



WATER RESOURCES

CHAPTER 13

WHY IS WATER IMPORTANT?

COVERS 71% OF EARTH

- MOSTLY SALT WATER

NO PLANT OR ANIMAL CAN SURVIVE WITHOUT IT

THERE IS NO SUBSTITUTE FOR ITS USES

- Sculptures earth's surface
- Moderates climate
- Dilutes pollutants

PROPERTIES OF WATER

Hydrogen bonds between molecules

High Boiling Point and Low Freezing Point

Has a HIGH heat capacity that:

- MODERATES CLIMATE
- PROTECT ORGANISMS FOR TEMP. CHANGES
- GOOD COOLANT

Has surface tension, cohesion, and adhesion

Has a HIGH Heat of Vaporization

- ABSORBS MUCH HEAT AS IT CHANGES TO WATER VAPOR

Is a UNIVERSAL solvent

Ionizes into Hydrogen and Hydroxide ions

Filters out UV Light

Expands when it freezes



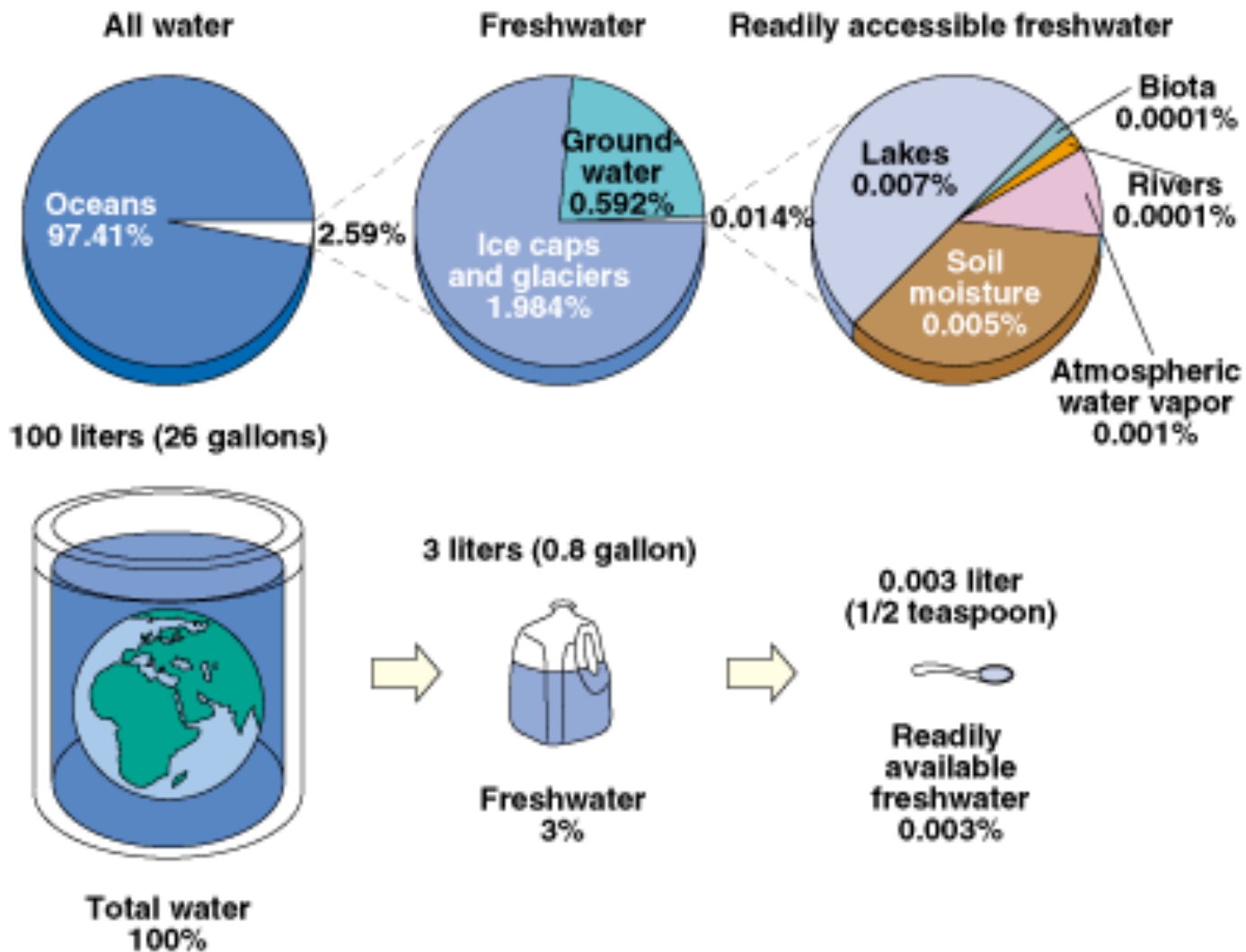
HOW MUCH IS AVAILABLE?

97.4% is **SALT** water

2.6 % is **FRESH** water - LOCKED IN ICE CAPS,
GLACIERS OR POLLUTED, SALTY OR DEEP
GROUNDWATER

.014% is available as SOIL MOISTURE, usable
GROUNDWATER, WATER VAPOR and SURFACE
WATER

PLANETS WATER BUDGET



RECYCLING WATER

Water is constantly being recycled by the Hydrologic cycle

UNEVENLY DIVIDED IN THE WORLD:

- CANADA HAS .5% OF WORLD'S POPULATION AND 20% OF ITS WATER
- CHINA HAS 21% OF POPULATION AND 7% OF ITS WATER

SHORTAGES WILL INTENSIFY IN THE FUTURE.

SURFACE WATER

Any precipitation that does not infiltrate into the ground.

About $2/3$ is lost by seasonal floods and is not available to humans.

Other $1/3$ is RELIABLE RUNOFF and we can count on as a stable source of water.

WATERSHED OR DRAINAGE BASIN – region where water drains into a stream, lake, reservoir, wetland, or other body of water.

WHAT IS GROUNDWATER ?

Water that infiltrates into the ground, percolates downward and fills up pores in soil and rock.

Area above the impermeable rock barrier that is filled with water is the **ZONE OF SATURATION.**

WATER TABLE - TOP OF ZONE OF SATURATION

Above the water table is the **ZONE OF AERATION** - AIR AND WATER

AQUIFER

Porous Water-saturated layers of sand, gravel or bedrock through which groundwater flows.

RECHARGE AREA – any area of land through which water passes downward into an aquifer

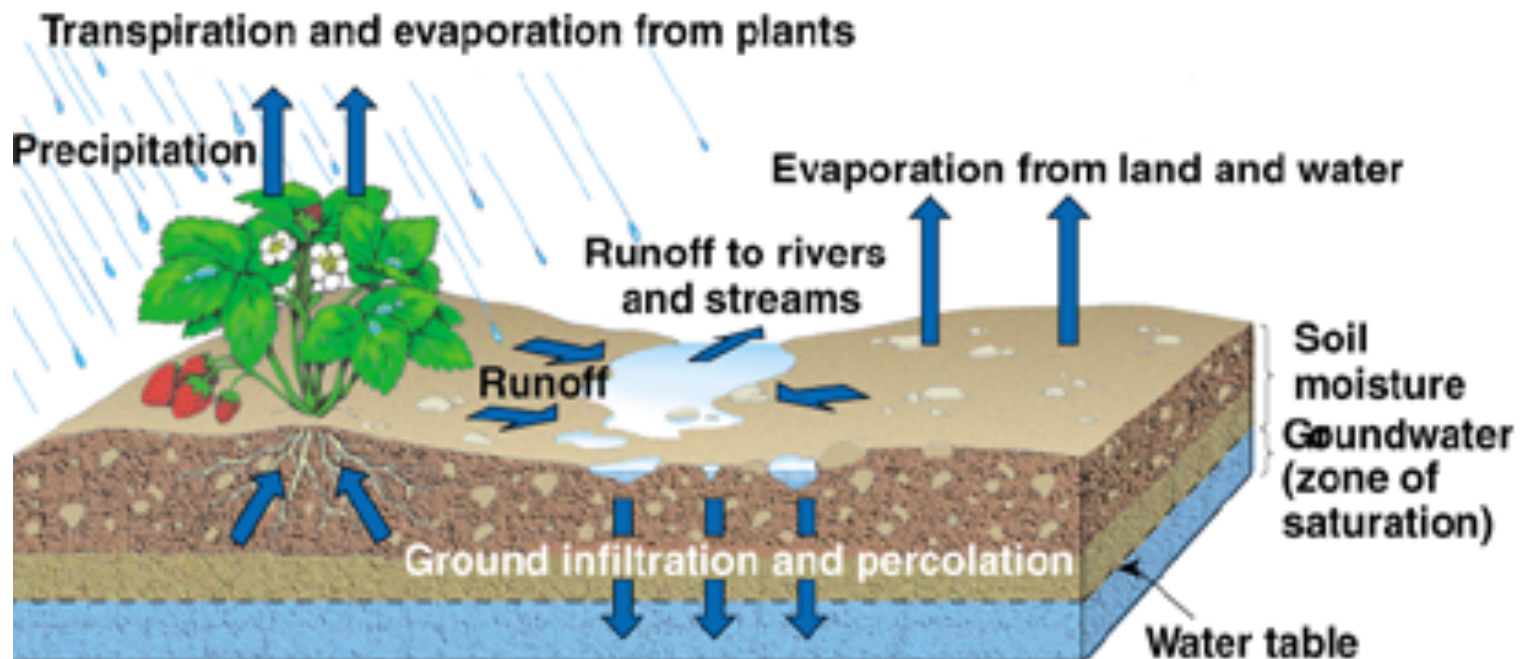
They are not underground pools of flowing water; THEY'S JUST SPONGES

DISCHARGE AREA – wells, lakes, geysers, streams, or ocean

Groundwater moves from **high** elevation & pressure to **lower** elevation & pressure

Groundwater moves VERY SLOWLY – about 1 meter/year

ROUTES & DESTINATION OF PRECIPITATION



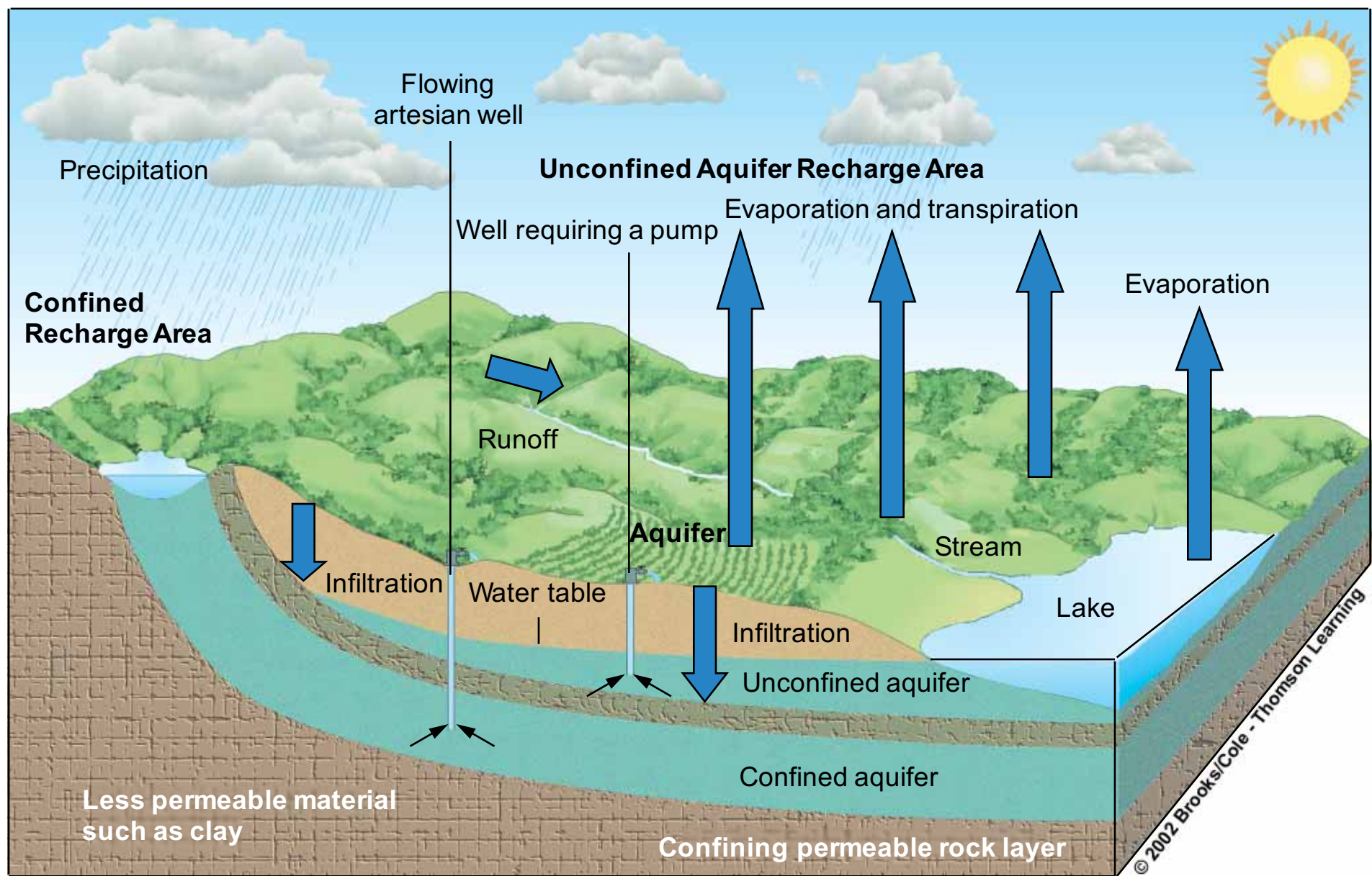


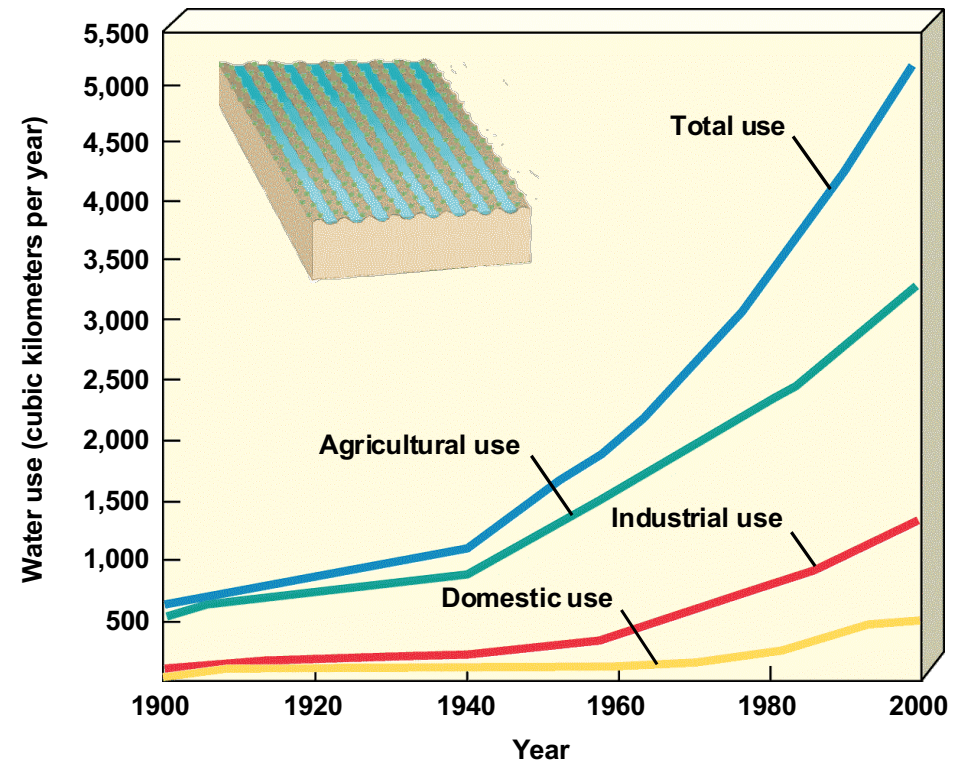
Fig. 13.3, p. 297

HOW IS WATER USED WORLDWIDE?

MOST FOR IRRIGATION - 70%

INDUSTRY - 20%

CITIES AND RESIDENCES - 10%



IN THE UNITED STATES?

We have plenty of FRESH water in the WRONG places

- EASTERN States have AMPLE precipitation
- WESTERN States have too LITTLE water
- EAST – Mainly used for ENERGY production, COOLING and MANUFACTURING
- WEST – Mainly used in IRRIGATION


1 automobile  **400,000 liters**
(106,000 gallons)


1 kilogram cotton  **10,500 liters**
(2,400 gallons)

1 kilogram aluminum  **9,000 liters**
(2,800 gallons)

1 kilogram grain-fed beef  **7,000 liters**
(1,900 gallons)

1 kilogram rice  **5,000 liters**
(1,300 gallons)

1 kilogram corn  **1,500 liters**
(400 gallons)

1 kilogram paper  **880 liters**
(230 gallons)

1 kilogram steel  **220 liters**
(60 gallons)

OUR MOST SERIOUS WATER PROBLEMS

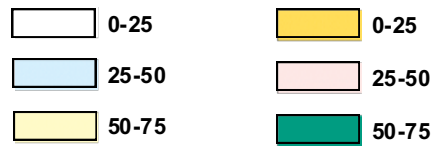
EAST

- Flooding
- Occasional Urban Shortage
- Pollution

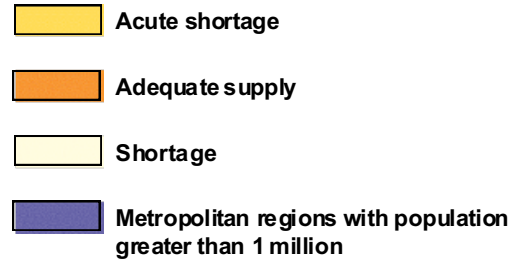
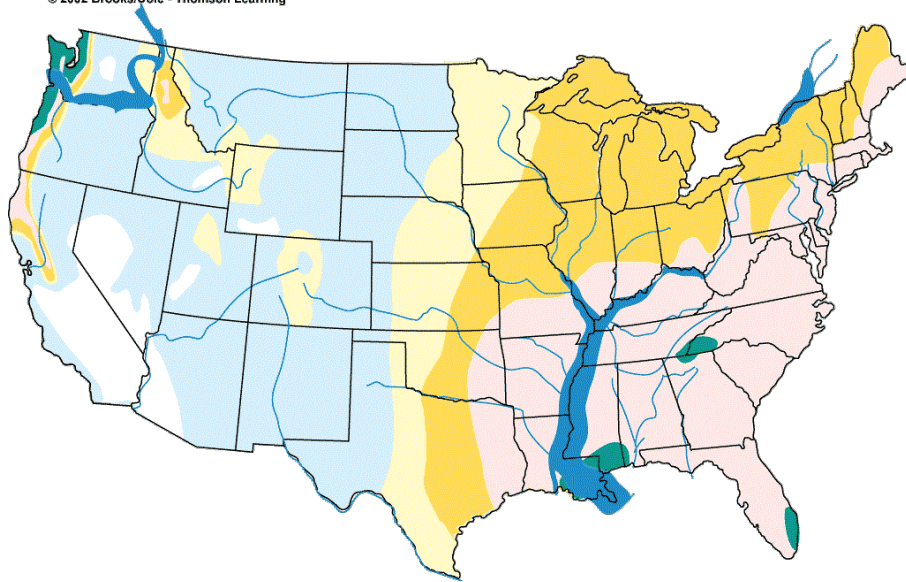
WEST

- Shortage of Runoff Caused by:
 - Low Precipitation
 - High Evaporation
 - Drought

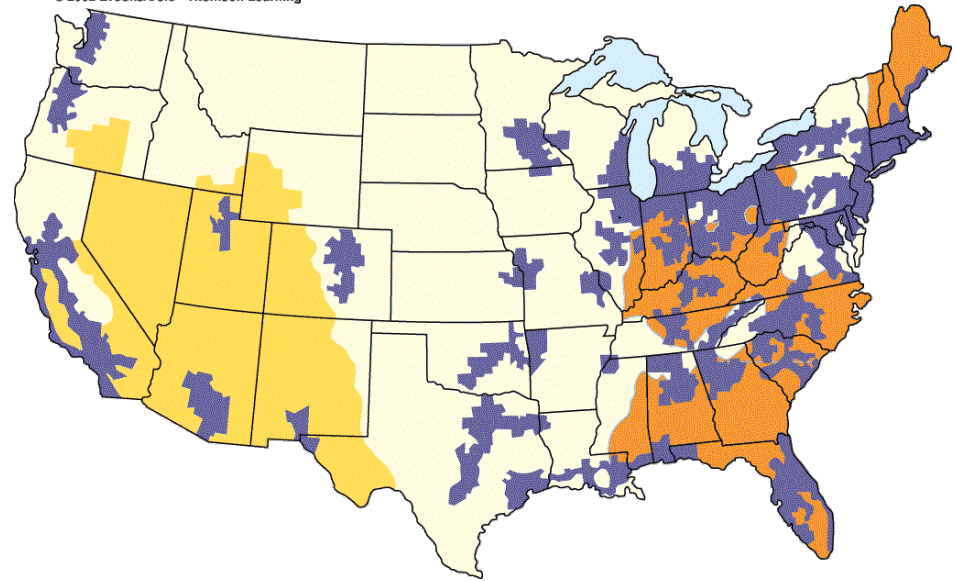
Average annual precipitation (centimeters)



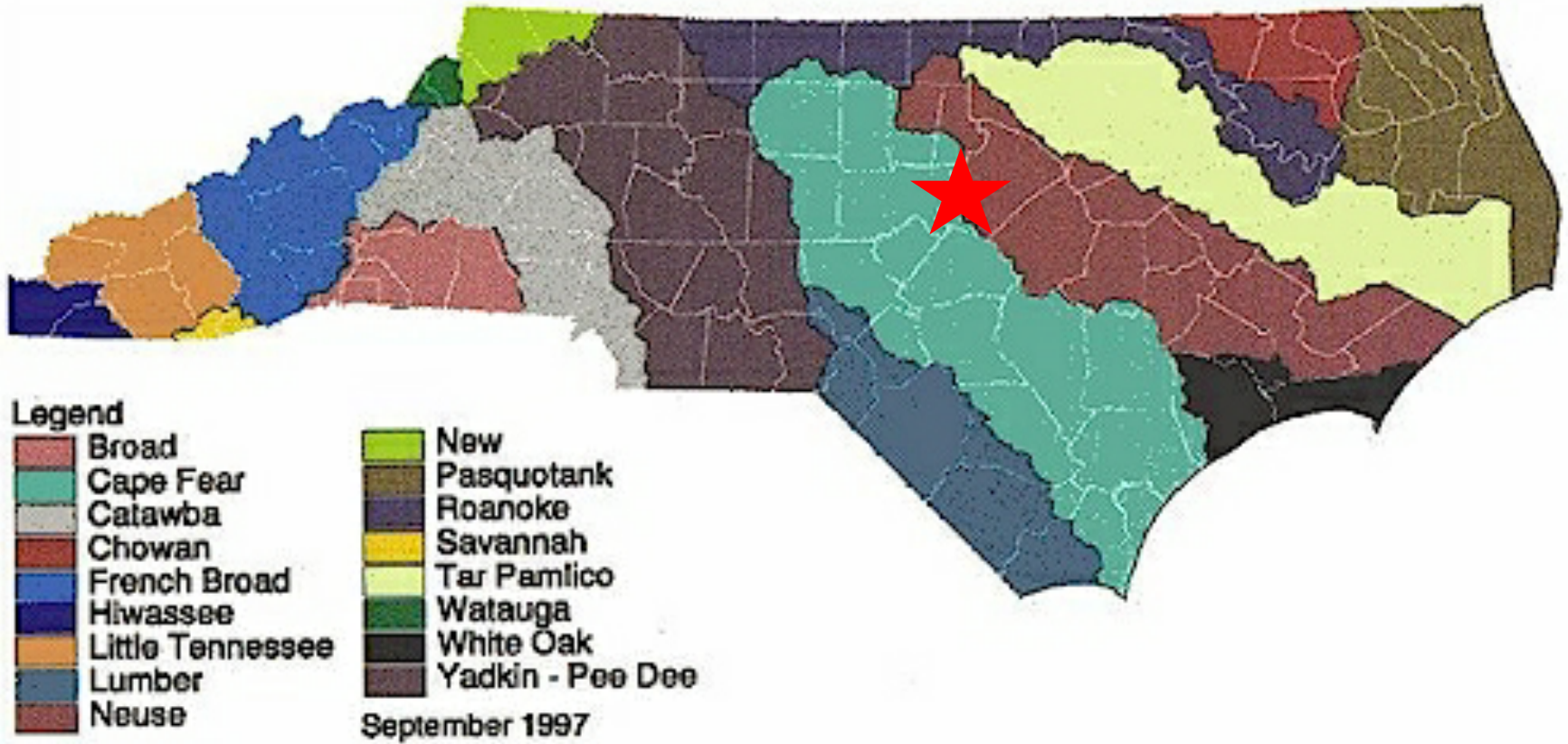
© 2002 Brooks/Cole - Thomson Learning



© 2002 Brooks/Cole - Thomson Learning



NC River Basins



WHAT CAUSES WATER SHORTAGES?

DRY climate

DROUGHT – a period of 21 days or longer in which precipitation is at least 70% below normal and evaporation higher than normal.

DESSICATION – Drying of soil

- DEFORESTATION, OVERGRAZING

WATER STRESS – Too many people and not enough water.

HOW CAN WE INCREASE FRESHWATER SUPPLIES?

BUILD DAMS AND RESERVOIRS TO STORE RUNOFF

BRING SURFACE WATER FROM OTHER AREAS

WITHDRAW GROUNDWATER

CONVERT SALT WATER TO FRESH WATER

IMPROVE THE EFFICIENCY OF WATER USE.



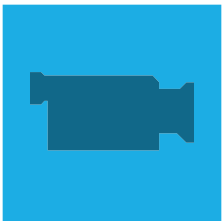
BENEFITS & DRAWBACKS OF DAMS

Benefits:

1. Control floods
2. Produce hydroelectric power
3. Supply water for irrigation
4. Recreation - swimming, fishing, boating

Drawbacks:

1. Reduce water flow below dam
2. Silting at the dam
3. Increase risk of flooding if dam breaks
4. Destroys natural ecosystem
5. Increase water pollution
6. Promote saltwater intrusion



TRANSFERRING WATER

Tunnels, aqueducts, and pipes

California Water Project moves from northern to southern California.

Canada's James Bay project - another major project

Trying to harness the wild rivers to produce electric power.



Fig. 13.13, p. 306




TAPPING INTO GROUNDWATER

Pros:

1. Can be removed year round
2. Is not lost by evaporation
3. Less expensive to develop than surface water systems

Cons:

1. Lowers water table
2. Land subsidence
3. Salt water intrusion
4. Moves contaminated chemicals toward wells
5. Reduces stream flow

-  Less than 61 meters (200 ft)
-  61-183 meters (200-600 ft)
-  More than 183 meters (600 ft)
(as much as 370 meters or 1,200 ft in places)

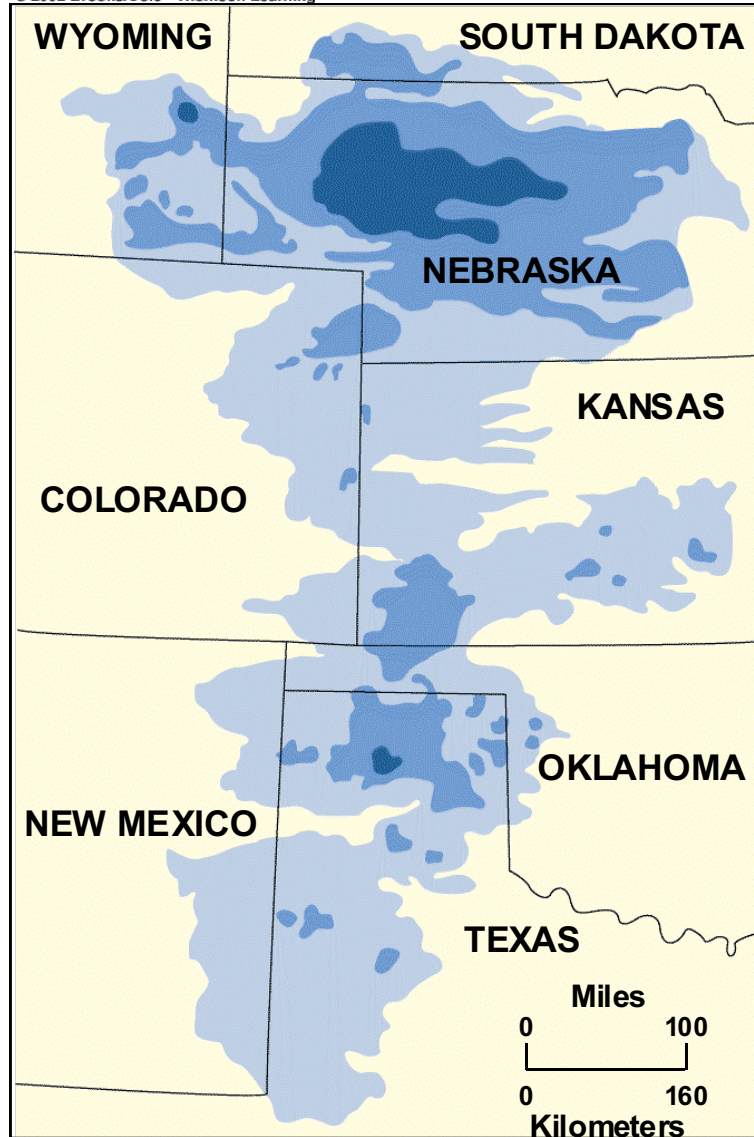


Fig. 13.18, p. 309

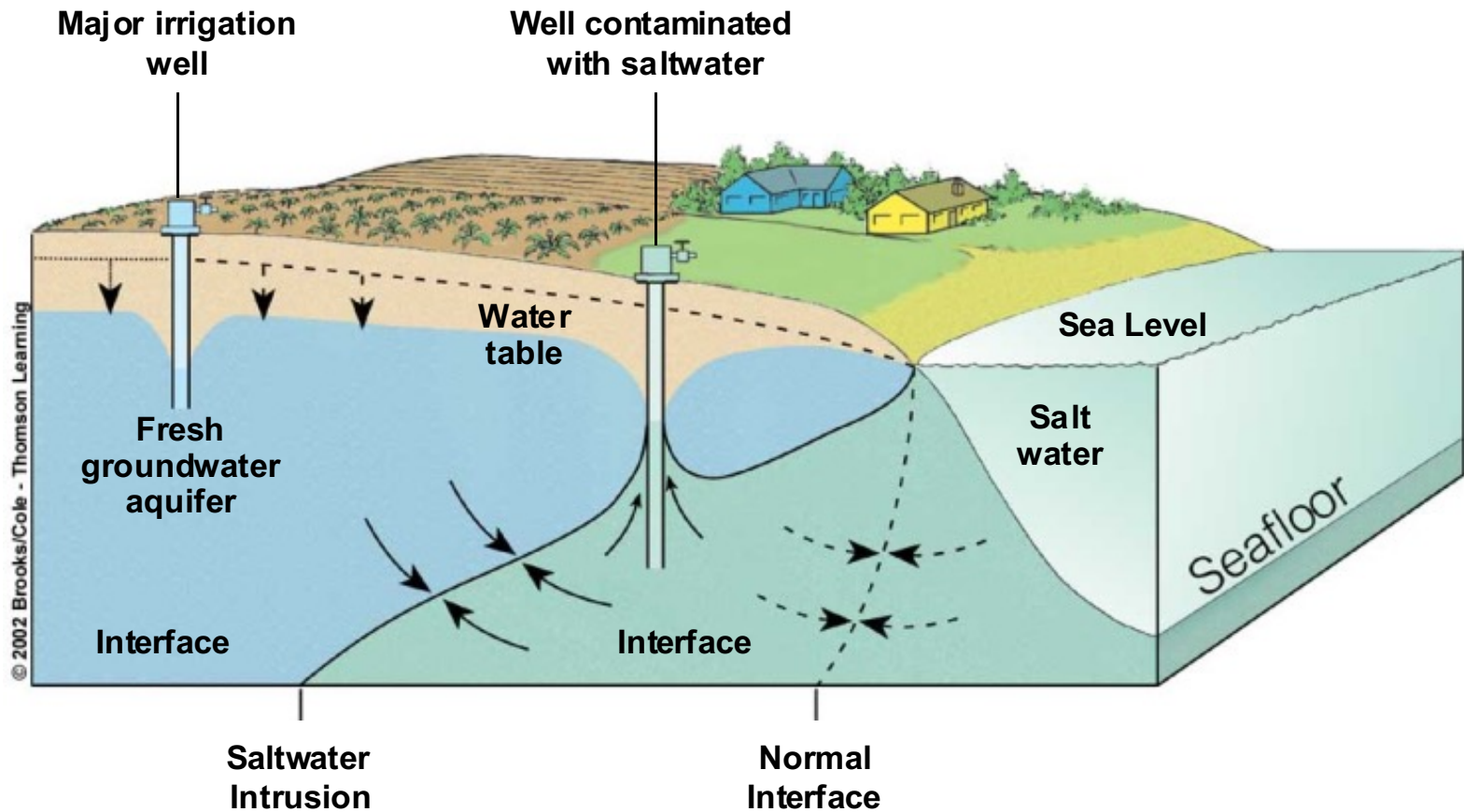


Fig. 13.17, p. 308

Slide 19

DESALINIZATION

Removing dissolved salts from ocean water or brackish groundwater

Two ways:

- DISTILLATION
- REVERSE OSMOSIS

Main plants are in Middle East and parts of North Africa

Two disadvantages:

1. Expensive - uses energy
2. Produces much wastewater (brine)

CLOUD SEEDING & TOWING ICEBERGS

Add silver iodide to clouds
- produces condensation
nuclei

1. Need moisture to bring rain
2. Puts chemicals in soil and water
3. Legal disputes over ownership of water in clouds

Towing icebergs to arid
countries such as Saudi
Arabia & pump water
ashore

1. Technology not available
2. expensive



USING WATER MORE EFFICIENTLY



WHY DO WE WASTE WATER?

IT IS ESTIMATED THAT 60-70 % OF THE WATER PEOPLE USE THROUGHOUT THE WORLD IS WASTED THROUGH EVAPORATION, LEAKS, ETC.

WHY DO WE WASTE SO MUCH WATER?

Government subsidizes “true cost” of water creating artificially low water prices.

Water laws that determine the legal rights of water users such as in the U.S. (see text)

Fragmented watershed management where water supplies are divided among local governments.

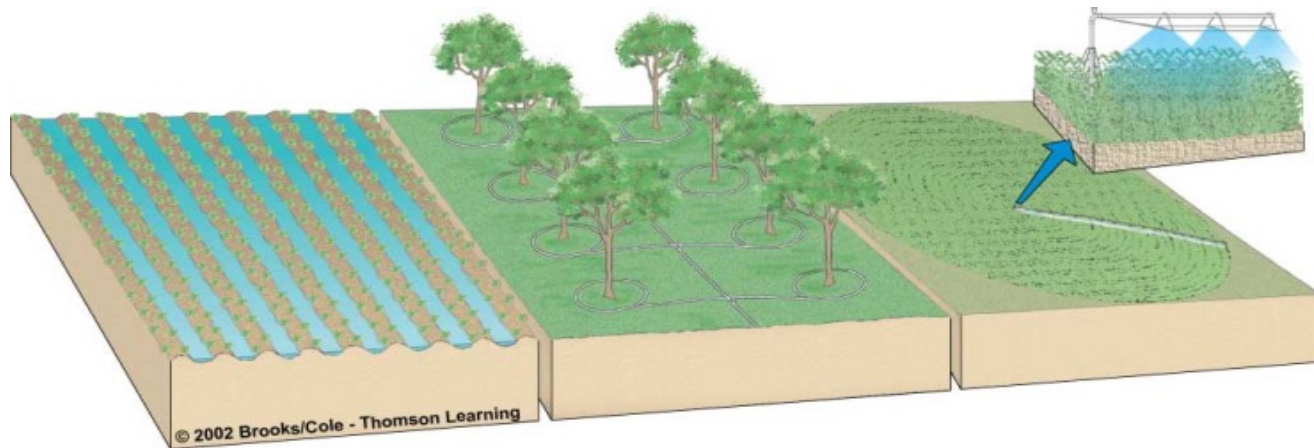
WASTING LESS WATER IN IRRIGATION

ONLY ABOUT 40% OF WATER USED REACHES CROPS

COULD:

1. USE CENTER PIVOT LOW PRESSURE SPRINKLERS
2. USE LOW-ENERGY PRECISION APPLICATION (LEPA) SPRINKLERS
3. USE TIME CONTROLLED VALVES
4. USE SOIL MOISTURE DETECTORS
5. USE DRIP IRRIGATION SYSTEMS

TYPES OF IRRIGATION



Gravity Flow
(efficiency 60% and 80% with surge valves)

Water usually comes from an aqueduct system or a nearby river.

Drip Irrigation
(efficiency 90 % to 95%)

Above- or below-ground pipes or tubes deliver water to individual plant roots.

Center Pivot
(efficiency 80% with low-pressure sprinkler and 90 % to 95% with LEPA sprinkler)

Water usually pumped from underground and sprayed from mobile boom with sprinklers.

IN HOMES AND BUSINESS:

REDESIGN MFG. PROCESSES
TO USE LESS WATER

XERISCAPING LAWNS

DRIP IRRIGATION TO WATER
LAWNS

FIX LEAKS

USE WATER METERS TO
MONITOR WATER USE

LAWS REQUIRING WATER
CONSERVATION


USE WATER-SAVING TOILETS
AND SHOWERHEADS

USE FRONT LOADING
WASHING MACHINES

USE GRAY WATER

COLLECT RAINWATER TO USE
IN TOILETS,

REDUCE PERSONAL USE



RAISING THE PRICE OF WATER IN HOMES
AND BUSINESSES IS ONE WAY TO REDUCE
WASTEFUL WATER USE.

CAUSES OF FLOODS

MAINLY CAUSED BY MELTING SNOW OR HEAVY RAINFALL

STREAMS OVERFLOW INTO NATURAL FLOODPLAINS WHICH

- PROVIDE NATURAL FLOOD AND EROSION CONTROL
- MAINTAIN HIGH WATER QUALITY
- RECHARGE GROUNDWATER



ADVATAGES OF FLOODPLAINS

FERTILE SOIL

AMPLE WATER FOR IRRIGATION

FLAT LAND FOR FARMING

NEARBY RIVER FOR TRANSPORTATION AND RECREATION



HOW TO REDUCE SEVERITY OF FLOODING:

LEAVE VEGETATION ON HILLSIDES

DON'T BUILD ON FLOODPLAINS

DON'T DRAIN WETLANDS



CHANNELIZATION

WIDEN, DEEPEN OR STRAIGHTEN STREAMS TO ALLOW
MORE RAPID RUNOFF

REDUCES FLOODING UPSTREAM BUT INCREASES
UPSTREAM BANK EROSION AND DOWNSTREAM
FLOODING

RUINS HABITATS



ARTIFICIAL LEVEES

REDUCE CHANCES OF WATER OVERFLOWING
INTO FLOODPLAINS

CONTAIN AND SPEED-UP STREAM FLOW



FLOOD CONTROL DAMS

STORES WATER IN RESERVOIRS AND RELEASES IT
GRADUALLY

FLOODPLAIN MANAGEMENT

THE BEST APPROACH

FIGURE OUT HOW FREQUENTLY THE AREA HAS
FLOODED IN THE PAST

EXAMINE VEGETATION

FORMULATE A PLAN

PROHIBIT CERTAIN BUILDING, ETC ON FLOODPLAIN