The Forest Planet

STUDENT PAGE

We often hear of Earth being "the water planet," but it might also be known as "the forest planet." Forests are the most prominent *natural community* on Earth, covering about 31 percent of the Earth's total land area.[1] On the global scale, those forests are vital to the functioning of Earth's essential biological systems. On the local scale, the forests provide food, fuel, and shelter.

Forests Are Vital to Life on Earth

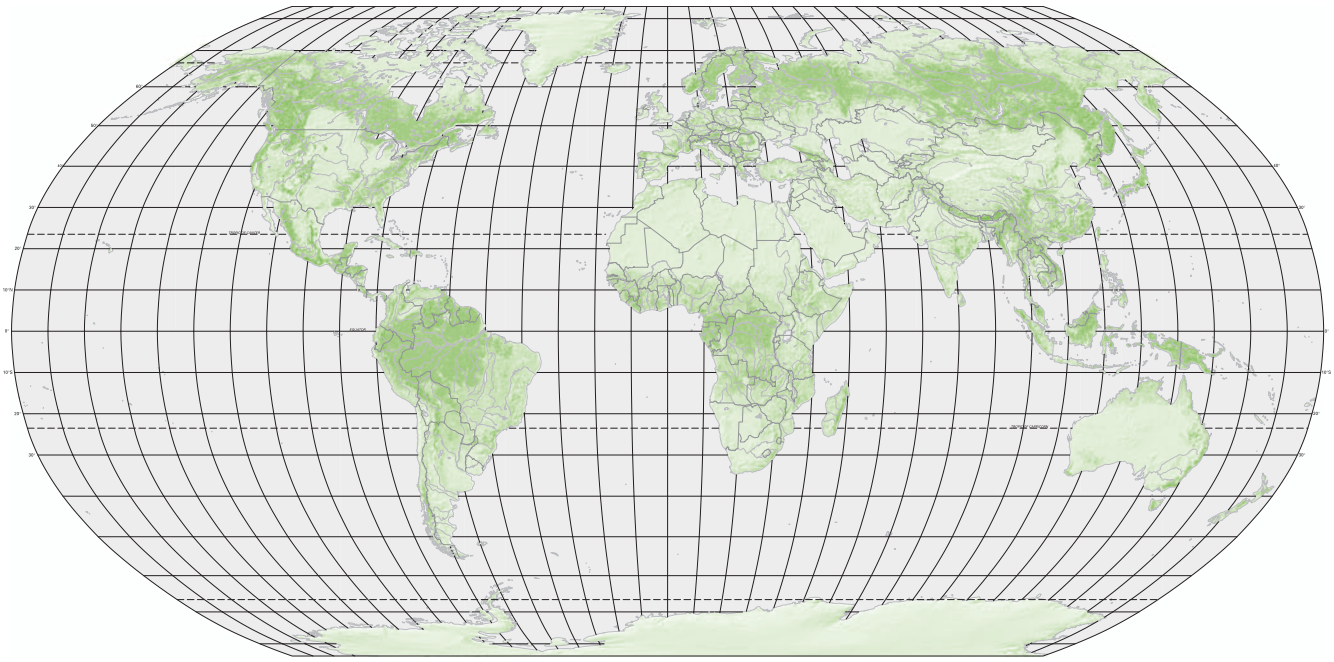
What is a forest? When most people think of forests, they usually think of the trees. Trees are the largest and most visible members of the forest, but trees alone do not make a forest. Forests also are made of a wide variety of other living things, including shrubs, vines, herbs, ferns, mosses, and other plants, as well as bacteria, fungi, and a host of animal life—from insects to mammals and from birds to reptiles and amphibians. This rich diversity of the forest *ecosystem,* both biotic and abiotic, helps to sustain life all over the planet.

Forests protect *watersheds* by anchoring the soil and preventing soil erosion. Their leaves, twigs, and bark decay into rich humus that nourishes plants and acts as a sponge to store water. Forest plants convert sun energy to chemical energy that can be stored and transferred through the food web. Through this process of photosynthesis, forests also absorb carbon dioxide and produce oxygen. In addition, forests give shade, cool the air, modify local climates, and provide *habitat* for millions of plant and animal species.

The benefits of forests go far beyond their boundaries. We depend on the world's forests to regulate the water cycle, to store carbon dioxide from the atmosphere, and to support biological diversity. But we also depend on them in many other ways. For example, North American farmers and foresters depend on migratory birds, along with bats and insects—which spend part of their lives in tropical forests—to pollinate crops, disperse seeds, and prey on pests.[2]

Forests also are crucial to the world economy. They provide wood-based goods such as lumber and paper, as well as nonwood products such as foods, gums, medicines, oils, resins, and spices. So important are forests to nations around the world that the annual value of *forest products* and services is estimated to be more than 10 percent of the world's total *gross domestic product*, or US$4.7 trillion.[3] (See the box "Where Are the World's Forests?")

The Forest Planet



Forest Other Land Cover Water

Source: FAO (2007).

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Where Are the World's Forests?

The world's forests are found in many different parts of the globe, as you can see by the following list of the world's 15 most forested countries (by area).[4]

Rank	Country	Total Forest Area *(in 1000s of hectares)*	Percent of the World's Forests
1	Russian Federation	809,090.00	20.06
2	Brazil	519,522.00	12.88
3	Canada	310,134.00	7.69
4	USA	304,022.00	7.54
5	China	206,861.00	5.13
6	Democratic Republic of Congo	154,135.00	3.82
7	Australia	149,300.00	3.70
8	Indonesia	94,432.00	2.34
9	Sudan	69,949.00	1.73
10	India	68,434.00	1.70
11	Peru	67,992.00	1.69
12	Mexico	64,802.00	1.61
13	Colombia	60,499.00	1.50
14	Angola	58,480.00	1.45
15	Bolivia	57,196.00	1.42

Forests are very different from place to place. The dominant type of tree found in a given forest depends on abiotic (non-living) factors such as temperature, moisture, soil, and other physical components, as well as the other plants and animals that live there.

The Food and Agriculture Organization of the United Nations (FAO) classifies forests using monthly mean temperatures as the primary criterion.[5]

- *Tropical* forests, found along the equator, have consistently warm temperatures throughout the year.
- *Subtropical* forests, widely scattered north and south of the tropics, have warm temperatures at least eight months of the year.
- *Temperate* forests, found at middle latitudes, have dramatic seasonal changes.
- *Boreal* forests, found at more northerly and southerly latitudes, have long, cold winters, and short cool summers.

See Activity 3. Mapping the World's Forests for more information on forest classification.

Source: FAO (2010).

People and Forests: Connected Through the Ages

Even before the first known human settlements, people both depended on forests and changed them. For early hunter-gatherer societies, forests were sources of food, fuel for fires, and shelter, as they are today. Over time, trees provided the primary building materials and energy that made it possible for people to inhabit cold climates, cook food, make pottery, and eventually smelt metal and work it into crafts, farming implements, tools, and weapons. In his book titled, *A Forest Journey*, author John Perlin writes, "Wood was the foundation upon which early societies were built," and he makes a case for the central role of wood in moving people from a "stone and bone" culture to our present state of technological advancement.[6]

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From early Greek and Roman civilizations on, people used wood and charcoal not only for cooking and heating, but also as fuel for making glass, dyes, soap, and construction materials such as brick, cement, and tile. Wood was an indispensable material in bridges, buildings, mineshafts, ships, wagons, water wheels, and windmills until the 19th century.[7] It was also a crucial element in the expansion of railroads in the late 19th and early 20th centuries. In the 21st century, we still depend on wood as a principal energy source: worldwide, more than 1.7 million cubic meters (60 million cubic feet) of wood are used as fuel each year, and wood furnishes 70-90 percent of the energy needs of 34 developing countries.[8] We also still use wood for building materials and other uses: more than 1.5 million cubic meters (53 million cubic feet) of wood are used for lumber, paper, paperboard, and a host of other products around the world.[9]

Forests As a Global Concern

Forests are a crucial element for life on our planet and are under great pressure from a growing human population. Most countries in the world include forests as a top environmental concern.[10] The most common reason is *deforestation*—the permanent loss of forest land—but another is the decline of forest health. Forests are at the crux of global environmental concerns such as population growth, *global climate change*, and the rise of infectious diseases.

Population Growth

The world population topped 6.6 billion people in 2007 and continues to expand. Although the rate of growth may level off[11], the 20th century alone saw 75 percent of the growth in world population over the entire history of humans.[12] As a direct or indirect consequence, that century also saw a loss of nearly half of the world's original *forest cover*—some 3 billion hectares. Throughout the 1990s, many countries with rapid population growth also had high rates of deforestation. "The correlation makes sense," reasons Earth Policy Institute president Lester Brown, "given the additional need for farmland, pastureland, and forest products as human numbers expand."[13]

Rising Consumption

The consumption of goods from forests has more than doubled in 30 years and will likely continue to increase. This rise is the result not only of an increased population, but also of individuals using more forest products. Since 1960, for example, the use of *paper and paperboard* per person in the world has nearly tripled.[14]

Developed countries account for most of the demand for forest products. With just one-sixth of the world's population based in North America, Europe, and Japan, those regions consume two-thirds of the world's paper and paperboard and half of its industrial wood. However, consumption of *fuelwood* and industrial wood in *developing countries* is also expected to increase.

Shade-grown Nicaraguan coffee

Deforestation

The permanent loss of forest land, usually from development, urbanization, or conversion to agriculture, is known as deforestation and is a growing international concern. Today, forests cover about 3.9 billion hectares (9.6 billion acres)—almost a third of the Earth's land surface excluding Antarctica and Greenland. (See the box "Worldwide Forest Area and Changes in Forest Cover"). While this is still a vast amount of forest land, it is only half that known to be in existence at the dawn of human agriculture some 11,000 years ago.[15]

The 20th century saw a significant rate of deforestation. During the 1990s, South America and Africa lost more than 89 million hectares (219 million acres) of forest. Although the overall rate of world forest loss appears to be slowing, deforestation in tropical areas is accelerating, likely exceeding 13 million hectares (32 million acres) each year.[16] Forests can and will grow on lands previously cleared for agriculture. Both Asia and Europe are showing a positive Annual Change Rate of Forest Cover.

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Worldwide Forest Area and Changes in Forest Cover

Geographic Region	Land Area, 2010			Annual Change Rate of Forest Cover (%)		
	Total Land Area [a] (1,000s of hectares)	Total Forest Area (1,000s of hectares)	Percent Forested	1990-2000	2000-2005	2005-2010
Africa	2,974,011	674,419	23%	-0.56%	-0.49%	-0.50%
Asia	3,091,407	592,512	19%	-0.10%	+0.48%	+0.29%
Europe	2,214,726	1,005,001	45%	+0.09%	+0.06%	+0.08%
North and Central America	2,134,979	705,393	33%	-0.04%	-0.01%	n.s.[b]%
Oceania	849,094	191,384	23%	-0.02%	-0.17%	-0.55%
South America	1,746,292	864,351	49%	-0.45%	-0.49%	-0.41%
World	13,010,509	4,033,060	31%			

a. Land area refers to the total area of a country, excluding areas under inland water bodies. The world total corresponds to the sum of the reporting units; about 35 million hectares of land in Antarctica, some Artic and Antarctic islands, and some other minor islands are not included.
b. n.s. – not significant, indicating that the number is close to zero.

Source: FAO (2010)

Biodiversity

Biological diversity, or *biodiversity*, is the biological variety at all levels of organization including genetic variety within a species population, and species variety within an ecological community.[17] It is often used as an indicator of the health of that ecosystem. Forests have the greatest species diversity of all terrestrial ecosystems, holding about two-thirds of the world's known terrestrial species.[18] However, when forests are degraded or diminished, diversity is also reduced. Human-caused pressures such as agriculture, hunting, and logging tend to decrease overall numbers of species, threaten local native species, and often create favorable conditions for nonnative species to colonize.

Sawnwood from Ocopa, Peru

Invasions by nonnative species are a major threat to global biodiversity as a whole and to forests in particular.[19] Invasive plants and animals often do not have natural predators to impede their reproduction, and they tend to both grow and reproduce quickly. In Tahiti, for example, the meconia tree was introduced in 1937 as an attractive landscape plant and has since replaced the native forest across much of the island, directly threatening 70 to 100 native plant species.[20]

Global Climate Change

Forests are interrelated with the issue of global climate change. The amount of carbon dioxide (CO_2) in the atmosphere rose 30 percent from 1850 to 1998, mostly as a result of humans burning fossil fuels, but also from burning wood for cooking and heating.[21] Climate models predict that more CO_2 will warm the Earth's atmosphere, causing changes in precipitation, sea level, and weather patterns, as well as in the distribution, extent, and structure of the world's ecosystems.

Carbon naturally cycles between the atmosphere, oceans, vegetation, animal life, and soils. During the process of photosynthesis, trees absorb CO_2 from the atmosphere and sequester (store) it in their

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woody tissues. Forests sequester more carbon than any other terrestrial ecosystem, and an average forest tree can remove approximately 9 kg of CO_2 from the atmosphere each year.[22] On a global scale, forests' potential to store carbon makes them critical for stabilizing atmospheric gases such as CO_2.[23]

Political Stability

When forests and other natural resources become scarce or severely degraded, political and social instability can follow, thereby leading to political crisis or even armed conflict. In Haiti, for example, there has been a precipitous decline in forest cover as a result of the uncontrolled logging, the conversion of forest to farmland, and the use of wood as a primary fuel. In 1920, Haiti was covered with trees—more than 60 percent of the land was forested. By 1999, just 2 percent of the land remained as forest. The degraded environment has contributed to political instability and large-scale migrations.[24]

Infectious Disease

Human health may also be closely related to forest health. For example, in the depths of the tropical rainforests of Peru, people are contracting malaria, a disease that was unknown in that region until recently.[25] Scientists have found that deforestation is directly involved in this new disease pattern. Apparently, as the forest is cleared and as wildlife is eliminated, the mosquitoes that carry the disease must seek out new hosts—namely humans. Although most malaria cases originate in the tropics, the United States and Europe have experienced a steady increase in "airport malaria" involving people who never visited the tropics themselves, but who were exposed to people who had.

Feeding the World's Hungry

The world's farmers face a common crucial issue: how to affordably feed more and more people without impoverishing the land. Throughout the world and throughout thousands of years, this pressing need has led to cutting or burning forest land to make room for more farm land. One of the major underlying causes of deforestation today is *subsistence* farming, with farmers simply trying to feed their families.[26]

Cashew fruit in Gambia

Indigenous Peoples and Cultures[27]

Many *indigenous* peoples throughout the world have a long history of using and managing forests and are severely affected when forests are degraded or lost. Past and present forestry policies have often excluded local peoples from forest planning and stewardship, resulting in a disruption of lives and livelihood for those peoples and a decline in forests.

In the face of substantial deforestation and forest degradation, many local indigenous communities are reasserting their role as stewards of the forests. In many parts of the world, for example, indigenous peoples are organizing to stop the rapid economic development that has led to deforestation. At the same time, the traditional knowledge of indigenous peoples is increasingly being recognized as an important component of *sustainable forest management.*

The Global to Local Connection

The extent and health of the world's forests on a global scale are affected by activities that take place on a local level. Those activities—such as farming and ranching, gathering fuelwood, conducting commercial logging, converting native forest to *plantations* with trees grown as a crop, increasing urbanization and building new settlements, using forest management on public and private lands, and constructing roads and hydroelectric reservoirs—may have profound effects on specific forest lands. Although

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local activities affect the forest, where, when, and how intensively those activities take place are often also driven by economic, political, and social forces on a national or international scale.[28]

Global Responses for Forests

At the global level, real efforts have been made to address the growing challenges facing forests. At the United Nation's 1992 Rio de Janeiro Earth Summit, world leaders from 102 countries adopted two international declarations that affirm the importance of the forests of the world. The Statement of Forest Principles was the first global agreement on forests and their sustainability, and Agenda 21 is an international action plan for sustainable development. (See the United Nations web site at www.un.org to view those documents.)

Since the meeting in Rio de Janeiro, several national and international programs have been launched to measure progress toward sustainable forest management. (See the box "Managing the World's Forest" for more about forest management.) The most comprehensive and potentially far-reaching of those programs are the regional and international initiatives, which now involve more than 100 countries.[29] The initiatives define *criteria*, or categories of conditions for sustainable forest management, as well as *indicators*, or measurable signs of those *criteria*. By endorsing those initiatives, each participating country has made a commitment to work toward the sustainable management of all of its forests.

As global interest in the world's forests continues to expand, coordinated international efforts are having a growing effect on how forests are used. For example, international agreements to reduce carbon dioxide and other "greenhouse gases" have already prompted financial incentives for private landowners in the United States and Latin America to turn their farm land into productive forests, which, in turn, store or sequester carbon.[32] (See the box "Sequestering Carbon" for more information.)

Managing the World's Forests

Humans have been managing forests since prehistoric times, often in very simple ways such as encouraging the growth of trees that serve particular needs for food, fuel, or shelter. Preferred species may be planted or encouraged - by techniques such as thinning - to provide more light for certain trees. Similarly, unwanted species can be eliminated by burning, felling, or poisoning.

One might think of forests on a continuum of human intervention. At one end of this continuum are primary forests. *Primary forests* are essentially intact forest communities, composed largely of native species and unmodified by human activity, or are minimally modified by the hunting and gathering activities of indigenous people. At the other end are plantations, on which trees are planted, grown, and harvested as crops.[30]

Along this continuum is a range of forests that are manipulated or managed by people to fill a variety of needs. Some of these forests are managed more intensively than others, purposely manipulated to serve certain priority functions. Production forests, for example, are managed primarily to produce forest products. Under a system of *agroforestry*, croplands or pastures are interspersed with forested areas. Even forests in protected areas, such as national parks and nature reserves, may be managed to minimize fire hazards or the spread of tree diseases, or to allow local people a subsistence harvest of fruits, nuts, and other products.[31]

Since the 1990s, people have begun to embrace the concept of sustainable forest management, which assumes that forests should be managed to meet the needs of both present and future generations. While seemingly simple, sustainability is a complex goal involving economic, environmental, and social factors. It means maintaining long-term economic benefits for human societies, as well as conserving the biological diversity and vitality of the forest ecosystem. It also requires compliance of all the parties involved, and it depends on accurate assessments of the present and future status of the forests. To learn more about international initiatives regarding sustainable forest management, see Activity 6. Seeking Sustainability: A Global Response.

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Forest Certification

Certification is a general term used to describe the process of verifying that forests are well-managed and communicating that through some type of recognition program.[33] Certification of forests and wood procurement was developed to provide guidelines and structure—a set of standards—to promote responsible forestry, and then verify it through third party independent certification. Certification is also a way to satisfy market demand—from consumers and customers—for "green" products. There are many different forest certification systems around the world, each with a slightly different focus to reflect differentiating features such as land ownership patterns, governmental structures, forest owner values, and differences in forest types.

All of these standards promote economic, environmental, and social values by including auditable requirements for a variety of issues, including protection of special biological and cultural sites, management strategies to protect species at risk and wildlife habitat, sustainable harvest levels, and prompt regeneration. (See Activity 6 for more information on certification.)

Buying Time for the World's Forests

Even if implemented fully, international initiatives could not be expected to stop forest degradation and loss completely. Many countries rely on forest products for economic development, and many individuals have few viable choices other than to cut or clear forest land for survival.

Such measures, however, are hoped to reduce pressure on the world's forest reserves. According to the Food and Agriculture Organization of the United Nations (FAO), while progress is being made toward that goal, it has been very uneven.[35] Some regions, especially with developed economies and temperate climates, are making significant progress toward creating sustainable forest management, revising forestry policy and legislation, and strengthening

Sequestering Carbon

Over the past century, human activities such as the burning of fossil fuels, deforestation, grassland conversion, and other land-use changes have contributed to a large increase in the amounts of carbon dioxide (CO_2) and other greenhouse gases in the atmosphere. Most scientists believe that this rapid increase in atmospheric CO_2 will affect the global climate.

Forest clearing in the Amazon

To help reverse this trend, people have been looking at *carbon sequestration* as one way to reduce the amount of atmospheric CO_2. Carbon sequestration means using both natural and industrial processes to capture atmospheric carbon and store it in living reservoirs (in green vegetation and forests) or nonliving reservoirs (in soil, depleted oil and gas reservoirs, and saline aquifers).

Because trees store a significant amount of carbon in their wood, forests are a possible mechanism for sequestering carbon. As photosynthesizing plants, trees absorb CO_2 from the air and, using the sun's energy, combine it with water to form sugars and other organic compounds. Compared to other plants, trees are especially good at long-term storage of carbon because they have so much wood in their trunks, branches, and roots. The wood and future wood products hold the carbon until it is released through burning or through decomposition.

The conservation and sequestration of carbon, although not necessarily permanent, may provide enough time to exercise other options. Although planting trees cannot offset all the greenhouse gas production related to human activities, forests might really make a difference. The cumulative global potential of carbon sequestration is in the order of 100 gigatonnes (100 trillion kilograms or 110 billion tons) of carbon by the year 2050, equivalent to 10 to 20 percent of projected fossil fuel emissions.[34]

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forestry institutions. However, in regions with developing economies and tropical ecosystems, forest area continues to be lost. Many of those countries lack the strong institutions needed to reverse the trend, owing in part to limited financial resources.

As FAO states, "The world is faced with an increasingly complex challenge: is it possible to achieve sustainable forest management and to achieve equitable economic progress at the same time?"[36] This is a challenge we must face on the local and global levels because safeguarding the world's forests is essential to the future health of all living things, including human beings.

Students planting a tree.

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