Climate and Terrestrial Biodiversity

Chapter 7
Core Case Study: Connections between Wind, Climate, and Biomes

- Wind
  - Indirect form of solar energy

- Circulates
  - Heat
  - Moisture
  - Plant nutrients
  - Soil particles
  - Long-lived air pollutants
Dust Blown from West Africa to the Amazonian Rain Forests
7-1 What Factors Influence Climate?

- **Concept 7-1** An area's climate is determined mostly by solar radiation, the earth’s rotation, global patterns of air and water movement, gases in the atmosphere, and the earth’s surface features.
The Earth Has Many Different Climates (1)

- **Weather** - a local area’s short-term physical conditions such as temperature and precipitation.

- **Climate** - a region’s average weather conditions over a long time.

Air circulation in lower atmosphere due to
- Uneven heating of the earth’s surface by the sun
- Rotation of the earth on its axis
- Properties of air, water, and land
The Earth Has Many Different Climates (2)

- **Currents**
  - Prevailing winds
  - Earth’s rotation
  - Redistribution of heat from the sun

- Link between air circulation, ocean currents, and biomes
Global Air Circulation or The Coriolis Effect

- Air cools and descends at lower latitudes.
- Warm air rises and moves toward the poles.
- Air cools and descends at lower latitudes.

The highest solar energy input is at the equator.
Energy Transfer by Convection in the Atmosphere
Heat released radiates to space

Cool, dry air
Falls, is compressed, warms
Warm, dry air
Flows toward low pressure, picks up moisture and heat

High, wet air
Rises, expands, cools

Low, dry air
Condensation and precipitation

Moist surface warmed by sun
High pressure

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Connected Deep and Shallow Ocean Currents

Warm, less salty, shallow current

Cold, salty, deep current
Warm, less salty, shallow current

Cold, salty, deep current
Global Air Circulation, Ocean Currents, and Biomes

Moist air rises, cools, and releases moisture as rain

Polar cap
Arctic tundra

60°
Evergreen coniferous forest
Temperate deciduous forest and grassland

30°
Desert

Equator
Tropical deciduous forest
Tropical rain forest
Tropical deciduous forest

30°
Desert

60°
Temperate deciduous forest and grassland

Polar cap

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Convection Cells

- Heat and moisture are distributed over the earth’s surface by vertical currents, which form six giant convection cells at different latitudes.
Cell 3 North

- Cold, dry air falls

Polar cap

Arctic tundra

60°

Evergreen coniferous forest

Temperate deciduous forest and grassland

30°

Tropical deciduous forest

Desert

0°

Equator

Tropical rain forest

60°

Temperate deciduous forest and grassland

Polar cap

Cold, dry air falls

Moist air rises — rain

Cell 2 North

- Cool, dry air falls

Cell 1 North

- Moist air rises, cools, and releases moisture as rain

- Cool, dry air falls

Cell 1 South

- Cool, dry air falls

Cell 2 South

Moist air rises — rain

Cell 3 South
Greenhouse Gases Warm the Lower Atmosphere

- **Greenhouse gases**
  - H$_2$O
  - CO$_2$
  - CH$_4$
  - N$_2$O

- **Greenhouse effect**

- Human-enhanced global warming
Flow of Energy to and from the Earth

- Solar radiation
- UV radiation (Most absorbed by ozone)
- Visible light
- Reflected by atmosphere
- Absorbed by the earth
- Heat radiated by the earth
- Greenhouse effect
- Radiated by atmosphere as heat

Lower Stratosphere (ozone layer)
Troposphere

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The Earth’s Surface Features Affect Local Climates

- Heat absorption by land and water

- Effect of
  - Mountains
    - Rain shadow effect
  - Cities
    - Microclimates
Rain Shadow Effect

Prevailing winds pick up moisture from an ocean.

On the windward side of a mountain range, air rises, cools, and releases moisture.

On the leeward side of the mountain range, air descends, warms, and releases little moisture.
Prevailing winds pick up moisture from an ocean.

On the windward side of a mountain range, air rises, cools, and releases moisture.

On the leeward side of the mountain range, air descends, warms, and releases little moisture.
Concept 7-2  Differences in average annual precipitation and temperature lead to the formation of tropical, temperate, and cold deserts, grasslands, and forests, and largely determine their locations.
Different climates lead to different communities of organisms, especially vegetation.

- **Biomes** – large terrestrial regions characterized by similar climate, soil, plants, and animals.
- Each biome contains many ecosystems whose communities have adapted to differences in climate, soil, and other environmental factors.
The Earth’s Major Biomes
Generalized Effects of Elevation and Latitude on Climate and Biomes
Elevation:
- Mountain ice and snow
- Tundra (herbs, lichens, mosses)
- Coniferous Forest
- Deciduous Forest
- Tropical Forest

Latitude:
- Tropical Forest
- Deciduous Forest
- Coniferous Forest
- Tundra (herbs, lichens, mosses)
- Polar ice and snow
Natural Capital: Average Precipitation and Average Temperature as Limiting Factors
DESERT BIOMES

- Deserts are areas where evaporation exceeds precipitation.
- Deserts have little precipitation and little vegetation.
  - Found in tropical, temperate and polar regions.
- Desert plants have adaptations that help them stay cool and get enough water.
DESERt BIOMES

- Variations in annual temperature (red) and precipitation (blue) in tropical, temperate and cold deserts.

Figure 5-12
Tropical Desert

- **Mean monthly temperature (°C)**
- **Mean monthly precipitation (mm)**

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Saudi Arabia

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Temperate Desert

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Saguaro cactus in the United States

Fig. 5-12b, p. 109
Bactrian camel in Mongolia’s Gobi (cold) desert.
DESERT BIOMES

- The flora and fauna in desert ecosystems adapt to their environment through their behavior and physiology.
Producer to primary consumer

Primary to secondary consumer

Secondary to higher-level consumer

All producers and consumers to decomposers
GRASSLANDS AND CHAPARRAL BIOMES

- Variations in annual temperature (red) and precipitation (blue).

![Figure 5-14](image-url)
Maasai Mara National Park in Kenya, Africa

Tropical grassland (savanna)

Mean monthly temperature (°C)

Mean monthly precipitation (mm)

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Fig. 5-14a, p. 112
East Glacier Park in Montana
Arctic tundra with caribou in Alaska’s Arctic National Wildlife Refuge.
GRASSLANDS AND CHAPARRAL BIOMES

- Grasslands (prairies) occur in areas too moist for desert and too dry for forests.
- Savannas are tropical grasslands with scattered tree and herds of hoofed animals.
Temperate Grasslands

- The cold winters and hot dry summers have deep and fertile soil that make them ideal for growing crops and grazing cattle.
Temperate Grasslands

- Temperate tall-grass prairie ecosystem in North America.

Figure 5-16
Golden eagle

Pronghorn antelope

Coyote

Grasshopper

Grasshopper sparrow

Prairie dog

Blue stem grass

Prairie Coneflower

Bacteria

Fungi

Producer to primary consumer

Primary to secondary consumer

Secondary to higher-level consumer

All producers and consumers to decomposers
Polar Grasslands

- Polar grasslands are covered with ice and snow except during a brief summer.
Fig. 5-17, p. 114

- Moss campion
- Mountain Cranberry
- Lemming
- Dwarf Willow
- Willow ptarmigan
- Horned lark
- Mosquito
- Snowy owl
- Long-tailed jaeger
- Grizzly bear
- Caribou
- Arctic fox
- Long-tailed jaeger
- Mosquito
- Snowy owl
- Horned lark
- Willow ptarmigan
- Lemming
- Dwarf Willow
- Mountain Cranberry
- Moss campion

Producer to primary consumer
Primary to secondary consumer
Secondary to higher-level consumer
All producers and consumers to decomposers
Chaparral has a moderate climate but its dense thickets of spiny shrubs are subject to periodic fires.
FOREST BIOMES

➢ Variations in annual temperature (red) and precipitation (blue) in tropical, temperate, and polar forests.
Western Congo Basin of Gabon, Africa

Fig. 5-19a, p. 116
Temperate deciduous forest in Rhode Island.

Fig. 5-19b, p. 116
Northern coniferous forest in the Malheur National Forest and Strawberry Mountain Wilderness in Oregon
FOREST BIOMES

- Forests have enough precipitation to support stands of trees and are found in tropical, temperate, and polar regions.
Tropical Rain Forest

- Tropical rain forests have heavy rainfall and a rich diversity of species.
  - Found near the equator.
  - Have year-round uniformity warm temperatures and high humidity.
Blue and gold macaw
Climbing monstera palm
Slaty-tailed trogon
Harpy eagle
Squirrel monkeys
Green tree snake
Katydid
Tree frog
Ants
Bacteria
Fungi
Bromeliad
Ocelot

Producer to primary consumer
Primary to secondary consumer
Secondary to higher-level consumer
All producers and consumers to decomposers
Filling such niches enables species to avoid or minimize competition and coexist.
Ground layer

- Black-crowned antipitta

Shrub layer

- Woolly opossum

Understory

- Brazilian tapir

Canopy

- Harpy eagle

Emergent layer

- Toco toucan

Fig. 5-21, p. 118
Most of the trees survive winter by dropping their leaves, which decay and produce a nutrient-rich soil.
Fig. 5-22, p. 120

Producer to primary consumer
Primary to secondary consumer
Secondary to higher-level consumer
All producers and consumers to decomposers
Evergreen Coniferous Forests

- Consist mostly of cone-bearing evergreen trees that keep their needles year-round to help the trees survive long and cold winters.
Bunchberry

Bacteria

Starflower

Snowshoe hare

Pine sawyer beetle and larvae

Bebb willow

Wolf

Moose

Balsam fir

Marten

White Spruce

Great horned owl

Producers to primary consumer

Primary to secondary consumer

Secondary to higher-level consumer

All producers and consumers to decomposers
Temperate Rain Forests

- Coastal areas support huge cone-bearing evergreen trees such as redwoods and Douglas fir in a cool moist environment.
MOUNTAIN BIOMES

- High-elevation islands of biodiversity
- Often have snow-covered peaks that reflect solar radiation and gradually release water to lower-elevation streams and ecosystems.

Figure 5-25
HUMAN IMPACTS ON TERRESTRIAL BIOMES

- Human activities have damaged or disturbed more than half of the world’s terrestrial ecosystems.
- Humans have had a number of specific harmful effects on the world’s deserts, grasslands, forests, and mountains.
Major Human Impacts on Terrestrial Ecosystems

**Deserts**
- Large desert cities
- Soil destruction by off-road vehicles
- Soil salinization from irrigation
- Depletion of groundwater
- Land disturbance and pollution from mineral extraction

**Grasslands**
- Conversion to cropland
- Release of CO₂ to atmosphere from burning grassland
- Overgrazing by livestock
- Oil production and off-road vehicles in arctic tundra

**Forests**
- Clearing for agriculture, livestock grazing, timber, and urban development
- Conversion of diverse forests to tree plantations
- Damage from off-road vehicles
- Pollution of forest streams

**Mountains**
- Agriculture
- Timber extraction
- Mineral extraction
- Hydroelectric dams and reservoirs
- Increasing tourism
- Urban air pollution
- Increased ultraviolet radiation from ozone depletion
- Soil damage from off-road vehicles
NATURAL CAPITAL DEGRADATION

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