GLG 110 – Chapter 12 – Water Resources

• ***Concepts to Understand from this chapter***
  - o Water cycle and water supply
  - o Main types of water use
  - o Basic surface water and ground water processes
  - o Key principles associated with water management
  - o Wetlands: What are they, and what is their environmental significance?
  - o Why are we facing a global water shortage linked to food supply?

• ***Case History*** – Long Island, NY
  - o Brooklyn and Queens on western Long Island, have polluted groundwater and rely on imported water from upstate NY
  - o Nassau and Suffolk counties (eastern Long Island) use groundwater, which is abundant, but this resource has been overpumped, resulting in dropping water table elevations, and contamination from landfills, septic tanks and salt water intrusion has degraded this resource, largely as a result of increased urbanization of the area

• ***Water Cycle*** (*hydrologic cycle*) involves the following processes:
  - o Evaporation
  - o Precipitation
  - o Transpiration
  - o Surface runoff
  - o Subsurface groundwater flow

• ***Residence Time*** for water in various locations varies from days (atmosphere and streams) to many thousands of years (deep groundwater and ice caps)

• A ***Drainage Basin*** is the total area that contributes runoff to a particular stream
  - o ***Drainage divides*** (ridge lines, etc.) separate individual drainage basins

• ***Surface Runoff*** produces erosion of the land surface and carries sediment downstream in dissolved, suspended, and bed loads
  - o Steeper slopes = faster flow = more potential erosion and sediment transport
  - o Crumbly rock, heavy weathering, and abundant fractures increase erosion potential
  - o High ***relief*** (difference in elevation between low and high areas) produces steep streams and increased erosion and sediment transport potential
  - o ***Climate*** effects – infrequent, intense rainfall maximizes erosion via flash flooding
  - o ***Vegetation*** can slow flow and decrease erosion and transport; removal of vegetation can increase both and drastically affect stream velocity and sediment load

• ***Land-use factors***
  - o ***Urbanization*** increases run-off, due to large amounts of impervious (blocks water infiltration) materials, such as asphalt, concrete, and building roofs
  - o ***Agriculture*** increases runoff and sediment yield when loose, plowed sediments are exposed before crops sprout

• ***Groundwater***
  - o ***Vadose zone*** – usually unsaturated zone below ground surface above the ***water table***
  - o ***Saturated zone*** – zone below water table in which all pore space is filled/saturated with water
  - o Resupplied by infiltration in ***recharge zones***

- o ***Aquifer*** – rock or sediment capable of supplying groundwater at a "useful" rate from a well
- o ***Confining layer/aquitard*** – rock or sediment that slows or blocks groundwater movement
- o ***Perched aquifer*** – locally saturated zone (typically above localized aquitard) above regional water table
- o ***Artesian*** conditions exist when water in a confined aquifer (between aquitards) is under pressure and rises up in wells above the local level of the top of the aquifer
- o ***Groundwater discharge*** occurs naturally at ***springs***, where the water table intersects the ground surface, and artificially through pumping from wells
- o ***Flow rate*** is directly proportional to the local water table gradient (or hydraulic gradient in a confined aquifer) and the ability of the sediment or rock to transmit the water (permeability/hydraulic conductivity)

• ***Groundwater supply*** is plentiful globally, but may be locally overused, causing drops in water table

- o Localized shortages are result of temporal (doesn't rain often enough) and spatial (water resources plentiful, but elsewhere) issues

• ***Karst*** landscapes involve ***sinkholes*** (roughly circular, crater-like depressions) and a rolling surface, resulting from the dissolving of subsurface limestone layers, producing caverns that periodically collapse

- o Wet climate required for sufficient infiltration to cause dissolving of limestone

• ***Desalination*** is the removal of salt from seawater in order to produce a fresh water resource

- o Very expensive and impractical in all but the most water-starved coastal areas

• ***Water Use***

- o ***Offstream use*** - water is removed or diverted from its source, as in irrigation, industrial uses, and public supply
- o ***Consumptive use*** – Offstream use that does not result in return of water to stream or groundwater
  - Evaporation, crop uptake of water, animal/human consumption
- o ***Instream use*** – use of water without removal from stream
  - Hydroelectric power, recreation, navigation by boat traffic
- o Different uses may require conflicting flow conditions, setting up conflicts

• ***Aqueducts and canals*** are commonly used to move water from regions of abundant supply to large urbanized areas where demands exceed local supplies of clean water

- o Urban shortages often compounded by local groundwater contamination due to urbanization itself, requiring import of most or all of the needed supply

• **U.S. water usage** increased steadily until about 1980, since then it has leveled off/dropped slightly, as decreases in use by thermoelectric power generation and flat demand by agriculture (due to more efficient practices) have more than offset increases in public demand resulting from population growth

• ***Water conservation*** practices, especially regarding efficiency and/or recycling uses in agriculture and industrial/power plant needs, may yet decrease our total water usage for some time to come, in spite of population growth

• ***Water management*** practices, including using more surface water in wet years, and groundwater in dry years, and water treatment and re-used, will be increasingly necessary in

the future

• ***Colorado River*** is one of the most heavily managed (and spoken for!) water resources in the U.S.
    - o Management for public use, as well as for river environmental conditions in the Grand Canyon, are both involved

• Water management that involves building of **artificial control structures**, such as dams, reservoirs, and aqueducts, has some negative environmental effects, such as:
    - o Loss of land flooded by new reservoirs
    - o Trapping/removal of sediment that would have traveled down the river system
    - o Change of downstream habitat w.r.t. Lost sediment, colder water, increased scour and streambed erosion, reduction of natural variation in river flow rates, etc.

• **Groundwater depletion** around the globe over the past 50 years is largely a result of the tripling in agricultural demand for irrigation of crops to feed the ever-increasing human population
    - o Future water shortages are, then, likely to lead directly to food/crop shortages as insufficient irrigation water might be available
    - o Conservation of water and controlling population growth are two keys to avoiding this potential food crisis