

TROPICAL DEFORESTATION

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The clearing of tropical forests across the Earth has been occurring on a large scale basis for many centuries. This process, known as deforestation, involves the cutting down, burning, and damaging of

forests. The loss of tropical rain forest is more profound than merely destruction of beautiful areas. If the current rate of deforestation continues, the world's rain forests will vanish within 100 years-causing unknown effects on global climate and eliminating the majority of plant and animal species on the planet.

Why Deforestation Happens

Deforestation occurs in many ways. Most of the clearing is done for agricultural purposes-grazing cattle, planting crops. Poor farmers chop down a small area (typically a few acres) and burn the tree trunks-a process called Slash and Burn agriculture. Intensive, or modern, agriculture occurs on a much larger scale, sometimes deforesting several square miles at a time. Large cattle pastures often replace rain forest to grow beef for the world market.

Commercial logging is another common form of deforestation, cutting trees for sale as timber or pulp. Logging can occur selectively-where only the economically valuable species are cut-or by clearcutting, where all the trees are cut. Commercial logging uses heavy machinery, such as bulldozers, road graders, and log skidders, to remove cut trees and build roads, which is just as damaging to a forest overall as the chainsaws are to the individual trees.

The causes of deforestation are very complex. A competitive global economy drives the need for money in economically challenged tropical countries. At the national level, governments sell logging concessions to raise money for projects, to pay

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international debt, or to develop industry. For example, Brazil had an international debt of \$159 billion in 1995, on which it must make payments each year. The logging companies seek to harvest the forest and make profit from the sales of pulp and valuable hardwoods such as mahogany.

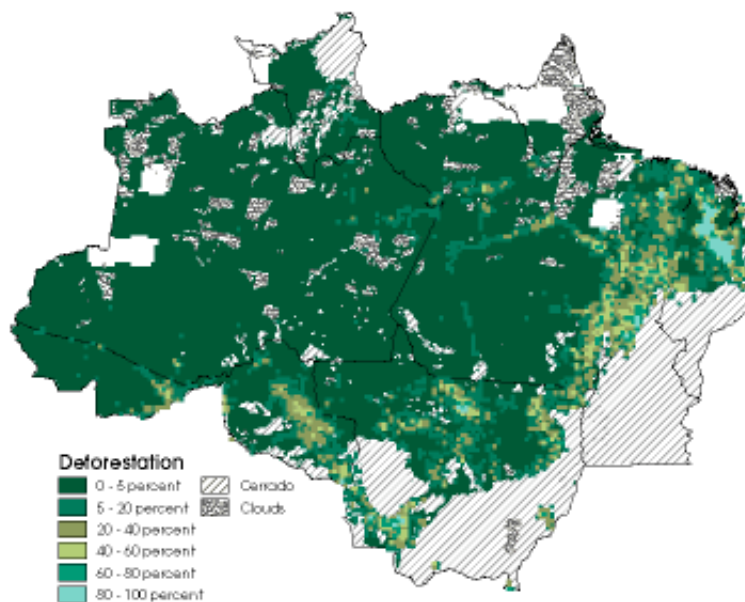


Figure 1. Deforestation in the Brazilian Amazon in 1986. The darker the area, the more forest that is remaining.

Deforestation by a peasant farmer is often done to raise crops for self-subsistence, and is driven by the basic human need for food. Most tropical countries are very poor by U.S. standards, and farming is a basic way of life for a large part of the population. In Brazil, for example, the average annual earnings per person is U.S. \$5400, compared to \$26,980 per person in the United States (World Bank, 1998). In Bolivia, which holds part of the Amazon rain forest, the average earnings per person is \$800. Farmers in these countries do not have the money to buy necessities and must raise crops for food and to sell.

There are other reasons for deforestation, such as to construct towns or dams which flood large areas. Yet, these latter cases constitute only a very small part of the total deforestation.

The Rate of Deforestation

The actual rate of deforestation is difficult to determine. Scientists study the deforestation of tropical forests by analyzing satellite imagery of forested areas that have been cleared. Figure 2 is a satellite image illustrating how scientists classify the landscape. Contained within the image are patches of deforestation in a distinctive "fishbone" of

deforestation along roads. Forest fragments are isolated areas left by deforestation, where the plants and animals are cut off from the larger forest area. Regrowth-also called secondary forest-is abandoned farmland or timber cuts that are growing back to become forest. The majority of the picture is undisturbed, or "primary," forest, with a network of rivers draining it.

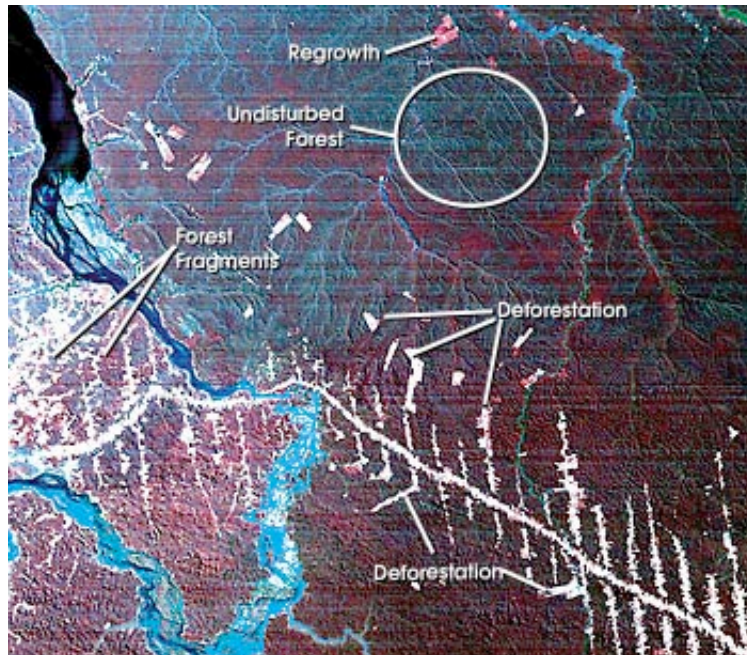


Figure 2. Satellite image of deforestation in the Amazon region, taken from the Brazilian state of Para on July 15, 1986. The dark areas are forest, the white is deforested areas, and the gray is re-growth. The pattern of deforestation spreading along roads is obvious in the lower half of the image. Scattered larger clearings can be seen near the center of the image.

The Food and Agriculture Organization (FAO) estimates that 53,000 square miles of tropical forests (rain forest and other) were destroyed each year during the 1980s. Of this, they estimate that 21,000 square miles were deforested annually in South America, most of this in the Amazon Basin. Based on these estimates, an area of tropical forest large enough to cover North Carolina is deforested each year!

The rate of deforestation varies from region to region. Recent research results showed that in the Brazilian Amazon, the rate of deforestation was around 6200 square miles per year from 1978-1986, but fell to 4800 square miles per year from 1986-1993. By 1988, 6% of the Brazilian Amazon had been cut down (90,000 square miles, an area the size of New England). However, due to the isolation of fragments and the increase in forest/clearing boundaries, a total of 16.5% of the forest (230,000 square miles, an area

nearly the size of Texas) was affected by deforestation. Scientists are currently analyzing rates of deforestation for the current decade, as well as studying how deforestation changes from year to year.

The much smaller region of Southeast Asia (Cambodia, Indonesia, Laos, Malaysia, Myanmar, Thailand, and Vietnam) lost nearly as much forest per year as the Brazilian Amazon from the mid-1970s to the mid-1980s, with 4800 square miles per year converted to agriculture or cut for timber.

Deforestation and the Global Carbon Cycle

Deforestation increases the amount of carbon dioxide (CO₂) and other trace gases in the atmosphere. The plants and soil of tropical forests hold 460-575 billion metric tons of carbon worldwide with each acre of tropical forest storing about 180 metric tons of carbon. When a forest is cut and burned to establish cropland and pastures, the carbon that was stored in the tree trunks (wood is about 50% carbon) joins with oxygen and is released into the atmosphere as CO₂.

The loss of forests has a profound effect on the global carbon cycle. From 1850 to 1990, deforestation worldwide (including the United States) released 122 billion metric tons of carbon into the atmosphere, with the current rate being approximately 1.6 billion metric tons per year. In comparison, fossil fuel burning (coal, oil, and gas) releases about 6 billion metric tons per year, so it is clear that deforestation makes a significant contribution to the increasing CO₂ in the atmosphere. Releasing CO₂ into the atmosphere enhances the greenhouse effect, and could contribute to an increase in global temperatures (see Global Warming Fact Sheet, NF-222).

Deforestation and the Hydrologic Cycle

Tropical deforestation also affects the local climate of an area by reducing the evaporative cooling that takes place from both soil and plant life. As trees and plants are cleared away, the moist canopy of the tropical rain forest quickly diminishes. Recent research suggests that about half of the precipitation that falls in a tropical rain forest is a result of its moist, green canopy. Evaporation and evapotranspiration processes from the trees and plants return large quantities of water to the local atmosphere, promoting the formation of clouds and precipitation. Less evaporation means that more of

the Sun's energy is able to warm the surface and, consequently, the air above, leading to a rise in temperatures.

Deforestation and Biodiversity

Worldwide, 5 to 80 million species of plants and animals comprise the "biodiversity" of planet Earth. Tropical rain forests-covering only 7% of the total dry surface of the Earth-hold over half of all these species. Of the tens of millions of species believed to be on Earth, scientists have only given names to about 1.5 million of them, and even fewer of the species have been studied in depth.

Many of the rain forest plants and animals can only be found in small areas, because they require a special habitat in which to live. This makes them very vulnerable to deforestation. If their habitat is destroyed, they may become extinct. Every day, species are disappearing from the tropical rain forests as they are cleared. We do not know the exact rate of extinction, but estimates indicate that up to 137 species disappear worldwide each day.

The loss of species will have a great impact on the planet. We are losing species that might show us how to prevent cancer or help us find a cure for AIDS. Other organisms are losing species they depend upon, and thus face extinction themselves.

After Deforestation



What happens after a forest is cut is very important in the regeneration of that forest. Different cutting techniques and uses of the land have diverse effects on the ground and

surviving organisms that make up a rain forest.

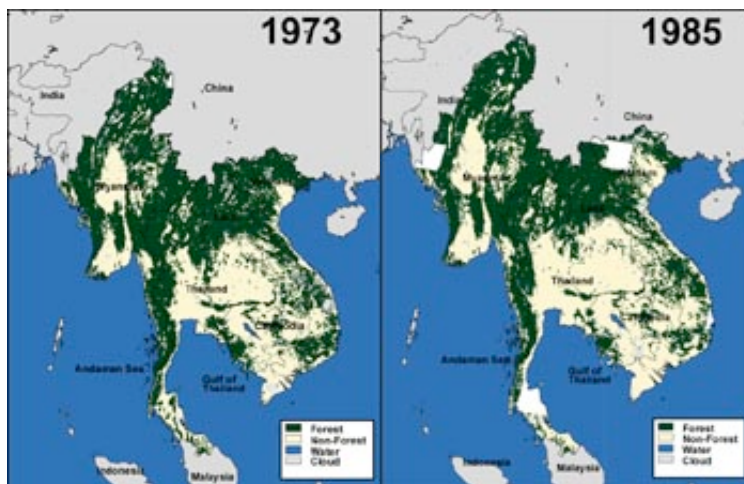
In a tropical rain forest, nearly all of the life-sustaining nutrients are found in the plants and trees, not in the ground as in a northern, or temperate forest. When the plants and trees are cut down to sow the land, farmers usually burn the tree trunks to release the nutrients necessary for a fertile soil. When the rains come, they wash away most of the nutrients, leaving the soil much less fertile. In as little as 3 years, the ground is no longer capable of supporting

crops.

When the fertility of the ground decreases, farmers seek other areas to clear and plant, abandoning the nutrient-deficient soil. The area previously farmed is left to grow back to a rain forest. However, just as the crops did not grow well because of low nutrients, the forest will grow back just as slow because of poor nutrients. After the land is abandoned, the forest may take up to 50 years to grow back.

Another type of farming practiced in rain forests is called shade agriculture. In this type of farming, many of the original rain forest trees are left to provide shade for shade-loving crops like coffee or chocolate. When the farm is abandoned, the forest grows back very quickly, because much of it was left unharmed in the first place. After this type of farming, forests can grow back as quickly as 20 years.

Other types of farming can be more devastating for forest regrowth. Intensive agricultural systems use large quantities of chemicals like pesticides and fertilizers. These chemicals kill a lot of the living organisms in the area, seeping into the soil and washing into the surrounding areas. On banana plantations, pesticides are used on the plants and in the soil to kill pest animals. However, these pesticides also kill other animals as well, and weaken ecosystem health. Banana plantations also use irrigation ditches and underground pipes for water transport, changing the water balance of the land. After the abandonment of a banana plantation, or other intensive agricultural system, it can take many centuries for a forest to regrow.



Figures 3a and 3b. Deforestation in continental Southeast Asia (excludes Malaysia and Indonesia) from 1973 to 1985. The dark gray represents forest,

the lighter areas deforestation. The white box-like areas on the 1985 map are places for which no satellite information was available. During this time period, about 50,000 square miles was deforested. China and India are included on the map but no assessment of their forest cover was made.

A study in Indonesia found that when only 3% of the trees were cut, a logging operation damaged 49% of the trees in the forest. Yet, even with that much damage, the rain forest will grow back relatively quickly if left alone after selective logging, because there are still many trees to provide seeds and protect young trees from too much sun.

Clearcutting is much more damaging to a tropical rain forest. When the land is commercially clearcut and all of the trees removed, the bare ground is left behind with very little regrowth. Unlike when the farmer cleared the land, there are almost no nutrients left behind because all the tree trunks were removed. A clearcut forest can require many years to regenerate—in fact, scientists do not know how long it takes for a clearcut forest to grow back.

The Future

The deforestation of tropical rain forests is a threat to life worldwide. Deforestation may have profound effects on global climate and cause the extinction of thousands of species annually. Stopping deforestation in the tropics has become an international movement, seeking ways to stop the loss of rain forests.

Because the loss of rain forests is driven by a complex group of factors, the solutions are equally complex. Simple solutions that do not address the nature of world economics and rain forest ecology have little chance of succeeding. The future requires solutions based on solving the economic crises of countries holding rain forests, as well as improvement of the living conditions of the poor people often responsible for deforestation.

NASA Missions to Study Deforestation

NASA's Earth Science Enterprise future plans to study the effects of deforestation include continuing analyses using data from such instruments as the Enhanced Thematic Mapper Plus (ETM+), scheduled for flight on Landsat-7, and the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) and the Moderate Resolution Imaging Spectroradiometer (MODIS), scheduled for flight on the EOS AM-1 satellite. The observational capabilities and scientific studies planned as part of

the Earth Science Enterprise, including the Earth Observing System, will help to assess the impacts of deforestation on the global climate system. An overarching objective of the Earth Science Enterprise is to improve our understanding of the causes and effects of climatic and environmental change so that we may become more effective and efficient managers of our natural resources, as well as mitigate potential impacts from natural disasters.

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