Botkin & Keller: *Environmental Science: Earth as a Living Planet*, 8th Edition
APES- Chapter #18- Water Supply, Use and Management

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Learning Objectives: *At the end of this chapter, students will understand:*

- *Why water is one of the major resource issues of the 21st century*
- *What a water budget is, and why it is useful in analyzing water supply problems and potential solutions*
- *What groundwater is, and what environmental problems are associated with its use*
- *How water can be conserved at home and in industrial and agricultural practice*
- *Why sustainable water management will become more difficult as the demand for water increases*
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- *The concepts of virtual water and a water footprint and their link to water management and conservation*
- *What the environmental impacts are of water projects such as dams, reservoirs, canals and channelization*
- *What a wetland is, how wetlands function, and why they are important*
- *Why we are facing a growing global water shortage linked to our food supply*

Case Study: Palm Beach County, Florida: Water Use, Conservation and Reuse *What are some of the benefits of using reclaimed water?*
-1: Private property that uses reclaimed water can save costs; 2: Reclaimed water can aid plant growth due to the presence of natural fertilizer in the water; 3: Use of reclaimed water leaves more water for consumption; 4: Wetlands that can use treated wastewater can create habitats and green space

1: What are some of the factors that make ***water so special***?
-Water has high heat capacity, so it stores more heat than other solvents; Water is the universal solvent (most solutes can dissolve in it); It has high surface tension; it is the only natural compound where its liquid form weighs more than its solid form; and sunlight penetrates water at variable depths, allowing organisms to thrive.

2: What is the ***largest reservoir of water*** on Earth?
-The ccean

What is the ***largest reservoir of freshwater*** on Earth?
-The atmosphere

3: What is the ***residence time of water*** in the atmosphere?
-About 9 days

Groundwater and Streams
4: What is the ***water table?***
-The upper surface of groundwater

5: What is a ***discharge zone?***
-A place where groundwater flows or seeps out at the surface

6: What is an ***aquifer***?
-An underground zone or body of earth material from which groundwater can be obtained at a useful rate

What is a ***cone of depression***? *How is it created?*
-A formation that is made when the water table is depressed from a well due to water pumping

7: What is an ***effluent stream***?
-A stream where flow is maintained during the dry season by groundwater seepage into the stream channel from the subsurface

What is a stream that **flows all year** called?
-A perennial stream

8: What is an ***influent stream?***
-A stream that is entirely above the water table and flows only in direct response to precipitation

What is a stream that **doesn't flow all year** called?
-An ephemeral stream

Water Supply: A U.S. Example
9: What is a **water budget**? *How is it calculated?*
-A model that balances the inputs, outputs, and storage of water in a system, It is calculated by this equation: precipitation – evaporation = runoff.

Precipitation and Runoff Patterns
10: What is the *average water use for people in the U.S.*?
-100 gallons a day per person

What is the *average water use for people in Europe?*
-About 50 gallons a day per person

What is the *average water use for people in Sub-Saharan Africa*?
-5 gallons a day per person

Groundwater Use and Problems
11: How many people in the U.S. use groundwater as *a source of drinking water*?
-50% of all U.S. citizens

12: *What problems* can **groundwater overdraft** cause?
-Decline of water table in aquifers, energy cost increase from more strenuous pumping, more money spent on acquiring water from other states/countries

13: What is happening to the **Ogallala Aquifer (High Plains Aquifer)**?
-Locations where irrigation was used for farming in the 1940s are now being converted to dryland farming due to the aquifer's depletion

Desalination as a Water Source
14: What is the **percentage of salt** in saltwater? **3.5**%
15: To be used as a *freshwater source*, the **salt content must be reduced** to about **.05**%
16: What are some of the *environmental impacts of desalination*?
-Saline discharge can kill animals in habitats and desalination plant discharge can damage the local environment

Water Use
17: Describe the *difference between off-stream use and in-stream use.*
-Off-stream use refers to the act of removing water from its source for use, which may be dispersed back as unused. In-stream use refers to using the water at the source.

18: What is one of the issues with **off-stream use in the Pacific Northwest?**
-Too much water in streams was removed from the Pacific Northwest, and fish populations declined

19: Describe what happened to the **Aral Sea.**
-Water diverted from the Aral Sea caused the sea to decrease by 50% and become more saline. Sea life have since died, and dust in the salt flats pollute the air. The climate has changed, and the fish trade is forever changed.

Some Trends in Water use
20: What are the **two biggest users** of freshwater withdrawals?
-Irrigation and thermoelectric industry

Water Conservation
21: What are some of the *suggestions for improved irrigation* to conserve water?

Public Supply and Domestic Use
22: *Domestic use* of water (homes) accounts for **12**% of total national water withdrawals.

23: What is **Southern California (San Diego)** doing to help with water shortages in the future?
-San Diego is negotiating with Imperial Valley farmers to purchase water for urban areas, building desalinization plants, raising height of dams, importing water, and utilizing the Inland Feeder Project to allocate water during times of extreme runoff.

24: List **5 things** that you can do at home to help conserve water usage
* Flush only when really necessary
* Take a long bath rather than a long shower
* Use reclaimed water
* Don't hose sidewalks and driveways, sweep them
* Plant drought-resistant vegetation that requires less water

Virtual Water
25: What is ***virtual water***?
-The amount of water necessary to produce a product

26: How much water does it take to ***make a cup of coffee***?
-140 liters (40 gallons)

27: How much water does it take to ***raise beef***?
-15,500 ml^3

Wetlands
28: How do we define **wetlands**?
-Area inundated by water or saturated to a depth of a few centimeters for at least a few days a year

29: Wetlands are *very important*, what are the **natural service functions** of wetlands?
-Wetlands store water and reduce flooding due to "sponge" effect, recharge and discharge groundwater, act as nursery grounds for many organisms, filter water, produce useful chemicals and nutrients, buffer inland areas during natural disasters, store organic carbon, and look nice.

30: How much of the original wetlands of the U.S. have disappeared? **50**%

Restoration of Wetlands
31: What did the **National Environmental Policy Act** of 1969 require?
-Additional wetlands must be created to compensate for any destruction or damage of existing natural wetlands

Dams and the Environment
32: Explain the ***environmental impacts of dams***
-Loss of land and resources, flood hazards, trapped sediment and depletion of beaches, changes in hydrology and environment, fragmentation of ecosystems near the dam, and restricted movement of organic material, nutrients, and aquatic organisms

33: What are the ***PROS and CONS*** of the Three Gorges Dam?
-The Three Gorges Dam produces 18,000 MW of electricity with a fraction of the pollution. However, the dam has drowned areas around the site, displacing 2 million people. The dam also reduces water quality, increases erosion, creates tremors, and blocks sediments that are vital to downstream ecosystems.

34: What are some of the *issues associated with removing of dams*?
-The hazards, risk of ecosystem damage, and the cost

Global Water Shortage Linked to Food Supply
35: What are the environmental issues associated with global water shortage and food supply?
-Depletion of groundwater aquifers, drying bodies of water, cost of energy, and limited river flow

36: Water is one of our most abundant resources, *why are we concerned about its availability in the future?*
-Because we may not have enough water to grow food for the population in the future if it grows too rapidly and resources are drained too fast

Study Questions
1: Which is more important from a national point of view, conservation of water use in agriculture or in urban areas? *Why?*
-Conservation of water use in agriculture should be more emphasized because the population is rapidly growing, so more agricultural practice must be made to sustain the population and provide it with food. Urban areas can decrease their water usage and still be able to thrive, but agriculture cannot go without water.