Chapter 7: Climate and Biodiversity

Part 1- Climate & Weather

Weather

- Short term atmospheric conditions-hours to days
- Temperature, pressure, moisture content, precipitation, cloud cover, wind speed and direction all influence weather.
- Most weather due to interactions between leading edges of moving masses of warm and cold air.

Climate

- A region's general pattern of long-term atmospheric conditions
- Regional differences in temperature and precipitation are main factors in determining climate and thus which organisms can survive in each region.
- Latitude and altitude also play a role.

Factors that Influence Earth's Climate

Climate varies in different parts of the Earth because of:

1) Uneven heating of Earth by sun
2) Atmospheric convection currents
3) Rotation of Earth
4) Earth's orbit around the sun on a tilted axis
5) Ocean currents

Climate- Uneven Heating of the Earth by the Sun

Uneven heating of earth's surface by the *variation in angle* at which the *suns rays strike Earth*. Air is heated more at the equator, where sun strikes directly than at the *poles where sun strikes at angle and spreads over a greater surface area.*

This explains the existence of Earth's major climate regions:

- Tropical
- Polar
- Temperate

Different Climates Support Different Life Forms

Tropical: equator, intense sunlight
Polar: poles, little sunlight
Temperate: between tropical & polar

Albedo Influences Earth's Surface Temperatures

Albedo: *the percent of incoming solar radiation that is reflected or absorbed.* Higher the albedo of a surface, the more solar energy it reflects and the less it absorbs. *White surface high albedo; Dark surface low albedo*

- Global average albedo 30%
- 10-20% tropics with dense green foliage
- 80-95% in snow covered polar regions

Climate- Atmospheric Convection Currents

Properties of Air

- Density: cold/more dense sinks; warm/less dense rises
- Water Vapor Capacity: warm air has a higher capacity for water vapor than cold air
- Adiabatic Cooling: air rises, pressure decreases, expands in volume and lowers temp of the air.
- Adiabatic Heating: air sinks, pressure increases, volume decreases and air temp rises
- Sun's energy **evaporates** water and forms vapor/**water vapor condenses** to a liquid & heat are produced. This is **latent heat**
  - **Low Pressure:** less dense, warm moist air rises allowing surface flows to move to the center of the low where air is rising.
  - **High Pressure:** more dense, cold dry air sinks and spreads outward as it strikes the ground creating surface flows (wind) that move outward from the center of the high.

Formation of Convection Currents: convection currents create global patterns of air movement as a result of unequal heating of Earth.

- Warm humid air in tropics rises, lower pressure and adiabatic cooling, reaches saturation point which leads to condensation, cloud formation and precipitation.
- Cold, dry air is displaced horizontally N and S of equator where it eventually sinks at 30^{o} N and S, creating an area of high pressure. When it reaches Earth's surface it is hot and dry-desert.
- Hadley Cells: Convection Currents that cycle between equator and 30^{o} N and S.
- Ferrell cells at mid-latitudes $30^{o} – 60^{o}$ N and S
- Polar cells form at 60^{o} N and S.
- Air circulation driven by alternating convection cells.

Climate- Earth's Rotation: The Coriolis Effect

Earth moves faster at equator because of difference in circumference causing deflection of objects that are moving directly N or S. As a result prevailing winds are produced by a combination of atmospheric convection currents and the Coriolis effect.

Ocean currents: the flow of water across the surface of the ocean. Driven by a combination of ***prevailing winds***, temperature, gravity, the Coriolis effect and the location of continents.
Gyres: large-scale patterns of water circulation; combinations of ocean currents.

Ocean currents are a major factor in the global distribution of heat and ultimately, climate.

Thermohaline circulation: the global circulation of ocean water initiated by density differences due to variations in temperature and salinity (salt concentrations). Cold salty water at high latitudes (near the poles) sinks and warm water near equator rises driving a global conveyor belt or deep ocean current that mixes all ocean waters.

Upwelling: In certain geographic regions, prevailing winds, along with ocean currents, push surface water away from the shore, which is then replaced by waters from below. This brings cold, nutrient rich waters to the surface. This upward movement of water towards the surface distributes nutrients and thus determines coastal areas of productivity.

Climate- El Niño -Southern Oscillation (ENSO)

- Occurring every 3-7 years, this interaction between the ocean and the atmosphere results from weakened or reversed trade winds.
- The normally cold waters off western coast of S. America warm and suppress the upwelling of nutrient rich water, resulting in decreased productivity and decline in fish populations.
- The area of humid, rising air and abundant rainfall, normally in the western Pacific, shifts eastward, to the central, and eastern Pacific.
- This shift causes torrential rains and flooding in the normally arid areas along the west coast of South America.

Climate- Land and Sea Breezes

- Water has a greater ***heat capacity*** than land, which means it gains and loses heat at a much slower rate than land. In other words, water stays in the same temperature range day to night and season to season, while land temperature fluctuates often.
- **Heat** is *absorbed* and *released* more slowly by water than by land to create land and sea breezes that moderate climate by oceans and large bodies of water.

- **Land breezes** blow from the land to the water.
- **Sea breezes** from water to land.
- *During the day* the sand will heat faster than the water, creating an updraft of rising air that then allows surface flows (wind) to flow inland from the ocean.
- At night the sand will cool faster than the water, thus reversing the flow & wind will blow from land to water.

Climate- Rainshadow Effect

Rainshadow Effect: when moist air blowing inland reaches mountains it cools and expands as it rises, dumping moisture on windward side as rain or snow (also known as orographic lifting). Consequently leaving the leeward side with a dry air mass that draws moisture out of plants and soil. Often forms desert (e.g. death valley, leeward side of Cascades, Gobi desert).

- *Most precipitation falls on the windward side (green side)* of mountain ranges; resulting in forest and areas of high productivity; *Deserts leeward (dry side)*

Climate- Mountain & Valley Breezes

Mountain & valley breezes are similar to land and sea breezes in their diurnal cycle (twice a day). Thus, they are often known as the diurnal shift.

- Valley breezes occur during the day because air along mountain slopes is heated and rises up through the valley.
- At night as air cools, due to rapid radiational heat loss, reversing the process sending a flow of colder denser air down the valley producing a mountain breeze.

Urban Heat Island (UHI)

Metropolitan areas are significantly warmer than surrounding rural areas. Cities create microclimates because concrete and asphalt absorb and hold heat; plus buildings block wind flow; motor vehicles and the climate control systems of buildings release large quantities of heat and pollutants

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Part 2- Biomes

Biomes- Ecosystem Diversity

Biomes are large regions characterized by specific climates and communities of species that are specifically adapted to the biotic and abiotic components of their ecosystems.
This variety of ecosystems is a major component of biodiversity.
Each of these ecosystems (biomes) is a storehouse of genetic and species diversity.

Abiotic Factors Determine Climate Zones: Biomes

Major **biomes**: large land regions with certain types of climate and dominant plant life

- Not uniform
- Mosaic of patches
  - Latitude and elevation
  - Annual precipitation
  - Temperature

3-Types of Deserts

1. **Tropical deserts**
2. **Temperate deserts**
3. **Cold deserts**

Fragile ecosystem

- Slow plant growth
- Low species diversity
- Slow nutrient recycling
- Lack of water

Staying Alive in the Desert

Beat the heat/every drop of water counts

- Plant adaptations
  - Succulents
  - Deep tap roots

Animal strategies and adaptations

- Physiology and anatomy
- Behavior

3-Types of Grasslands

1. **Tropical**
2. **Temperate**
3. **Cold (arctic tundra)**

Tropical

- Savanna
  - Grazing animals
  - Browsing animals

Temperate

- Cold winters and hot and dry summers
- Tall-grass prairies & Short-grass prairies
- Often converted to farmland

Arctic tundra: fragile biome

-Plants close to ground to conserve heat & most growth in short summer

- Animals have thick fur

Permafrost: underground soil that stays frozen

✧ **Alpine tundra**: above tree line in mountains

Temperate Shrubland

- **Chaparral**
  - **Nice climate, risky place to live**
  - **Near the sea: nice climate**
  - **Prone to fires in the dry season**

3-Types of Forests

1. **Tropical**
2. **Temperate**
3. **Cold**
    - Northern coniferous
    - boreal forests
    - subalpine forests

Tropical rain forests

- Temperature and moisture
- Stratification of specialized plant and animal niches
- Little wind
- Rapid recycling of scarce soil nutrients
- Impact of human activities: agriculture, forestry, mining, oil & gas

Temperate deciduous forests

- Temperature and moisture
- Broad-leaf trees
- Slow rate of decomposition: high biomass
- Impact of human activities

Evergreen coniferous forests: boreal and taigas

- Temperature and moisture
- Few species of cone: bearing trees
- Slow decomposition: significance
- Canadian boreal forest
- Coastal coniferous forest & temperate rain forests (Washington State)

Latitude & Elevation Gradients

The increase in species richness or biodiversity that occurs from the poles to the tropics, often referred to as the latitudinal diversity gradient (LDG), is one of the most widely recognized patterns in ecology. This pattern is also recognized as one increases in elevation.

Mountains Play Important Ecological Roles

- Majority of the world's forests
- Islands of biodiversity
- Habitats for endemic species
- Help regulate the earth's climate
- Major storehouses of water: Important role in hydrologic cycle

Natural Capital Degradation

Major Human Impacts on Terrestrial Ecosystems

Deserts	Grasslands	Forests	Mountains
Large desert cities	Conversion to cropland	Clearing for agriculture, livestock grazing, timber, and urban development	Agriculture
Destruction of soil and underground habitat by off-road vehicles	Release of CO_2 to atmosphere from burning grassland	Conversion of diverse forests to tree plantations	Timber and mineral extraction
Soil salinization from irrigation	Overgrazing by livestock	Damage from off-road vehicles	Hydroelectric dams and reservoirs
Depletion of groundwater	Oil production and off-road vehicles in arctic tundra	Pollution of forest streams	Increasing tourism
Land disturbance and pollution from mineral extraction			Air pollution blowing in from urban areas and power plants
			Soil damage from off-road vehicles
			Water supplies threatened by glacial melting