

Chapter 7

Climate and Biodiversity

Summary

1. Key factors that determine the earth's weather are short-term atmospheric conditions such as temperature, pressure, moisture content, sunshine, cloud cover, precipitation, wind direction, and wind speed.
2. Climate is a region's long-term atmospheric conditions over decades. The two main factors in determining climate are average temperature and average precipitation.
3. The average climate—annual precipitation and temperature—determines terrestrial regions with characteristic types of natural ecological communities. According to these two factors, biomes form.
4. The major types of desert biomes are hot, temperate, and cold. Human activities have created large desert cities, destroyed soil through urban development and off-road vehicles, salinized the soil through irrigation, depleted underground water supplies, disturbed land and polluted, stored toxic and radioactive wastes, and located arrays of solar cells and solar collectors.
5. The three major types of grasslands are tropical or savannas, temperate grasslands, and polar grassland/tundra. The savannas have been destroyed by grazing cattle, which destroy vegetation and kills grass through fecal droppings. The temperate grasslands have been used to grow crops and graze animals. As a result, the grasslands have disappeared. The arctic tundra has been compromised by oil drilling, mines, and military bases.
6. The three main types of forest biomes are tropical, temperate, and polar/boreal. Human activities have destroyed much of the native trees; grazing has compromised the vegetation and eliminated food sources for native animals. And the deforestation has changed the tropical forest's ecosystem, leading to death of plants and animals. The temperate forest has a fewer number of broadleaf trees and rich forest soil; but fires, logging, and hunting have undermined this type of forest. The evergreen firs of the polar forest support a variety of wildlife. But oil drilling and oil spills have compromised the water, the wildlife, and the vegetation in the arctic.
7. Mountain and arctic biomes play important ecological roles; they help regulate climate and effect sea levels. Mountain biome degradation arises from timber and mining extraction, from hydroelectric dams and reservoirs, from air pollution, increased tourism, and radiation from ozone depletion.

Key Questions and Concepts

1. What factors influence climate?

CORE CASE STUDY: The location of biomes is determined by climate. There are three major types of climate: tropical, polar and temperate. These determine the three major biomes: forests, grasslands and deserts. When climate changes, there is a concomitant shift in biome location.

- A. Weather is a local area's short-term physical conditions such as temperature and precipitation. Average temperature and average precipitation are the two major factors that determine climate of a region, together with the related factors of latitude and elevation.
 1. Climate refers to long term general patterns of atmospheric conditions.
- B. Global air circulation is affected by the uneven heating of the earth's surface by solar energy, seasonal changes in temperature and precipitation, rotation of the earth on its axis, and the properties of air, water, and land.
 1. Uneven heating of earth's surface: the equator is heated more than the poles.
 2. Rotation of the earth on its axis results in the earth moving faster beneath air masses at the equator and slower at the poles. Belts of prevailing winds are the result.

3. Properties of air, water, and land affect global air circulation. Water evaporation sets up cyclical convection cells. These occur both vertically and from place to place in the troposphere. The result is an irregular distribution of climates and patterns of vegetation from pole to pole.
- C. Ocean currents influence climate by distributing heat from place to place and mixing and distributing nutrients.
 1. Differences in water density and heat create ocean currents that are warm/cold.
 2. Currents redistribute absorbed solar heat from one place to another, influence vegetation and climate near coastal regions.
 3. Currents also help mix ocean waters to distribute nutrients and dissolved oxygen needed for aquatic organisms.
 4. Winds and the earth's rotation drive the currents.
- D. Water vapor, carbon dioxide, and other gases influence climate by warming the lower atmosphere and the earth's surface.
 1. These gasses (water vapor, carbon dioxide, methane, and nitrous oxide) are known as greenhouse gasses. They allow mostly visible light, some infrared radiation, and ultraviolet radiation to pass through the troposphere. This natural warming is the greenhouse effect.
- E. Interactions between land and oceans and disruptions of airflows by mountains and cities affect local climates. Various topographic features can create local and regional microclimates.
 1. One example of this is the rainshadow effect.
 2. Bricks, asphalt, and other building materials create distinct microclimates in cities.

7-2 How does climate affect the nature and location of biomes?

- A. Different climates lead to different communities of organisms, especially vegetation. Differences in average temperature and precipitation due to global air and water circulation lead to differences in climate.
 1. Average annual precipitation, temperature, and soil type are the most important factors in producing tropical, temperate, or polar deserts, grasslands, and forests.
 2. Biomes are actually a mosaic of different biological communities.
 3. Climate and vegetation vary with latitude and elevation of an area.
- B. Deserts have little precipitation and little vegetation and are found in tropical, temperate, and polar regions.
 1. Tropical deserts are hot and dry most of the year with few plants, rocks, and sand.
 2. Temperate deserts have high daytime temperatures in summer and low temperatures in winter, with more rain than in tropical deserts.
 3. Cold deserts have cold winters and warm summers, with low rainfall.

SCIENCE FOCUS: Plants and animals have numerous adaptations to the harsh conditions in desert environments. These tend to revolve around avoiding heat, and absorbing or retaining the maximum amount of water.

- C. Grasslands have enough precipitation to support grasses but not enough to support large stands of trees. The three main types of grasslands are tropical, temperate, and polar (tundra).
 1. Savannas are tropical grasslands with scattered trees and enormous herds of hoofed animals.
 - a. Large herds of grazing and browsing animals feed here.
 2. Temperate grasslands with cold winters and hot, dry summers have deep and fertile soils that make them widely used for growing crops and grazing cattle.
 - a. Organic matter accumulates, producing fertile soil, as aboveground plant parts die each year.
 - b. North American grasslands are tall-grass prairies and short-grass prairies.
 3. Polar grasslands are covered with ice and snow except during a brief summer.
 - a. Under the snow there is a thick, spongy mat of low-growing vegetation (grasses, mosses, dwarf woody shrubs).
 - b. Permafrost is a permanently frozen layer of soil when water freezes.
 - c. Global warming is causing some parts of the permafrost in parts of Alaska to melt.
 - d. Another type of tundra, alpine tundra, occurs above tree line, but below permanent snow line. This area gets more sunlight than arctic tundra and has no permafrost.
- D. Chaparral has a moderate climate but its dense thickets of spiny shrubs are subject to periodic fire. Chaparral, or temperate shrubland, is found in coastal areas that border deserts.
 1. The winter rainy season is longer than in desert; fog during spring/fall reduces evaporation.
 2. Low-growing evergreen shrubs with occasional trees is the vegetation type.
 3. Fires move swiftly when started in these areas. Chaparral is adapted to occasional fires.
 4. Floods/mudslides occur after fires at times.

- E. Forests have enough precipitation to support stands of trees and are found in tropical, temperate, and polar regions. There are three main types of forest—tropical, temperate, and boreal (polar).
1. Tropical rain forests have heavy rainfall on most days and a rich diversity of species occupying a variety of specialized niches in distinct layers. Tropical rain forests are near the equator and have hot, humid conditions.
 - a. Dominant plants are broadleaf evergreens with shallow roots.
 - b. A dense canopy blocks most sunlight from reaching lower levels.
 - c. Vines often drape individual trees.
 - d. Tropical forests cover about 2% of the land surface, but are habitat for about half the terrestrial species of earth.
 - e. Very little litter is on the forest floor because of rapid recycling of dead materials.
 - f. So far, at least half of these forests have been destroyed or disturbed by human activities.
 2. Temperate deciduous forests grow in areas with moderate average temperatures, abundant rainfall, and long, warm summers.
 - a. Broadleaf, deciduous trees dominate this biome. Leaves drop in fall, trees become dormant, and new leaves grow in spring.
 - b. More sunlight penetrates the canopy so there is richer diversity of ground level plant life.
 - c. On a worldwide basis, this biome has been disturbed by human activity more than any other terrestrial biome as a result of establishing settlements, industrialization, and urbanization.
 3. Evergreen coniferous forests or boreal forests are located in areas just south of arctic tundra around the northern sub-arctic regions of the earth. These forests consist mostly of cone-bearing evergreen trees that keep their needles year-round to help the trees survive long, cold winters.
 - a. Long, dry, extremely cold winters are the norm. Summers are short.
 - b. Dominant trees are coniferous (cone-bearing) spruce, hemlock, fir, cedar, and pine.
 - c. There is low plant diversity.
 4. Coastal areas support huge cone-bearing evergreen trees such as redwoods and Douglas fir in a cool and moist environment. Coastal coniferous forests or temperate rain forests are located along the western coast of Canada to northern California. Cool temperatures, abundant rain, and dense fog are the norm.
 5. Mountains are high-elevation forested islands of biodiversity and often have snow-covered peaks that reflect solar radiation and gradually release water to lower-elevation streams and ecosystems. Mountains are places with dramatic changes in altitude, climate, soil, and vegetation within very short distances.
 - a. Mountains have important ecological roles such as habitats for endemic species, biodiversity, and sanctuaries for animal species driven from other habitats.
 - b. Mountains play a major role in the hydrologic cycle.

7-3 How have we affected the world's terrestrial ecosystems?

- A. Human activities have damaged or disturbed to some extent about 62% of the world's terrestrial ecosystems.
- B. Humans have had a number of specific harmful effects on the world's deserts, grassland, forests, and mountains.

Key Terms

biomes

climate

greenhouse effect

greenhouse gases

ocean currents

permafrost

rain shadow effect

weather