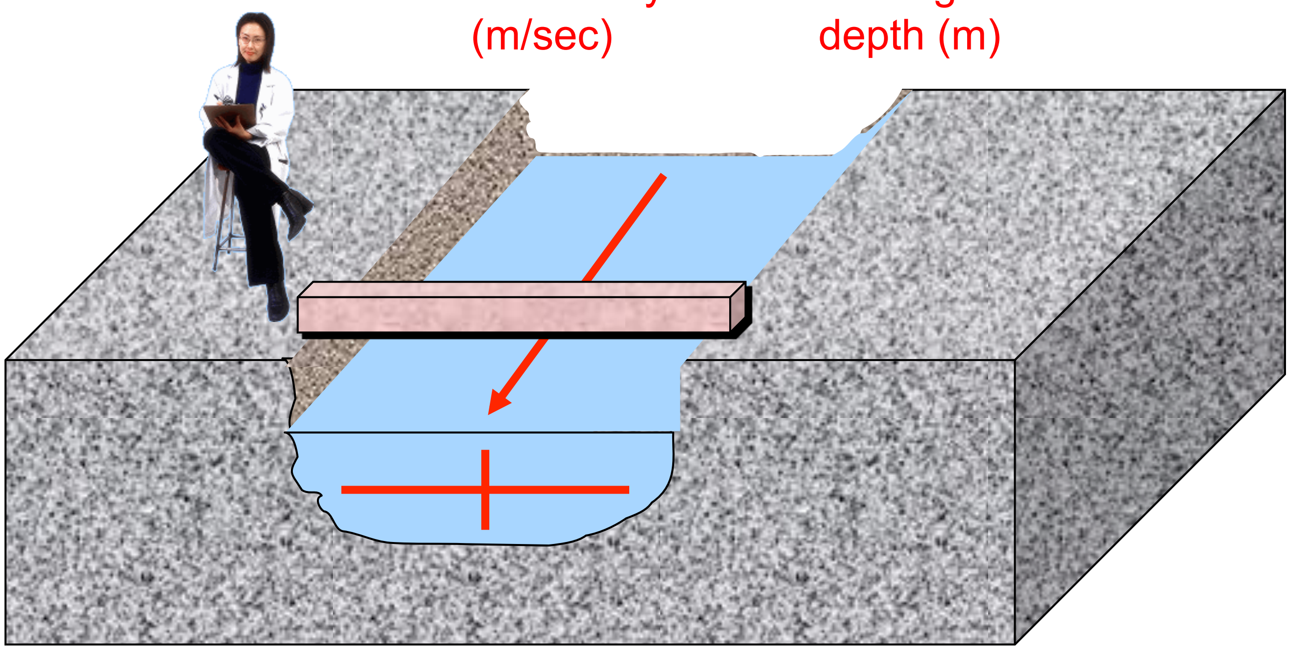
Volume of water per unit time that passes a specific point on the river.

average width (m)

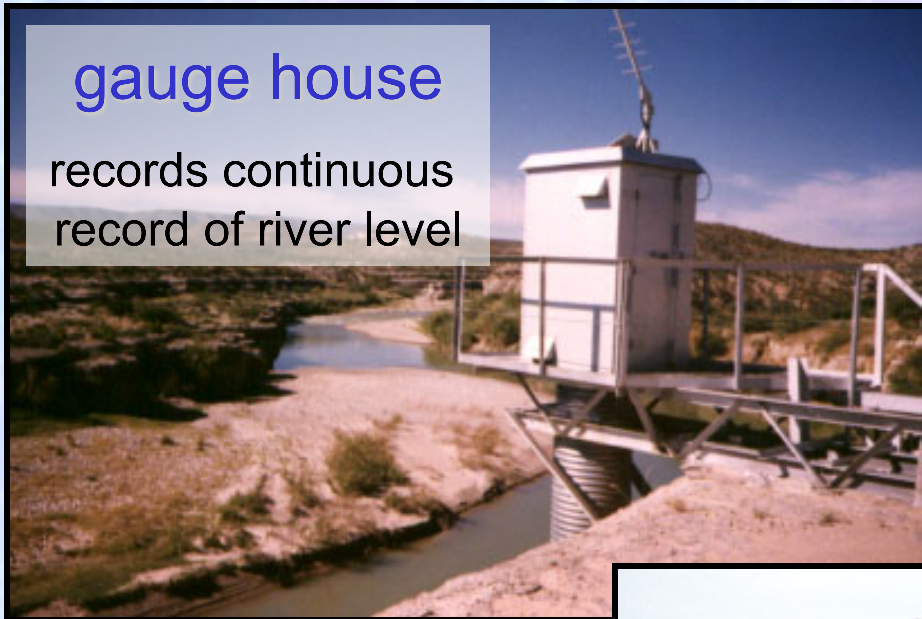
$$Q = V \quad W \quad D \quad m^3/s$$

water velocity (m/sec)

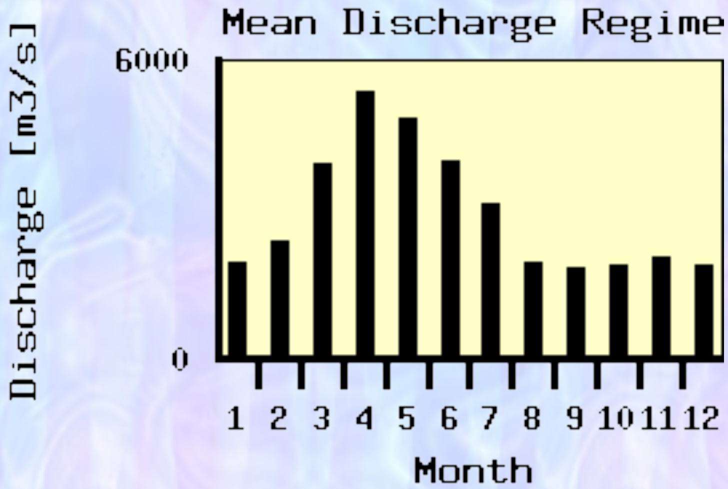
average depth (m)

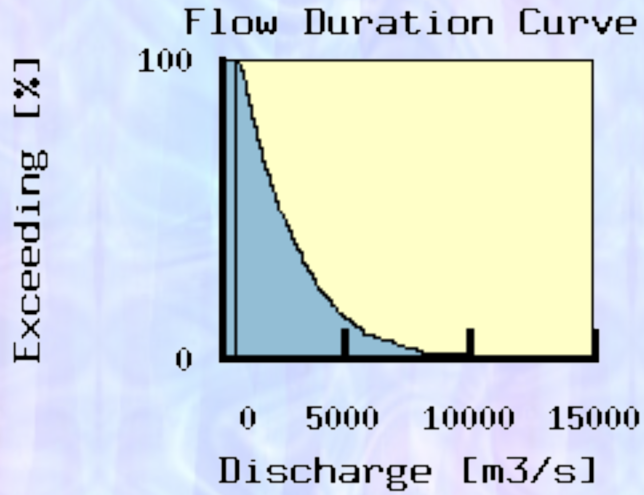


Tracking Discharge

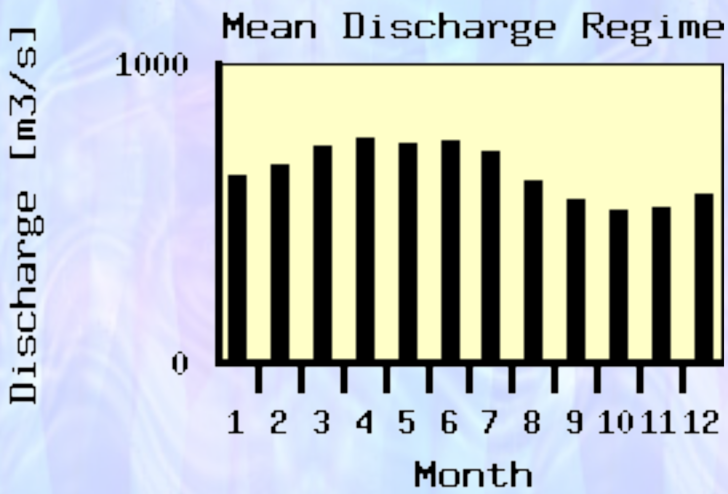


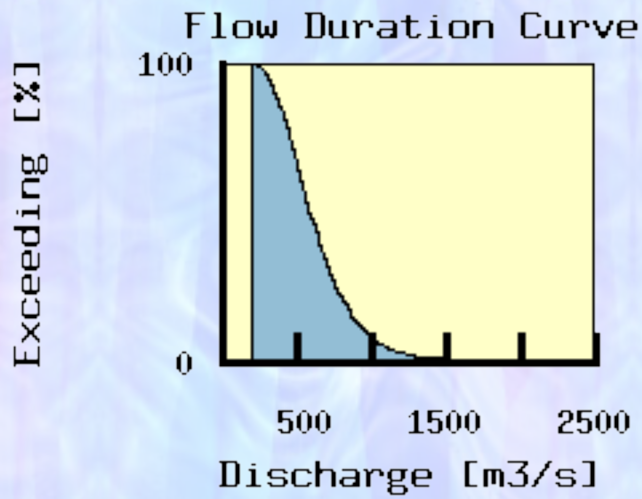
Mississippi River (Alton, Illinois)





Danube River





Determining Return Interval (RI) based on maximum yearly discharge (Q_{max})

Weibull Equation

$$RI = \frac{(n+1)}{m} = \frac{(\text{\# of years recorded} + 1)}{\text{rank of recorded value}}$$

Fake River

year	Q_{max}	rank	RI
1963	2550	1	8.0
1964	2490	2	4.0
1970	1280	5	1.6
1971	1380	4	2.0
1980	1600	3	2.7
1982	1240	6	1.3
1986	1230	7	1.1

Fake River