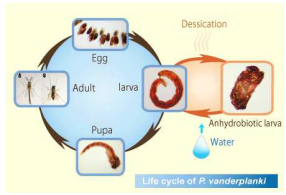
Water and Health

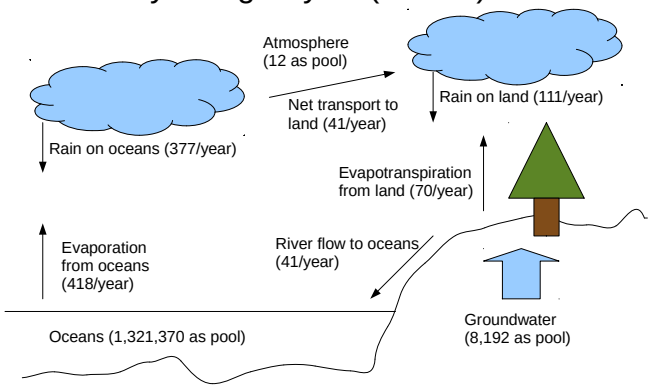
- Frumkin H [Ed.] (2010) Environmental Health: From Global to Local, 2nd Ed. Chapter 15 "Water and Health" pp.487-555.
- KEY CONCEPTS
  - Critical for all forms of life on the earth
  - Human may threaten quality and quantity of water in many ways, then human health and the earth's health
  - Protecting our health needs to conserve water, reduce wastewater production, begin to recycle
  - US regulatory framework ensures the provision of safe drinking water to the public
  - Future risks to water resources and potential mitigation
- Other reference web pages
  - <World Water Council> http://www.worldwatercouncil.org
  - <WHO/Water> http://www.who.int/topics/water/en/
  - <WHO/Water sanitation and health> http://www.who.int/water_sanitation_health/en/

Role of water in life

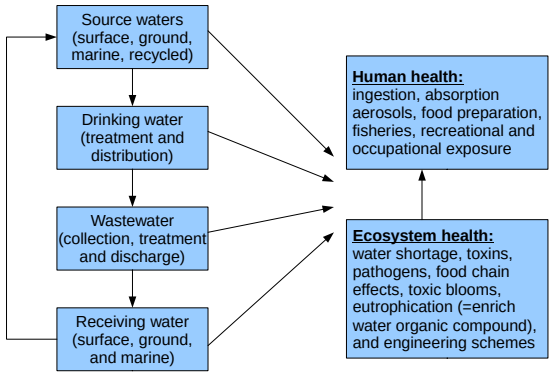
- No water, no life
  - Human, animal, avian, reptile, amphibian, plant, microbe
    - (cf.) sleeping chironimid can survive for several months without water (cryptobiosis = suspending metabolism, losing 97% of its body water) (http://www.nias.affrc.go.jp/anhydrobiosis/Sleeping%20Chironimid/e-index.html, see below)
  - Searching for life on other planets begins from searching water
  - Humans are 60% water
    - cannot survive for more than a few days without water
  - Human culture has been restricted to the area with rich water supply by big rivers: Egypt, Indus, China, Mesopotamia



Hydrologic cycle (unit: Tt)



Interconnections between water and health



Definitions

- Freshwater supplies (EPA, 2007)
  - Surface water: all waters naturally open to the atmosphere (rivers, lakes, reservoirs, ponds, streams, impoundments, seas, estuaries, ...)
  - Groundwater: the supply of fresh water found beneath the Earth's surface, usually in aquifers, which supplies wells and springs
  - Groundwater under the direct influence of surface water (significant occurrence of insects or other microorganisms, rapid shift of water characteristics)
- Humans can manage the water resource
  - Source water: highest quality for drinking water can reduce treatment cost, avoid contamination
  - Groundwater: traditionally considered as high quality because of percolation through soil, but not always due to human activities

Water scarcity as one of the most critical health threats

- Water use may cause water scarcity
  - Long term view: the use of nonrenewable resource is finite; if resource extraction is faster than renewal, any resource supplies eventually cannot meet the demand -> both nonsustainable, like fossil fuels
  - If the water use increase faster than its renewal, the same situation as fossil fuels may happen
    - In arid regions: aquifer recharge are low ("aquifer" refers the soil zones containing rich water). Ogallala Aquifer in USA (ranging SD to TX): 448,000 km^2, provided 30% of all groundwater for irrigation in the USA, changed central plains of North America to rich farm, but it was fossil water, may deplete in the next 20-30 years.
- Population increase may cause water scarcity
  - Balance among water availability, population, the ways of water use
  - 27% of nations face water stress (available water per person < 1,700 t/year) by 2025 + 11% of nations face water scarcity (<1,000 t/year)
  - Zero available water in West Bank of Jordan, Seychelles -> import
  - Renewable freshwater supply per person: 10,527 t/year in USA, 1,787 t/year in Somalia
  - Annual withdrawal in USA: 1,654 t (46% industry, 41% agriculture, 13% home); Among home use (0.59t/day/person), only 0.2% for drinking
- Agricultural use may cause water scarcity

Political implications

- Food production depends on irrigation
  - freshwater use is linked with food security, human nutrition, then well-being
  - enormous political implications of water scarcity
    - Major rivers / aquifers cross international / state borders -> use by a nation/state affects downstream
      - Dams damage to downstream users
      - Political hot spots: Nile, Tigris/Euphrates, Indus/Beas/Sutlej/Ravi, Ganges/Brahmaputra, Jordan, Parana/Paraguay, Rio Grande, Colorado
    - "Resource Wars" may occur
- Global burden of waterborne diseases
- Safe drinking water needs -> treatment technologies , including chlorination (by-products should be paid attention)

Climate change and water

- Global climate change affects water
- Global warming cause the increase of evaporation from the oceans -> increase of water vapor in the atmosphere -> increase of precipitation -> more severe weather events
- Positive feedback loop (cf. hydrologic cycle)
- The burden of water scarcity may shift
  - Arid regions may benefit
  - Mountainous regions (depending on snowpack) may short

Human impacts on water

- Hydrodynamics (the way water moves) is dramatically altered by human activity (construction of dams, levies, canals, ...) -> completely change the biology and chemistry of an ecosystem, sometimes eutrophication, oxygen depletion, massive fish die-out
- Engineering schemes resulted in large health effect
  - Dam and irrigation -> snails -> schistosomiasis
  - Hydroelectric -> methylation of Hg -> Hg overintake
  - Channelization -> extreme flood -> Huge economic loss
  - Draining -> loss of wildfowl and fish -> economic loss, long term effects on human may occur (unknown)
- Water contaminants
  - Chemical: (eg. As, Hg, PCB, oils, chloroform, salt) naturally (esp. N, F, As) or artificially (esp. POPs) comes
  - Biological: (eg. bacteria, virus, protozoa) comes from many sources including human and animal wastes -> waterborne disease outbreaks (eg. cryptosporidiosis, E. coli O157)
  - Deposition, storage, bioconcentration should be paid attention for both.