Chapter 6: Humans in the Biosphere

6-1 A Changing Landscape

- Human Activities
  - Ecosystems provide goods and services
    - Breathable air, drinkable water, fertile soil
    - Storage and recycling of nutrients
  - Global human activities use as much energy, and transport almost as much material, as all Earth’s other multicellular species combined
  - We have become the most important source of environmental change on the planet
    - Hunting & gathering
    - Agriculture
    - Industry
    - Urban development

- Hunting and Gathering
  - Hunted birds and mammals
  - Fished in rivers and oceans
  - Gathered wild seeds, fruits, and nuts
  - Caused a major mass extinction of animals
    - Wooly mammoths, giant ground sloths, saber-toothed cats

- Agriculture
  - The practice of farming
  - Early hunter-gatherers learned how plants grew & ripened and raised their own animals (cows, sheep, pigs, horses)
  - Humans began to gather in large settlements
  - In the 1800s and 1900s, advances in science & technology led to
    - Irrigation
    - Use of machinery for plowing, planting & harvesting
    - Development of new varieties of crops, producing higher yields
      - Often grown using monoculture (large fields are planted with a single variety year after year)
• Chemical fertilizers and pesticides
  ▪ *Green revolution*
    • The development of highly productive crop strains and the use of modern agricultural techniques to increase yields of food crops
    • To solve food shortages in many parts of the world
  ▪ Challenges for the Future
    • Large-scale monoculture can lead to problems with insect pests & diseases
    • Finding enough water for irrigation

• **Industrial Growth and Urban Development**
  ▪ Industrial Revolution in the 1800s
    • Led to the combination of industrial productivity and scientific know-how that provides most of the conveniences of modern life
  ▪ Effects of human activity on environments
    • Requires energy (mostly from burning fossil fuels)
    • Wastes from manufacturing, energy production & other sources discarded into air, water & soil
    • Land use changes
    • Habitat destruction
6-2 Renewable & Nonrenewable Resources

- Tragedy of the Commons
  - Any resource that is free and accessible to everyone may eventually be destroyed
    - If no one is responsible for protecting it, and if no one benefits from preserving it, people will use it up

- Classifying Resources
  - Environmental goods and services may be classified as either renewable or nonrenewable
    - **Renewable resource**
      - Resource that can regenerate quickly and that is replaceable
      - Ex: trees, fresh water
    - **Nonrenewable resource**
      - Resource that cannot be replenished by natural processes
      - Ex: fossil fuels (coal, oil, natural gas)

- Sustainable Development
  - A way of using natural resources without depleting them and of providing for human needs without causing long-term environmental harm
  - Human activities can affect the quality and supply of renewable resources such as land, forests, fisheries, air, and fresh water.
  - Must take into account both the functioning of ecosystems and the ways that human economic systems operate.

- Land Resources
  - Provides space for human communities, raw materials for industry, soils for growing crops
  - Soil is renewable if managed properly.
  - Fertile topsoil produced by long-term interactions between soil & plants growing in it
  - Plowing removes roots & increases rate of **soil erosion** (wearing away of surface soil by water & wind)
  - **Desertification**: process caused by a combination of poor farming practices, overgrazing, and drought that turns productive land into desert

- Forest Resources
  - Important for the products they provide & for the ecological functions they perform
    - Wood to make products and burn as fuel for cooking and heating
    - **“lungs of the Earth”**: remove carbon dioxide and produce oxygen
- Provide habitats, food, moderate climate, limit erosion
- **Deforestation**: loss of forests
  - Can lead to severe erosion, washing away nutrients, and preventing future tree regrowth
- Forest Management
  - Selective harvesting of mature trees
  - Replant and manage tree farms
  - Genetically modified faster-growing varieties

- **Fishery Resources**
  - Valuable source of food
  - Declining fish populations (Tragedy of the Commons)
  - Sustainable development
    - Guidelines for commercial fishing
    - Caused short term loss of jobs
- **Aquaculture**
  - The raising of aquatic animals for human consumption

- **Air Resources**
  - **Pollutant**
    - Harmful material that can enter the biosphere through the land, air, or water
    - Burning of fossil fuels from automobiles & industry releases nitrates, sulfates & particulates into the atmosphere
    - Can cause respiratory & other health problems
    - Can lead to acid rain when they combine with water vapor in the air

- **Freshwater Resources**
  - Pollution threatens water supplies
    - Chemicals, wastes discarded on land, domestic sewage
  - Sustainable use involves protecting the natural systems involved in the water cycle.
    - Wetlands help purify water passing through them
    - Forests & vegetation help purify water
  - Water conservation is becoming increasingly important as the demand for water grows rapidly.
6-3 Biodiversity

- **Biodiversity**
  - The sum total of the genetically based variety of all organisms in the biosphere
    - **Ecosystem diversity:** includes the variety of habitats, communities, and ecological process in the world
    - **Species diversity:** the number of different species in the biosphere (about 1.5 million species identified and named so far)
    - **Genetic diversity:** the sum total of all the different forms of genetic information carried by all organisms living on Earth today
  - One of Earth’s greatest natural resources
    - Provide us with foods, industrial products, and medicines

- **Threats to Biodiversity**
  - Human activities
    - Altering habitats
    - Hunting species to extinction
    - Introducing toxic compounds into food webs
    - Introducing foreign species to new environments
    - Can lead to *extinction* (when a species disappears from all or part of its range)
    - **Endangered species:** a species whose population size is declining in a way that places it in danger of extinction
  - **Habitat Alteration**
    - As habitats disappear, species vanish.
    - Development can split ecosystems into pieces
      - Habitat fragmentation
      - Remaining pieces of habitat become biological “islands”
        - New York’s Central Park
      - The smaller the “island”, the fewer species can live there, the smaller their population can be, and the more vulnerable they are to further disturbances or climate change.

- **Demand for Wildlife Products**
Humans have pushed some animal species to extinction by hunting them for food or other products.

In the U.S., endangered species are protected, but in parts of Africa, South America, and Southeast Asia hunting still threatens rare animals.

- For meat, fur, hides, body parts for medicinal properties

**Pollution**

- Toxic compounds can accumulate in the tissues of organisms
  - DDT
    - One of the first widely used pesticides
    - Remains active for a long time & kills many different insects
    - Nonbiodegradable and, when it is picked up by organisms, they do not eliminate it from their bodies.
    - *Biological magnification*
      - Concentrations of a harmful substance increase in organisms at higher trophic levels in a food chain or food web

**Introduced Species**

- Apparently harmless plants or animals that humans transport around the world either accidentally or intentionally
  - Often become *invasive* species
    - Not native
    - Reproduce rapidly (new habitats lack the parasites & predators that control their population)

**Conserving Biodiversity**

- *Conservation*
  - The wise management of natural resources
  - Efforts focus on protecting entire ecosystems as well as single species
  - Must be informed by solid research
  - Try to maximize benefits while minimizing economic costs
6-4 Charting a Course for the Future

• Researchers are gathering data to monitor and evaluate the effects of human activities on important systems in the biosphere
  ▫ The ozone layer high in the atmosphere
  ▫ The global climate system

• **Ozone Depletion**
  ▫ Ozone layer
    • High concentrations of ozone gas ($\text{O}_3$) 20-50 kilometers above Earth’s surface
    • Absorbs harmful UV (ultraviolet radiation) from the sun
      • Increased exposure to UV radiation can cause cancer, damage eyes, decrease resistance to disease, damage tissue in plants & phytoplankton
    • “hole” or gap in ozone layer
      • Caused by **chlorofluorocarbons** (CFCs)
        • Originally used as a propellant or coolant
      • Today most uses of CFCs are banned, but molecules can linger for as long as a century

• **Global Climate Change**
  ▫ Since the late 19th century, average atmospheric temperatures have risen about 0.6 Celsius degrees
  ▫ Since about 1980, average temperatures have risen between 0.2 and 0.3 Celsius degrees.
  ▫ **Global warming**: increase in the average temperatures of the biosphere
    • **Evidence**
      • Is the current trend part of a larger, natural cycle of climate change or is it caused by human activity?
      • Human activities (burning fossil fuels, cutting & burning forests) are adding $\text{CO}_2$ to the atmosphere faster than the carbon cycle can remove it.
    • **Possible Effects**
      • Sea levels may rise, causing coastal flooding
      • More droughts
      • Habitat alterations, leading to more threatened or endangered species