

## Water Unit

### Water Resources and Use

- Distribution/Availability- water is scarce, only 25% of water on Earth is fresh and most of that is in glaciers and ice caps, unevenly distributed
- Water Uses- drinking, agriculture, industry...
  - Consumptive use- water removed and not returned
  - Non-Consumptive use- water temporarily removed
  - Irrigation
    - Gravity flow- water comes from aqueduct or river
    - Drip irrigation- pipes deliver water to plant roots
    - Center pivot- water pumped and sprayed with sprinklers
- Water cycle
  - Transpiration- water goes through tree leaves
  - Evaporation- bodies of water evaporate into the air
  - Precipitation- rain, hail, snow
  - Condensation- water forms clouds
  - Infiltration- water seeps into the ground
  - Runoff- water drains off land
- Water Properties/Structure
  - Made up of hydrogen bonds (one molecule attracts another molecule)
  - High Specific Heat
  - Strong Cohesion (sticks together)
  - Ice is less dense than water
  - Water is a common solute (dissolves other things)
- Aquifers- porous formations of rock, sand, and gravel that hold ground water
- Groundwater- precipitation that doesn't evaporate or goes into water ways
  - 1/5<sup>th</sup> of Earth's freshwater supply
  - Aquifers- porous formations of rock, sand, and gravel that hold ground water
    - Confined Aquifer- porous rocks trapped between layers of non permeable layers (clay)
    - Unconfined Aquifer- no upper layer to confine it
  - Aquifer Recharge zone- any area where water infiltrates Earth's surface and reaches aquifer
    - Lateral Recharge- water move upwards
  - Zone of Aeration- spaces partially filled with water
  - Zone of Saturation- spaces completely filled with water
  - Water Table- boundary between two zones
  - Wells- create cones of depression (lead to contamination and salt water intrusion)
  - Getting depleted
- Reservoirs-store water
- Dams/Dikes/Levees- used to store water

- Dams-obstruction used to store water
  - Used to prevent floods, provide drinking water, irrigation, generate electricity
  - Hydroelectric Power-water flow turns turbine and creates energy/electricity
  - Dikes/Levees- mounds placed along river banks to hold in rising water
- Tributary- smaller river flowing into larger one
- Watershed- area of land drained by a river
- Riparian- riverside areas that are productive
- Lakes
  - Littoral Zone- region around edge of water body
  - Benthic Zone- region along entire bottom of water body
  - Limnetic Zone- open portions of the lake where sunlight penetrates
  - Profundal Zone- where sunlight doesn't reach
- Costs vs Benefits
  - Benefits
    - Power generation
    - Emission reduction
    - Irrigation
    - Drinking water
    - Flood Control
    - Shipping
    - Recreational Opportunities
  - Costs
    - Habitat alteration
    - Decline in fisheries
    - Pop. displacement
    - Sediment capture
    - Flooding disruption
    - Loss of rec. opportunities
- Case Studies
  - Aral Sea- loss volume due to diversion for cotton fields, loss of fish, toxic dust goes into the air
  - Salton Sea- California, runoff high in nutrients flow into the sea
  - Colorado River- brings water to 15 millions people, used for agriculture, extensively dammed and diverted
  - Mono Lake- California, volume has decreased while salinity increased
  - Idagon Simulation
- Ways of “making” more
  - Desalinization- expensive, requires fossil fuels
  - Residential ways- xeriscaping (landscaping using plants adapted to arid conditions), low-flow toilets and faucets

## Ecosystems

- Ecology-study of how organisms interact with their environment
- Source (part of environment from which materials move) vs. Sink (part of environment that receives an input)
- Biotic vs Abiotic
  - Biotic- living (plants, animals...)
  - Abiotic- non living (water, air, temp...)
- Food chains/webs/energy flow/trophic levels
  - Trophic Levels- levels of consumers
  - Producers- autotrophs, source of all food
  - Consumers- heterotrophs, aerobic and anaerobic respiration
  - Decomposers- decompose
  - Omnivores-eat both plants and meat
  - Detritus Feeders/Scavengers-consume dead stuff
  - Food Chains- one link, relationship between trophic levels
  - Food Webs- many food chains together
    - Energy Flow goes from small to large
  - Rule of 10- only 10 % of energy goes on to the next trophic level
    - Energy pyramid
- Indicator (species that may show environmental change) /Keystone Species (strong impact in proportion to its abundance, removal impacts whole food web)
- Nitrogen Cycle
  - Made up of four processes
    - Nitrogen fixation- nitrogen taken from molecular form and converted into compounds
    - Nitrogen decay- Nitrogen is broken down by waste and is converted into ammonia
    - Nitrification- Ammonia is taken up by plants and converted to nitrates
    - Denitrification- make nitrates into nitrogen gas
- Carbon Cycle
  - Carbon stored in the lithosphere, ocean, biosphere, and atmosphere
  - In the sea- respiration, decomposition, carbonates in sediments
  - Land-plants, animals, photosynthesis
  - Carbon stored in oceans, lithosphere, organic matter, atmosphere, living and dead organisms
- Primary Productivity
  - Photosynthesis- plants make energy
  - Respiration- organisms use oxygen
  - Gross Primary Productivity-conversion of light energy to chemical energy
  - Net Primary Productivity- energy accumulated in plant biomass (NPP=GPP-respiration rate)
- Dissolved oxygen- amount of oxygen in the water

- Case Studies
  - Otters

#### BOD/Pollution

- BOD- demand for oxygen needed by organisms
  - Pollution Zone- BOD increases, DO decreases
  - Evens out
- Pollution- chemical, biological, or physical change in water quality that has a harmful effect on living organisms
  - Nitrates/Phosphates-add nutrients, contribute to eutrophication
  - Acid Mine Drainage-too many acids in water
  - Dissolved Oxygen- oxygen in water
  - Turbidity- total suspended and dissolved solids
  - Salinity-too salty, harmful to organisms
  - Fecal Coliform- bacteria indicate fecal contamination
- Point Source (discrete location of pollution) vs non point source (pollution from cumulative input over a large area)
- Toxic Chemicals- natural and synthetic (arsenic, lead)
- Thermal Pollution- warmer water holds less oxygen
- Polluted Water Solutions- treat sewage, disinfect, education, government enforcement
- Water Quality Standards-set standards for drinking and water ways water
  - EPA set Maximum Contaminant Levels (MCLS) for contaminants
  - Clean Water Act-illegal to discharge pollution without a permit and containing pollution
  - Safe Drinking Water Act- allowable levels for drinking water
- Easier to prevent than to correct!
- Septic Tanks- treat small volumes of waste
- Waste Water treatment- treat larger volumes of waste
  - Primary Treatment: removal of physical and solid waste
  - Secondary Treatment: oxygenation and removal (chemical processes)
  - Tertiary Treatment: filtration, chlorination, treatment for drinking and discharge
- Oligotrophic- high oxygen and low nutrient
- Eutrophication- process of water bodies gaining nutrients and losing oxygen
- Contaminants vs Pollutant
  - Pollutant- man made things that contaminate water
  - Contaminant-things that go into water that is harmful (include pollutants)
- Economics
  - Measure income by: gross domestic product, net domestic product
  - Marginal cost: damage increases as amount of pollution increases
  - Marginal cost of pollution abatement: as pollution amount decreases cost increases