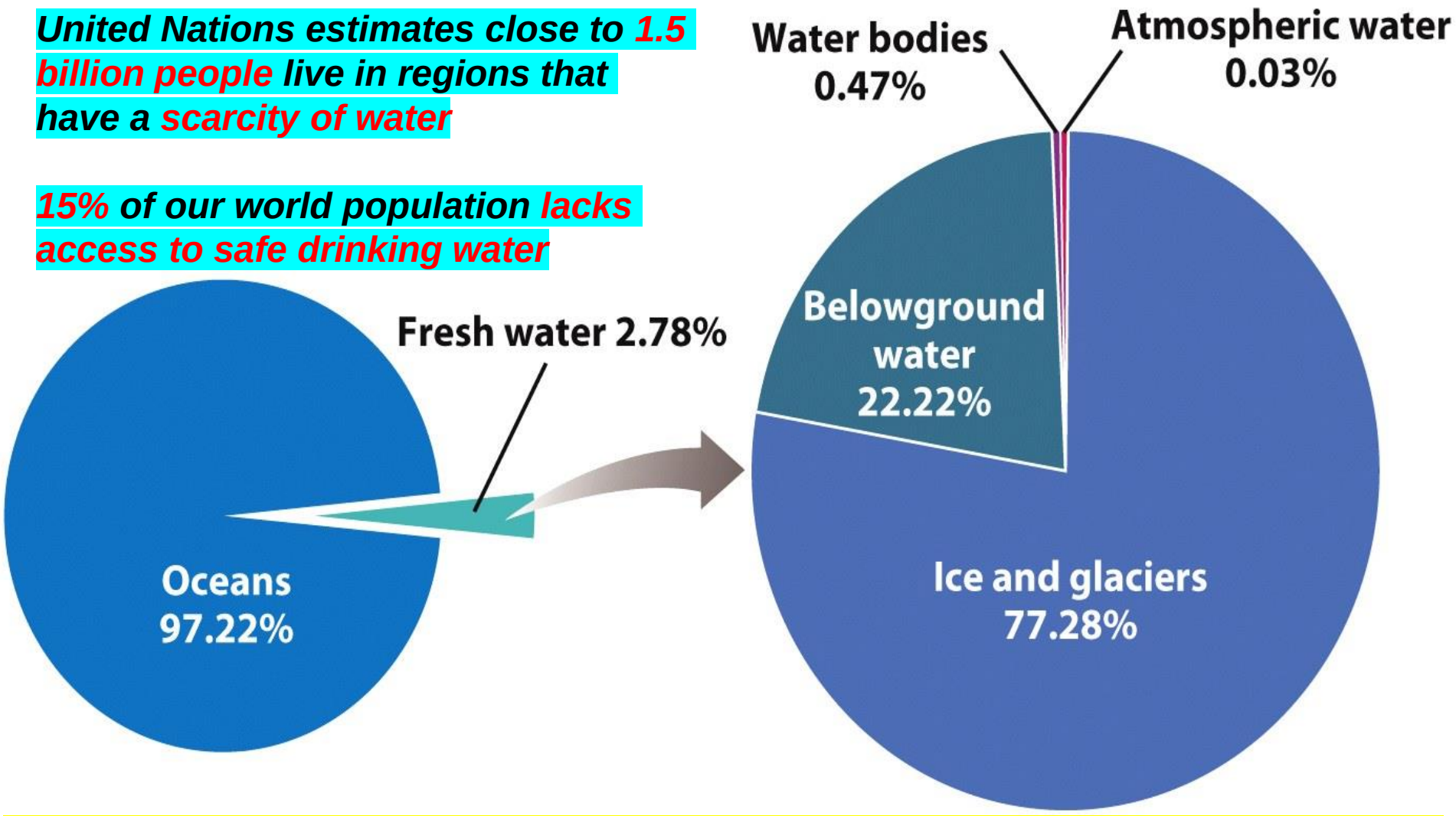
Chapter 9
Water Resources

Usable Water is Rare

70% of Earth's surface is covered by water.

United Nations estimates close to 1.5 billion people live in regions that have a scarcity of water

15% of our world population lacks access to safe drinking water



Out of the fresh water (2.8%), ¼ is underground. Remaining ¾'s is mostly in ice and glacier form.

Less than 1% of all water is accessible for use by humans

Groundwater

- **Aquifers**-(sources of usage groundwater) small spaces found *within permeable layers of rock and sediment where water is found*.
  - **Unconfined aquifers- (water can easily flow in and out, easily polluted, rapidly *recharged* by water that penetrates downward from land)** an aquifer that is simply *porous rock covered by soil*.
  - **Confined aquifers-** an aquifer surrounded by a *layer of impermeable rock or clay* (causes ***water pressure to build*** underground, allows an **Artesian Well** to be drilled and be able to extract water)

Groundwater

- **Water table**- the *uppermost* level at which the water in an area *fully saturates* the *rock or soil*.
- **Recharge**- the *input process* of water percolating (*seeping*/infiltrating) into an aquifer.
- **Springs**- water from an *aquifer* that naturally *percolates up to the surface*.

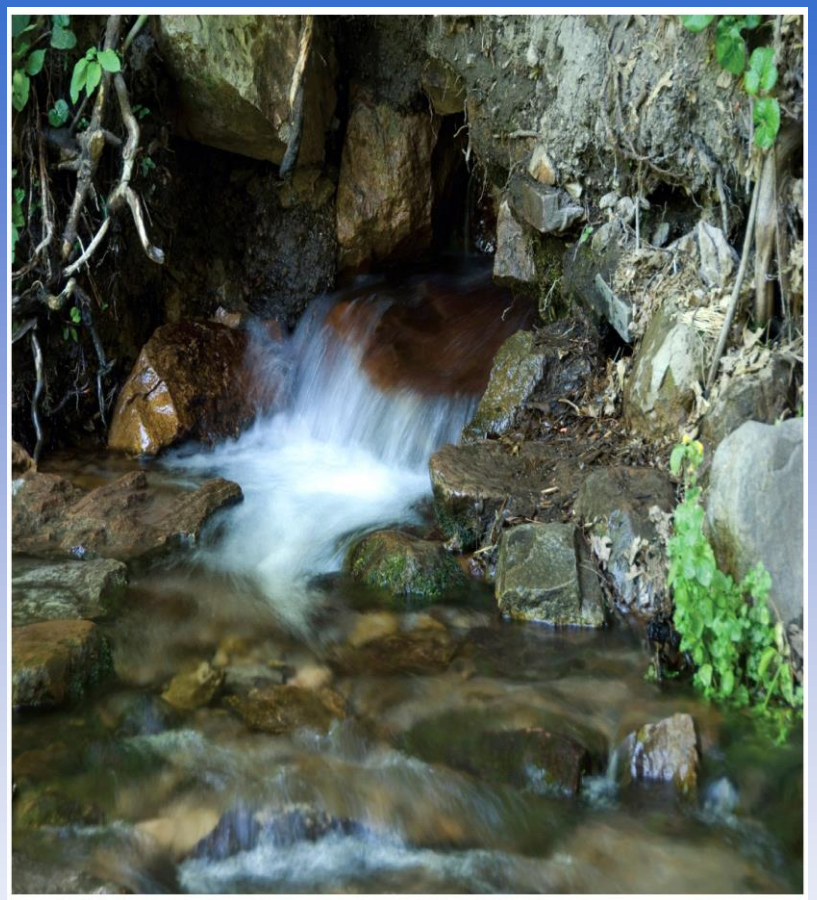


Figure 9.3
Environmental Science

Natural Spring (New Mexico), source of water for organisms…initial source for many streams & rivers.

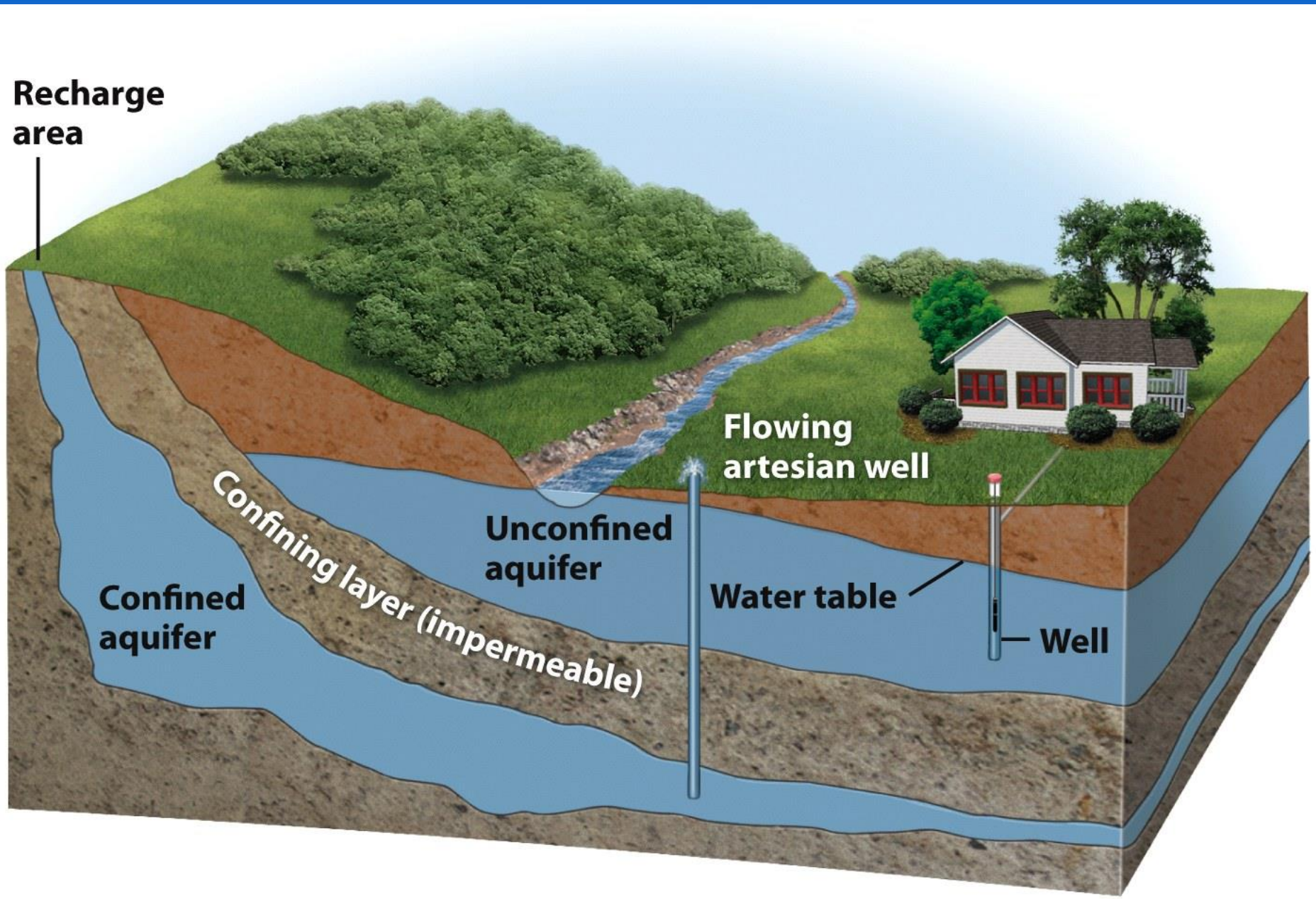


Figure 9.2
Environmental Science

Groundwater

- **Cone of depression-** an area where there is no longer any groundwater.

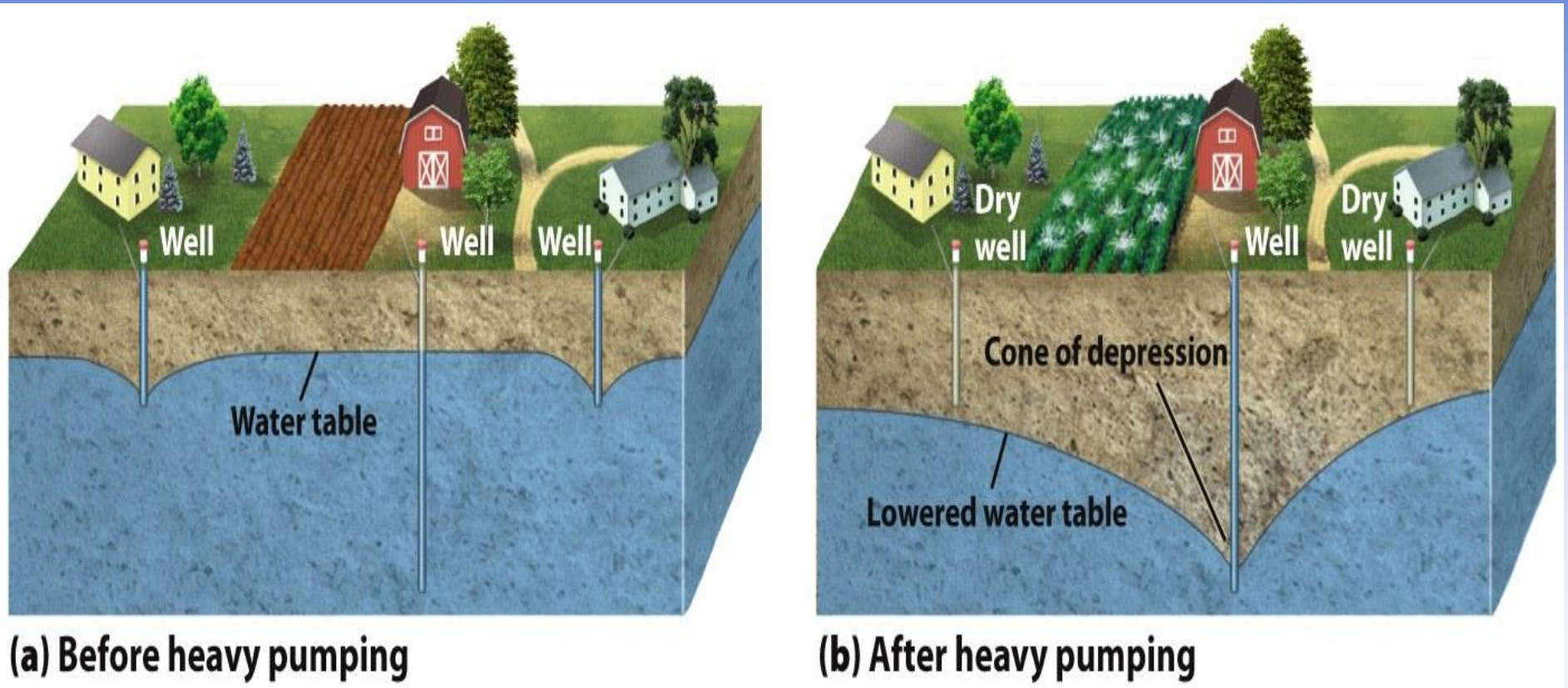
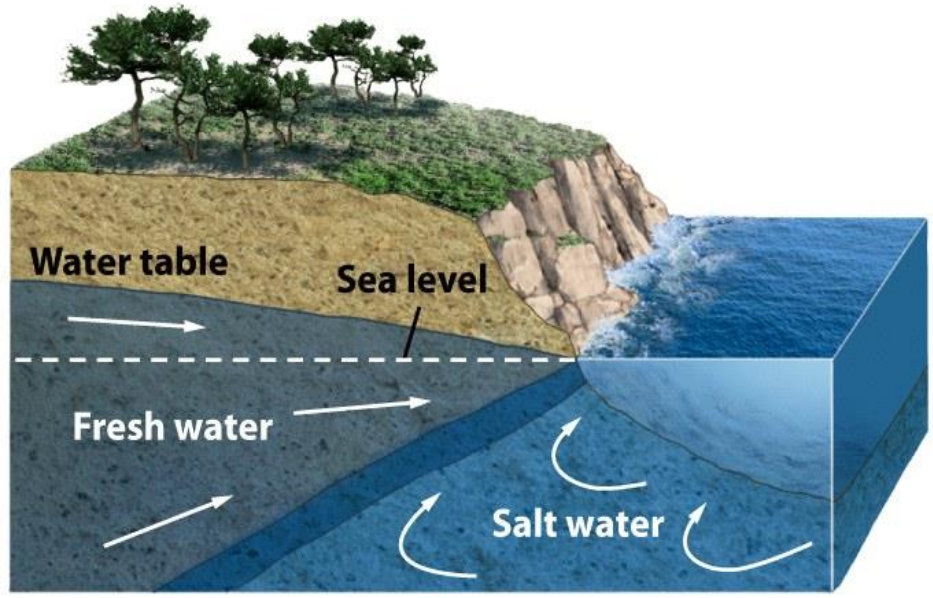


Figure 9.5
Environmental Science

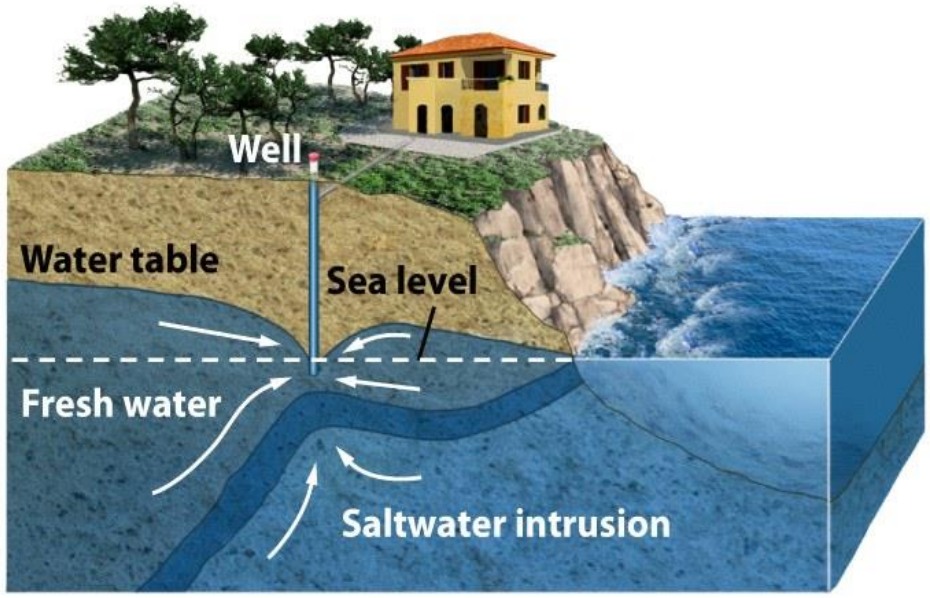
Well pumps water more rapidly than it can be recharged, causing shallow wells to go dry.

Groundwater

- **Saltwater intrusion-** when the pumping of fresh water out of a well is faster than the recharge. Near coastal areas this can cause salt water to infiltrate the aquifer.



(a)



(b)

Figure 9.6
Environmental Science

Surface Water

- Fresh water exist above the ground include...Streams, rivers, ponds, lakes and wetlands.
- Measured by volume of water
- Used as transportation and land surrounding, very fertile land
- *Floodplain* –*excess water & nutrients spread onto adjacent land for agricultural.*

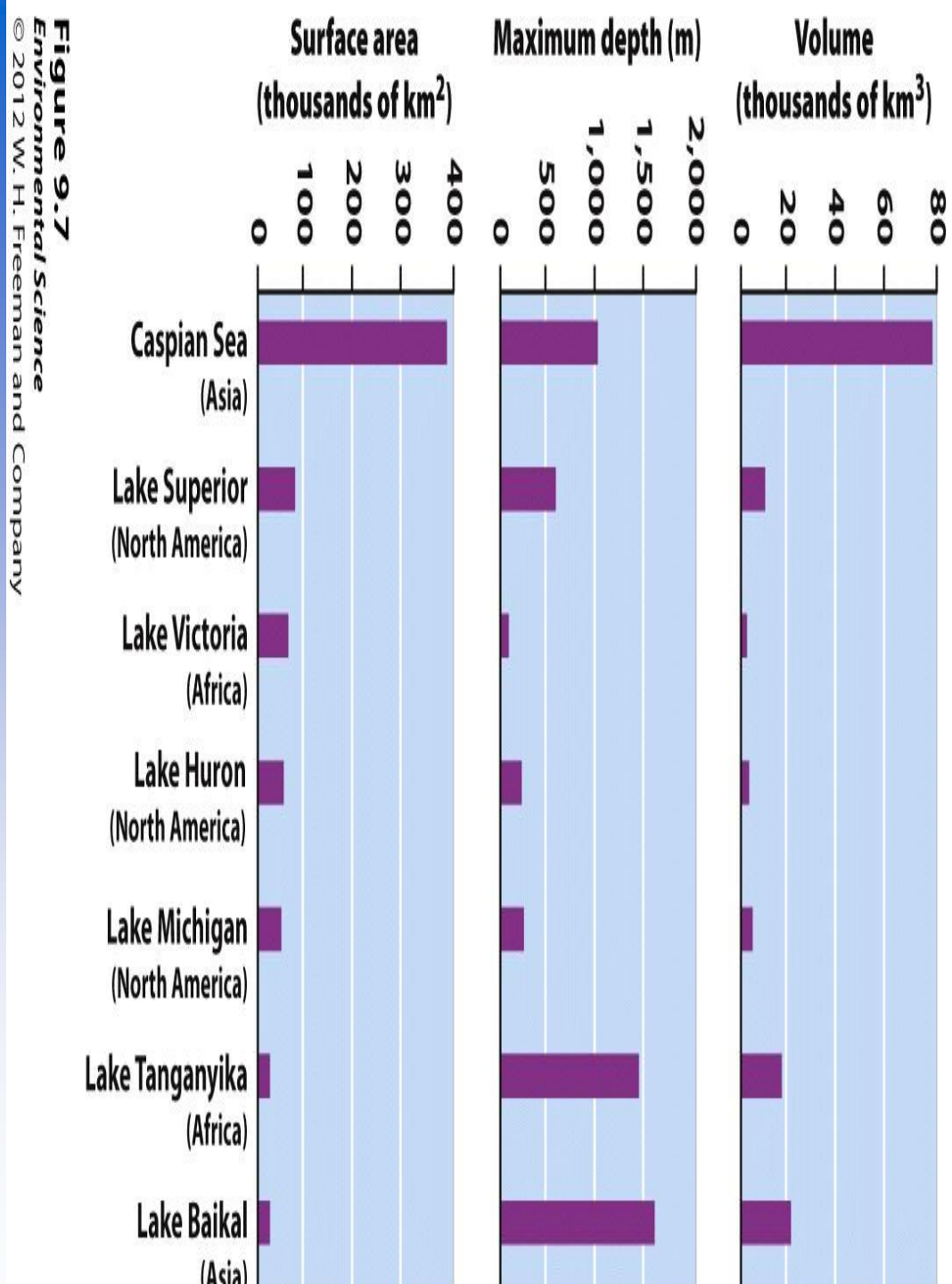


Figure 9.7 *Environmental Science*

Surface Water

- *Lakes can be created* by **tectonic activity** (areas of land to rise up, &/or split open) & **glaciation** (movement of glaciers created large depressions in the land…*creation of the Great Lakes*)

- **Productivity in a lake**:
  1. **Oligotrophic**- low amounts of nutrients such as phosphorous and nitrogen (low productivity).
  2. **Mesotrophic**- a moderate level of productivity
  3. **Eutrophic**- high levels of productivity

- **Wetland, Salt marshes and Mangrove swamps** -can absorb & store the excess water (flooding) and slowly release back into ecosystem

Atmospheric Water – Human Impacts

- **Predictable rainfall patterns can experience unexpected droughts**….

1. Destroying of crops *(increase of erosion)*
2. Long time effects on soil *(water cycles nutrients such as nitrogen/phosphorus – infertility & impermeable)*
3. Killing cattle
4. Risk of starvation *(people dying/going hungry)*

*Human Activities such as **conversions** of native grasslands into Wheat fields (U.S.1920s & 1930s), caused **soil erosion** by winds, lead into dust storms (Texas Dust Bowl of 1935) carried away topsoil and fertility of soil.*

***Droughts vs. Floods** – both can lead to crop and property damage, as well as losses of animal and human lives*

Altering the Availability of Water

- **Levees**- (prevent flooding) an enlarged bank built up on each side of the river, to prevent rivers from flowing over onto floodplains.

Challenges:

Natural floodwater, no longer add fertility to floodplains.

Sediments do not leave river, settle downstream where river enters oceans

Redirect of floodwater farther downstream can cause worse flooding in city.

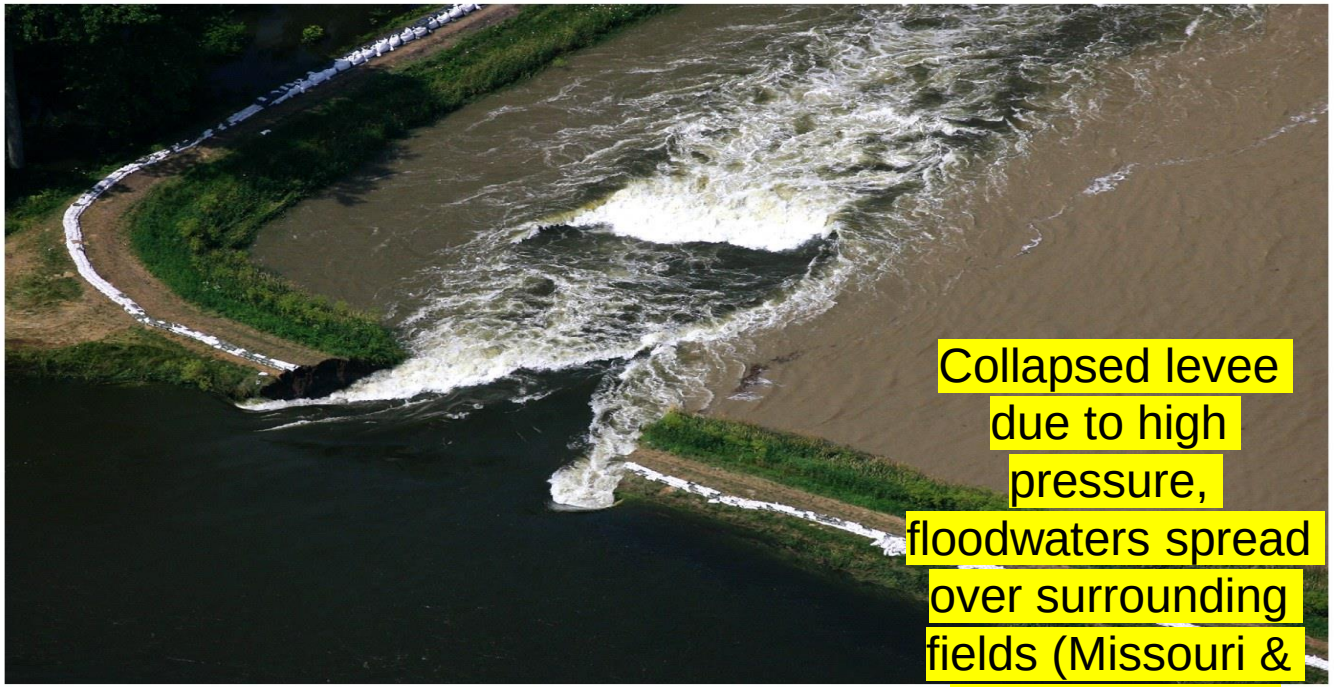


Figure 9.9
Environmental Science

Collapsed levee due to high pressure, floodwaters spread over surrounding fields (Missouri & New Orleans – hurricane Katrina)

Dikes- *similar to a levee*, but built to prevent ocean waters from flooding adjacent land (use of pumps redirect)

Altering the Availability of Water

- **Dams**- a barrier that runs across a river or stream to control the flow of water.

Purposes:

1. ***Flood Control***
2. ***Generation of Electricity*** (hydroelectric dams)
3. ***Human consumption***
4. ***Recreation***

(scenic lake for housing developments)

Downfall:

Financial, societal and Environmental costs (isolation & relocation, Natural flow of water, Population loss)

Figure 9.10
Environmental Science

Reservoir- the area where water is stored behind the dam.

Altering the Availability of Water

- **Fish ladders-** a set of stairs with water flowing over them that have been added to some dams to help migrating fish such as salmon get upstream (allow fish to get around the dam).

(Solution to dams that interrupt flow of water, prevent displacement of migrating upstream organisms to breed)

Figure 9.11
Environmental Science

Altering the Availability of Water

- **Aqueducts**- canals or ditches used to carry water from (lake/river) one location to another.
- Concrete canals & pressurized steel pipes above or underground.
- Brings water to cities, very expensive, disturbs and fragments natural habitats (construction to put in)

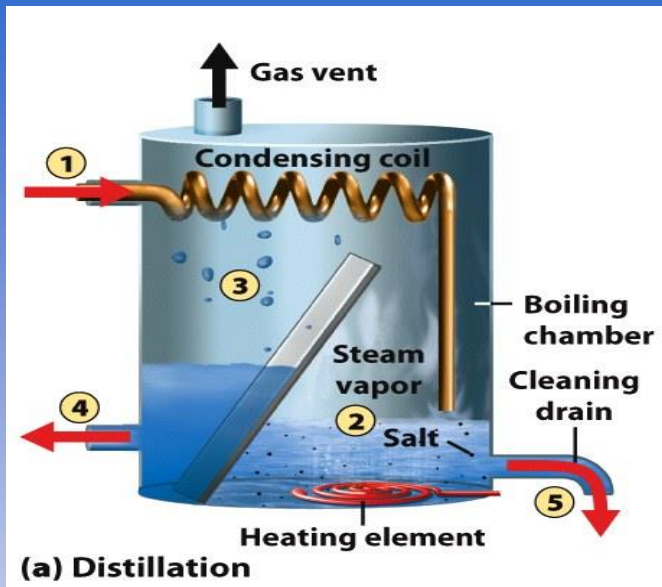
Figure 9.12
Environmental Science

Altering the Availability of Water

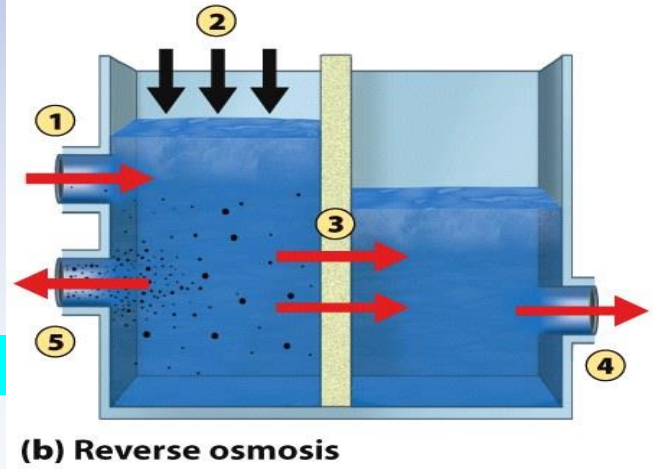
Desalination- removing the salt from salt water *(usually from oceans, but may come from salty inland lakes)* to obtain fresh water.

Typically, brine (high concentration of salt water) is returned to open ocean – can cause harm to life

Distillation is environmentally & monetary expensive (to build, maintain & repair…)



(a) Distillation



(b) Reverse osmosis

2 ways to remove salt… Distillation & Reverse Osmosis *-more efficient & less costly than distillation)*

Agriculture, Industry and Household Needs

- **Agriculture**- the largest user of water around the world *(approx. 70% use).*

Irrigation techniques:

Furrow irrigation

Figure 9.17a
Environmental Science

1. **Furrow irrigation**- a trench that is flooded with water. (easy, inexpensive, 65% efficient... Accessible to the plants but run off or evaporates).

Flood irrigation

Figure 9.17b

2. **Flood irrigation**- the entire field is flooded with water (70-80% efficient, disruptive to plant growth)

Agriculture, Industry and Household Needs

Spray irrigation

Figure 9.17c
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3. Spray irrigation- an apparatus that sprays water across a field (more expensive and uses more energy 75-95% efficient).

Drip irrigation

Figure 9.17d
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4. Drip irrigation- using a slow dripping hose that is laid on or buried beneath the soil (95% efficient, reduces the weed growth)

5. Hydroponic agriculture- crops grown in fertilized water and no soil. (uses 95% less water than other irrigation methods, cost of growth and purchase is higher)

Water costs, energy costs, equipment costs…

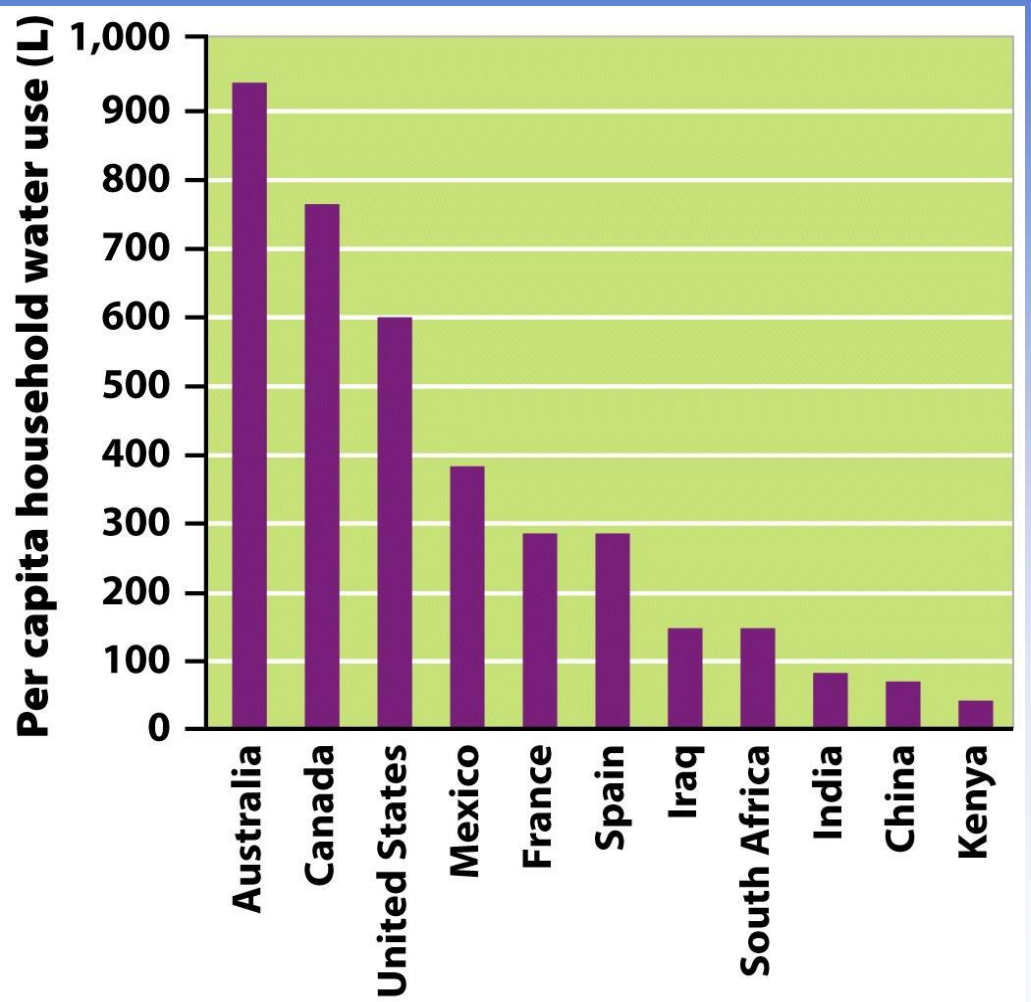
Agriculture, Industry and Household Needs

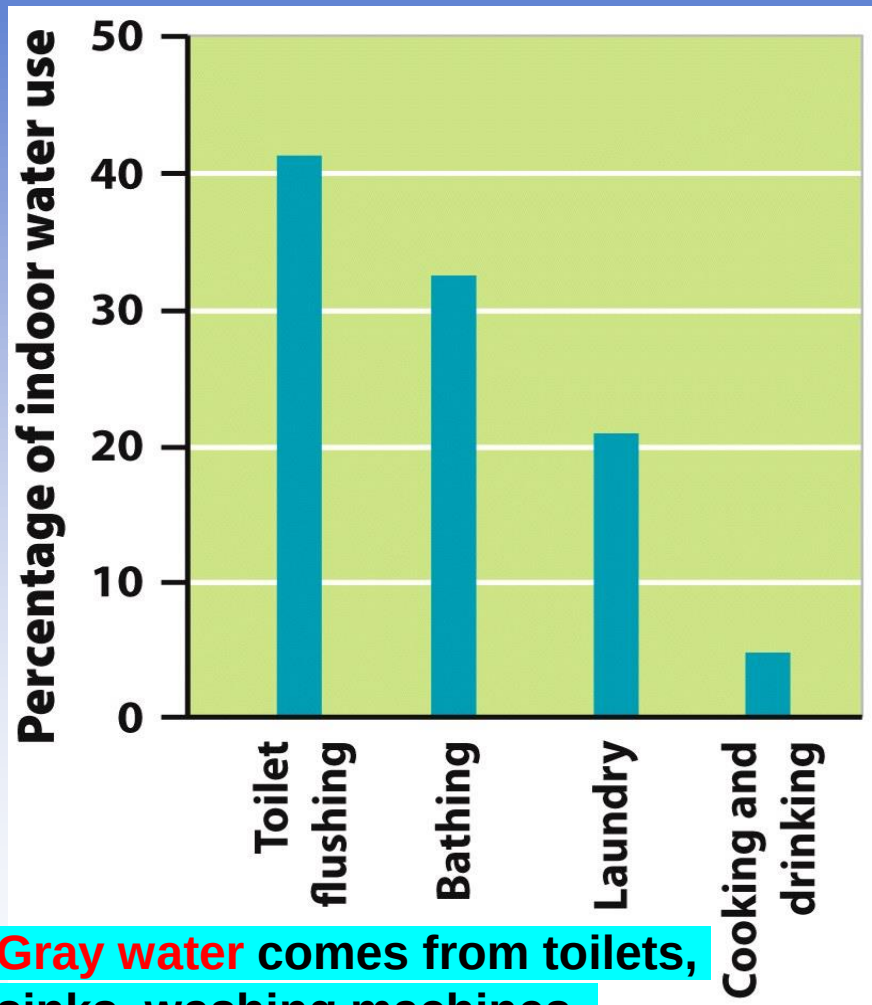
- **Industry**- the second largest user of water worldwide *(approx. 20% use).* .

Figure 9.19
Environmental Science

Agriculture, Industry and Household Needs

- **Households**- the third largest user of water worldwide *(approx. 10% use)*. .





Gray water comes from toilets, sinks, washing machines, showers..etc

Figure 9.20
Environmental Science

The Future of Water Availability

- **Water ownership-** people can have rights to water use, but they do not own the water.
- **Water conservation-** using techniques such as more efficient water fixtures, faucets and washing machines. (one of the best ways to reduce water use- efficient manufacturing equipment).

Figure 9.23
Environmental Science

Planting organisms that are more accustom to the landscape…AZ, reduction in water