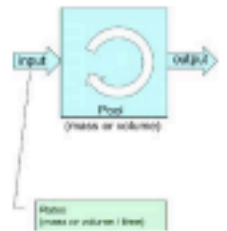


TOPIC 21: ECOSYSTEM ECOLOGY: PHYSIOLOGY + BIOGEOCHEMISTRY

- Movement + transformation of matter + energy conforms to laws of conservation of mass + energy
- **Earth is a closed system** (eg. hydrological cycle) measured in:
 - **Pools:** (eg. ocean, ice) – measured in volume
 - **Fluxes:** (eg. evap, precip) – measured as a rate of volume per unit time
- Different cycles dominated by different pools + fluxes
 - Other cycles: nitrogen, carbon etc. – sedimentary or atmospheric natured
- How to research? Collect, grind + analyse – measure biomass of trees, carbon, collect leaf litter to measure flux – then chemically analyse compared to other species of tree
 - Can measure gas fluxes to measure photosynthesis + respiration rates



MASS BALANCE

- Steady dynamics occurs when **inputs = outputs**
- Mean residence time: length something stay in before moving out = **pool/flux rate**
- Turnover: fraction of the pool that turns over per unit time = **flux rate/pool**
- Exponential decay – concept of the $\frac{1}{2}$ life (time required for a quantity to reduce to half its initial value)
 - Characteristic unit for the exponential equation – $\frac{1}{2}$ life constant over life of exponential decaying object
 - The **constant** is different depending on the system



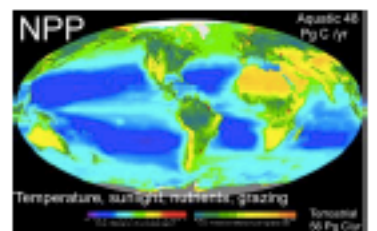
Hubbard Brook Forest - Experiment

- Whole ecosystem experiment in upstate NY, used small watershed as unity of measurement (rather than quadrat)
- Modified forest with diff management to understand how this affects ecosystem
- Manipulates the units (methods of forestry): control, clear fell, felled with buffering strip (riparian vegetation)
- Measured deforestation effects on ion export: **Increased exported Cl, P + nitrate in stream outflow**
- Value of long term research – most grants only last 3 years – after initial change other things may happen

Acid Rain: burning fossil fuels esp. coal fired power plants, sulphate in atmosphere react with hydrogen ions to increased acidity through sulphur acid – falls in precip + damages forests

PRODUCTIVITY

- **Biomass:** amount of biological material standing in space + time – measured as mass per unit area
- **Primary Productivity:** GPP (total fixation by photosynthesis), NPP (GPP – respiration)
- **Secondary Productivity:** production of biomass by consumers/heterotrophs
- Globally, **terrestrial more productive** than aquatic (in terms of carbon)
 - Yet less land than water, showing it has higher productivity
 - Terrestrial: None at poles, more at tropics
 - Aquatics: higher productivity coasts than oceans, high at poles (more available nitrate – controls productivity in ocean)



Liebig's Law of Minimum

- Explains what controls productivity – plants have to have **one limiting nutrient** to control productivity
- Can also be **co-limited** by more than one nutrient
 - Nitrogen limiting in polar + boreal regions
 - Phosphorous limiting at tropics
- Degree of limitation changes as ecosystems evolve over time – **succession** – due to depletion of nutrients
- Tropical forests: nitrogen limits young soils (sedimentary storage), then colimitation, then phosphorous limiting

STOICHIOMETRY

Stoichiometry: relationship between the abundance of elements in organisms

- **Redfield Ratio:** N:P = 15:1
- Ratio similar to presence of elements in marine upwelling regions
 - Marine organisms need to take up N + P in ratio that cellular components are made of
- When ratio more than 15:1 – take up excess phosphorous = cyanobacteria growth which fix atmospheric N = dynamic balance of ratio

<15:1 get cyanobacteria fixing atmospheric N
>15:1 get bacterial consumption of organic N (NO₃⁻, NO₂⁻, NH₄⁺)