Ecology and Environmental Health

(as of Environmental Health Special Lecture (2) on 13 Oct. 2016)

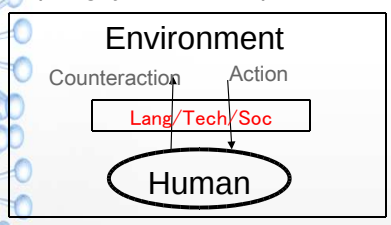
- Agenda of today's lecture
  - Ecology: the interactions between biological organisms and their biotic/abiotic environments can be quantified and described
  - Humans exist within (are not separated from) ecosystem and ecological interactions
  - Ecosystem functioning <- material cycles + energy flow (as biological and physical components interact both hierarchically and circular feedback loops) <- largely altered by human activities // in turn, the pace of global climate change and its public health impacts increase
  - Ecosystem functioning -> toxins/pathogens are broken down or concentrated / those become environmental health risk or not
  - Biodiversity -> ecosystem functioning (eg. system capacity to regulate weather, break down hazardous agents, ...)
  - Populations
    - minimum size limit <- resource availability and intrinsic characteristics
    - maximum size limit <- extrinsic environmental factors
  - Rapid environmental change (<- human population growth, unplanned development, overexploitation of natural resources) -> ecosystem change, including emerging/reemerging infectious diseases

Ecology and Ecosystem

- Ecology
  - derived from *oikos* (ancient Greek); household/place to live
  - the study of interactions between organisms and environments
  - natural history -> natural selection / evolutionary biology -> social-ecological systems perspective / resilience theory -> sustainability
- Three different but complementary perspectives: ecosystem ecology, community ecology, and population ecology
- Ecosystem ecology: functional entity, formed by interactions of living organisms with physical environment
  - Collection of ecosystems -> biosphere (occurs at the edge of geosphere, hydrosphere, and atmosphere)
- Community ecology: Interactions of species; emphasis on specie's composition and diversity
- Population ecology: Population level processes; emphasis on population dynamics and regulation, and on interspecies interactions
  - Human ecology is a kind of population ecology

Interaction between human and environment

- A system of subject and environment
  - Ecosystem: a system in which all organism populations have relationship with physical-chemical environment, which in turn generates trophic stages, biodiversity and material cycles (hydrologic cycle, carbon cycle, nitrogen cycle --- ecosystem services) with energy flow (lost through work and dissipated as heat at each step of biological food chain).
  - Humanized (domesticated) ecosystem: physical-chemical environments are largely affected by human-beings
  - How to consider humanized ecosystem
    - Habitat+Resource+Environmental factor (Shosuke Suzuki)
    - Human<->[Language, Technology, Social organization] <-> Environment (Tsuguyoshi Suzuki)



Ecosystem services:
* Provision of clean water
* Waste recycling
* Regulation of infectious diseases
* Regulation of climate

Biomes

- Mostly determined by temperature and precipitation
  - marine ecosystems / freshwater ecosystems / terrestrial biomes / domesticated ecosystems
- Only human beings can live in any biome

Boreal Conifer Forest

Temperate Forest

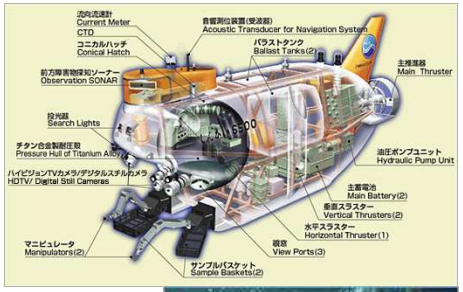
Tropical Rain Forest

Tundra

Tropical Semi-arid Grassland (Savanna)

Desert

Extraordinary biomes / non-biomes



Submarine in the deep sea

Antarctic bases

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Homeostasis

- Living organism needs metabolism (chemical reactions) within the body which requires non-extreme temperature, pressure, humidity
  - nonhuman organisms are adapted to their specific biomes (cf. dried water-bears and sleeping chironomid's larvae in cryptobiosys status)
  - Humans can make microenvironments (eg. cloths) and/or largely modify environments with technology to keep homeostasis within the body where chemical reactions occur.
- Homeostasis
  - Stressor (changes in external environments) stimulates organisms; can be regarded as anything disturbing homeostasis
  - Living organisms have "negative feedback" to keep homeostasis against perceived stressor.
    - In humans, homeostatic actions are not only biological but also artificial (using technology)
    - Carry-over of negative feedback returns out to external environment
  - Material cycle between the body and external environment through exposure, absorption, distribution, metabolism and excretion; the pathways are <u>not fixed</u>

Negative feedback in human population

- Human population has "adaptive renewal cycle", from r phase (growth and exploitation under low stored capital and connectedness), through K phase (conservation) and Ω phase (release), to α phase (reorganization)
- Recently the importance of adaptive management (a system of cyclical monitoring and adjusting), the central idea of ecosystem management is recognized
- Density dependent regulation is related with carrying capacity and logistic growth. Also related with emerging infectious diseases, which is also related with biodiversity.

Communities and species

- Habitat diversity
- Species-area relationship: in log-log scale, number of viable species are positively correlated with area
  - "division of area by ten divides the fauna by two" -- Darlington's rule (1957)
- Ecosystem components
  - niche
  - competitive exclusion principle
  - equilibrium theory