

Water Resources

Chapter 13

Freshwater Is an Irreplaceable Resource That We Are Managing Poorly

- Why is water so important?
- Health – we are made up of 60% water, supplies us with food, shelter
- Sculpts earth's surface, moderates climate, removes wastes and pollutants
- Earth as a watery world: 71% of surface of earth
 - .97% in oceans
 - .2.976% locked up in ice caps and glaciers
 - .0.024% is easily accessible – Soil moisture, Groundwater, Water vapor, Lakes, streams

Freshwater Is an Irreplaceable Resource That We Are Managing Poorly

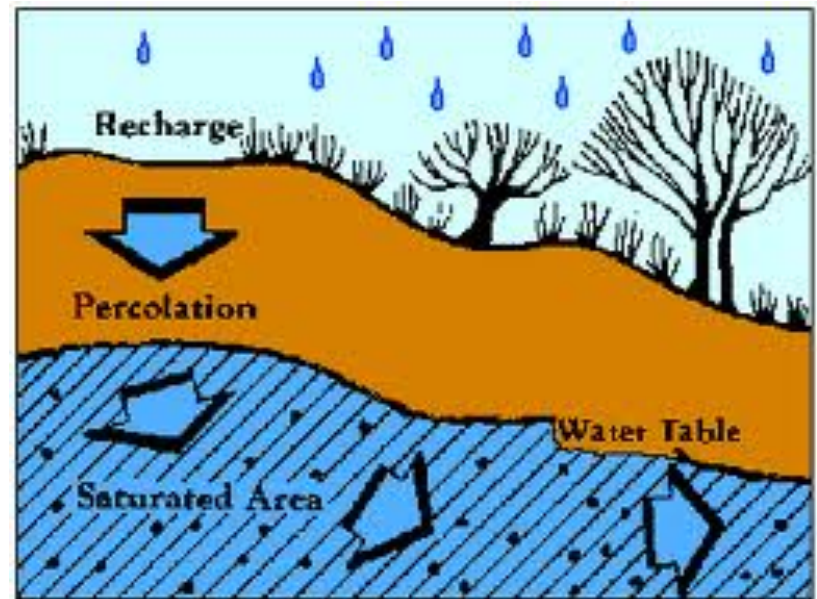
- Access to water is
 - A global health issue
 - An economic issue
 - A women's and children's issue
 - A national and global security issue
 - Environmental issue

We Get Freshwater from Groundwater and Surface Water

- **Ground water** – water found in spaces between soil, gravel, and rock due to infiltration. Very important source of water.

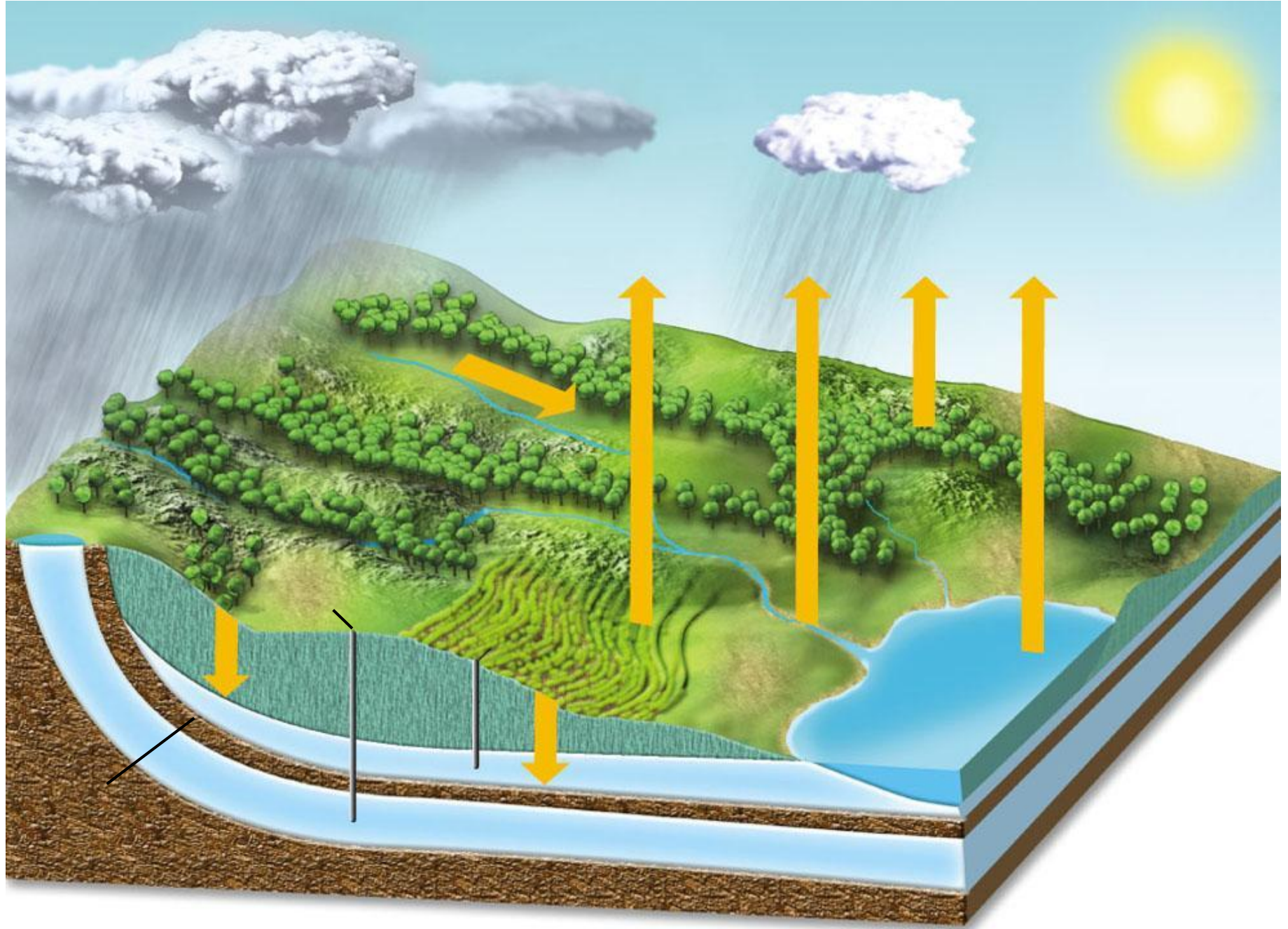
- **Zone of saturation** – is at a depth where ground is filled with water. Above this point, there is little moisture.

- **Water table** – uppermost level at which water in a given area fully saturates the rock or



Aquifers

- underground caverns and layers of sand, gravel or bedrock through which groundwater flows. Recharge is generally very slow. Source of freshwater
- **Confined**
- **Unconfined**
- **Recharge**
 - Natural recharge
 - Lateral recharge
- Springs – where water from aquifers percolates up to the surface.



Aquifers

- Artesian wells
- Ogalla Aquifer



Problems of aquifer overuse

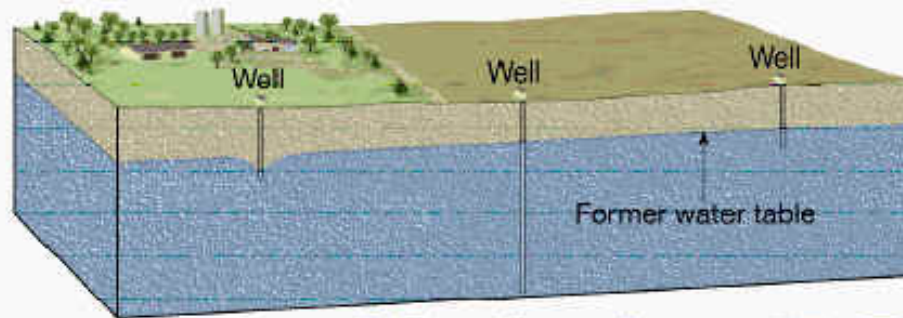
- **Cone of depression**
- **Land subsidence** – sinking of land due to depletion of an aquifer = impossible recharge
- Mexico City – some parts have sunk as much as 10 meters
- **Sinkholes** – large craters that form when the roof of an underground cavern collapses after being drained
- **Reduces water quality** – saltwater intrusion



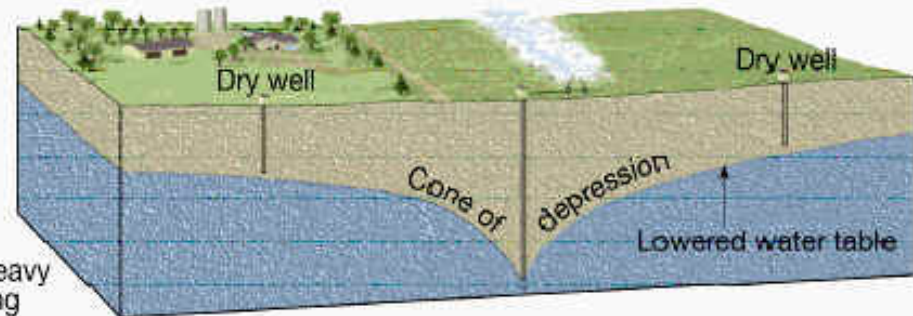
Photo courtesy of Doug Gouze, 2006



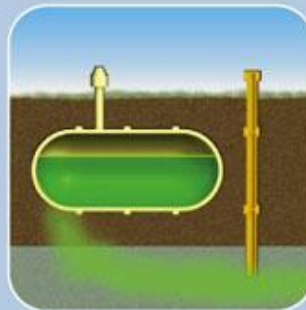
Formation of a cone of depression in the water table



Before heavy pumping



After heavy pumping



Surface Water

- Largest rivers in the world – Amazon, Congo, Yangtze
 - Civilization settlements
- Lake formation
 - Classification of lakes
 - Oligotrophic
 - Mesotrophic
 - Eutrophic
- Wetlands role in ecosystems

We Use a Large and Growing Portion of the World's Reliable Runoff

- 2/3 of the surface runoff: lost by seasonal floods
- 1/3 runoff usable
- Domestic: 10% (household drinking water, sanitation)
- Agriculture: 70% (irrigation)
- Industrial use: 20%
- The average person needs a minimum of 1.3 gallons of water per day to survive in a moderate climate at an average activity level.
- Minimum amount needed for drinking, cooking, bathing and sanitation is 13 gallons.
- US – 65–78 gallons/day, Netherlands – 27 gallons/day, Gambia – 1.2 gallons/day

Atmospheric Water

- Small % but society is very dependent on it!
- Drought
 - Effects
 - Causes
- Flood
 - Causes

Humans can alter the availability of water

- Levees – a way to prevent flooding. An enlarged bank built on each side of a river.
- Challenges
 - Natural flooding stopped
 - Sediments
 - Prevent flooding in one place but increase flooding elsewhere.
 - Encourages development on

• Hurricane Katrina



Humans and water supply

- Dikes – built to prevent ocean waters from flooding adjacent land



Humans and water supply

- Dams – barrier that runs across a river or stream to control water flow.
- Reservoir
- Reasons to build dams
- Benefits
- Downfalls

- Three Gorges Dam



Who Should Own and Manage Freshwater Resources?

- Most water resources
 - Owned by governments
 - Managed as publicly owned resources

- Veolia and Suez: French companies
 - Buy and manage water resources
 - Successful outcomes in many areas – they have the money and expertise to manage them better than government

Ship Stranded in Desert Formed by Shrinkage of the Aral Sea



Removing Salt from Seawater Seems Promising but Is Costly

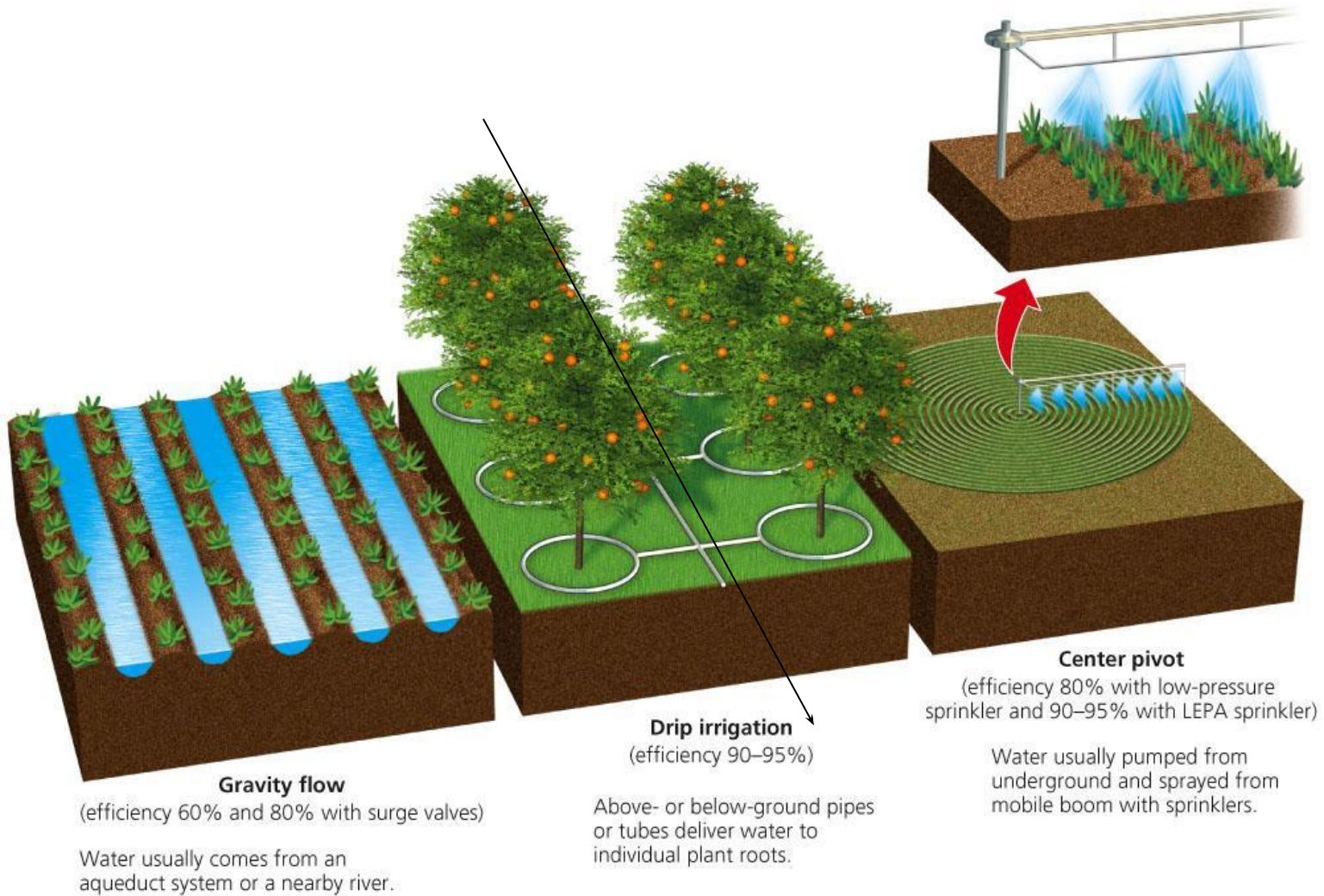
- **Desalination** – removing dissolved salts from ocean water or brackish water for domestic use
 - **Distillation** – heating saltwater until it evaporates and condenses as freshwater
 - **Reverse osmosis, microfiltration** – using high pressure to force saltwater through a membrane filter with pores small enough to remove salt
-
- 15,000 plants in 125 countries
 - Saudi Arabia: highest number

Removing Salt from Seawater Seems Promising but Is Costly

•Problems

- High cost and energy footprint
- Keeps down algal growth and kills many marine organisms
- Large quantity of brine wastes – dumping it into oceans increases salinity which threatens food resources and aquatic life. Disposing on land could contaminate groundwater and surface water.
- Future economics – only an option for water-short, wealthy countries and cities that can afford the high cost

Major Irrigation Systems



Gravity flow

(efficiency 60% and 80% with surge valves)

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

Drip irrigation

(efficiency 90–95%)

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

Center pivot

(efficiency 80% with low-pressure sprinkler and 90–95% with LEPA sprinkler)

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

Solutions: Reducing Irrigation Water Waste

SOLUTIONS

Reducing Irrigation Water Waste

- Line canals bringing water to irrigation ditches
- Irrigate at night to reduce evaporation
- Monitor soil moisture to add water only when necessary
- Grow several crops on each plot of land (polyculture)
- Encourage organic farming
- Avoid growing water-thirsty crops in dry areas
- Irrigate with treated urban wastewater
- Import water-intensive crops and meat

Hydroponic Agriculture

- Cultivation of crops under greenhouse conditions
- Benefits

Industrial use

- Generating electricity
- Refining metals and paper

Solutions: Reducing Water Waste

SOLUTIONS

Reducing Water Waste

- Redesign manufacturing processes to use less water
- Recycle water in industry
- Landscape yards with plants that require little water
- Use drip irrigation
- Fix water leaks
- Use water meters
- Raise water prices
- Use waterless composting toilets
- Require water conservation in water-short cities
- Use water-saving toilets, showerheads, and front-loading clothes washers
- Collect and reuse household water to irrigate lawns and nonedible plants
- Purify and reuse water for houses, apartments, and office buildings

Solutions: Sustainable Water Use

SOLUTIONS

Sustainable Water Use

- Waste less water and subsidize water conservation
- Do not deplete aquifers
- Preserve water quality
- Protect forests, wetlands, mountain glaciers, watersheds, and other natural systems that store and release water
- Get agreements among regions and countries sharing surface water resources
- Raise water prices
- Slow population growth



What Can You Do? Water Use and Waste

WHAT CAN YOU DO?

Water Use and Waste

- Use water-saving toilets, showerheads, and faucet aerators.
- Shower instead of taking baths, and take short showers.
- Repair water leaks.
- Turn off sink faucets while brushing teeth, shaving, or washing.
- Wash only full loads of clothes or use the lowest possible water-level setting for smaller loads.
- Use recycled (gray) water for watering lawns and houseplants and for washing cars.
- Wash a car from a bucket of soapy water, and use the hose for rinsing only.
- If you use a commercial car wash, try to find one that recycles its water.
- Replace your lawn with native plants that need little if any watering.
- Water lawns and yards in the early morning or evening.
- Use drip irrigation and mulch for gardens and flowerbeds.