Chapter 13: Water Resources

APES 2013

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Freshwater Management

Irreplaceable

Wasted and Polluted

Health Issue: Unsanitary water is the largest cause of illness

- Each year 1.6 million people (90% 5 or younger) die from waterborne diseases like diarrhea, typhoid, and hepatitis

Economic Issue: Vital for reducing poverty, producing food, and making energy

National/Global Security Issue: Limited resources cause conflict over them

Environmental Issue: Excess withdrawal from rivers and aquifers and pollution result in lower water tables, lower rivers and lakes, loss of wetlands, declining water quality, lower fish populations, species extinctions, loss of environmental services

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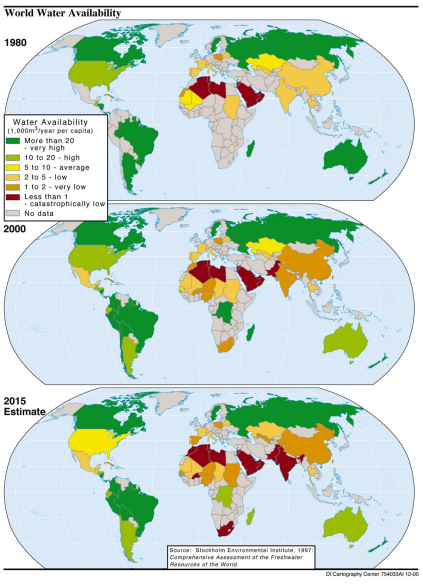
Availability

About 0.024% of the earth's water is available fresh water

- Most is salt, frozen, or deep underground.



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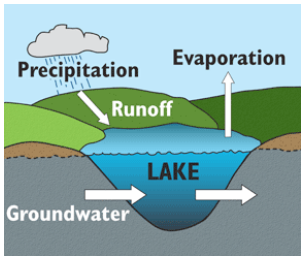
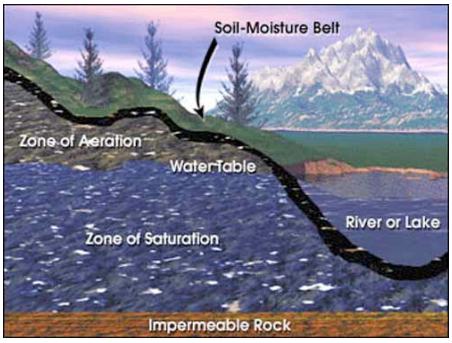
Groundwater





Water infiltrates the soil and continues through until it hits an impenetrable layer of rock

Zone of Saturation - where the spaces are completely filled with water

Water Table - top of the groundwater zone

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Aquifers

Underground caverns and porous layers of sand, gravel, or bedrock

Natural Recharge - replenishing the aquifer through precipitation traveling downward

Lateral Recharge - replenishing the aquifer from the sides by rivers and streams

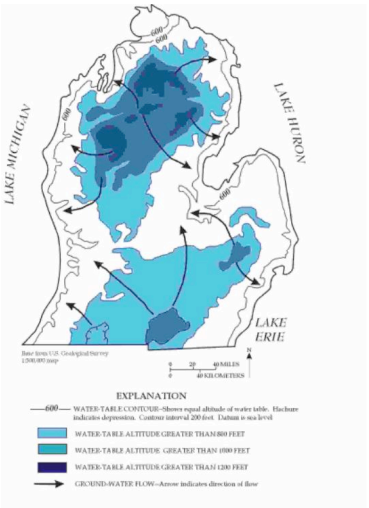

Figure 6. Generalized water-table configuration for the glaciofluvial aquifer in Michigan's Lower Peninsula (Modified from Barton and others, 1996, p. 10, fig. 5).

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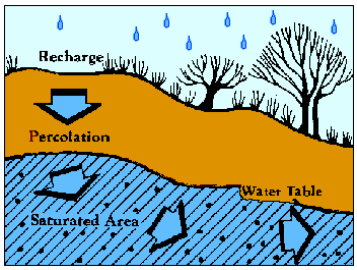
Aquifer Recharge

Aquifers recharge very slowly

- Impermeable surfaces prevent downward travel
- Water travels at most a foot per day through the aquifers (usually 3 feet a year)

Nonrenewable aquifers - those too deep to be recharged by natural means



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Surface Water

Freshwater from precipitation and snowmelt that flows across the earth's surface

Surface runoff - does not infiltrate the ground

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Global Water Use

70% = crop irrigation

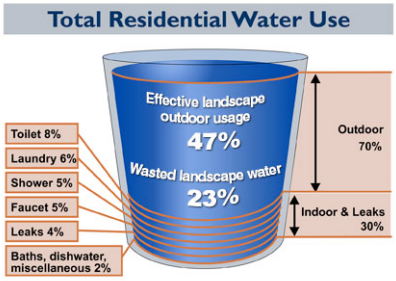
20% = industry needs

10% = cities and residences

450,000 liters for a car

140 liters for a cup of coffee

4,700 liters for a t-shirt



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United States

U.S. has huge supplies of freshwater, but they are unevenly distributed

By 2013, 36 U.S. states will have water shortages

Legal battles have already started

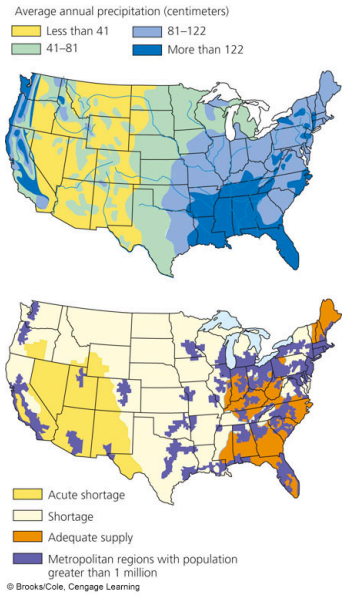

Fig. 13-4

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Water shortages will lead to conflict

Fig. 13-5

Severe Drought

- dries soil
- reduces stream flow
- decreases tree growth and biomass
- lowers NPP
- reduces crop yield
- shifts biomes

Water Management

- Public vs. Private utilities
- REREAD pages 320-321

Extracting Groundwater

If groundwater is not extracted in a sustainable way, it is no longer a renewable resource.

The amount of water removed can not exceed the amount of water recharged.

Fig. 13-7

U.S. Groundwater

Withdrawn four times faster than being recharged

Ogallala (worlds largest known aquifer) - under eight Midwestern states is an area of great depletion

Some places are pumping water out at 40 times the recharge rate causing water tables to drop significantly

Overdrafts threatens biodiversity

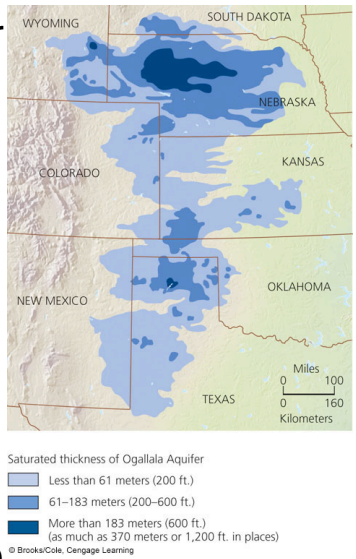

Fig. 13-10

Other consequences to overpumping

Increases gap between rich and poor

Land subsidence (land above the empty aquifer collapses)

Contamination by pulling in salt water in coastal regions

Dams

Control water flow

Creates a reservoir (artificial lake) behind the dam

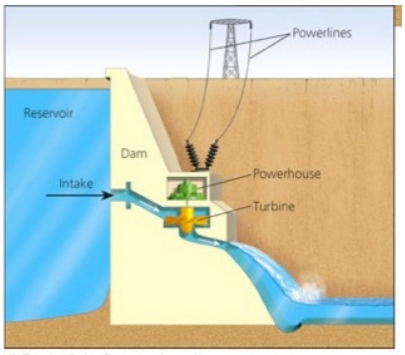

Fig. 13-12

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Colorado River (U.S.)

Fig. 13-14

Source - snowmelt from Rocky Mountains

14 major dams and reservoirs that support mostly agriculture and cities within the rain shadow created by Californian mountains

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Colorado River major problems

Basin includes driest lands in US and Mexico

Only a modest flow of water

Legal pacts allocated more water than the river can supply

Amount of water flowing has dropped significantly

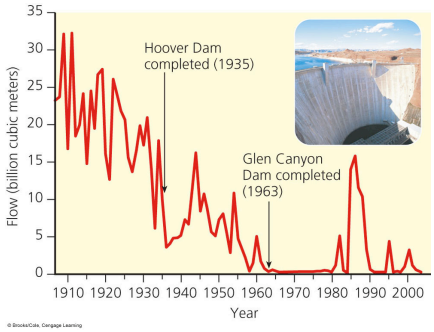

Fig. 13-16

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Three Gorges Dam (China)

Across Yangtze River

World's largest dam

Can produce enough electricity to support a city 10 times as large as Los Angeles

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Transferring Water: California Water Project

Uses dams, pumps, and aqueducts to transport water from Northern California to Southern California

Without this transport, Southern California would resemble a desert.

North and South argue over the water usage. South needs water for agriculture and population growth. North says that it is destroying the Sacramento River, threatens fisheries, and increases local pollution because the river doesn't have enough power to flush the pollutants out into the ocean.

North argues water is wasted. Government subsidizes water so there is no incentive to promote efficiency.

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Transferring Water: Aral Sea

Since 1960, irrigation has diverted water and made a drastic change.

This has caused the sea's salinity to increase seven times its former average and the sea level to drop 72 feet.

Impacting biodiversity: 85% of wetlands have been eliminated and half of the bird and mammal species have disappeared. 26 of 32 native fish species are now extinct.

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Transferring Water: Aral Sea

Most of the area is now a salt covered desert.

The salt and dust blow up to 500 km away which pollutes water, kills wildlife, and destroys crops.

The dust and salt also settles on glaciers in the Himalayas causing faster melting.

Increased salt concentration has decreased crop yields causing farmers to use more fertilizers and herbicides. This has polluted the groundwater which has caused health problems.

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Desalination

Removing dissolved salts from ocean water

- Methods: distillation and reverse osmosis

Currently only provides 0.3% of freshwater

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Problems with Desalination

High cost and energy footprint (distillation requires 10 times as much energy as reverse osmosis)

Sterilizing water kills many marine organisms

Produces huge quantities of briny wastewater that must be disposed of. If put in the ocean it increases local salinity which threatens aquatic life. If disposed on land, groundwater is contaminated.

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Water and Sustainability

65-70% of water is wasted through evaporation, leaks, and other losses.

If this is reduced by 15% we could meet world water needs for the foreseeable future.

Main cause of waste is underpricing through subsidies

There is no financial incentive to conserve

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Irrigation

Traditionally very inefficient

- Often more water used than needed (looses 40%)

Some more efficient ways:

- Center pivot/low pressure (80-95% efficient)
- Drip irrigation (90-95% efficient with 20-90% greater crop yields)
  - Only used for 1% of crops

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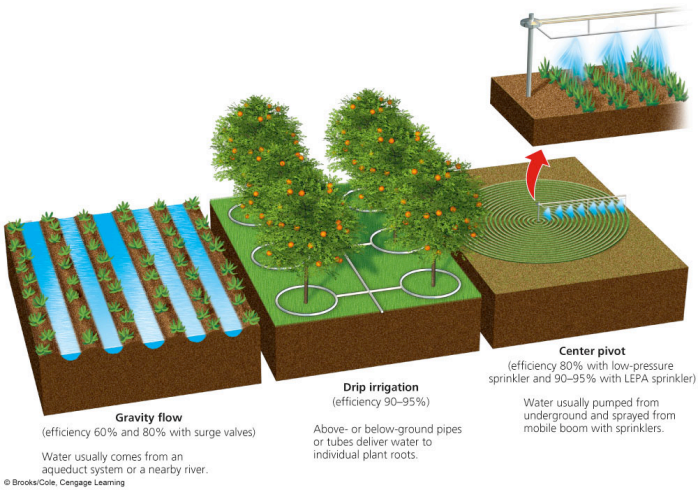
Irrigation Methods

Fig. 13-20



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