


Lesson 17. Water Quality



Water Resources & Health

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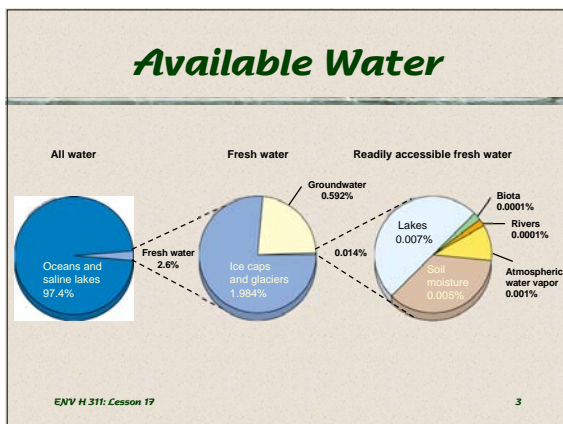
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How much fresh water is available?

- ❖ Ocean water - 97.4%
- ❖ Most of the remaining 2.6%
- ❖ locked up in ice caps or glaciers
- ❖ Very deep groundwater
- ❖ too salty to be used

- ❖ What's left for us to use?

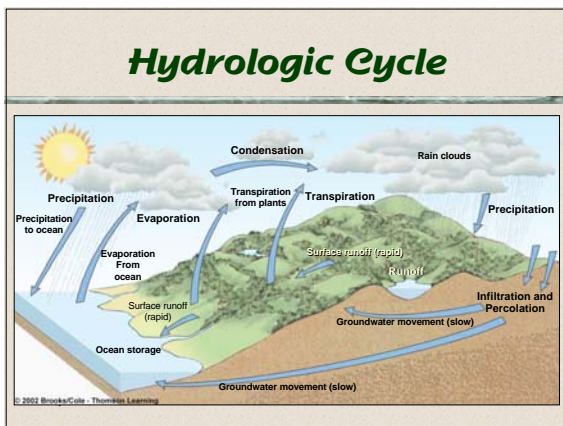
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Hydrologic Cycle

❖ How does fresh water cycle through the biosphere?

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Key Terms

- ❖ Evaporation
- ❖ Transpiration
- ❖ Condensation
- ❖ Precipitation
- ❖ Infiltration
- ❖ Percolation
- ❖ Runoff

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Random Water Facts

- ❖ Most precipitation ever recorded?
- ❖ Mount Waialeale on Kauai, Hawaii.
Annual average rainfall = 460 inches
- ❖ That's 38.3 feet of water!!
- ❖ Seattle = 36 inches / year

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Random Water Facts

- ❖ Driest place on record?
- ❖ Arica, Chile
- ❖ Averages 0.03 inches / year of rain
- ❖ Out of the 61 years of data, 14 of those years had no rain at all

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What is surface water?

- ❖ Fresh water that arrives by precipitation
- ❖ Rivers, Lakes, Streams, Wetlands

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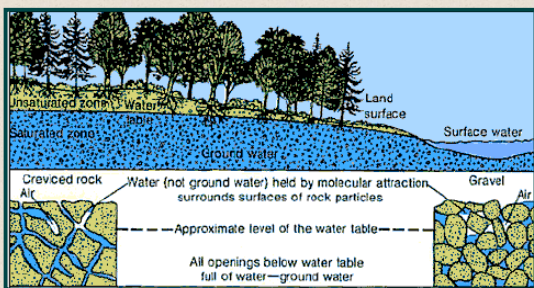
What is Groundwater?

- ❖ Precipitation infiltrates the ground and percolates downward through voids in soil and rock.
- ❖ Moves from high elevation to low elevation.
- ❖ Moves slow - 3 feet / year.

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Ground Water



Zone of Saturation

- ❖ Where the voids are completely filled with water.

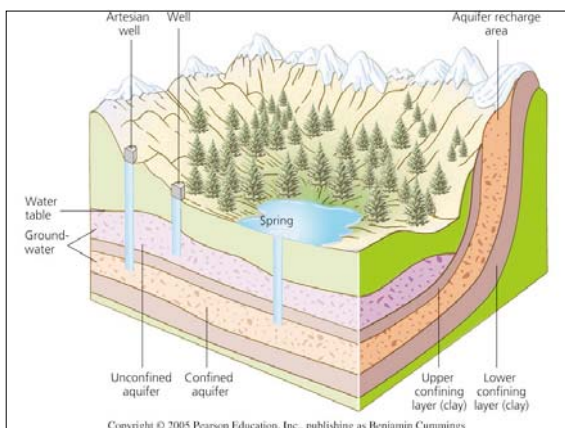
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What is a Water Table?

- ❖ Located at the top of zone of saturation.
- ❖ This table rises with wet weather, lowers with dry weather.

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Aquifers

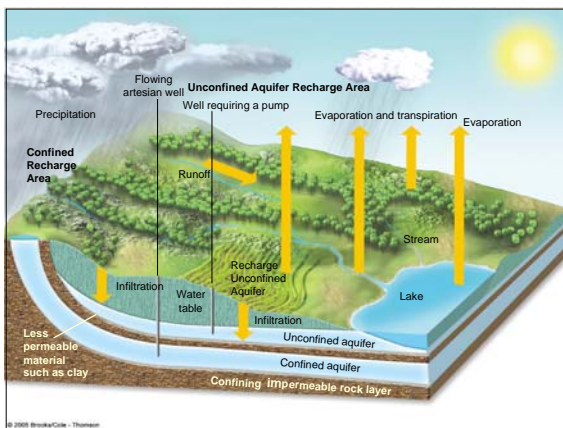
- ❖ "water layer"
- ❖ Porous, water-saturated layers of sand, gravel, or bedrock through which groundwater flows.
- ❖ Like long sponges through which groundwater seeps.

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Aquifers

- ❖ Unconfined - no confining layers above it. Top of water table.
- ❖ Confined - water layer is bounded above and below it with impervious soils (clay).
 - Water is under pressure.

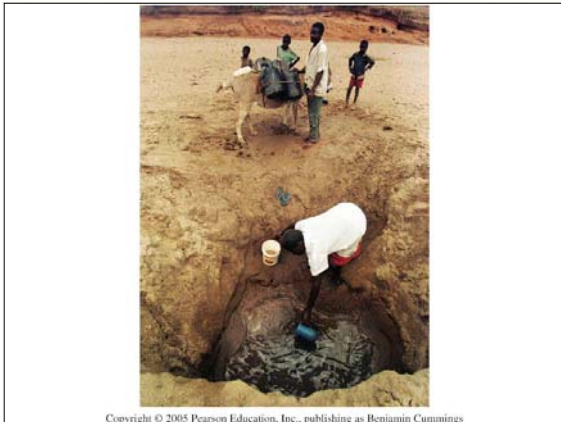
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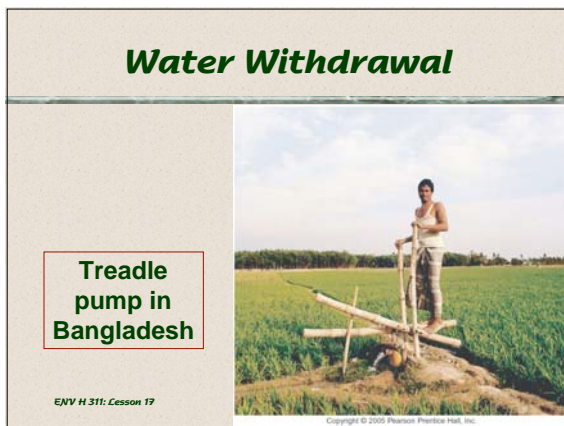


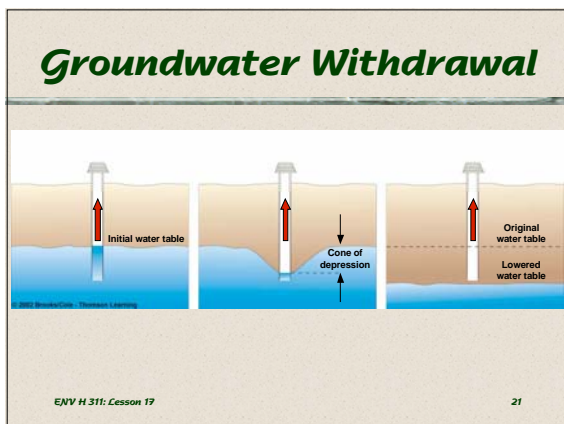
Aquifers

- ❖ Recharge area - area of land through which water passes downward or laterally into an aquifer.

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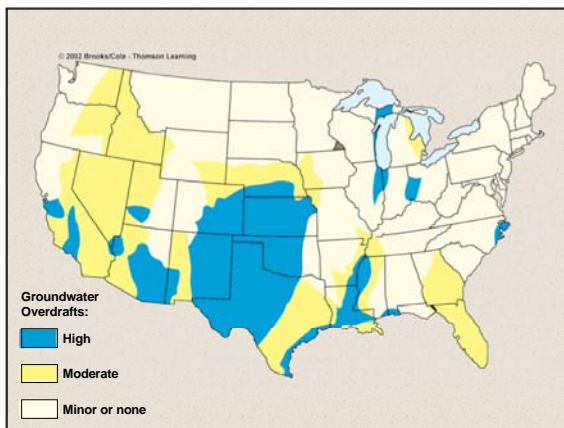




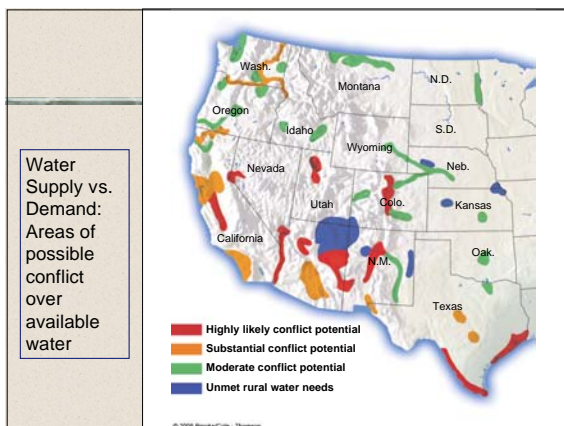




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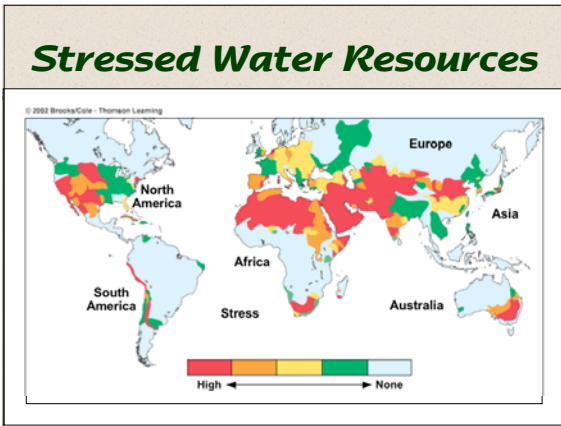


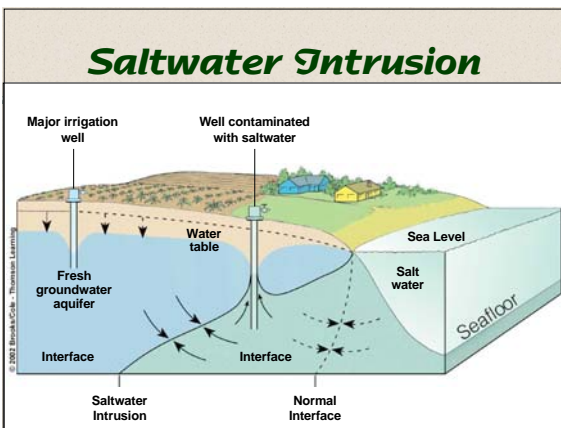
Groundwater Overdrafts:
High
Moderate
Minor or none

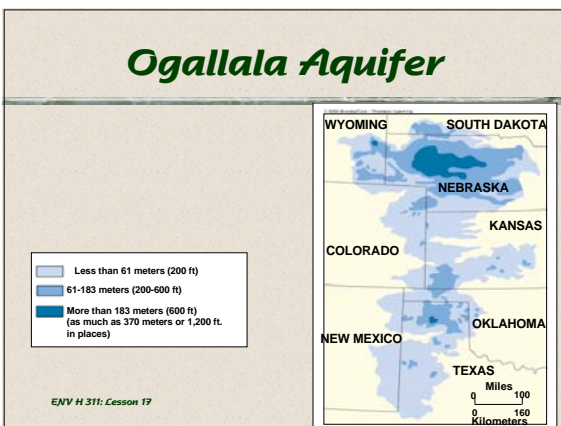


Water Supply vs. Demand:
Areas of possible conflict over available water

Highly likely conflict potential
Substantial conflict potential
Moderate conflict potential
Unmet rural water needs








Ogallala Aquifer Facts

- ❖ Largest groundwater system in N. America
- ❖ If pumped out over the US, would cover all 50 states with 1.5 feet of water.
- ❖ If completely drained, it would take more than 6,000 years to refill.
- ❖ 170,000 + wells pump out water from the aquifer.
- ❖ 50,000 of these wells are in NW Texas.

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How much water do Americans use?

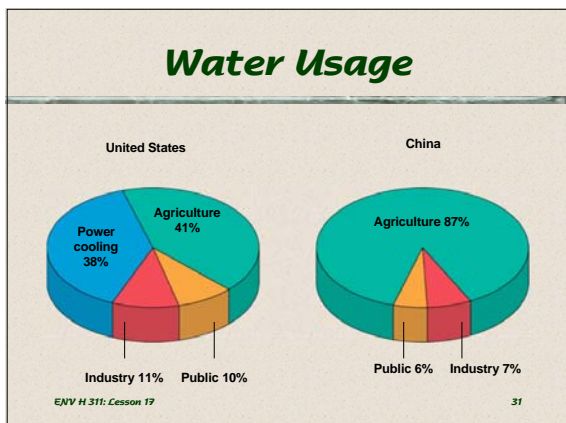


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Question

- ❖ Estimate how much water you use a day.

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How much do you use?

Typical Household Water Use		
Water use	%	Gal/person/year
Toilets Flushing	38	13,000
Bathing	31	10,600
Laundry & dishes	21	6,800
Drinking & Cooking	6	2,000
Teeth brushing etc	5	1,700
Total	100	34,200

Daily Water Use:

Activity	Gallons
Flushing toilet	1.5 - 7
Taking a shower	25 - 50
Taking a bath	36
Washing Clothes	35 - 60
Washing dishes (machine)	10
Brushing teeth	2
Washing hands	2
Watering the lawn	5 - 10 gal / minute

Total Daily Water Usage in the U.S.A.

- ❖ Utilities = 187 billion gal/day
- ❖ Irrigation = 137 billion gal/day
- ❖ Public supply = 36 billion gal/day
- ❖ Industry = 26 billion gal/day
- ❖ Rural & Livestock = 8 billion gal/day
- ❖ Total = 394 billion gal/day

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Another way of looking at it ...

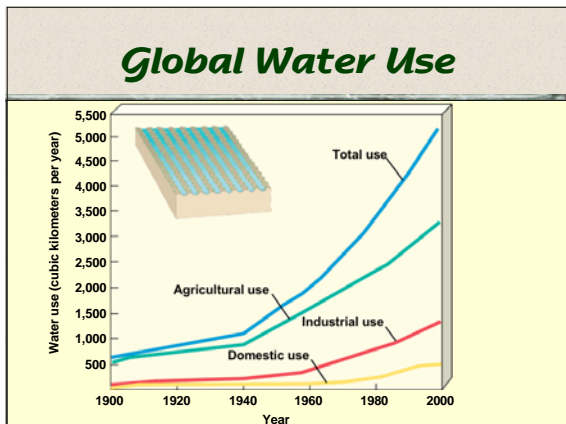
- ❖ USA - taking in account all water usage (agriculture, industry, & public) and dividing it by the number of people = 1,300 gals/person/day.
- ❖ Haiti = 8 gals/person/day

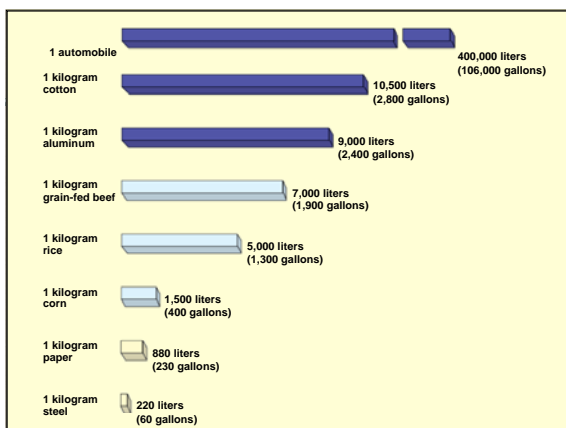
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Leaky faucets....

- ❖ Slow dripping spigot wastes 15 gals/day
- ❖ Slow stream can waste 400 gals/day

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Questions

- ❖ Do you prefer bottled water or tap water? Why?
- ❖ Which do you think is safer?

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Bottled Water Classifications

- ❖ **Artesian Well Water** - from a confined aquifer.
- ❖ **Mineral Water** - from an underground source that contains at least 250 ppm total dissolved solids. Minerals and trace elements must come from the source, not added later. Can be confined or unconfined.
- ❖ **Spring Water** - derived from an underground formation from which water flows naturally to the earth's surface. Must be collected at the source.
- ❖ **Well Water** - from an unconfined aquifer.


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Who's in charge?

- ❖ **FDA sets regulations for bottled water**
 - > Federally mandated, weaker laws, allows higher amounts of contaminants in water
 - > No treatment requirements
- ❖ **EPA sets regulations for tap water**
 - > Federal and state enforced (remember state can always make these laws stricter), laws stricter

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Where do we get our tap water from?



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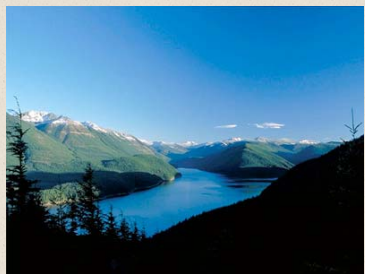


Cedar River Watershed

- ❖ If you live south of Greenlake, your water comes from the Cedar River.
- ❖ Supplies water to 1.3 million people.
- ❖ System has the capacity of 68.5 million gallons per day (MGD).
- ❖ System brought online 1901.

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Cedar River Watershed



Looking east across Chester Morse Lake towards the highest point in the watershed, Meadow Mountain.


<http://www2.cityofseattle.net/util/tours/CedarRiverTour/slide12.htm> 45

Tolt River Watershed

- ❖ If you live North of Greenlake or on the Eastside, this is where your water comes from.
- ❖ Can supply up to 100 MGD.
- ❖ System brought online in 1964.

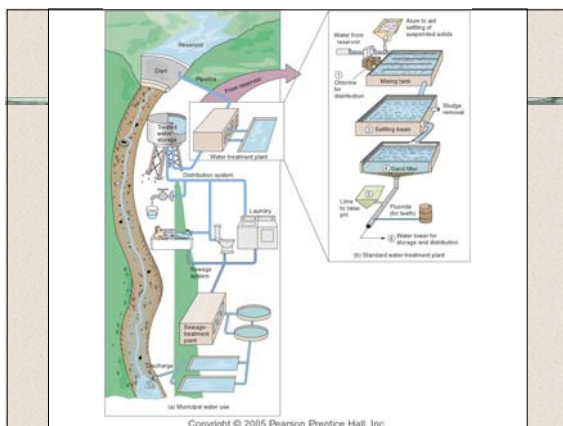
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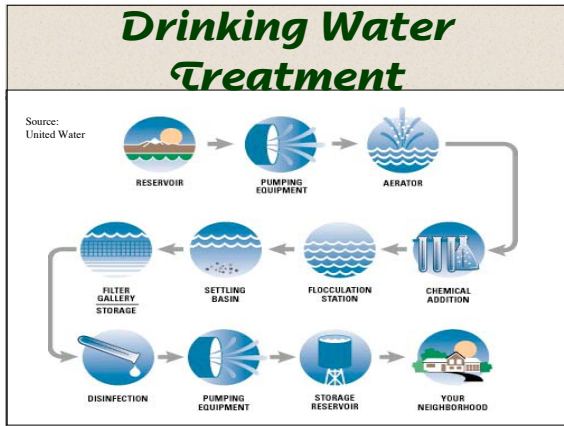
Tolt River

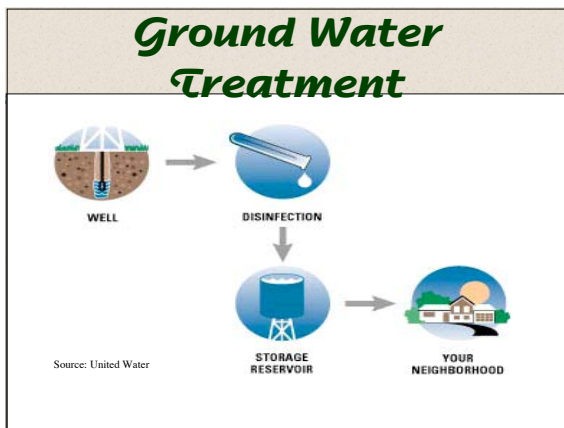


The steep slopes surrounding the Tolt Reservoir form the boundaries of the South Fork Tolt River Watershed and are being reforested to preserve water quality.

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Water Storage facilities

- ❖ Adequate pressure for proper delivery
- ❖ Uniform pumping rate and water supply
- ❖ Detention time for disinfection
- ❖ Reserve water to meet peak demand
- ❖ Water for fire protection
- ❖ Blending of water sources
- ❖ Backwashing

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Water Quality

Water Quality

- Health Effects
- Treatment



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Water Quality


- ❖ Aesthetics
 - Color
 - Odor
 - Taste
- ❖ Biological (Microorganisms)
- ❖ Chemical (Organic & Inorganic)
- ❖ Physical (Radiation Standards)



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Water Contamination

Concept of the Water Cycle



Notes:
 1) Precipitation in this figure is the average precipitation over 50 years from 1967 to 1996.
 2) Other values are the averages from April 1994 to March 1997.
 3) Outflow of 1000 trillion liters calculated as follows:
 (Precipitation - evaporation - infiltration) + water supply + leakage + factory pump discharge + inflow to groundwater + outflow
 1420 - 412 - 988 = 100 + 100 = 100 + 100 = 100

Health Effects



- ❖ Indirect
 - ➔ Drought
 - ➔ Floods
 - ➔ Insanitary conditions
- ❖ Direct
 - ➔ Disease


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Health Effects

- ❖ Two main transmission routes
 - Contamination of drinking water supplies
 - Water contact

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Waterborne Disease



Chemical Contamination

- Agriculture
- Industry
- Transportation
- Residential

Fecal Contamination

- Human Wastes
- Livestock
- Wildlife

Soil

- Bacteria
- Minerals, etc.
- Radioactive Elements

Due Miller / World Resources Institute

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Waterborne Diseases

- Acute Diarrhea
- Amebic Dysentery
- Cholera
- Cryptosporidiosis
- Giardiasis
- Infectious Hepatitis
- Legionellosis
- Shigellosis
- Typhoid Fever
- Viral Gastroenteritis
- Neurological and Systemic Poisonings

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Exposure



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Causative Agents

- ❖ Amebic Dysentery
 - > *Entamoeba histolytica*
 - > 20 cysts
- ❖ Cholera
 - > *Vibrio cholerae*
 - > 100,000,000 - 1,000,000,000 organisms
- ❖ Diarrheal Disease
 - > *Escherichia coli*
 - > 100,000,000 organisms

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Causative Agents *Continued*

- ❖ Giardiasis
 - > *Giardia lamblia*
 - > 100 organisms
- ❖ Shigellosis
 - > *Shigella dysenteriae*
 - > 10 - 100 organisms
- ❖ Typhoid Fever
 - > *Salmonella typhi*
 - > 100,000 organisms

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Causative Agents *Continued*

- ❖ Viral Gastroenteritis
 - > Miscellaneous Viruses
 - > 1 organism
- ❖ Chemical Contaminants
 - > Inorganics -- systemic toxicity
 - > Organics -- chronic diseases

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Disease Transmission

- ❖ Approximate Survival Time of Certain Pathogens in Water
 - > *Vibrio cholerae*: 3-9 days
 - > *Salmonella typhi*: 1 day - 2 months
 - > *Entamoeba histolytica*: 1 month
 - > *Shigella sp.*: 1 - 24 months

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Waterborne Disease United States, 1999-2000

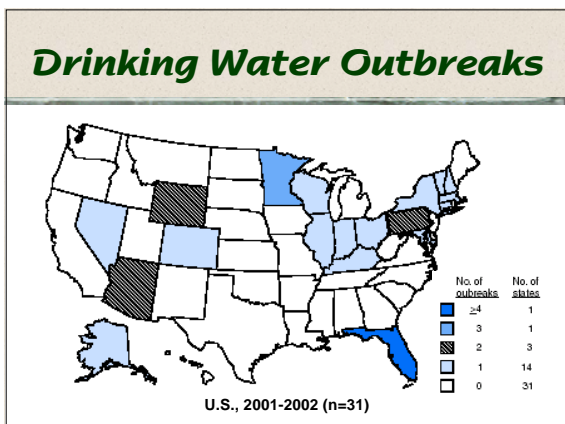
- ❖ From Drinking Water:
 - > 39 Outbreaks
 - 38 in 25 states
 - 1 spanned 10 states
 - > 2,068 Cases
 - > 2 Deaths
- ❖ From Recreational Waters
 - > 59 Outbreaks in 23 states
 - > 2,093 Cases
 - > 4 Deaths

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Waterborne Disease United States, 2001-2002

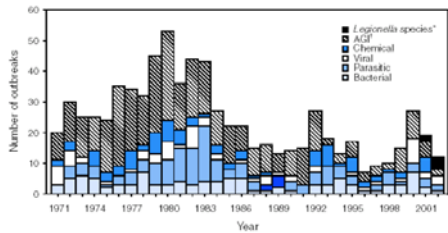
- ❖ From Drinking Water:
 - > 31 Outbreaks
 - 38 in 19 states
 - 1 spanned 10 states
 - > 1,020 Cases
 - > 7 Deaths
- ❖ From Recreational Waters
 - > 65 Outbreaks in 23 states
 - > 2,536 Cases / 81 Hospitalized
 - > 8 Deaths

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Drinking Water Outbreaks

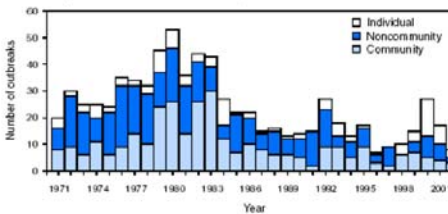
FIGURE 3. Number of waterborne-disease outbreaks (n = 764) associated with drinking water, by year and etiologic agent — United States, 1971–2002



* Beginning in 2001, Legionnaires disease was added to the surveillance system, and Legionella species were classified separately.
† Acute gastrointestinal illness of unknown etiology.

Drinking Water Outbreaks

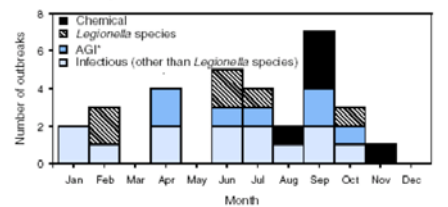
FIGURE 4. Number of waterborne-disease outbreaks (n = 758)* associated with drinking water, by year and type of water system — United States, 1971–2002



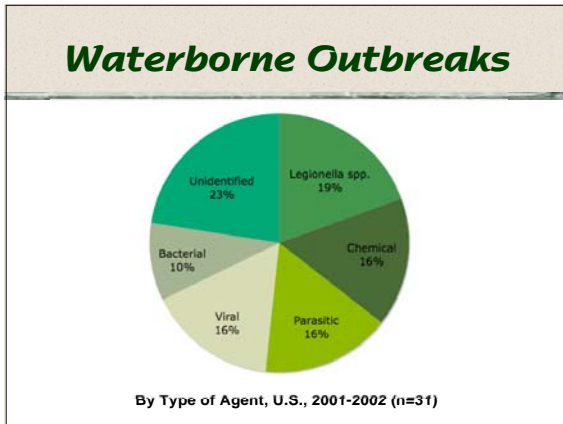
* Excludes outbreaks of Legionnaires disease.

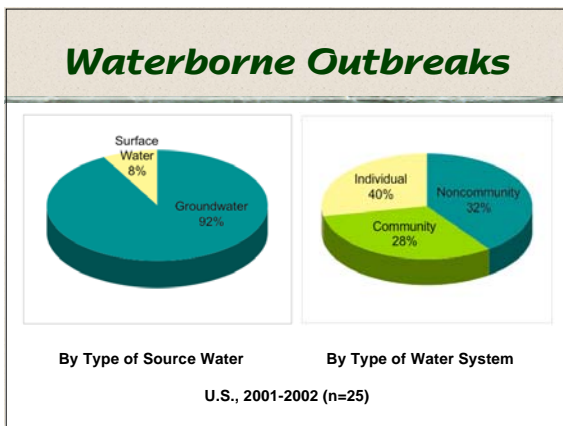
Drinking Water Outbreaks

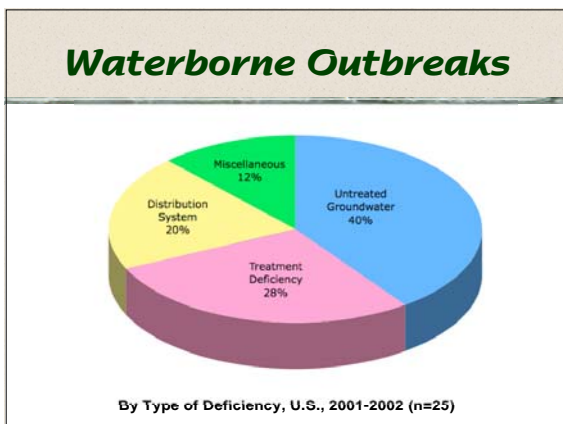
FIGURE 5. Number of waterborne-disease outbreaks (n = 31) associated with drinking water, by etiologic agent and month — United States, 2001–2002

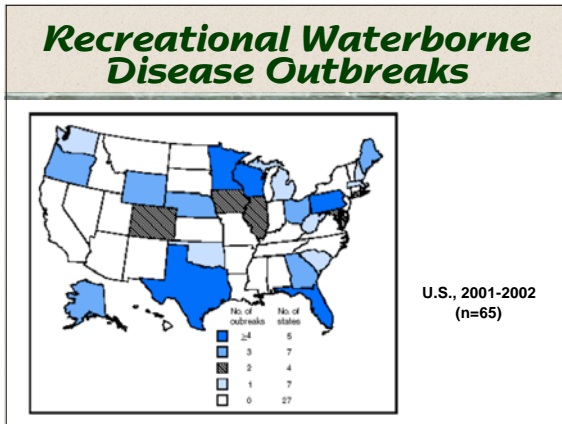


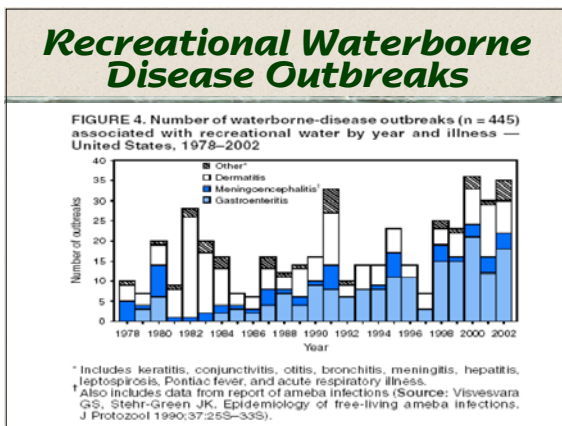
* Acute gastrointestinal illness of unknown etiology.

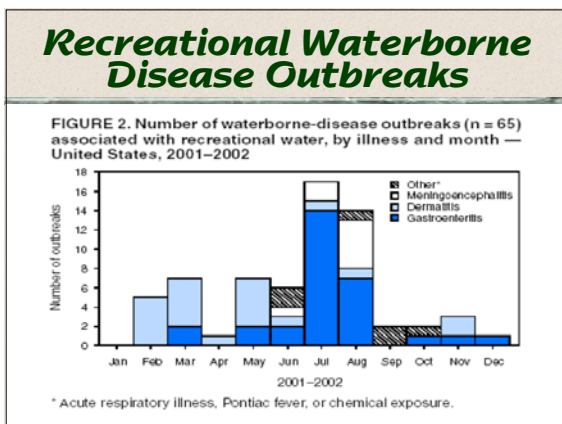


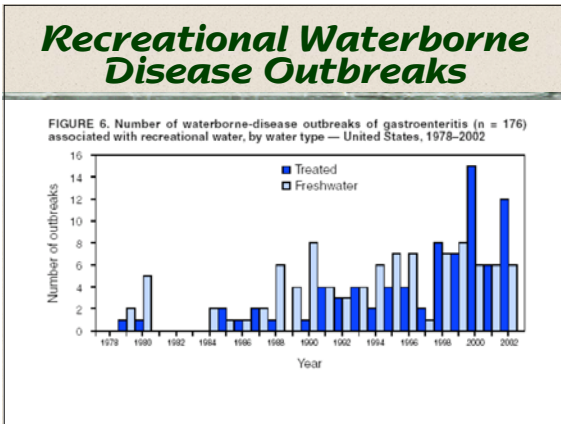


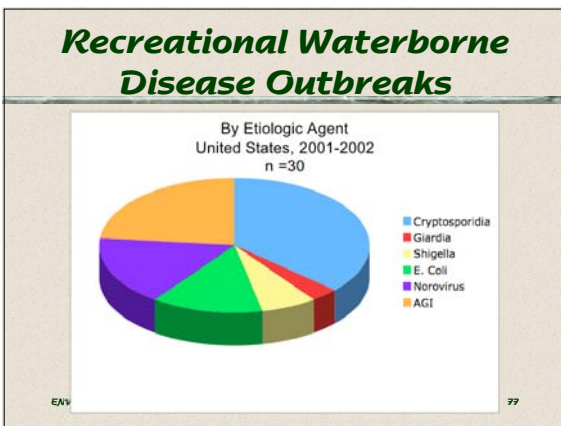


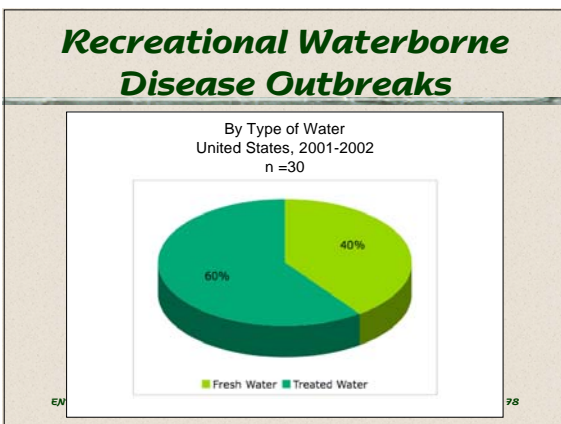












Lesson Summary

- ❖ Water is a vital & finite resource
- ❖ Most of the Earth's Water is unavailable
- ❖ What is available can be a vehicle for disease transmission
- ❖ Waterborne Disease Transmission
 - Drinking water
 - Recreational water


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Questions



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Next Lesson



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