Chapter 4

Causes of Deforestation and Forest Resource Degradation

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HIGLIGHTS

- Tropical deforestation and forest resource degradation are caused by subsistence agriculturalists, livestock raisers, firewood collectors, and loggers.
- The agents of tropical forest loss vary in prominence among the three major tropical forest regions (American, Africa, and Asia), Many times, the combination of these activities exacerbates forest resource problems.
- In many tropical areas, political, ecocomic, and social forces lead to overexploitation and underinvestment in management of tropical forest resources.
- Regardless of what activities are responsible-for forest removal from tropical lands, the soil plays a large role in determining whether agriculture, new forest growth, or barren wastelands will replace the forest in the long run.

HISTORICAL CONTEXT

Deforestation of tropical lands is not solely a recent phenomenon, In fact, the main loss of forests in some places occurred in the 19th century, when forests were cleared to establish plantations of export crops such as sugar, abaca, coffee, indigo, and tobacco (36).

Sugar plantations swept away the Caribbean forests in turn: first Barbados, then the Leeward Islands, Jamaica, and Haiti. The slave rebellion in Haiti left the country in ruins and made possible the sugar boom in Cuba.

Cuba's story is typical and better documented than that of other parts of the Caribbean (7). Upon reaching the northeast coast of Cuba in 1492, Christopher Columbus was impressed by the island's rich forests. A few years later, priest Fray Bartolome wrote that it was possible to walk from one end of the island to the other without leaving the shade of trees. In 1812, forests still covered 89 percent of Cuba. But thereafter, fields of sugar cane began to replace the forests. Fire and axe were used to clear forests for ranching as well. Forest cover had shrunk to 53 percent by 1900. with the declaration of the Republic in 1902, and the subsequent heavy influx of foreign capital into the Cuban economy, forests continued to shrink, Small farms were swallowed up by large plantations. The farmers were driven to eke out a living in the hills where their struggle for survival, together with the insatiable fuel demands of the sugar mills, took a heavy toll on the upland forests. By 1946, forest cover was down to 11 percent of the land area. The average yearly deforestation had been 1.7 percent of the forest area that existed in 1900.

The history of Brazil, which was the world's largest sugar producer until the middle of the 17th century, illustrates the severe damage that deforestation can inflict. The northeastern region of the country is notorious for its poverty. The densely populated coastal region receives substantial rainfall and when the area

was forest-covered, its soils were described as fertile and rich in humus. But the forests were cleared for sugar plantations, which were abandoned as the soils wore out. Now the infertile, eroded soils only support savanna. Rainfall is rapidly shed as runoff so that streams and storages dry up during protracted droughts. As a consequence, the region frequently gives rise to mass emigrations (50).

Similarly, little of South China's tropical forests remain except in the extreme southwest and in the interior of Hainan Island. Fire and cultivation took a heavy toll as these forests came under increased human pressure about 1,000 years ago (45). Fire was used widely to clear forests for grazing lands and croplands. Overgrazing and poor agricultural practices further reduced the likelihood that forests would ever reestablish naturally. Timber was used to build houses, temples, and ships, and wood was cut to supply fuel for cooking and heating. Forests probably were eliminated in part to destroy the habitat of dangerous wild animals or to minimize the hiding places for bandits. Today's partly grass covered, eroded, and depopulated hills and mountains in South China attest to the severity of past land-use practices and the inability of the forest to regenerate naturally (46).

In the African Sahel, resource degradation of dry forests has for centuries been caused by a combination of processes including dry and erratic climate, brush fires, trans-Saharan trade, gum arabic trade, agricultural expansion, and cattle. Herodotus and others, writing around 450 B. C., described an active trans-Saharan trade based on precious stones called "carbuncles," gold dust, and slaves. This trade had great adverse impacts on the land. For instance, large areas were cleared of Acacia rad-***diana*** to produce charcoal. In the late 18th century, huge caravans of 4,000 camels and 1,000 men would stop at the desert margin and cut wood for charcoal to cook and trade. The charcoal even was used as emergency rations for the camels (34).

The resulting encroachment of the desert margin encouraged a southward shift of drysteppe vegetation. This, in turn, altered eco-

logical relationships and amplified the impact of hazards such as drought (27). Even though the human populations in the Sahel had suffered periodic droughts for centuries, far greater harm was caused during the 1970's when drought was coupled with a seriously degraded natural resource base. This is the expected response of a resource system where there is self-perpetuating degradation. The problem increases gradually for a long time, but it is typically a logarithmic progression and can lead to catastrophe (11).

For centuries, tropical deforestation has been associated with poverty (17). People displaced by development processes are often the direct agent of deforestation. While peasant cultivators and herders have done the actual tree cutting and burning, the causes lie in a chain of events that have left these people few options but to destroy the forest or starve.

SOIL: ITS RELATIONSHIP TO DEFORESTATION AND LAND DEGRADATION

Soils, by themselves, are not a direct cause of tropical deforestation. They do, however, set the stage in many tropical regions for the practice of shifting cultivation, which causes deforestation. When it is cleared, forest land commonly loses its fertility, produces declining crop yields, and ultimately is abandoned. If forest soils could sustain agriculture, continual relocation of farm fields would be less likely to occur and fewer forests would be cut down. But few tropical forest soils can sustain productive agriculture over the long term. The presence of large areas of either heavily leached soils of low fertility, thin erosion-prone soils, or dry soils makes the establishment of permanent farming sites extremely difficult. Therefore, regardless of what activities are responsible for cutting tropical forests, the underlying soil materials play a large role in determining whether agriculture, new forest growth, or barren wastelands will be the long-term results.

A simple but useful way of discussing tropical forest soil is to divide the forest lands into three categories:

1. hot, wetlands;
2. arid/semiarid lands; and
3. mountainous lands.

Although the soils on certain deltas, young volcanic materials, and flood plains may be fertile, most soils in hot, wetlands have significant fertility problems. These soils are formed by chemical weathering of rocks. High temperatures and high rainfall combine to accelerate leaching of nutrients from the rock and soil mineral particles. The residual minerals tend to be composed mostly of aluminum, silicon, iron, oxygen, and water, a chemical composition so restricted that many food or tree crops planted on such soils will have stunted growth or will not survive. In some of the soils, silicon and iron concentrations are so low, and aluminum so high, that the soil may approach or reach the composition of bauxite, an aluminum ore. *

These soils have other problems when fertilized with certain essential plant nutrients. Phosphorus becomes so tightly held by certain clay minerals, aluminum, iron, and manganese oxides that plants cannot extract enough for their own benefit (4,13). In the Amazon Basin,

*See Van Wambeke (47) and Fripiat and Herbillon (12) for more detailed information. These are good references on soils of the hot, wet tropics that not only contain the commonly cited information on agriculture, soil names, etc., but also provide discussions of mineralogical and chemical processes.

for example, 16 percent of the soils suffer this problem. Overall, 90 percent of the Basin's soils (table 7) have a phosphorus deficiency (37). Some 15 percent of the Amazon Basin soils have a poor ability to hold potassium and other common plant nutrients (low cation exchange capacity). If such nutrients are added to the soil as fertilizer, they can be expected to be leached away rapidly (4,13).

In addition, an estimated 2 percent of these soils will harden irreversibly upon drying (47), severely limiting reestablishment of vegetation (21). In some cases, soil hardening is so complete that the hardened material can be crushed and used as gravel for road building (24).

Undisturbed tropical forests have an efficient nutrient recycling system. As long as the forest is undisturbed, the nutrient supply remains stable. Soil shaded by the closed forest canopy is cool enough for the abundant organic material to decay gradually. Thus, the forest soils typically have a substantial humus content and can hold the nutrients released by microorganisms until they are absorbed back into the web of tree roots to be recycled again. Slash-and-burn agriculture takes advantage of the humus and of the rapid release of nutrients that occurs when the vegetation is burned. But as soil temperatures rise, the humus is oxidized rapidly, and as the forest is removed, the organic inputs are reduced. Soil with less humus is less able to hold nutrients, and when rain falls the soil fertility fades. If the land is returned to forest fallow soon enough, a new growth of trees can reestablish the soil's humus, the web of roots, and the recycling system.

In hot, dry lands physical breakdown of rocks and soil minerals plays a larger role in soil formation. In this process, the particles become smaller, but the chemical composition remains nearly the same and leaching of soil nutrients is low. Physical disintegration can occur in a number of ways; for instance, day and night temperature variations cause rocks and minerals to expand and contract and, in time, crack. Salts and other substances collect in cracks, expanding when wet and contracting when dry, further breaking the grains (3). Another mechanical way particles become smaller is through impact of other windblown grains. And, of course, the growth of plant roots is a powerful agent in breaking up and holding rock and soil particles.

In arid/semiarid areas, nutrients needed by many plants commonly are in the soil but become available to the plants only if sufficient water is available (6). If most of the water evaporates from the soil surface rather than percolating down into the soil, dissolved solids or salts can accumulate as crusts at or near the land surface in concentrations that few plants can tolerate (16).

Mountainous lands, though generally cooler than the other two categories, exist in both wet and dry climates and, thus, either chemical or physical processes may dominate. Rather than percolating into the ground to form thick soils through chemical weathering, much of the

Table 7.—The Main Soil Constraints in the Amazon Basin Under Native Vegetation

Soil constraint	Millions of hectares	Percentage of Amazon Basin
Phosphorus deficiency	436	90
Aluminum toxicity	315	73
Low potassium reserves	242	56
Poor drainage and flooding hazard	116	24
High phosphorus fixation	77	16
Low cation exchange capacity	64	15
High erodibility	39	8
No major limitations	32	6
Steep slopes (>30 percent)	30	6
Laterite hazard if subsoil exposed	21	4

SOURCE: P. A. Sanchez, D. E, Bandy, J. H. Villachica, and J, J. Nlcholaides, "Amazon Basin Soils Management for Continuous Crop Production," *Science* 216:821-827, 1982.

rainfall runs off the land surface to streams. The soils that do form are easily eroded. Consequently, soils in mountainous lands, in general, are likely to be rocky and thin, except perhaps on the lower slopes (6). Deforestation in mountainous regions is one of today's most acute and serious ecological problems (10).

The presence of organic matter is an important factor in the soil's productivity because it:

- contributes to the development of soil aggregates, which enhance root development and reduce the energy needed to work the soil;
- increases the air- and water-holding capacity of the soil, which is necessary for plant growth as well as helping to reduce erosion;
- releases essential nutrients as it decays;
- holds nutrients from fertilizer in storage until the plants need them; and
- enhances the abundance and distribution of vital biota (3 I).

Therefore, deforestation, by reducing organic matter, lowers the potential productivity of tropical lands. Thus, when tropical land is abandoned, natural regeneration of the forest may not occur, and replanting the forest may be difficult.

VISIBLE AGENTS OF FOREST CHANGE

Subsistence

Shifting Cultivators

Shifting cultivation is common in the Tropics. The techniques are basically similar everywhere: farmers fell and burn the woody vegetation; then cultivate the cleared ground for 1, 2, or 3 years; and then abandon the site for a long period to forest or brush cover (forest fallow). There are four reasons for shifting to new fields: decreasing soil fertility, reduced soil moisture, pest outbreaks, or excessive weeds that raise labor requirements. Long fallow periods generally allow the land to recuperate and become productive once more.

Shifting cultivators fall into two broad classes: indigenous groups and recent occupants. Indigenous groups have long experience with the local environment and use farming practices that tend to be resource conserving. These farmers traditionally have practiced shifting cultivation using methods particular to them and woven into their family and tribal customs, and sometimes into their religion. Usually the choice of land to be cleared is based on knowledge of nature and soils. The timing of various agricultural activities is determined by specific indications of nature, such as the blossoming of wild plants, the emergence of particular insects, and so on.

In contrast, recent occupants generally are less knowledgeable about local environments and apply farming systems that are more destructive of resources (23). These people also cut and burn part of the forest. But unlike native populations, they may farm the same plot until the fertility of the soil is exhausted or shorten the fallow period so that the vegetation cannot recover. This type of cultivator is often a "colonist" who comes to the forests for land because ownership there is ill-defined or badly protected.

Generally, the new lands are only marginally productive for agriculture. In addition, recent occupants bring with them dietary preferences and agricultural technologies that are suited to intensive culture of the more fertile lowlands. By applying inappropriate farming systems on fragile soils, they often destroy the land's productivity.

A large part* of the agricultural population of Latin America farms on steep slopes. Population growth often leads to increased clearance of forested watersheds and forces many farmers to migrate down the slopes, clearing

*In most of the tropical countries of Latin America, over 30 percent of the agricultural population is on steep slopes, including 50 percent in Peru and Colombia, 40 percent in Ecuador, 65 percent in Guatemala and Haiti, and 45 percent in Mexico (33).

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Photo credit: H. Bollinger

Forested hillsides such as this one in Guatemala are being cleared for agriculture throughout the Tropics in part because of population increases and inequitable land distribution

the forests as they go, even into the inhospitable humid lowlands of the Amazon Basin. In recent decades, colonization by farmers who practice shifting cultivation has taken place throughout tropical Latin America. Colonization was primarily spontaneous in the 1940's and l950's, but became more systematically planned by government agencies in the 1960's and 1970's.

Even traditional shifting cultivation practices are breaking down under increasing population pressures. Commercial exploitation and subsequent colonization leave less land for traditional cultivators, With limited land and increasing populations, fallow periods have decreased. These shorter cycles do not allow enough time for forests to restore adequate soil fertility. The result is even more extensive forest clearance and a gradual decline in human living conditions.

It is easy to attribute recent increases in shifting cultivation to population pressure and inadequate land outside the forests. But other important factors are involved as well. In many places, good farmable land is reserved for the privileged and not used intensively to produce needed food crops for domestic consumption. Governments may build highways and promote colonization projects as alternatives to land reform (as has happened in Latin America). Some colonization projects are viewed as an effective way to occupy empty territory. This is especially true near frontiers in Brazil and Mexico **(28).** Still, indications are that forest clearing by peasant farmers will continue to expand with or without government encouragement and assistance.

Livestock Raisers

Nomadic herders in open forests are analogous to shifting agriculturalists in wetter tropical forests. In arid and semiarid areas, nomadic herding is a major land use (43). At one time, the nomadic way of life probably did not degrade the limited resources of dry regions significantly because there was a long fallow period before an area was reused. It is likely that an ecological balance among man, animals, and the surrounding natural vegetation existed. This has changed, however.

Livestock symbolize wealth and provide barter materials and insurance against future disasters (44). Cattle herds have increased in the Sahel in response to economic conditions. For example, the French-speaking Sahel had a fivefold increase in cattle during the 25 years preceding the 1968 drought (14). Cattle, however, are poorly adapted to Sahelian conditions: their conversion efficiency of plants to animal products is poor; they require substantial quantities of water; and they are highly prone to stress, Further, their feeding habits are incompatible with the Sahelian environ-

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ment. Since cattle are largely grazers, not browsers, they must be moved very frequently or they may completely eliminate perennial grasses. The reduction of dry-season grasses triggers a number of degradation processes once the seasonal rains begin. Raindrops striking the soil surface raise mud spatters that seal the soil surface to water infiltration. Then overland waterflow erodes the soil.

High-yielding wells have been built during recent droughts to alleviate chronic livestock water shortages. This has led to a rapid increase in the number and size of herds of cattle and small ruminants, which in turn have overgrazed the land in the vicinity of wells. Natural vegetation has disappeared in generally concentric circles around the wells until the grazing resources are so distant from the well that animals nearly starve before they reach forage sites. Meanwhile, parts of the remaining trees in the vicinity of the wells are lopped off for animal feed, and goats overbrowse shrubs.

These effects accelerate desertification, a process that spreads desert-like patches around villages or waterholes as a consequence of continued excessive pressure on the natural environment. Desertification is serious in tropical Africa, Latin America, and Asia.

Fuelwood Gathers

Cutting trees and woody vegetation to meet the growing demand for fuelwood has accelerated the process of deforestation and now seriously threatens the environmental stability of large areas. Such situations prevail in Africa (especially in the arid and semiarid areas

south of the Sahara, in the east and southeast, and in mountainous areas); in Asia (in the Himalayas and the hills of South Asia); and in Latin America (mostly in the Andean Plateau, the arid and semiarid areas of the Pacific coast in South America, and in the Caribbean).

Wood provides two-thirds of all fuel used in Africa, nearly one-third in Asia, and one-fifth in Latin America (z). Among the poor in tropical countries, it is often women and children who collect subsistence firewood. When possible, they avoid felling whole trees. Instead they lop off small branches, twigs, and roots and pick up dead wood from the ground. Men are more likely to collect wood for commercial sale and are more to fell whole trees.

Demand for wood fuels is concentrated in towns, cities, and densely populated farmlands, so the impacts of fuelwood cutting and gathering are greatest around such areas. Eventually, the intense pressures around urban places can lead not only to destruction of the forest but also to complete removal of tree and shrub cover.

It is the commercialization of fuelwood collection that most threatens forests. As towns grow, markets develop for traditionally noncommercial firewood and charcoal. The relatively rich in small towns and fringes of cities, create the demand, while the poor, who are often landless, take advantage of an opportunity to gain income (38). However, if the mar-

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kets place a price on wood above the price of collecting and transporting it, the trees become valuable. In this case someone is likely to claim ownership and to take over cutting from the landless poor (l).

Fuelwood cutting and gathering often have adverse effects on the land. Maintaining tree and bush cover in arid and semiarid areas is important to prevent desertification. Where fuelwood is available, animal dung and crop residuals are used as fertilizers and compost, but when wood becomes too scarce, these materials are diverted to become fuels. For the very poor, wood scarcity may mean the elimination of cooked food, boiled water, and an essential minimum level of warmth.

Firewood gathering is not the major cause of deforestation in Latin America, but the impacts are great on tropical mountain vegetation. Large circles around mountain settlements have been denuded of woody vegetation. The use of wood and charcoal for industrial fueI is particularly important in Brazil, where it provides **40** percent of the fuel used in the steel industry **(42).**

Fuelwood gathering has had detrimental effects in Africa and Asia. In the sparsely populated Sahel, areas surrounding population centers are largely deforested. The affected areas continue to grow each year. Until recently, fuelwood was hauled as far as **50** kilometers (km) to large Sahelian towns; now, it is commonly hauled 100 km. Within 40 km of Ouagadougou, the capital of Upper Volta, virtually all trees accessible to roads have been cut to provide fuel for the city's inhabitants. Only a few years ago, fuelwood could be collected in the immediate vicinity of most households; now people must walk half a day to reach it.

Since collection and transport of fuelwood in rural areas is mainly by human and animal labor, its free supply generally is limited to areas within walking distance of the consumer. Rural people will seek fuelwood from more distant locations until travel time becomes too great; then consumption may drop. A survey of India showed that most villages located inside or adjoining the forest meet their total fuel requirements from the forest. At localities within 10 km of the forest boundaries, about **70** percent of the fuelwood used comes from the forest; beyond 10 km, the use of fuelwood from the forests diminishes steadily until at about 15 km it is almost nil (22). However, in nations such as Thailand, with developed road systems and adequate trucks, urban consumers may use fuel or charcoal from much farther away.

Fires

Repeated burning has altered vast areas of tropical forest and woodland. Natural fires are caused by lightning, volcanic activity, spontaneous combustion, or sparks from rockfalls. The majority of manmade fires are set intentionally. Hunters use fire to drive game and to clear bush so that game can be seen more easily. Gatherers use it to encourage the growth of desirable plants and to discourage the growth of others, and to smoke honey bees out of their hives. Farmers use it to clear and fertilize land for planting. Pastoral people use fire to kill insects and snakes and to discourage predators. Other people use fire to ease travel through densely vegetated areas, to make war on neighboring people, or for other reasons. The primary reason, however, is to improve the quality of grasses for grazing.

Repeated fires generally impoverish vegetation and deplete soil through losses of organic matter, reduced nutrient cycling, and reductions in soil microbe populations. Regeneration may be rapid, but plant succession depends on a host of factors including the frequency and intensity of fire. After frequent burnings, fast-growing, light-loving second growth trees and shrubs eventually are replaced by savannas (permanent grass-covered plains). Fires can convert closed forests to savanna and can extend conifer forests at the expense of the broad-leaved forests. Such degradation leads to the establishment of plant communities adapted to physiologically drier conditions.

Seasonally dry forests are being more severely modified than wet forests. Many dry tropical

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forests were converted to savannas by human activities long ago. Some savannas are natural grasslands, but these have been expanded beyond their natural boundaries by forest clearing for agriculture and by manmade fires. In many places, it is difficult to determine what savanna is natural and what is derived from human activity, since all savanna vegetation is adapted to frequent fires and appears similar regardless of origin.

Warfare

Warfare has adverse effects on tropical forests. Bombing and shelling of some islands in the Pacific during World War II nearly eliminated the forest cover and the effects remained visible years later (48). Forested areas of Central America, Vietnam, Laos, and Kampuchea more recently have suffered the effects of military conflicts. Dense patterns of bomb and shell craters can eliminate forests or severely damage the trees. In some large areas, forests were removed by plowing and bulldozing to eliminate protective cover for enemy troops. Attempts were made to burn large tracts of dead, defoliated forests, but these largely were unsuccessful *(41).*

Between 1961 and 1971, about 14 percent of the land surface of Vietnam was repeatedly sprayed with herbicides and defoliants, adversely affecting the forests and mangroves (29). A recent examination of Vietnam's forests

some 12 years after the war shows that the long-term effect of spraying on inland forests depended on the dosage (30). An obstacle to reforestation of these damaged lands, which now are covered with coarse grasses, is uncontrolled burning by village farmers even though the land is more suitable for growing trees than farm crops.

The impact of defoliants has been most severe on mangrove forests, as much as 40 percent of which were sprayed. Natural regeneration has brought the regrowth of some minor "weed" species, but commercial species have returned naturally on only about 1 percent of the mangrove area (49). Some replanting has occurred, however, and commercial species have been reestablished in some areas.

Commercial Resource Use

Commercial Agriculture and Cattle Ranchers

Few data are available on the amount of deforestation now caused by commercial farming, which usually involves permanent fields with perennial bush and tree crops. This was once a major cause of tropical deforestation, but now it is a less significant cause than shifting cultivation and ranching.

Cattle raising plays a major role in the loss of tropical moist forests in the Brazilian Amazon and in Central America. In contrast, it is not a major factor in moist regions of tropical Asia and Africa, where shifting cultivation and logging are more important.

Photo credit: H. Bo//inger

Conversion of moist tropical forest to temporary grazingland in Panama, a common scene throughout Latin America. Most of the beef is exported

Pastures commonly are abandoned after 10 to *15* years of grazing because of declining soil fertility, erosion, soil compaction, invasion of unpalatable weeds, and low productivity. In parts of the Brazilian Amazon, ranches only 5 years old fail because of pasture degradation (19). Pasture instability and degradation result in greater pressure to clear new forests.

The area of pasture in Central America more than doubled between 1950 and 1975, almost entirely at the expense of undisturbed forests. Between 1966 and 1978,8 million ha of Brazil's Amazon forests were converted into 336 cattle ranches supporting 6 million head of cattle. In addition, some 20,000 other ranches of varying sizes have been established (25).

There are several ways that forests are converted to pasture in Latin America. On large land holdings, forests are often leveled, burned, and seeded with native or introduced grasses. Owners of smaller holdings commonly clear their land by making arrangements with peasant shifting cultivators whereby the peasants clear the land, farm it for 1 or 2 years, and then seed it to pasture and move on (9,32). In southeastern Panama and probably elsewhere, professional deforesters move into national forests, cut the forest, plant grass, and then sell plots as "improved land" (28).

Land consolidation, however, is probably the most common means of converting forest to pasture. Agricultural colonists leave their fields and move elsewhere when yields decline significantly or losses to pests or weeds become too severe. The land is abandoned or sold to more successful neighbors, to a second wave of settlers with more capital, to speculators, or to cattle ranchers. Small plots may then be combined into larger, more efficient units that sometimes are used for tree crops but more commonly for pasture. This process is widespread in tropical Latin America (8).

A number of factors account for the acceleration of cattle ranch development. Cattle ranching, having its roots in Spain and Portugal, always has been a prestigious occupation in Latin America (32). Furthermore, a tradition exists in the Amazon and elsewhere in Latin America that it is the act of deforestation, or other "improvement," which gives one the right of possession of land. The capital costs of ranching are low compared with commercial crop production, and the market for beef is steady or expanding. Government incentives minimize the costs of credit, land, taxes, and production for the conversion of rainforest to pastureland. Finally, strong export markets have encouraged expanded beef production in this region of the world. U.S. companies annually import as much as 330 million lb of Central American beef. That is 25 percent of the region's annual beef production and 90 percent of its beef exports (39), though this imported beef only amounts to about 2 percent of annual U.S. beef consumption.

Several researchers have recommended that the United States ban beef imports from Latin American countries where cattle raising plays a major role in tropical forest destruction [28, 39), or that the United States import no beef from Central America (26). A number of questions would have to be answered before legislation for the first suggestion could be seriously considered. How much time must pass between forest clearing and cattle grazing to avoid the proposed ban? How could it be proven that beef from a particular country is produced primarily at the expense of tropical forests? Who would make the judgment that the beef is produced primarily at the expense of tropical forests? Who would monitor cattle grazing operations day to day in each Latin American country? Such questions need to be examined carefully and answered in detail to deal fairly with other countries. The second suggestion is simpler than the first but the foreign policy implications are equally complex.

A variety of inducements for cattle operations come from international organizations and development agencies. For instance, international agencies and governments provide loans for cattle development, including credit for individual ranchers. Between 1971 and 1977, international and bilateral agencies provided more than $3.5 billion in loans and technical assistance to Latin America to improve

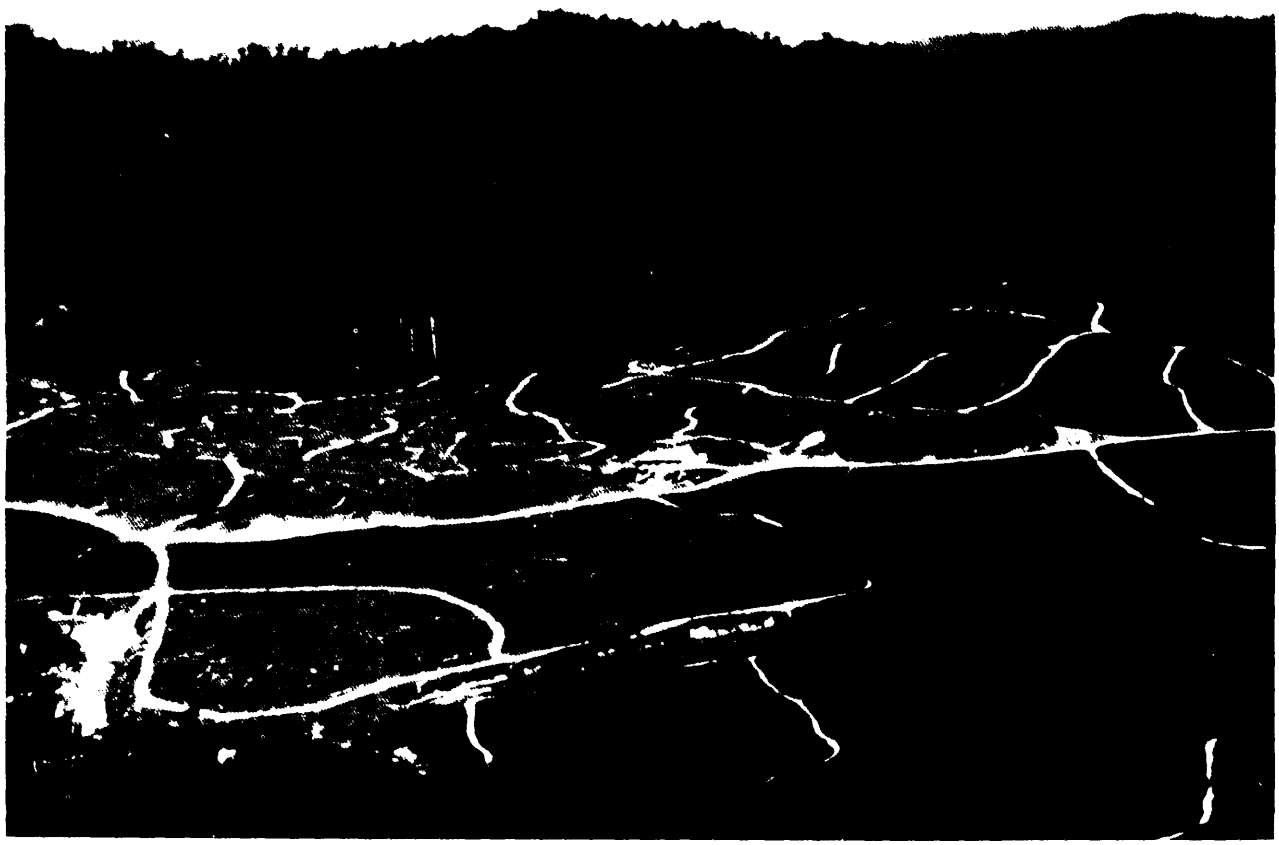
livestock production and meat processing (28). In sum, the growth of cattle ranching reflects not only markets but government and international assistance, low cost loans, and other incentives.

Loggers

Commercial logging causes deforestation in moist broadleaved and conifer forests, especially in Asia, West and Central Africa, and parts of Latin America. It is expected that as the Asian wood supply is exhausted, the Latin American share of international trade in tropical wood will increase accordingly, from 16 percent today to about 40 percent by the year 2000 (25). Most tropical American softwoods—and the more valuable hardwoods of tropical Mexico, the Caribbean, and Central America—already are depleted. Most of the remaining timber is in the Amazon, where most of it remains inaccessible and unsuitable for current methods of selective logging.

Logging practices in the tropical forests differ from those in temperate woodlands. Logging companies have markets for only a few tree species, and these are widely scattered in highly diverse tropical forests. For example, in the Ivory Coast only 25 species are regularly cut out of the hundreds available (25). Thus, extensive areas must be worked to get enough logs, and this can be quite destructive. Cutting one tree commonly brings down other trees around it. Additionally, species diversity decreases with repeated selective cutting.

Logging practices frequently influence subsequent natural regeneration and rarely are fol-



lowed by assisted regeneration or intentional reforestation. For timber concessionaires in Asia, tropical silviculture has been a rationalization for cutting economically valuable trees rather than a technique for securing forest regeneration (35). National forestry departments usually exercise only weak control over logging concessionaires.

Even though loggers may gradually degrade forest quality, the relationship between loggers and cultivators exacerbates the rapid depletion of forest resources. These two agents of forest removal reinforce one another. Networks of forest roads designed to transport timber provide entry for farmers. Through a sequence of felling, burning, and cultivation, forest lands are actively degraded to low productivity farms, which in turn maybe converted to low-grade grasslands through further burning and grazing. An adequately trained forestry staff rarely is available to police either the logging operations or the movement of cultivators into the concession.

UNDERLYING CAUSES OF FOREST DEGRADIATION

In most of the Tropics sustainable forestry and agriculture practices are not being developed and applied. The underlying causes of this failure are institutional more than technical (8,15).

Institutions include national, state, or provincial forestry departments as well as international donor and technical assistance agencies. Institutions also comprise the broad set of rules and arrangements that assign rights to resources, define roles, and govern individual and collective ownerships. Institutions define what individuals can and cannot do, what they can expect others to do or refrain from doing, and what they can expect the government to do on their behalf (15). Institutions set the rules by which policies are applied to produce desired results; policies and actions correspond to the extent that institutions are effective.

Forest degradation represents a case of chronic institutional failure. The two most important factors are:

1. the pattern of property rights and the absence of effective common property institutions for forest-land management, and
z. the ineffectiveness of State and national forestry agencies.

Properety Rights and Control Of Forest Resources

Forests supply rural people with food, fuelwood, and fodder. A large portion of both moist and dry tropical forests is government owned and people gather freely what they need. Sometimes the government allows such gathering, but more often people take natural forest products whether it is legal or not because the forests are not well policed. Although some forest land is owned by villages or tribes, the individual quest for wood and fodder often overwhelms the collective need to sustain forests. The same principles hold true for other resources. As pressures mount to fulfill human needs, overuse and mismanagement of resources lead to degradation and deforestation.

Growing population is a major force behind this increasing demand, but property rights status (or lack thereof) is an underlying cause of the failure to meet the demand with sustainable production. Use without management is characteristic of natural resource systems that lack clearly defined property rights. When any potentially renewable resource is used in common, no user will delay use or otherwise invest in efforts to sustain the renewability of the

resource unless some institution guarantees that he will benefit from the investment. Thus, tropical forests have been degraded because of institutional problems related to control over access to forest land and forest products.

Uncertain institutional arrangements and inadequate administering agencies are at the root of many forest degradation problems. When forests become nationalized, as in parts of Asia, traditional tenure and institutions for common property management of forest lands are abandoned. National governments acquire formal control, replacing local administrations and denying the validity of prior land-use arrangements. The rights of forest occupants to continue using forest land, acquired over generations, have been removed or reinterpreted in the national effort to control people and territory.

Unlike commercial agriculture, which generally takes place on lands where property rights are understood, agreed on, and respected, forestry takes place on lands where complex and often conflicting systems of land tenure apply. This difference creates the acute contrast between investments in technologies to increase agricultural productivity and the lack of such investments in forestry, The lack of clear land tenure will continue to constrain development initiatives in forestry and efforts to reverse forest land degradation. Where communal or national tenure is clear, the lack of capable administration institutions is the major constraint.

The potential for forestry to support national economic development that brings benefits at the village level is great, provided sustainable resource-use systems are applied. But such systems depend on the establishment of institutions to administer forest lands as common property. Developing these institutions will require a better understanding of history, culture, and social organization than is now applied.

To be effective, forest administrations need local support and participation, and this contrasts with how forestry bureaucracies typically work. Unless the institutional component of a forest management technology is understood by villagers to support their goals, that technology will not be used. With respect to villagers in or around public forests, effective common property institutions would clearly define individual and group claims on the benefits that stem from the forest. However, what generally prevails are claims on uses which, in the absence of control over rates of use, drive the resource to depletion (5). Since privatization of forest lands may not be possible in many parts of the Tropics, open access must be controlled through such means as issuing licenses for users, setting quotas, taxing users, or strengthening local social institutions (18).

Transformation of Forestry Administrations

The second part of the issue of institutional change relates to changes in the forestry agencies themselves. Government forestry institutions typically have been designed to protect state or private logging and ranching interests. In many countries, the forest has been a zone of tension between the state and the people. The pattern has been exacerbated by government insecurity with respect to its citizens and borders.

Although agency attitudes and traditions are deepseated, they seem to be changing as government forestry institutions evolve from being custodians of public land to functioning as managers of a development process. For example, in many Asian nations increasing strength is being given to national forestry development corporations charged with managing forests according to sound economic principles. At the village level, small-scale forestry projects for local community development are beginning to be promoted by national agencies. These are intended to create new income for villagers from degraded public forest lands and to reduce pressure on the remaining or regenerating public forest. Some nations have begun to provide forestry extension services for village farmers.

Many Asian nations also have begun to apply policies to encourage investment in wood-processing facilities and to use forest industries

within broader strategies of regional development. Few African or tropical American nations have developed such policies, and very few nations in any region have developed feasible long-term plans for forest land allocation.

Even where appropriate policies exist, forest resource development is constrained by poor implementation and reluctance to enforce the policies. The effectiveness of government control over logging concessionaires depends on the degree to which national leaders are committed to maintaining long-term forest productivity. The real value of hardwoods from Asia and West Africa has made it difficult to restrain powerful individuals and firms from enriching themselves by sponsoring illicit cutting, by misrepresenting volume and grade of legally cut logs, or by conferring the rights to exploit the remaining forest to others. Several national governments have banned export of unprocessed logs to encourage forest conservation and local employment. However, data on tropical wood imports by industrialized countries indicate that illicit logging and exporting continue despite the bans (15). The persistence of these problems is due to incentives for rapid economic gains by elite groups and the lack of political commitments to conservation and development of public resources for the benefit of the general public.

Improving forest administration also depends on developing effective participatory approaches to forest management. Through participatory approaches, forestry programs may adapt techniques and institutions to local environments to develop productive and protective forestry systems with an equitable distribution of products. However, substantial obstacles to participatory approaches exist within the implementing agencies and at the local community level. For example, many forestry departments tend to be hierarchical, with highly centralized decisionmaking and little room for delegation. National programs seldom permit field officers to adapt techniques in response to local conditions and provide few incentives for local initiative. Moreover, the current generation of foresters often lacks the necessary skills and resources to provide leadership in this area.

At the community level, common obstacles to participation are the absence of appropriate local organizations and shortage of leadership skills. Typically, even where community development is practiced, inadequate attention is paid to building community problem-solving capacities and to dealing with social diversity in highly stratified village social structures (20). Effective community organization can provide some measure of control over corruption and can restrict the opportunity for individuals in positions of authority to take unfair advantage of their positions at the expense of others (15).

The degradation of forests can in large part be attributed to the failure of state and national forestry agencies to change with changing conditions and to increase the effectiveness of forestry in ways comparable to agriculture. Two especially important tasks are the control of logging concessionaires, which will require political backing from the highest level, and the development of effective participatory approaches to forestry.

CHAPTER 4 REFERENCES

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