Global Deforestation and the Nineteenth-Century World Economy

Edited by
Richard P. Tucker
and J. F. Richards

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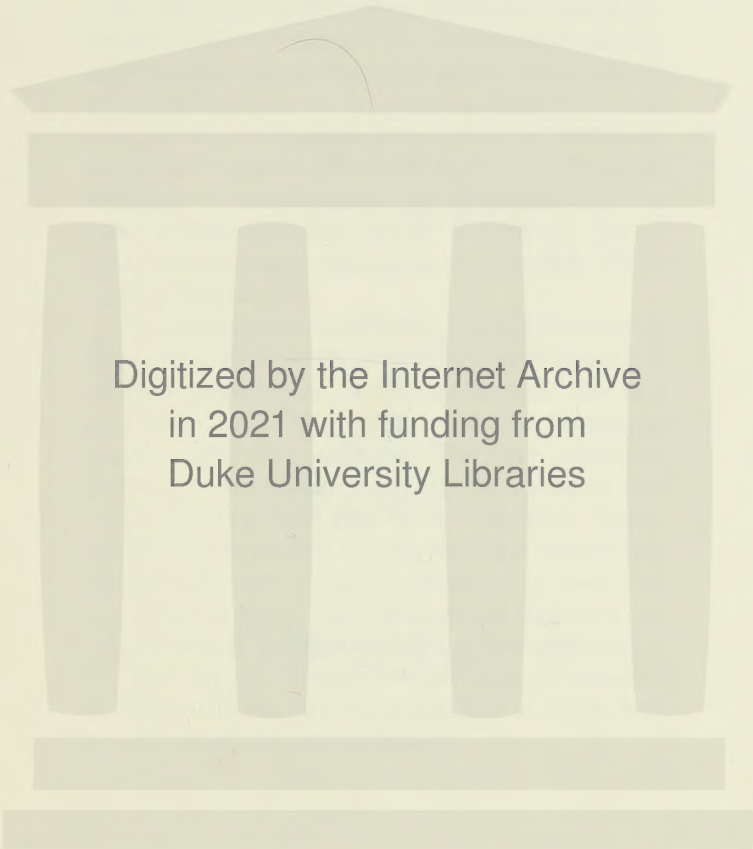

The period between 1800 and 1914 saw an unprecedented expansion of agriculture and population throughout the world, with an accompanying clearing of land and forests. The contributors to this volume demonstrate that this global trend toward deforestation was not so much a response to the pressure of growing population as it was a function of world market forces generated by Europe's growing demand for commodities and raw materials. The result of this increased demand was the clearing of land and the rapid disappearance of much of the world's forest cover.

This deforestation made many rural populations, especially in the non-Western world, more dependent on these international market forces than they had ever been before. Their natural resources, previously readily available in the form of forest and woodland products, were rapidly depleted. The essays in this book, drawing from the North American, Asian, South American, and African historical experience, present case studies which for the first time reveal the full extent of this process of economic and environmental change, a process which has been obscured in the past by the compartmentalization of national histories and the lack of integration between economic history and forest history.

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Preface

At a pub on the Thames one summer evening in 1979, in the home city of what had been the modern world's most powerful imperium, the question arose as to what kind of relationship might have developed between the Empire's worldwide economic networks and the processes of ecological change which have brought the Third World in recent times to its acute shortage of natural resources. By extension this question began to seem a fruitful way to approach the intricate interactions between economic forces and ecosystems, and therefore a way of bridging the abyss between the social and historical sciences on one side and the ecological sciences on the other. No single person could hope to cut a path through the tangled excitement of this jungle, but a group with varied skills and shared curiosity might hope to identify some landmarks to use as a basis for further exploration together.

Nearly two years later, in May 1981, that group assembled at Meadow Brook Hall on the campus of Oakland University for three days of discussions. We had agreed to center our attention on the economic context of forest clearance in various parts of the nineteenth century world which we individually knew in detail, hoping that the stimulation of sharing methods and material would lead to a more confident sense of how to pursue further work in the future.

The setting for the conference was not only extremely gracious; it was symbolically appropriate as well. Meadow Brook Hall was built in 1929, expressing the union of Alfred Wilson, a timber company executive from northern Michigan, and Matilda Dodge, heiress to one of the great automotive fortunes. The mansion and its 1500-acre estate were one result of the link between our industrial economy and our forest wealth; the conference set out to discover other such links.

Of the many people whose imagination and concerted work have gone into making the conference and this volume possible, our particular gratitude goes to those at Oakland University who provided the financing and facilities: then-President George T. Matthews, Dean Lewis N. Pino and the Faculty Research Committee, and Dean Lowell Ecklund and the staff of the Hall.

In addition we all benefited from the participation of two European friends whose papers will be published elsewhere, Drs. Heinrich Rubner, Department of History at Regensburg University and chairman of the Forest History Section of the International Union of Forest Research Organizations, and Dr. Arlette Brosselin of the Department of History, University of Dijon. All of our discussions were enriched by the formal participation of discussants who brought expertise from fields not otherwise represented around the conference table: G. Robinson Gregory, Professor of Resource Economics at the University of Michigan, Jane Schneider, Professor of Anthropology at New York University, Harold Steen, Director of the Forest History Society, and Jack Westoby, Forest Economist for

the United Nations Food and Agriculture Organization. Their insights, and those of several members of the Board of Directors of the Forest History Society who joined us more briefly, are reflected in the revised texts of our papers at more points than the authors can possibly acknowledge explicitly.

Introduction

The meeting of forests and industrial wealth has been one of the momentous factors of modern history, but its role in the evolution of the biosphere, and especially the impact of the modern industrial nations on the natural resources and receding frontiers of the globe, is still very poorly understood. As one step toward clarifying the record, twelve scholars from nearly as many different branches of historical studies and related disciplines, with the aid of discussants from forestry management, forest economics, and anthropology, met for four days in May 1981 to compare their findings. This volume is a record of the results.

Preparing the conference, we were faced with the vast and largely unexplored subject of what happened to the forests of the world as the contemporary era was emerging. We began with the central hypothesis that in the course of the long nineteenth century before the cataclysmic global changes initiated in 1914, the steeply rising demand for production of agricultural commodities exerted by the core or metropolitan societies of Europe, North America, and Japan was the dominant cause of rapid depletion of world wood and forest resources. We had perceived a link between an accelerating worldwide market demand for foodstuffs, fibers, and raw materials, the clearing of land for expanded cash crop production, and accelerating depletion of forest cover. Much of the impetus for forest clearing, we postulated, came from forces outside forestry management itself, which after all was still in its infancy in most parts of the world.

It is common knowledge that in the century preceding the outbreak of World War I both political and technical changes combined to cause unprecedented integration of the world's economy. The imposition of formal colonial rule or indirect political and economic control by the industrialized nation states of western Europe and North America was well under way by mid-century. By the 1860s a global transport network consisting of railways, feeder roads, ports and harbors, and steamship lines was under construction. The transport revolution was soon buttressed by information flows speeded by the new postal union and by intercontinental cables. The opening of the Suez Canal in 1869 merely added but one link to the structure, as did the Panama Canal several decades later.

Sharply enhanced demand for commodities in the metropolitan countries, for both industrial and domestic consumption, transmitted outward to the remainder of the globe as political and economic centralization proceeded. Thus, regions in eastern and southern Asia, the Middle East, Africa, Latin America, and even eastern Europe and Russia felt the invitation to intensify export commodity production. Demand from the core countries stretched across a wide and growing range of food crops such as rice, sugar, and wheat, industrial crops such as indigo, jute, and sisal, and narcotics such as coffee, tea, and opium. European, North American, and (toward the end of the period) Japanese colonial regimes, or

indigenous regimes subject to their economic and political pressure, made systematic efforts to increase incentives and to reduce barriers to export production of these commodities.

As a result, combined state and market pressure engendered land clearing on a massive scale in every world region before 1914. For each crop, whether indigenous or newly-introduced, whether grown by peasant or sharecropper or directed by plantation owner, the primary means of increased production to meet the new market demand was to increase the area under cultivation. Rarely were there sustained attempts to increase yields by more intensive labor or investment in more intensive land-use technology. We postulated that one major result of global political and economic integration must have been the steady destruction of the world's woodlands and forests, especially in the regions which were being newly integrated into that economy.

Dramatic examples of forest cover depletion and expansion of cultivated area occurred in the virgin lands of the New World, Australasia, and Siberia, the areas of European settler populations. Similar processes were at work in long-settled regions of Asia and Africa. The rapid expansion of monocrop commodity production in the nineteenth and early twentieth centuries in the world's colonies and dependencies was one of the primary reasons for today's dangerous imbalance between the "First World" and "Third World." While that process very likely brought increased real income to peasant-proprietors, estate owners, and other groups in Third World societies, by 1920 the terms of production and trade became unfavorable, and opportunities for bringing new lands under cultivation there became increasingly limited. It is probable that present-day patterns of rapidly rising population and local needs for food production on depleted soils, characteristic of the less developed countries, began a rapid acceleration from the end of World War I onwards.

Written from disparate perspectives, disciplines, and world areas, the papers discussed at the conference tend to support these interpretations and provide a context for extension of the analysis beyond single dimensions of the story (such as agriculture or timber harvesting) toward a more systematic understanding of the full interplay between human and natural systems. In the process a fuller understanding of our key issue, the loss or changing composition of forest cover, becomes more clearly illuminated. We begin to see a broader range of analytical tools brought to bear than single disciplines had heretofore mustered.

The timber harvesting and marketing which transformed large parts of North America in the nineteenth century is relatively well understood. It is exemplified by the forty-year process of commercial lumbering of the white pine forests of northern Michigan, based on the technology and economy of an industrial age, which lies behind the paper presented by Michael Williams, a geographer. His work reminds us, however, that in other regions the elimination of forests was caused far less by lumbering for profit than to make way for food and other marketable products. Williams describes the small-farmer world of the oak-hickory forests in southern Michigan, Indiana, and Ohio. There, on the frontier of a rapidly

expanding agricultural economy, it is appropriate to take a close view of the individual farmer whose primary purpose was to open soil for locally consumed food. In contrast to the Michigan lumberman, the Ohio farmer cleared the land in order to grow first subsistence crops and only later cash crops. Small scale sale of logs and rough boards was usually incidental to his work. Between 1850 and 1920 the amount of "improved" farm land in Ohio alone rose from 4.0 million hectares (40.5 percent of the state area) to 5.9 million hectares (76.3 percent of the area). Over the seventy year period the woodlands and forests of Ohio were reduced by 1.9 million hectares. As Williams points out, this process did not go unnoticed at the time and was an issue of contemporary concern among the residents of the state.

On a very different agricultural frontier, plantation cropping and its related secondary farming in southeastern Brazil, Warren Dean, a historian, shows the impact on sub-tropical vegetation of European commodity demand, a prolonged assault on the primary rain forest which had once covered some 500,000 square kilometers south of Amazonia. Even though European intervention had begun in 1500 A.D. with gold-mining, followed by the evolution of mestizo swidden farming and clearing of lands for supply of fuel and food to the new towns in the mining districts, it is unlikely that more than two-fifths had been cleared in the three centuries prior to 1800. By the closing decades of the eighteenth century large-scale sugar plantations began to encroach inland on the forest. In a pattern typical for sugar farming at this period the land cleared for planting cane was extended as wood was harvested to meet the annual fuel needs of each processing plant. Newly-introduced African slaves provided the essential labor power.

By the 1830s the accelerating planting of coffee trees on cleared forest land had begun to surpass the effects of sugar planting in southeastern Brazil. From its initial area around Rio de Janeiro coffee planting traveled as far as São Paulo in the 1840s. By the 1880s, after the abolition of slavery and the introduction of an immigrant European labor force, the growth of coffee intensified. During the 1890s the number of coffee trees in the state of São Paulo rose from 300 to 650 million. Because of a pervasive belief "that the [coffee] plant required the soils of the primary forest," land clearing for coffee was far more extensive and sustained than was probably necessary. Dean estimates that under the Brazilian system, the trees felled in São Paulo represented the destruction of 12,000 square kilometers of primary forest and another 3,000 square kilometers for subsistence food crops for coffee workers. Ascending world market demand for coffee and the railways' linking of the forested interior regions of southeastern Brazil with the coast after 1890 meant that the coffee expansion continued until the 1930s. More and more land in swidden as well as in primary forest fell to the planter's land clearers.

Halfway around the globe the forces of the world system were powerful enough to impel millions of paddy-rice growing peasants in Southeast Asia into clearing virgin land for intensive cultivation of rice to export. As Michael Adas had previously described, after 1850 an export rice economy emerged in the deltaic zones of the Irrawaddy River in Burma, the Menam Chao Phraya River in

Thailand, and the Mekong River in Vietnam. Between 1860 and 1914 export rice soared from a regional average of nearly 700,000 tons per year to 4.2 million tons per year. British conquests in Burma, French victories in Indochina, and British diplomatic pressure on Thailand swept away existing constraints on international trade imposed by the indigenous regimes. At the same time the world price of rice reflected the combined impact of a European consumption market and reexport market to the West Indies. Sugar planters depended upon a newly-perfected method of parboiling, gelatinizing, and shipping rice to feed their indentured Indian and Chinese laborers. The colonial and Thai governors invested public monies in railways, river control projects, ports, and fiscal incentives for producers. Indian and Chinese middlemen provided capital for peasants anxious to respond to these incentives.

Adas' essay in this volume reveals with what speed and energy the peasantry of upper Burma moved into the virgin lands of the Lower Delta to clear new rice lands at the expense of primary forest. In spite of a long catalogue of pioneer hardships, including tigers, malaria, and swamps, the Burmese peasants created a new landscape in Lower Burma in a few short decades. Inland, the evergreen rain forests, which were estimated to be about four million hectares in 1852, fell to the axe and flooding techniques of the Burmese pioneers. By 1914 even the mangrove swamps on the coasts had succumbed to the drive for new rice lands.

The expansion of agriculture in western India shows a similar pattern of peasant energy and capital put into land clearing. In their joint paper J. F. Richards and Michelle McAlpin analyze the effect of rising international raw cotton demand, colonial enabling measures, and construction of cartable roads, railways, and Bombay port facilities upon the peasants of the Bombay Deccan. In the districts covered by this study the total arable area rose from 6.3 million hectares in the period 1856–60 (annual average) to 10.1 million hectares in the period 1916–1920. The figures for cotton, the leading cash crop, show a jump from annual averages of 322,000 hectares in 1856–60 to 1.3 million hectares under cotton in 1916–20, an enhancement much in excess of that of the increase in total arable land in this period. By 1920 one result was the clearing of virtually all accessible scrub, woodland, and jungle from the wetlands, village woods, and uncleared lands of the region. The dry deciduous monsoon forest survived only in isolated stands or in the government's reserved forests.

These and other chapters give us insights into different stages of the ecological impact of Western colonialism or neo-colonialism. The intricate penetration of British institutions in western India and the transformation of Lower Burma also at British hands were only two examples. Dennis Roth shows the impact of the transition of the Philippines from Spanish to American control at the turn of the twentieth century; Warren Dean describes southern Brazil in the turbulent aftermath of Portuguese rule; while James Thomson outlines the open woodlands in the Sahelian savannah before French colonial control took hold.

In Ohio and southeastern Brazil we see uncontrolled deforestation on the frontiers of white penetration into regions whose small earlier populations had made only limited changes in the forest cover. Thomas Cox's survey of timber

operations on the northwest coast of North America sees similar economic forces at work but demonstrates that in Oregon and Washington "the specter of a coming timber famine" was ultimately laid to rest. There agriculture did not become dominant: neither aboriginal nor settler population could compete with a recovering timber economy in an ecological setting highly favorable to the harvest of forest resources. Cox's paper is unique in this volume in describing the seminal era of a region which remains a major timber producer in the 1980s.

In contrast with these frontiers of white population, in India and China great civilizations had long since brought river basins under the plow and had settled relatively dense peasant populations. There the nineteenth century produced further land clearance for cash cropping including acceleration of older agricultural patterns into the interstices of old agriculture and onto higher hill lands, more marginal for some agriculture but until the European arrival heavily forested.

There were, of course, changes even within the major Asian civilizations, along a spectrum of Western penetration, from India, where Great Britain developed the most complex of all colonial regimes, through crumbling imperial China, where the West came to control the coast but penetrated inland only selectively, to Japan, which resisted Western overtures almost entirely until 1854 and then successfully contained those forces through the end of the century.

Rhoads Murphey's survey of deforestation in China during the era of Western imperialism portrays a landscape already severely degraded by previous centuries' human pressures, despite the fact that much of the Chinese landscape is so rugged and inaccessible to modern transport that it presented formidable obstacles to any sort of rural development. Western political and economic forces remained primarily clustered on the coastal periphery until World War II. Ironically the timber which built the treaty port system came largely from the Pacific Northwest of North America, as Thomas Cox suggests, and when modern industrial forces began exploiting the remaining Manchurian forests, it was the Japanese economy after the turn of the century which began building the requisite infrastructure. By 1914 the signs were becoming clear that the Pacific Basin would be one of the twentieth century's basic economic and ecological units.

Japan's role in these developments is presaged in Masako Osako's study of forestry management during the Tokugawa era of the seventeenth through mid-nineteenth centuries. For the Western world's students of the history of forestry management, her report opens an extremely significant window, giving us one of our first glimpses into the long and important indigenous tradition of forestry management in the Japanese islands. This tradition, evolving under very different conditions from those which produced professional forestry in Europe, has been chronicled in detail by Japanese scholars, as Osako's references indicate. Her essay provides non-Japanese scholars with a baseline for further studies of Japan's critically important role in twentieth-century forest exploitation around the Pacific Basin.

Pursuing a theme mentioned briefly in several other papers, Richard Tucker presents a perspective on a major mountain periphery which came under colonial developmental pressures during the nineteenth century. In this instance, as in

some other non-Western mountain regions before the present century, relative inaccessibility to transport and international markets gave some protection to the mountains' forest cover. The portion of the Himalayas which came under British management was not primarily exploited for export production of either timber or alternative cash crops such as tea. Yet the influence of the British imperial economic system was as powerful, even at one remove. In order to find proper timber to build the railways necessary for military control and long distance shipment of north India's grain, the British Raj initiated in the 1860s the colonial world's first and most sophisticated forestry service, whose personnel later replicated its work for many other colonies in Africa and Asia. The Forest Department of British India was constructed partly in response to the sudden transformation of land and vegetation in the western Himalayas from the 1840s which had been caused by reckless logging for the new markets of the north Indian plains. The Forest Department's task was to sustain and regulate the commercial use of the Himalayan forests.

This study points to the peculiar fragility of mountain environments, susceptible as they are to sudden and irreversible changes when the outside world penetrates. A comparative analysis of this theme might also note the parallel problems which mountain systems in eighteenth and early nineteenth century Europe faced, as rapid commercial timbering produced grievous floods and landslides. This collection does not survey that story, but it has been well covered in the French and German literature on European forest history. The lessons which the Continental foresters learned in those years about managing mountain landscapes are likely to have influenced colonial approaches to similar landscapes in the twentieth century, or so our future work will test.

The mountains of the Himalayan system, like temperate and alpine mountains of Europe and North America, are paralleled for fragility only by the tropical rain forest, which does not appear clearly in this set of papers on the nineteenth century. What can we say concerning the destinies of tropical forests before 1914? Within the past ten years ecologists, foresters, and development planners have all turned in increasing alarm to the rapid depletion of the rain forest. No one questions any longer that this trend represents one of the greatest dangers to the long run viability of life on the planet. At present rates the clearing of the tropics threatens to deplete the diversity of plant and animal species on which our biological survival is based, and may also be a major factor in dangerous increases in atmospheric carbon dioxide, leading to disruptive warming of the earth's atmosphere. The general impression is that this depletion of the tropical forests has accelerated massively in the past thirty years or so. But we may simply be thinking of commercial timber harvesting, which may not have been the only, or even the major source of forest clearance in the tropics until recently. In other words, our sense of the rate of change of the tropical forest cover is as yet only guesswork for the years until the 1950s.

This conference, centering as it did on the dynamics more than the statistics of nineteenth-century forest use, did not provide definitive data on quantitative

changes in the tropical forest cover before 1914. Analyzing processes such as the spread of plantation agriculture, it could not assess the much more difficult problem of the spread of shifting cultivation, which has been most significant in the tropics. Dean's contribution traces the disruptive spread of small scale peasant cultivation on the southern frontier of Brazil, but he is at pains not to encourage facile generalization in the different circumstances of the Amazon basin. Roth is able to show the intricate interplay of grasslands and forests in the intensification of land pressures in nineteenth century Luzon, but he warns that this too represented different trends from the much less known story of one twentieth-century crisis point, the Philippines' southern island of Mindanao, which is more truly tropical. Adas' analysis of the Irawaddy river delta presents a closer parallel, in both economic and biotic terms, to the other major river deltas of mainland southeast Asia which were turning rapidly toward export production of rice as the century progressed.

Certainly in the present state of scholarship, we can see more clearly the trend of plantation cropping than the other major dynamics of tropical deforestation. In Ghana and western Nigeria the cocoa plantations which spread rapidly in the late nineteenth century have been described in some detail, as has the changing forest use which resulted in southeastern Nigeria from rising European demand for palm oil. In Central and South America, where plantation cropping for sugar and other export products must be traced nearly 300 years earlier than our chronological period allowed, the story of plantation crops is also well chronicled, but the impact on the forests has not been studied in any detail yet. In the Dutch colonial administration of Indonesia, though formal forestry management began in 1857 and thirty-six logging firms were harvesting teak by 1880, timber work was minuscule in contrast with massive plantation cropping. The French colonial system's impact in Indochina was similar. Massive new rice and rubber planting in the lower Mekong basin and central Vietnam contrasted with the almost total absence of timber export or formal forestry management before 1914.

Perhaps most significant in cases such as these, as Dean demonstrates in his paper, is the secondary impact of land clearance on the "hollow frontier": the small scale but in aggregate massive clearance of land for the subsistence needs of peasants whose livelihoods had become tied to plantation labor but whose basic necessities were not provided by plantation owners, in contrast to many slavery or serfdom plantations. We may well find that these secondary effects of the international economy were the most important, as well as the most difficult to measure, of all causes of forest degradation until the massively mechanized agriculture of very recent years.

We do know, though the material for this study remains as yet fragmented, that tropical timber exploitation and its closely related phenomenon, modern forestry management, penetrated very little into the rain forests of Africa and Southeast Asia before World War I. One reason is purely botanical: tropical forests are vastly more diverse in their genetic pattern than other types of forest, making it far more difficult for timber hunters to locate dense enough stands of commercially de-

manded hardwoods to make harvesting feasible. In addition, factors of politics, transport and even disease meant that the European empires' penetration of the tropics was only tentative before 1920. The valuable forests of Ghana remained under the control of local authorities hostile to British interests; railways there as in Nigeria began to roll only toward the end of our period, after lengthy political maneuvers between Africans and Europeans. Furthermore, Europe's main source of timber remained, as it had for centuries, the cooler forests of the Baltic region. Specialized demand for tropical hardwoods for fine cabinetmaking was too limited to make major inroads on African forests before 1920. Reflecting and shaping these trends, professional forestry in British Africa began as a transplant from British India around the turn of the century, as did many of the most important timber trees: teak, sissoo, and others.

In French Africa extensive tropical forests were found in the Ivory Coast, which became a French colony before the nineteenth century closed. Private concessionnaires began arriving in these forests in the mid-1880s, but they faced severe problems of communications and available labor. Formal forest management there was initiated only in 1912; a French colonial forest service was begun eleven years later.

The great rain forest of central Africa, in the Congo river basin, came under Belgian control in the 1880s. The first sawmill appeared there in the early 1890s, but before the 1920s the Belgians' primary interest in the forest was to test possibilities for rubber production, which developed haltingly. Limba, the most valuable Congolese hardwood, was first harvested there only in 1920. Formal forestry management appeared only when the Forest Service was established there in 1936.

In summary the Meadow Brook conference only began to determine the issues which must be faced in assessing the history of tropical forest use. The second conference in our series, which will cover the years since 1914, will have as a major focus the exploitation of the tropics from World War I onward.

Richard P. Tucker
J. F. Richards

Global Deforestation and the Nineteenth-Century World Economy

1. Ohio: Microcosm of Agricultural Clearing in the Midwest

Michael Williams

In the northern part of the United States' Midwest we find two contrasting systems of forest exploitation during the nineteenth century. To the north, in Michigan, the rapacious lumbering of the pine forests found in and near such river basins as the Saginaw, Muskegon, Manistee, and Au Sable provided about one fifth of the entire lumber output of the United States at every census year between 1869 and 1889, and nearly a tenth in 1899.[1] It was a story of spectacular rise and fall in the space of forty years, of a new scale and mode of exploitation based on the tools, technology and strategy of the industrial age: the railway, the steam driven saw, the corporate structures and trading organizations, the supply to mass markets on a continental scale.[2] It was the epitome of capitalistic destructive exploitation, of cutting the greatest amount of lumber as quickly and as cheaply as possible, and getting out.

To the south, in the broad-leaved oak-hickory forests of the southern section of Michigan and the adjacent states of Indiana and Ohio, there existed another system, very different in its purpose and organization, but no less destructive of the forests. Broadly speaking, it was a domestic, noncommercial system, and clearing land for agriculture was its prime aim. The farmer took a long term view, clearing the land incrementally in order to grow first subsistence and then cash crops, and, if he was near an urban market or a line of communication, he would enter the commercial world by supplying logs, crudely cut planks, firewood or potash to local wood-using industries, instead of burning his lumber on the cleared fields.

This distinction between the two systems was blurred at times as the pioneer farmer was sometimes a part time lumber man. At either extreme there was a distinction which tended to become clearer with time: the ability of the farmer to compete satisfactorily in the market diminished, as the demand for timber quality and type became more precise and varied, and timber getting and production methods became more capital intensive and expert. This trend is noticeable in the United States after about 1860, but its incidence varied across the country depending on the state of development of the regional economy.

The relatively familiar story of the commercial exploitation in Michigan,[3] is not dealt with here; the focus is on Ohio because it is a good example of the impact of agricultural clearing on the forests, something about which we know very little. The wider implications for the United States of this microcosmic study of Ohio are then considered.

Clearing in Ohio: The Local and National Setting

The broad-leaved, hardwood forests of oak, hickory, elm, maple, and beech associations dominated the vegetational cover of Ohio before the coming of American settlers in large numbers, in about 1790. One can say confidently that somewhat over 95 percent of the state was forest covered, the only extensive areas of open ground being in the bluestem/oak-hickory openings in the south central counties of Logan, Champaign, Clarke, Madison, Delaware, and Licking, and the extensive area of badly drained ground in the Black Swamp in the northwest corner of the state.[4]

In 1800, the population of Ohio was, in round figures, 45,000, and it rose to more than 2 million by 1850, by which date we can say that 9,851,493 acres (3,986,701 ha) of the 24,300,000 acres (9,833,724 ha), or 40.5 percent of the state was recorded as having "improved" land, nearly all of which must have been cleared from the forest.[5] All parts of the state were affected, over half the land being cleared in a broad belt extending through the center of the state from Cincinnati in the southwestern extremity to the Pennsylvanian border in the east.[6] With 143,807 holdings in existence in 1850 the average amount of cleared land per holding was approximately 68.5 acres (27.7 ha), and it stayed fairly constant from then on.

It is possible to trace the extension of clearing across the state for each successive decade from the evidence of the census returns, but the distributions are not really worth showing or commenting about in detail because they merely confirm that clearing was denuding woodland in all areas of the state in a more or less uniform manner as settlement extended and thickened. The absolute and incremental changes are shown in table 1.1. They show that the really big depletion came between 1870 and 1879 when 3.6 million acres (1,456,848 ha) were cleared.

The simple extrapolation forward of these figures caused great alarm in the state which looked as though it could be totally devoid of timber by the beginning of the twentieth century. The concern was not new, of course, as consciousness of timber depletion had been rising throughout America during the 1860s and 1870s. George Perkins Marsh had written *Man and Nature: or Physical Geography as Modified by Human Action* in 1864, fully one-third of which was devoted to the deleterious environmental consequences of prolonged timber clearing, drawing from examples throughout the world and throughout history. In the next year Frederick Starr of St. Louis extended the warning to the United States, emphasizing the utilitarian consequences of timber depletion on the American standard of living and way of life. In 1867, in neighboring Wisconsin, Increase A. Lapham combined both the environmental and economic views in his report on the *Disastrous Effects of the Destruction of Forest Trees*, which related specifically to the destruction of hardwoods in the southern margins of the state. Lapham also

Table 1.1. Ohio: improved land (in acres: 100,000 acres = 40,468 ha)

	Improved	Inter-censal increment	Improved land as percentage of state	Number of holdings	Improved land per holding
1850	9,851,493		40.5	143,807	68.5
1860	12,625,394	2,773,901	52.0	179,889	70.2
1870	14,469,133	1,843,739	59.0	195,953	73.8
1880	18,081,091	3,611,958	74.4	247,184	73.1
1890	18,338,824	257,733	75.5	251,430	72.9
1900	19,244,472	905,648	79.2	276,719	69.5
1910	19,227,469	−23,503	79.1	272,045	70.7
1920	18,542,353	−685,616	76.3	256,695	72.2

Source: U.S. Bureau of Census

posed the idea that "a country destitute of forests as one covered with them is only suited to the condition of a barbarous or semi-barbarous people." America without forests might be as uncivilized as America before the European came and cleared some of them.[7] By 1870 the Bureau of the Census attempted to calculate the amount of cleared land in the United States, partially in order to decide whether some critical threshold had been crossed,[8] and in the same year William Brewer began to map "The Woodland and Forest Systems" of the continent, which maps finally appeared in Walker's *Statistical Atlas of the United States*, published in 1875.[9]

The pendulum of concern swung back and forth between local (state) and national forums. In Ohio, David Millikin, a farmer of Hamilton, wrote a prize essay for the Ohio Agricultural Society entitled "The best practical means of preserving and restoring the forests of Ohio."[10] Drawing on the 1879 agricultural returns for the state he drew attention to the fact that 14.4 million acres (5.8 million ha) had been "improved," out of the total acreage of the state which was originally almost totally forested. The destruction had arisen from the "small regard, or indeed contempt" with which the pioneers had looked on the forest, an attitude which was the result of long, drawn-out episodes of farmmaking that went back not only to early Ohio colonization but also to the abodes of the ancestors of the Ohio pioneers on the eastern seaboard. The pioneer knew that "as he made war on the woods, so he prospered." However, Millikin was convinced that it was time to make peace: timber depletion was affecting lumber and fuel supplies and prices. In his opinion, the imported supplies from Michigan and Wisconsin would soon either run out or stop as they were diverted to the treeless west then being settled, where people were presumably willing to pay higher prices. In Ohio itself the local climate was being affected by excessive clearing, and the expanding telegraphic and railroad systems were consuming vast quantities of woodland, as were the manufacturers of implements, containers, and charcoal.

Writers in nearly every timber growing state in the north were beginning to voice concern, not only about the agricultural inroads into the forest and the massive depredations made by the lumbering companies, which were becoming

evident in the lake states in particular,[11] but also about the attitude of people in general about the country's resources. Maine had already appointed a commission on forest policy in 1869, Charles Sprague Sargent sounded warnings in Massachusetts a few years later, and in New York, a commission was set up to inquire into the effects of lumbering on the watersheds in the Adirondacks which fed the Hudson and other rivers, and particularly the Erie Canal. No action was taken immediately, but in 1883 further sale of forested state land was forbidden, and the nucleus of the Adirondack State Park was in the making.[12] In Ohio, J. H. Klippart summed up the prevailing attitude as a case of "after the deluge." That, he continued, "is so unmistakeably written upon all developments of these resources as to cause a feeling of regret and sadness rather than a joyous anticipation for the condition in which we are transmitting nature's Bounties to future generations."[13]

It was against this growing mood of unease about the country's resources in the future, as well as the problems of settling the sub-humid plains west of the 96th meridian, that Franklin B. Hough delivered his address on forest problems to the American Association for the Advancement of Science in Portland, Maine, in 1873. There was nothing particularly new in Hough's address on "The duty of governments in the preservation of forests"; it drew heavily on Marsh and many others, but Hough had responded to the sense of urgency that was abroad, and his address caught the right people at the right time. It led some years later to the establishment of the Division of Forestry within the Department of Agriculture, with Hough as the first Agent to the Division.[14]

Federal involvement in forestry matters could now be said to have begun, but the involvement was directed more towards the industrial and lumbering inroads into the forests, and almost ignored the agricultural impacts. The economy and society of the country were still traditionally enough based for people to feel that agricultural expansion was the natural, almost "God-given," order of things, and that it should be encouraged in order to provide the ideal of the self-sufficient family farm. Consequently they did not care, even if they were aware, of the inroads which agriculture was making on the forest cover. Concern did not return until the publication of Hough's article on "The decrease of woodland in Ohio" which appeared in the fourth massive *Report upon Forestry*, edited by his successor, Nathaniel Egleston. The article became widely quoted and was used as a case study throughout the United States, it being, in Hough's words, "a convenient means of studying with some care and in some detail by counties the progress of clearings, and in an inverse proportion the exhaustion of its woodlands."[15]

Ohio: The Causes of Forest Destruction

In Ohio, the degree of devastation revealed by the 1880 census caused an uproar that was clearly documented (if not accurately, at least relatively correctly) by Hough.[16] The newly formed Ohio State Forestry Bureau decided to produce a report based on a questionnaire survey of all "township officials and intelligent

Table 1.2. Reasons given, by county, for forest destruction in Ohio, ca. 1884

Reason by rank	Agriculture	Timber and fuel	Cattle	Fire	Insects	Draining	Cold	Drought	Storm/wind	Total	No rank
1	78	8	2							88	0
2	3	36	17	6	3	4				69	19
3	2	5	26	9	6	1	1	1		51	37
4		1	7	4	9	2	4	2	1	30	58
5			1	2	4	1	4		1	13	55
Total	83	50	53	21	22	8	9	3	2	251	

Source: *Ohio Forestry Report*, vol. 1 (1885)
Note: Many respondents gave only one or two reasons, some more, hence the total number of "reasons" does not add up to any theoretical total. Often one reason was so overriding that no other was offered.

farmers."[17] To the question, "What causes are in operation to produce the waste and decrease of forests in your township?" the overwhelming majority stated "clearing for agricultural purposes" whether to create new farms, to enlarge farm holdings or to enlarge individual fields. It was listed as the first ranking cause in nearly 90 percent of the 88 counties and was a reason in nearly all others (table 1.2).

Timber-getting for construction purposes and for fuel was considered the main cause of destruction in eight counties, five of them in a contiguous block in the iron-producing area of Hanging Rock in the south of the state, i.e., Vinton, Jackson, Pike, Scioto, and Lawrence. Charcoal-getting was also the first-ranking cause of destruction in Belmont and Columbiana, which had numerous local furnaces further upstream along the Ohio. After Pennsylvania, Ohio was the most important iron producing district in the United States at this time, well above its nearest rivals, and its blast furnaces consumed prodigious amounts of charcoal.[18] Timber-getting was also a secondary cause of forest destruction in thirty-six counties and a tertiary cause in five others, and this conforms with all that we know about the interrelationship which existed between pioneer farming and part time timber-getting.

The grazing of sheep and particularly cattle was another important secondary or tertiary cause, often coupled with, and a consequence of, both agricultural clearing and timber-getting. In one case only—Hamilton County—was it a primary cause of destruction and ninety-six percent of the forested area in that county had been felled in order to provide grazing for sheep. Damage by grazing was particularly important in the group of adjacent counties of Miami, Logan, Champaign, Clarke, Greene, and Clinton, and also Pickaway and Ross in the west central part of the state. Here Kentucky stockmen had established themselves in the mosaic of small prairies, barrens, and oak openings in these counties, first as

seasonal graziers and then permanently.[19] It was suspected by some county correspondents that the cattle owners "fired the woods" surrounding the plains in order to obtain more and better pasturage, as in Scioto county, but they were not the only incendiaries; hunters smoked out game and tobacco farmers cleared an acre here and there, but in all cases "reckless hands burn the bush without caring whether the fire is kept within bounds."[20]

The depredations of fire, insects, and the drying out of the soil due to draining were of relatively little importance in number or rank. Similarly, there were only fourteen instances of climatic causes of destruction, such as cold weather, storms, and drought, and none of these ever got above third rank.

There is ample descriptive evidence to bear out these assessments of the causes of forest destruction. For example, the local correspondent in Crawford County in north central Ohio commented on the totality of the original woodland cover and then went on, "its adaptedness [sic] to agriculture attracted attention at an early period. The forest, then the great barrier to progress, had to be cut without regard to value; a portion of the trees felled were split for rail fences, another cut up into fuel, and the rest was burned, for it had no market value then."

Although over 80 percent of the country was cleared, and although

> the woodman's ax is at rest, the forest area is decreasing from year to year, and the condition of the existing forests becoming worse; for the generally prevailing practice of utilizing the forests for pasturing purposes not only prevent a second growth, but injures the older trees by laying bare the roots and thus exposing them to the extremes of heat and cold. Trees, especially beech and oak, are reported as "dying off rapidly".

The process of destruction had gone so far, and timber become so scarce that another correspondent, James Robinson of Polk township in the same county said, "woodland is worth more than cleared land," and similar evaluations were made by many other correspondents.

In Belmont county, fronting the Ohio River near the border with Pennsylvania, the local spokesman bemoaned the "wholesale slaughter" of forest trees: "Hundreds of acres of them are annually cut down and sawed into lumber, large quantities being left on the ground to rot or piled up and burned. The moving cause for the destruction seems to be the desire of land owners to clear the lands for agricultural and grazing purposes, and also the immediate profits arising from the sale of lumber."

Certainly, there were many small-scale local timber-using factories scattered throughout the state. For example, the census of 1870 revealed that 28,500 people were employed in about 4,645 establishments scattered throughout every county of the state.

In Muskingum county, the newly penetrating Baltimore and Ohio Railroad had seemed to unleash a "mania for buying woodland, stripping it of its timber and then selling it for what it will bring for agricultural purposes." Mr. John English of Union township, Auglaize County, had no doubts about the cause of

Table 1.3. Number of acres improved in forested and non-forest counties, U.S.A., by decade (in millions of acres: 1 million acres = 404,680 ha)

Date	Forested	Non-forested
By 1850	113.7	?
1850-59	39.7	9.1
1860-69	19.5	19.4
1870-79	49.5	48.7
1880-89	28.6	57.7
1890-99	31.0	41.1
1900-09	22.4	51.6
Total	304.4	227.6 (+)

Source: U.S. Bureau of Census, and M. Primak, appendix table 3.4

destruction; "owners want to cut and sell every thing that will sell at all," he said. Some necessity but mainly plain greed were the causes of forest destruction. The construction of railroads was providing a ready market for some farmers, but even putting aside these special local demands, agricultural clearing was dominant and "the trees seem to be looked upon as cumberers of the ground, to be cut down and got rid of as soon as possible."

Ohio: The Consequences of Clearing

The indiscriminate clearing of steep slopes and poorly developed soils led inevitably to erosion and the permanent destruction of the land. This was particularly true in the dissected and hilly country of the Allegheny Plateau of the southern portion of the state. When the hillsides of shale in Pike County were stripped of forest and cultivated they quickly eroded and "soon become a nearly desert [sic] as any lands in the State ever become." Lowland and valley bottoms were cropped continuously for fifty years in Greene County and total exhaustion of the soil was the result.

To the question "Has the clearing of the forests had any noticeable effect upon the climate, soil and water supply?" 381 people replied in varying degrees of detail, ranging from a fairly typical reply, such as that from Mr. E. B. Smith of Colton in Henry County, "Yes; warmer, less rainfall, and more productive soil," to the extended consideration of John S. Patton of Hill Fork, Adams County:

> Yes. Very perceptible, especially on soil and water supply. Streams that twenty-five or thirty years ago were fair mill streams are now worthless for that purpose, rise rapidly and run out in a few hours. Thirty-five years ago this township had four grist and saw mills run by water, while none exist at present. The soil

> washes a great deal more than it did a number of years ago. On rolling or hilly land the farmer must be vigilant or his farm will be cut to pieces by washes. The climate is different, which I attribute to the clearing away of the forests.

In Belmont county the correspondent ventured to suggest that the losses to the environment were beginning to outweigh the gains in new farmland, and that the adoption of more scientific farming would bring far more profit than extending the area to be farmed by new clearing. In Columbiana county, a Mr. J. Jenkins of Winowa spelt out the arguments more forcibly:

> We have gained pasture and farming lands on the hills. We have gained in the aggregate productions of the region and in population by extending the cleared land. On the other hand, we have subjected ourselves to cloud-burst on the naked hills, which once drank in the descending floods in the porous woodland soil, but now the solid compact hill-sides throw off the floods into the valley, at times an irresistible torrent, carrying destruction and death in its course. We have lost in the untold destruction of untold millions of feet of lumber, sold at prices low compared with present rates. . . .
>
> When we consider also the fact that as a result of our interference with the restorative operations of nature, we have stamped out all prospect of the renewal of the forest-growths by close pasturing and continuous ploughing; it is, indeed, a question whether we have not lost instead of having gained by the change.

Of the 381 respondents, only 25, or a mere 6.7 percent, denied that clearing had had an effect. The practical farmers were convinced that a deterioration had set in, and that it was largely due to their own forest felling. Whether this was the result of long and hallowed folklore, or independent observation, or the extended propaganda campaign of nearly twenty years duration by people like Marsh, Lapham and Millikin, we do not know. But it is ironical that at a time when it seems that the message of exclusive clearing had finally disseminated through the farming population and had become accepted by them, the experts' and the propagandists' attention was being diverted by the activities of lumbering, and by the campaign to plant trees to increase rainfall on the plains.

Ohio: Clearing after 1880

After 1880 the rate of clearing slowed down (table 1.1). From a total of 18,081,091 acres (7,317,055 ha) cleared by that year, the total rose by only a mere 257,733 acres (104,299 ha) by 1890. During the subsequent decade the amount cleared rose again to 191,244,472 acres (7,787,852 ha) by 1900, a level of cleared land that was never to be equalled again because the total fell slightly to 19,227,669 acres (7,781,053 ha) in 1910 with the reversion of many fields to forests.

The pattern of change between 1880 and 1910 was very clear cut. Nearly every county east of a line drawn south from Lorain on the Lake Erie shore experienced

some decline in the amount of cleared land, that is to say, large areas reverted to forest. The greatest declines were in a group of fifteen adjacent counties in the northeast of the state, most of them in the hinterland of the lake-side industrial towns such as Cleveland and Ashtabula but stretching as far south as Zanesville in their southwestern corner and Wheeler in their southeastern corner. Here a total of 482,995 acres (195,458 ha) of farmland was lost to cultivation, some taken over by industrial and suburban development but most reverting to forest. Further south and west was another group of counties—Muskingum, Morgan, Perry, Hocking, Vinton, Athens, and Pike—which together lost 91,860 acres (37,173 ha) of cleared land, while in the hinterland of Cincinnati three counties lost a total of 19,151 acres (7,750 ha) of land, again largely due to suburban development.

In contrast the proportion of land cleared increased as one moved westward, but more specifically northwestward. A broad belt of land across the center of the state had up to 10 percent more forest land cleared; thirteen counties a little further northwest had up to 20 percent more forest felled, and in a triangular area across the extreme northwest corner of the state in what was once the badly drained Black Swamp (a mixture of marshes and scrubby beech-maple forests), nine counties had up to 62 percent more land cleared, to make them some of the most open areas in the state. By 1910, after which new agricultural clearing is minimal, Ohio could be divided into half by a north-south line running very nearly through the center of the state. To the west of the line over four-fifths of the land was cleared, and most of it placed in crops; this was part of the Corn Belt.[21] To the east between half and four-fifths of the land was cleared, but generally the forests and woodland accounted for a greater proportion of the land than in the west. Only two counties—Scioto and Lawrence—in the southernmost tip of the state had less than half of the land cleared. A century of agricultural advance and clearing had left its mark.

The Wider Implications

The 1885 survey of Ohio was unique, and, as far as is known, was not repeated for any other state. But the method of assessing the amount of land cleared by county can be applied throughout the country. If the counties of each state are divided into predominantly forested and non-forested, and the statistics on improvement regarded as a measure of the amount of land cleared or broken up, then we have a way of estimating the amount of forest depletion. The division is, admittedly, a crude one, but it can be assumed that on a state level at least some of the inaccuracies (i.e., non-forested portions of the forested counties and forested portions of non-forested counties) will tend to cancel out each other. Land withdrawn from farms through land abandonment can be subtracted from the new improved land to eliminate another potential source of error.[22]

By 1850, then, there were 113,740,000 acres (46,028,303 ha) of improved land, nearly all of which, except for small clearings, must have come out of forested

Table 1.4. Improved land in farms, by census region, 1880, 1910, 1920 (in millions of acres: 1 million acres = 404,680 ha)

Region	1880	Increment 1880–1910	1910	Increment 1910–1920	1920
New England	13.1	−5.8	7.3	−1.2	6.1
Mid Atlantic	33.2	−3.9	29.3	−2.7	26.6
East North Central	75.6	13.3	88.9	−1.0	87.9
West North Central	61.3	103.0	164.3	7.1	171.4
South Atlantic	36.2	12.3	48.5	0.0	48.5
East South Central	30.8	13.1	43.9	0.5	44.4
West South Central	19.0	39.3	58.3	5.7	64.0
Mountain	2.2	13.7	15.9	14.2	30.1
Pacific	13.4	8.6	22.0	1.9	23.9

Source: U.S. Bureau of Census, 14th Census, 1920. vol. V, *Agriculture, General Report and Analytical Tables.*

land. Therefore, at the very least 100,000,000 acres (40,468,000 ha) represented the culmination of two and a half centuries of pioneering endeavor. Table 1.3 lists the increments for other decades. The relative ease of settling the open prairie (by a time factor of 1:50 or more) after 1880, was indicative of a radical shift of agriculture in the country. While the forest had the advantage of offering the continuation of an old and well-known technology of farm making, the prairie gave quick returns, provided that some capital was available initially for sodbusting and ploughing equipment. After 1880, therefore, some of the pressure to clear the forests for farm land was relieved.

The amount of improved land in farms in the statistical divisions of New England and the mid-Atlantic states showed a radical decline between 1880 and 1920, and the east north central division, which included Ohio, began to show decline after 1910. One can only conclude that there must have been a gradual reversion to forest of some of these acres, although the land actually classed as woodland in farms does not show an increase. In the west central division, a largely non-forested area, the number of improved acres in farms nearly tripled (table 1.4).

Despite the early and excellent census data, reliable information on agricultural clearing is difficult to come by: surrogate measures have to be used. In addition, the forest was so commonplace, so taken for granted, that it was ignored. It was the incidental backdrop to other events like settling the land and growing food; its destruction was the first stage in what was perceived to be the inevitable progression of events as the "waste" or wilderness was converted to farm land. Consequently, the common experience of millions of farmers was largely unrecorded. Wider studies of regional development and economic and social change have subsumed the topic of forest clearing. Not until some critical limit had been reached, made evident by a deficiency of timber or fuel supply, the degradation of the environment, or by the intuitive conviction that some important threshold between the cultivated and uncultivated had been passed, did the urge to record and check become important.

Besides standing as marked contrast with events in the forests to the north, Ohio stood at a sort of locational and temporal crossroads in the history of agricultural utilization of the forest in the United States. Early pioneer settlement in the forest before 1850 was largely a repetition of the pioneer experience of the eighteenth century on the eastern seaboard, but after midcentury a more commercial attitude to farm and forest prevailed, which was characteristic of the larger and newly emerging agriculturally rich region of the Midwest.

2. Trade, Development, and Environmental Change: The Utilization of North America's Pacific Coast Forests to 1914 and Its Consequences

Thomas R. Cox

Spaniards, Russians, Englishmen, and others tapped the forests along the Pacific coast of North America during the early nineteenth century, and indigenous Indian populations did so even earlier, but the forests on which they drew were left virtually unchanged.[1] Even in the areas most worked, such operations resulted in the felling of only a minuscule percentage of the standing timber. Not until the California Gold Rush at mid-century did a lumber industry begin to emerge in the area. Unprecedented demand for building materials combined with exorbitant prices to draw men and capital to the woods. Lumbering was soon a major operation not only along the coast of California but also along the coasts of Oregon, Washington, and British Columbia and to a lesser extent in the Sierra Nevada. Subsequent to the Gold Rush, developments in Hawaii, Australia, China, Latin America, and elsewhere created additional demand—often complementary to that in California. The development of the West Coast's lumber industry was thus intimately tied to events throughout the Pacific basin. Shipments of lumber to the interior by rail did not reach significant levels until late in the century. Even then, the old cargo mills, as those producing lumber for shipment by sea were called, continued to be major factors in the industry.[2]

The rail mills and cargo mills did not greatly reduce the total forest area of the Pacific Coast region, nor did agriculture. Few farms were cleared from the forest, those cleared were of modest size, and most proved submarginal and were soon abandoned to the forest. Unlike many other areas—including the eastern United States—in the far west no extensive areas of forest were brought permanently under the plow. The forests of the area were changed in a variety of ways—developments in the woods and on the farms, and in the larger world affecting both, made the Pacific Coast's forests very different by 1914 from what they had been on the eve of California's Gold Rush. Change was to continue in the years that followed, but forests remained. The story of the West Coast's timberlands is a story not of deforestation but of change. That not all of the change was either beneficial or foreseen goes without saying.

The Area and Its Forests

The temperate-zone forest of the Pacific Coast of North America has characteristics quite different from those of the Atlantic coast, owing primarily to the mountains that closely parallel the coast and a second, higher uplift further inland.[3] Instead of an essentially solid and wide body of timber, as on the Atlantic coast, there are comparatively narrow belts of heavy timber in the Coast Range and on the western slope of the Cascade-Sierra Nevada divide, and less dense forests on their eastern slopes. Forested areas are separated and intersected by alpine areas that are nearly treeless and by intervening valleys with open woodlands or prairies. Various transverse ranges add further complexities. As one proceeds south along the Cascade, Sierra Nevada, and Coast Ranges, the timber stands of this varied coniferous forest become gradually less dense, the species more tolerant of heat and aridity, and the timber more restricted to the wetter and higher westward-facing slopes. In southern California timber stands are seldom found below an elevation of 5000 feet; in northern Oregon the *upper* limit for timber is little more than that; further north it is even lower. From approximately Monterey northward, stands extend to sea level. South of Monterey, Coast Range forests are restricted to increasingly higher elevations, while the chaparral which dominates the foothills becomes more extensive.

The most significant commercial species in the coastal forest of California is the coast redwood, but Douglas fir, Jeffrey pine, and other species are common and dominate inland from the fog belt to which the redwoods are limited. North from the California-Oregon border the species mix changes. Douglas fir is the main commercial tree of the area, but western hemlock, Sitka spruce, and true firs abound. Sitka spruce dominates in a narrow belt along the coast. Port Orford, Alaska yellow, and western red cedar have their individual ranges; each grows intermingled with other species.

In the Sierra Nevada, pines—ponderosa, Jeffrey, and sugar—have been the main commercial species, although in the higher elevations they give way to a forest dominated by Shasta fir. The giant sequoia, for all its size, is too hard to reach, too limited in range and number, and too brittle to be more than marginally merchantable. South of the Lake Tahoe area, the eastern slopes of the Sierra Nevada are so dry as to be virtually treeless in all save a few spots where juniper-piñon woodlands are found. From the vicinity of Lake Tahoe northward, pines extend further and further down the eastern slopes until they form significant commercial stands in the northeasternmost counties of the state. Significantly for loggers, the precipitous escarpment of the east side of the Sierra Nevada is far less pronounced here than further south. Unlike the east side of the range, where for the most part one passes abruptly from forest to desert, in the western foothills a transition zone of digger pine and oak woodlands and/or of chaparral separates the naturally treeless central valley floor from the mountain forests.

In the Cascades, to the north of the Sierra, Douglas fir replaces pine on the westward-facing slopes, although on the drier eastern slope of the range ponderosa pine remains the predominant commercial species. Lodgepole pine, long despised as a "weed" tree, is also common, and in central Oregon western juniper provides a transition woodland between the pine belt and the sagebrush-grasslands of the semiarid interior plateau. When Douglas fir is found east of the Cascade summit, its wood tends to be harder, more brittle, and thus less valuable than that from the west side. As one proceeds northward, increasing quantities of Douglas fir are found on the eastern side of the Cascades, but virtually pure pine stands are found on the lower slopes even in far northern Washington. On the east slope of Washington's Cascades there is also a fairly large area where western larch provides the dominant tree species. As in the Sierra Nevada, in the higher elevations of the Cascades pines and Douglas fir give way to a sub-alpine forest of true firs and associated species. All in all, forest density east of the Cascade summit is considerably less than that west of it; the original stands on the east side often averaged less than one-third of the board feet per acre of those on the west. Annual growth and regeneration rates are also markedly slower.[4]

Like the Cascades and Sierra Nevada, the Coast Range casts a rain shadow. Precipitation in Oregon's Willamette Valley is roughly half what it is on the coast to the west and a fifth of what it is on the higher, westward-facing slopes of the Coast Range. The open prairies natural to much of the Willamette Valley were the product of this relative aridity; being located in the West Coast maritime climatic zone, the area would have been forested if the mountains had not blocked out much of the moisture.[5] Further south, the transition from coastal redwoods to Jeffrey pine and eventually to oaks and grassland is only partially a product of the rain shadow effect; since most of California is in the Mediterranean climatic zone, forests would not extend far inland even if the Coast Range did not exist.

Numerous streams drain the well-watered slopes of the Coast Range, Cascades, and Sierra Nevada, providing access to the limited stand of each watershed but tending to separate one stand from another and making large-scale lumber operations more difficult and costly than would otherwise have been the case. Few passages through the mountains provide lumber from the interior with outlets to the sea or coastal markets. There are also few good harbors. Only Puget Sound offered good anchorages, safe access, and a richly timbered hinterland. Grays Harbor, Coos and Humboldt Bays, and the Columbia River were adequate, but even after extensive improvements less commodious and safe than Puget Sound. Other ports ranged from poor to wretched. Along the redwood coast, sailors referred to the outports where they put in for lumber as "dog holes," presumably because they furnished barely room enough for a dog to turn around in. But bad as these ports were, lumbermen had no choice but to ship from them; mountains blocked coastal mills from access to markets in the Willamette Valley and other places in the interior.[6] Although the timber stands of the Pacific Coast were rich, tapping them and getting the cut to market was no easy task.

The soils of the forested areas of the Far West were not for the most part well suited for agriculture. On the western slope of the Cascades and in the Coast Range they were generally badly leached gray-brown podzolic soils. On the eastern slope of the Cascades and in the Sierra Nevada they were more often thin lithosols; those in the latter range, derived from weathered granite, were especially infertile. The sandy-pumice soil on the east slope of the Cascades in south-central Oregon was even worse: there even the hardy lodgepole pine grew poorly. In western Washington much of the land had been scoured by glaciation during the Ice Age. The soil left behind was generally thin, gravelly, and lacking in fertility. Occasionally, deltas and flood plains provided deep, rich alluvial deposits, but these often required extensive diking and draining to be usable, and in any case were limited in extent and widely scattered. The red and yellow podzolic soils of the Willamette Valley (even though somewhat leached) and the areas of alluvial soil in California's Central Valley had more to offer would-be farmers. Moreover, they supported only scattered trees and so could be brought under the plow with relative ease. Even though settlers commonly assumed that land that could support forests such as they found in the Far West must be fertile, it is nonetheless understandable that it was in the unforested valleys, not on timberlands, where farmers coming to the area first settled.[7]

Utilization and Deforestation

In 1920 the Forest Service estimated that some 62 million (25 million ha) of the original 77 million acres (32 million ha) of forest in the Pacific Coast states remained. Included in these remaining stands were 44 million acres (18 million ha) or more of sawtimber, which represented a far higher percentage of the total stand than in any other part of the country; three-fourths of the acreage supported virgin forests. These figures stood in marked contrast to those for the country as a whole: nationally only about half of what had originally been forestland remained in trees in 1920. Over half of the nation's remaining sawtimber was in the three Pacific Coast states.[8]

Three major factors combined to limit the extent of both forest utilization and deforestation in the Far West. First, the area's isolation long hindered the growth of its lumber industry. Second, ruggedness of terrain limited access to timberland. And, third, the poverty of the area's forest soils and the size of its trees combined to discourage people from clearing timberland for agriculture. Each of these factors deserves further discussion.

With the spectacular growth of settlement on the Pacific Coast during the 1840s and 1850s, utilization of the region's forests rose rapidly. Most significant was the rise in lumber production. The area yielded only 25.9 million board feet of lumber in 1849 but a decade later produced 239 million board feet.[9] However, the forest resources of the region were so vast that the overall impact of this lumbering was negligible. The region's output paled into insignificance when compared with the production in the Northeast, Lake States, and South during the period. Still, in

some locations the effect was great. The redwood forests in the hills east of San Francisco Bay, being readily accessible, were so thoroughly stripped that they never returned to production.[10] Heavy inroads were also made into other small stands located close to centers of demand. Except in such places, logging had little impact on the Pacific Coast's forests until the 1860s or, in most cases, much later. The population on the West Coast was still too small to generate sufficient demand to support a major lumber industry, while overseas markets were just beginning to grow. Outlets in the Midwest and on the Atlantic seaboard were unavailable, for mills closer to hand could supply them at prices that entrepreneurs on the Pacific shore could not match.[11]

Distance not only isolated West Coast lumbermen from the nation's great markets for lumber but also served to slow the growth of the region itself and thus the intra-regional demand for wood products. Not until the completion of transcontinental railroad connections in 1869 did the pervasive sense of isolation begin to break down so that a sizable migration might come to the Far West without such abnormal stimuli as the Gold Rush had provided. The impact of the railroad encouraged the flow of investment capital as well as people to California. The economic development that resulted led to accelerating demand for lumber and other products of the forest. When additional rail lines reached the West Coast in the 1880s, they brought even more rapid growth. Initially, none of these lines opened significant new markets in the interior to lumbermen—freight rates were too high and competitors nearer the centers of demand in the Midwest too strong—but by encouraging the general growth of the Far West they helped to usher in a new economic order in which the Pacific Coast's lumber industry was to grow apace.

Developments around the Pacific basin produced markets for West Coast lumber that supplemented those within the region. The emergence of plantation agriculture in Hawaii, the growth of sheep raising and mining in Australia, and programs of railroad construction in China, Chile, and Peru combined with lesser developments elsewhere to provide vital outlets for lumber. Although the distances were great, merchant sail could reach these markets at a reasonable cost. The Far West might be isolated from the markets of the rest of the country, but its lumbermen had found a substitute overseas and their industry could thus continue to grow. The investment capital that was to make this growth possible came not only from the older parts of the United States but also from profits earned through the exportation of lumber by sea and from investors in San Francisco who saw the possibilities of good returns in an industry that had markets both at home and abroad. In short, the growth of modern enterprise in and around the Pacific basin had reduced the isolation of the Far West and made large-scale lumbering possible far earlier than would otherwise have been the case. By the 1880s, the manufacturing of lumber had become one of the West Coast's leading industries.[12]

Rugged terrain was the second major factor limiting the utilization and deforestation of far western forests. It made access to many fine stands difficult at best. For example, not until a railroad reached Bend in 1911 was it possible to log the

magnificent ponderosa pine forests of central Oregon, separated from major population centers to the west by the Cascade divide. Indeed, not until considerably later, when truck logging had been perfected, could many of the region's finest stands be tapped. As already noted, numerous streams drained the western slopes of the Far West's mountains, often through deeply cut canyons. The resulting isolation of the stands within watersheds made the consolidation of operations difficult, limiting the economies of scale that could be achieved. In addition, the ruggedness of the country resulted in tortuous streams, the vast majority of which were unsuited for log drives. In the Sierra Nevada especially, the rivers often descended through precipitous gorges that could be used neither for drives nor for usable routes to the timbered uplands.[13] Finally, much of the terrain was too high for raising crops; farmers could hardly be expected to clear land for agriculture where killing frosts might be expected any month of the year.[14]

These barriers worked less effectively against herdsmen and miners than they did against loggers and farmers. Much of the utilization of the forested areas of the Far West came from the former sources, and the overgrazing and fires that often resulted were for a long time greater threats to the forest than were the logger's axe or the farmer's plow. In 1902 the Geological Survey found that during the period of white occupancy fires had burned more forestland in the northern Sierra than there was total acreage; obviously, much had been burned more than once. Many of the fires, investigators believed, were set by sheepherders—often deliberately, to improve grazing. Fires had been less extensive in the Pacific Northwest. In western Washington approximately 12 percent of the forest had been logged by 1902, but 17 percent had been burned over. The Yacolt burn and other major conflagrations had raised this figure even higher by 1914. In Oregon, where whites had been settled longer than in Washington, fires had been more extensive. West of the Cascade summit, one-third of the forest had been burned, much so heavily that it was not restocking itself. Indeed, far more forestland went out of production by this route than through clearing for agriculture. Oregon's worst fires were between 1843 and 1870, before logging became significant in the state's forests. Even the great Tillamook burn of 1933 did not surpass the Yaquina burn of 1846 (apparently set by hunters to drive game), the Nestucca fire of about the same time, or the Coos-Coquille burn of 1868. Although the Far West's mountains limited the inroads of loggers and farmers on the forest, they clearly provided little if any protection against the ravages of fire.[15] Overgrazing, while less spectacular, also plagued vast areas. It was a concern especially in the Sierra, where the growth of ground cover was generally slower than in the Cascades and Coast Range. Concern with protecting sources of irrigation water by limiting grazing in the mountains was a major factor behind the drive for establishment of forest reserves in the Sierra Nevada and southern California ranges.[16]

Woodcutters, who felled trees for fuelwood, were an important group in the Sierra Nevada. Barred from the high country by distance and terrain, they worked primarily in the digger pine woodlands of the foothills. By 1902 investigators found that virtually all of the 364,000 acres (147,000 ha) of woodlands of the

northern Sierra had been culled for firewood. A ten mile wide strip along the edge valley floor had been most heavily cut, yielding an estimated 50 percent of the wood taken. While some digger pine was sawn for lumber, most was harvested not by loggers but by woodcutters serving nearby population centers, steamboat landings, smelters, and other sources of demand. Shake makers were also at work in the Sierra turning sugar pines into shakes that could be transported out from mountainous areas from which logs and lumber could not. Only the lower portions of the better trees were fit to be split into shakes; sometimes none of a tree was, but one could often not tell until after the three had been felled. Unlike the operations of the woodcutters, those of the shake makers were quite wasteful—and what was being wasted was sugar pine, one of the most valuable and versatile of timber species.[17]

In Oregon and Washington, where trees were more widely distributed and populations smaller, the impact of woodcutters and shake makers was markedly less than in California, but farmers did go into the timber to cut trees for their personal needs. Their activity, for reasons not entirely clear, was often decidedly wasteful, unlike that of woodcutters in the foothills of the Sierra. In the Willamette valley a host of tiny mills also sprang up early to meet the needs of local farmers. All in all, woodcutters, shake makers, and the operators of these tiny, local mills were important, if often overlooked, parts of the foresty history of the Far West.[18]

The third major factor shaping the utilization of far western forestlands—the poorness of the soils—has already been noted. But the low quality of the soils had effects beyond the obvious one of limiting the acreage converted to agriculture. Beginning in colonial times, the expenses of clearing farmland had normally been partially, and often entirely, met through the sale of timber, potash, and other by-products of the clearing process.[19] Many communities on the early agricultural frontier were as dependent upon harvesting the forest as they were upon tilling the soil. In New York, Pennsylvania, and elsewhere this dual economic support made possible expansion into areas that were sub-marginal for agriculture alone.[20] But the pattern was not replicated in the Far West, which was settled after the market for potash had ceased to be significant, and where huge stumps raised the cost of clearing while an abundance of timber depressed the price of logs. The costs of clearing the land generally exceeded the combined value of its timber products and the resulting farmland. Although John Minto of Oregon continued to advocate the "family forest farm," the concept never took hold in the Far West and was fast becoming an anachronism elsewhere.[21]

Most of the forestland that was converted to agriculture was in the northern Sierra Nevada, where an estimated 83,000 acres (33,588 ha) of forest and woodland had been turned to crop and pasture land by 1902. In this area the forests were more sparse than in the redwood and Douglas fir forests of the Coast Range and Cascades. Stumps tended to be smaller, too. All in all, farmland there could be carved from the forest at a cost many judged not to be prohibitive. Even so, they were frequently wrong, and many a submarginal farm was subsequently abandoned. Where the balance sheet had been clearer from the beginning, lands had

never been brought into agricultural production in the first place. Only in a few favored locations—such as the Hood River valley, which had ample water for irrigation, good soil, and a climate ideal for orchards—did it prove profitable to clear large tracts and convert them permanently to agriculture.[22]

There were some locations where, although logging did not appear as an adjunct of farming, the reverse did occur. The area around Humboldt Bay in northern California provides a case in point. Lumbering brought settlement to the area and was the backbone of its economy. However, to meet growing local demand, dairying, vegetable production, and similar activities soon sprang up. By the 1880s a sizable export trade in agricultural products from Humboldt Bay to San Francisco was underway. Agricultural development would certainly have been much slower in coming to the vicinity of the bay—or would have failed to come at all—if large-scale lumbering had not first created a large demand in the area for foodstuffs. Even here agriculture made limited inroads on the forest. Most of the land that was turned to farm use, here and at similar coastal locations, had originally been a coastal prairie-scrub mosaic, not timberland.[23]

The poverty of the soils caused problems for lumbermen as well as agriculturists. Many a firm, having removed the merchantable timber, hoped to sell its cutover land to would-be farmers. Doing so would relieve the firms of tax burdens while serving as a source of supplementary income. Believing as did most Americans of the period that forestland, once logged, would and should succeed to farmland, lumbermen confidently anticipated buyers for their cutover tracts. Few materialized, for the costs of clearing the remaining stumps and the quality of the soil had become evident early on. Even active campaigns to encourage farming in the cutover tracts failed to move large numbers of people to take up such land. Lumbermen found themselves still saddled with cutover; and although some hated to let it revert to the government for unpaid taxes, recognizing the added fiscal burdens this would place on the rest of the area's citizenry and the bad public relations this might cause, in the end most did so anyway. Thus, rather than being deforested and then converted to agriculture, most of the cutover land of the Far West remained idle for a time—only to eventually grow another crop of timber.[24]

Economic, Technological, and Political Forces

Utilization of the Pacific Coast's forests was shaped by economic, technological, and political factors as surely as by isolation, ruggedness of terrain, and poverty of soil. Of all of these, the impact of technological change was perhaps most readily apparent.[25]

From the first, lumber producers utilized timber that was readily accessible with existing technology and transportation facilities. In practice this meant that while forests near drivable streams or in the immediate vicinity of communities were affected by logging, those in more remote locations or on difficult terrain remained untouched by lumbermen, if not by others. Initially most demand was met by whipsawing or riving boards in the woods and moving them out by carts, or by felling streamside trees into the water (or close enough so they could be rolled in).

But as both sawmills and demand grew, more sophisticated methods of tapping the forests had to be developed. In the coastal forests, skidroad logging (which utilized oxen for motive power) made timber harvesting feasible as far as two miles from floatable streams. In the 1880s, the adoption of the steam engine for skidding logs extended operations even further from the water's edge. Railroads, splash dams, and flumes opened additional tracts during the late nineteenth and early twentieth centuries, but even then the earlier pattern was still readily apparent: when the United States Geological Survey studied the forests of western Washington in 1902, it found cutover land lining the waterways, while elsewhere the forests remained unlogged. The USGS found even more virgin timber in Oregon than in Washington. There were fewer floatable streams south of the Columbia River, so most of Oregon's forests were still unreached by lumbermen. Out of 4.8 million acres (1.9 million ha) in the Cascade Forest Reserve, by 1903 only 5,589 (2,262 ha) had ever been logged.[26] The acreage that had been cut both north and south of the Columbia had increased by 1914, but the basic picture remained unchanged. Existing technology was still inadequate for removing logs from mountain fastnesses at a competitive price.[27]

The technology of sawmilling also changed. The first mills at Humboldt Bay were so small and primitive that they were incapable of handling the redwoods, the main forest tree of the area, and had to cut Douglas fir instead. Such extreme inefficiencies quickly passed, both there and elsewhere. Circular saws (single, then double or even triple) replaced reciprocal saws as the headrig of mills, only to be replaced in turn by band saws. Gang saws, which did in one pass through a log what formerly had taken several, became common. Steam powered log carriages and countless other improvements were also added to mills. Productive capacity rose sharply with these changes, but so did the amount of investment capital a lumberman needed; optimum mill size increased considerably. Although logs were being brought from ever more distant sites, the economies of scale that came with growth and the increased efficiencies that accompanied the new technology were sufficient to keep lumber prices low and relatively stable from the end of the Gold Rush to the beginning of the twentieth century.[28] The combination of low prices and increasingly large supplies helped prevent a shift to alternative materials, keeping demand up and increasing the drain on the forests beyond what it would otherwise have been.

Changes were also occurring at sea. Larger, more efficient vessels combined with better loading facilities and harbor improvements to keep the cost of moving lumber from mills to maritime markets low. The opening of the Suez Canal, which could not be used by sailing vessels because of prevailing calms and contrary winds, encouraged the shift to steamships that was already underway; this resulted in a surplus of merchant sail, which forced their owners to seek employment in low-paying cargo trades such as hauling lumber and drove down the charter rates for them. During the late nineteenth and early twentieth centuries, the combination of cheap lumber and inexpensive maritime transportation insured that West Coast forests would continue to meet a major portion of the demand for building

materials around the Pacific Basin—a demand that was itself growing as economic development proceeded in Latin America, East Asia, Australia, and places nearer to hand, such as southern California. Moreover, the inexpensive, improved transportation allowed the cargo mills to penetrate new markets in South Africa, in Europe, and on the east coast of North America.[29]

Not all coastal mills were able to participate in this far-reaching commerce. Those located on the smaller harbors could only be served by relatively tiny vessels that could not be made to pay on long runs. Thus, while large mills on Puget Sound, Grays Harbor, and the Columbia were serving distant outlets, the small mills on lesser ports had to depend almost wholly on San Francisco as a market for their cut. Special vessels, such as the steam schooner and shallow draft centerboard schooner, were built to meet the needs of this trade. Even they could not fully compensate for the handicaps under which the mills on the poorer coastal locations operated. Near the end of the nineteenth century, when railroads began carrying increased quantities of lumber to San Francisco and its hinterlands from the interior forests of southern Oregon and northern California, the doom of many of these small mills was sealed. They had lost their single, vital market. The result was increased concentration of production around the better ports and in those favored locations served by through-line railroads.[30]

Other changes were occurring at the same time that these shifts were taking place in the maritime lumber trade. Reduced freight rates joined with declining production in the region of the Great Lakes to open increasingly large markets for west coast lumber in the midwest. Big new mills appeared; existing ones located so that they could ship by rail eagerly joined in the trade. Since demand in the cargo and rail trades was complementary, those fortunate enough to be able to engage in both were especially strengthened by this penetration of midwestern markets. However, since demand in the rail markets was for high grades and quality products, mills that turned to them found it necessary to install planers, dry kilns, and other expensive improvements in order to compete successfully. The result was a demand for investment capital that many of the older West Coast firms had difficulty meeting; control of the Far West's lumber industry thus passed increasingly to men who moved into the area from the Lake States seeking places to put their knowledge of lumbering and their money to work anew. Most notable among these was Frederick Weyerhaeuser, who entered the Pacific Northwest with a huge timber purchase in 1900.[31]

Trade regulations were understandably a major concern to lumbermen whose markets were far distant from their mills. Cargo mill owners in the three Pacific Coast states had long supported a tariff to protect their important markets in California from competitors from British Columbia, where logs and labor tended to be cheaper. By the early twentieth century, a new argument had become important in the protectionist's arsenal: by keeping out cheap Canadian products, tariff barriers would help to conserve American forests because they would make economically possible less wasteful but more expensive methods of timber harvesting and management in the United States. Faced with the barriers that kept them

from the California markets for all but a few years, lumbermen in British Columbia had to depend even more than their neighbors to the south on trans-pacific markets—at least until rapid development in Canada's prairie provinces around the turn of the century opened to them new rail markets of their own.[32]

Reductions in railroad freight rates during the 1890s helped the West Coast's lumbermen to penetrate Midwestern markets. Thereafter rail rates and regulations were an almost constant source of concern and contention within the industry. In the Portland gateway case, producers in western Washington appealed to the Interstate Commerce Commission for the same rates to the Midwest as those paid by shippers in Portland (in spite of the superior river-level route enjoyed by the latter). After months of hearings and maneuvering, the Washington lumbermen won a favorable decision in 1908. Rail shipments from western Washington soon mushroomed in size and frequency. This and similar controversies, including that over tariffs, demonstrated clearly how much the pattern of lumbering on the West Coast was affected by governmental policies and decisions.[33]

Although not so intimately tied to the patterns of trade as were the tariff and freight rate questions, the issues of forest fire control and taxation were nonetheless vital to the industry. Only when legislation had been passed creating mechanisms for bringing the menace of fire under control, and tax laws had been revised to encourage lumbermen to hold their cutover land for a second crop of timber, could conservative forest management practices be expected to replace those of cut-out and get-out. By 1914 great advances had been made toward controlling fires, but the question of taxation of cutover and growing stands continued to bedevil lumbermen and lawmakers alike for several years thereafter.[34]

For all the changes in technology, economic conditions, and laws affecting the industry, certain continuities run through the history of the West Coast lumber industry from the Gold Rush to 1914. Throughout the period, lumbering was an extractive enterprise moving into areas with relatively tiny indigenous populations. Earlier epidemics had largely cleared the area of the sort of preexisting forest dependent local groups that were so severely disrupted when commercial lumbering moved into the Himalayas and various other forested areas. The expansion of lumbering on the West Coast was aided somewhat by the relative absence of opposition from indigenous peoples. At base, however, the course of the industry's development was determined not so much by local factors, such as this, as it was by economic developments far from the points of production. Lumbering provided an excellent example of the export base theory of economic development in operation. Shipments of lumber from producing areas to outside consumers drew capital into the Far West and thus helped to build a modern, diversified economy. Seattle's development is a case in point. Largely dependent initially upon lumbering (either directly or indirectly), the city had by 1914 come to possess a much broader, and thus more stable, base. Resources had been turned into capital through trade, and a modern city resulted. Seattle might have grown in any case, but it seems reasonable to assume that, in areas such as around Humboldt Bay, without the foundation provided by lumber shipments little would have developed.[35]

The contrast between Oregon and Washington offers a useful indication of the importance of lumber exports. Although Oregon had a head start in development, its harbors were inferior and its timber more difficult to tap. Soon after the Gold Rush began, exports from Washington outstripped those from Oregon, enabling the former to surpass its southern neighbor in both economic vitality and population. The greater number and size of shipments made it easier for entrepreneurs in Washington to attract investment capital from California, the East, or Europe. Residents often grumbled about their "colonial" status, in which this influx of capital had placed them, but the fact remained that it had brought development as well as a degree of external control to the local economy. Both the development and the external control were results of the ease with which lumber, long western Washington's primary export, could be produced and shipped. By 1914 Oregon was beginning to follow more briskly in Washington's footsteps, but the greatest years for lumber shipments from Oregon still lay ahead.[36]

Ecological Changes

Inevitably, the economic and social forces unleashed on the forests of the Far West during and after the Gold Rush had a variety of ecological effects. Equally inevitably, these effects were far from uniform across the region. Land in California that was heavily utilized by sheepmen suffered from soil erosion and destruction of range. Some areas slowly recovered, but some seem to have suffered essentially permanent damage. In Oregon's Cascades, where the mountain rangeland had greater resiliency, little lasting harm was done even in areas heavily over grazed.[37]

Fires set by sheepmen to "green up" the range also seem to have had a major impact in California. Below 7,300 feet elevation in the pine forests of the northern Sierra Nevada, repeated burning killed young trees and prevented natural restocking. Vast tracts of one-time pine forest were thus converted to chaparral. Nor was damage from fire limited to California. In the southern Cascades, the Geological Survey found in 1900 that fire opened the way for lodgepole pine to replace hemlock-noble fir and ponderosa-sugar pine stands and, where often repeated, sometimes left barren, treeless tracts. In the northern portion of Oregon's Cascades, the Survey also found that extensive burned over areas were not restocking. Six decades later, they were still not doing so; huckleberries, salal, and other shrubby growth covered the tracts. Of course, not all fires were caused by sheepmen. Loggers caused some accidentally and others on purpose, the latter usually to dispose of slash and thus lessen chances of a major conflagration. When slash fires prevented second growth, their impact was decidedly negative in spite of the preachments of foresters who advocated "light burning."[38]

Like grazing and fires, timber harvesting affected various areas differently. Sugar pine came back poorly after logging. Large logged over areas in the northern Sierra Nevada that once supported sugar pine grew back to ponderosa pine. For the foreseeable future, the latter species seems destined to continue to

dominate in these areas. Elsewhere in the Sierra logging sometimes encouraged the spread of chaparral.[39] In the Douglas fir forests, logging would at first glance appear to have interfered with the normal ecological succession through which Douglas fir as the sub-climax species would give way to a forest of shade-tolerant spruce and hemlock, established in the understory beneath the Douglas fir, where the latter's sun-loving offspring did poorly. By allowing the sun to reach the ground, logging opened up areas for young Douglas fir, allowing one generation to succeed another. But the ecological change may have been more apparent than real. Fire (whether set by hunters, Indian or white, or by natural causes) had once done what loggers now did, opening areas where thick stands of young Douglas fir could become established. In controlling fire, this process had been slowed if not halted. To a degree at least, the ecological effects of logging and forest fire control would appear to have cancelled each other out in the Douglas fir forests.[40]

Economic and technological factors also helped to shape logging's impact on different areas. Noncommercial and inaccessible forests were affected only indirectly, if at all. Sub-alpine forests, digger pine and juniper woodlands, and lodgepole pine stands were hardly touched by the logger's axe—although grazing and fuelwood gathering surely had an impact on them. Even in fine stands of Douglas fir, ponderosa and sugar pine, and redwood, logging's impact was uneven. As has been demonstrated, many stands could not be profitably logged with existing technology and prices; this tended to concentrate timber harvesting, and its ecological effects, in a small portion of the forest. Technological improvements gradually opened more and more land to logging, but in 1914 the majority of the Far West's forestland was still untouched. Moreover, the rise of larger mills and the increasing concentration of operations on the better harbors actually led to a slowing of activity in some of the less favored locations of coastal Oregon and California—and thus to a lessened impact on the forest there that partially counteracted the opening of new stands elsewhere. The upshot of this all was that, while forests around Puget Sound, Grays Harbor, and a few other favored locations underwent major ecological change, most areas were affected little or not at all.[41]

Changing technology not only allowed the harvesting of new stands, it also changed the pattern—and impact—of logging. Bull team logging, horse logging, and their antecedents were far easier on the forest than the steam logging that replaced them. The new technology got out logs faster than had the old, but it was much more destructive of young growth, destroyed most of the poorer trees that would have been left by the old methods to reseed the cutover, left far more slash and debris, and tore up the land more than earlier methods had. With steam engines operating in the midst of the slash and debris that the new technology produced in such quantity, more forest fires resulted from woods operations than before. With more ground fuel, they burned hotter too. The cumulative impact was both immediate and long-range. As Richard White has recently demonstrated, in Washington's Island County steam logging led to a new type of forest, one far less valuable than that which had preceded it. The pattern was repeated elsewhere

in the Douglas fir region, and to a lesser degree, in other areas. A study carried out in 1912 and 1913 convinced the State Forester that "lumber manufacturers in California leave their cut over areas in a condition which renders a second crop doubtful by the great fire hazard allowed to exist."[42]

Steam logging and conditions encouraging cut-and-run logging practices worked together to undermine the quality of the upcoming forest. In 1920, Forest Service officials estimated that second growth would have been occurring at three times the rate it was if earlier logging had been carried out with an eye toward encouraging a second crop.[43] In other words, not just steam technology, but how that technology was used—so called high-ball logging—was responsible for the ecological changes that White noted. Public attitudes, economic realities, and apathetic officials must share the blame with the lumber industry for this state of affairs.

On the other hand, one should not lose sight of the fact that however unattractive the immediate aftermath of steam logging may have been, normally the forest was not permanently destroyed thereby. In subsequent years much of it grew back to be harvested a second time. Indeed, in areas around Port Gamble, Washington, where Pope & Talbot has been steadily sawing lumber since 1854, and on lands around Monterey Bay, California, where lumbering has gone on even longer, loggers have already harvested a third-growth crop.[44] Steam loggers may not have had their eyes focused on the future, but the forest survived to be harvested again nevertheless.

Conclusion

During the early twentieth century both perceptions and rhetoric differed markedly from the picture just presented. The specter of a coming timber famine was widespread. Both among foresters and among the public, talk of forest depletion was common, and many assumed that the Pacific Coast states would soon go largely out of lumber production just as much of the country to the east had earlier. This concern overlooked certain facts. As previously noted, far western forests were not being converted to agricultural use to any significant extent. Moreover, while the Lake States' forests had suffered from the presence of inexpensive, untapped stands in the West and South, stands whose presence had worked to discourage the careful husbanding of the forests around the Great Lakes, by 1914 the same could not be said in regard to far western forests. There were no new forest frontiers where cheap timberland was available to depress prices, and, as stumpage became more scarce and costly to reach, sustained-yield management became more and more rational economically. At the same time, diminished acreage in timber meant rising prices for wood products, increased use of substitutes, and a lower per capita consumption of lumber. Production of lumber reached its peak in 1909 and declined thereafter. The drain on the forests declined with it.[45]

As an inexpensive building material, readily available and easily produced with limited capital and labor, lumber was in much demand during the years of rapid

economic growth during the late nineteenth century.[46] As the economy became more mature, the nation grew less dependent upon such extractive industries. Labor- and capital-intensive operations rose in importance; as they did, the demand for lumber and similar lightly processed wood products declined. This trend was already underway in 1914, but it was to become more evident in subsequent years. In time a new society would emerge in which recreational demands on the forests would loom as large as those for stumpage and in which protection of what some call the forest's "amenity values" would be a more common source of concern than the danger of a timber famine. In short, those bedeviled by fears of forest depletion during the Progressive Era and 1920s were concerned with an issue that was in some ways irrelevant to the world into which they and their country were rapidly moving.

Much of the evidence these concerned citizens gathered on forest depletion was flawed at its heart. For example, the Forest Service's study of timber depletion done in 1920 pointed out that logging was proceeding at nine times the rate that new wood was being grown, and that even second growth was being cut at one-and-a-half times the growth rate. The future depicted was bleak.[47] While it was true that the latter figure was partially the result of a failure to restock cutover lands and of logging practices that had hindered the second growth forest, these data missed the central point. Most of the cut was from old growth timber that had reached a point of relative equilibrium between annual growth and loss through fire, disease, and age. In removing this old growth, the way was opened for a younger, more vigorous forest in which annual growth would exceed the earlier rate. There would be a lag between when the old growth was cut and when the new forest would be producing at its optimum rate; that was inevitable in moving from an unmanaged to a managed forest. But in the long run the change would increase the annual production per acre. What was seen in 1920 as a sign of forest depletion was actually evidence that the forests of the Far West—the nation's largest remaining stands—were entering this transition period.[48]

What was lost to logging in the Far West prior to 1914 was not forestland per se, but virgin forests in which decades of growth were stored. In time second growth forests would emerge that would be adequate to supply the wood needed by a more modern, less lumber dependent society. The ecological changes involved in this shift from stagnant old-growth to dynamic second-growth forests were important, but hardly catastrophic. The real loss was aesthetic, lying in that realm of amenity values that had so little place in the equations of foresters—or of most of society—prior to 1914. And with the passage of time even this loss was muted, for fewer and fewer Americans—increasingly urbanized creatures that they had become—could tell virgin forests from second growth or had any idea of what they were missing when they took their recreation among the latter.

During the nineteenth and early twentieth centuries, the evolving international economy, and the international trade that was its vital link, had been responsible for extensive logging in those parts of the Far West's forests that were accessible

with existing technology at a reasonable cost. Trade had brought a level of lumbering that local demand could never have supported. It was left to future generations of Americans to devise ways of living with the new type of forest that was left behind by this evolution. But forests there still were—and still are today.

3. Philippine Forests and Forestry: 1565–1920

Dennis M. Roth

In recent years some Philippine citizens have become concerned as they have seen their country's forests disappear under the assaults of uncontrolled logging and agricultural expansion. The increasing frequency of devastating floods in the twentieth century and the spread of eroded landscapes are the most serious consequences of Philippine deforestation. The history of deforestation as it unfolded until approximately 1920 and the attempts to control it are the subjects of this paper.

When the Spanish conqueror of the Philippines, Miquel Lopez de Legazpi, arrived in the archipelago in 1565, he found tribal societies with a total population of less than three-quarters of a million people living along the coasts and river valleys near the coasts. The geographers Spencer and Wernstedt estimate that at least 90 percent of the Philippines was forested at that time.[1] There may have been some areas which because of local topographic and soil conditions were covered with various species of tropical grasses. Human action had created other grasslands. Ordinarily, trees will in time succeed tropical grasses unless interrupted by fires, which kill everything but the fire resistant grass rhizomes.[2] If fire continually invades an area, the grass will become permanent, and, if that area is large enough, grass may persist for decades even after fires have stopped because other plants have been completely eliminated. The use of fire in slash and burn agriculture (the most common type in the pre-Hispanic Philippines) and in hunting, created grasslands. It is impossible today to estimate their extent.[3]

The Filipinos, for whom fish was an important dietary item, were concentrated on islands such as Cebu with its long coastline, in the Ilocos region of northwestern Luzon (a thin strip of Luzon bounded on the west by the China Sea and the east by mountains), in the Manila Bay region of Luzon with its winding coastline and the largest lake in the islands (Laguna de Bay), and in other areas where fishing and agriculture could be combined. In the years following the conquest, these regions would continue to grow in population, would become the first to show signs of ecological degradation in the nineteenth century, and would send forth emigrants who would begin to clear the virgin forests of the Philippine interior.

The conquistadores encountered little difficulty in subduing the great majority of the Philippine tribes. Only the more politically advanced Muslim sultanates in Mindanao and the pagan tribes located in the mountain fastnesses of northern Luzon successfully resisted Spanish authority, holding out until well into the nineteenth century. The Spaniards' next task was to consolidate their control, which they did by establishing administrative town centers called *poblaciones* and encouraging Filipinos to settle in them under the watchful eyes of the priests. The

class of Filipino chiefs, who had become the tax collectors and local officials under the new rulers, was persuaded to make this move. Such a change of residence, however, was impractical for the peasantry who had to remain near their fields. The Spaniards adjusted to this situation by organizing the rural population into *barrios* and *sitios* under the jurisdiction of the town centers and having small chapels built in them which were occasionally visited by the parish priests. The priests also promoted the adoption of wet rice agriculture, which had the dual advantage of increasing agricultural production and making the rural population more sedentary. The spread of wet rice agriculture also began the first significant conversion of forest land to permanent agricultural use.

The Spaniards enjoyed less success in some other attempts to reshape the Philippine landscape, however. Soon after the conquest, the crown began to distribute land grants to conquistadores in the provinces surrounding Manila, but most of the small Spanish community showed little inclination to engage in agriculture, preferring instead to live in Manila and speculate in the entrepot trade (known as the Galleon Trade) in Chinese silks, which were brought to Manila by Chinese traders and then transshipped to Acapulco in exchange for Mexican silver. By the mid-seventeenth century those grants which had not disappeared entirely had either been donated, sold, or auctioned off to the religious orders, which became the only agricultural landowners of consequence until the commercial expansion of the late eighteenth and nineteenth centuries. These landed estates, which encompassed nearly half of the land area within a 100 kilometer radius of Manila, were to become important in Philippine history because of their proximity to the capital and eruptions of agrarian unrest on them in 1745 and 1896. The origins of the hacienda system in other parts of the Philippines, however, must be sought in the export revolution of the late eighteenth and nineteenth centuries and not in the Spanish land grants and *encomiendas* of the sixteenth and seventeenth centuries.[4]

Related to the lay Spaniards' failure to become agricultural landowners was their inability to introduce large scale ranching into the islands. In the Viceroyalty of New Spain (Mexico), from which the Philippines was nominally administered, the sixteenth-century ranch was the precursor of the seventeenth-century hacienda which combined both crop and beef production. But in the Philippines, the limited market for beef provided by the small Spanish community and the difficulty of adapting cattle and horses to the tough, unpalatable Philippine grasses frustrated early livestock ventures.[5] Although the running of livestock was important on some of the religious estates and on some of the much more limited landholdings of the Filipino elite, it was not until the nineteenth century that ranching had a large impact in transforming forest to grass. But where ranching did exist, the very toughness of the Philippine grasses encouraged the use of fire to bring up tender, succulent shoots. These fires, like those started by hunters and slash and burn cultivators, must have gradually extended the range of the grasslands by spreading beyond the area of intended burn into inflammable second growth park-savannahs, known as *parangs*, and forest margins.[6]

Because it had few easily exploitable sources of precious metals, the Philippines was a financial drain on the Spanish empire for two hundred years, dependent on an annual subsidy from New Spain to pay those costs of administration not covered by local taxation. For the same reason, the Filipinos escaped the severe social disruption experienced by many Latin American populations.[7] The Spanish community remained small until the late nineteenth century and most of its attention was turned towards the Galleon Trade. Also, the Filipinos, unlike the American Indians, had some immunities to European diseases. Therefore they were able to avoid the drastic population declines that nearly wiped out the American Indians. By 1770 the population of the islands had increased slowly but steadily to about one and a half million or a little more than double what it had been at conquest two centuries earlier. The great majority of the Filipinos still lived near the coasts, while the interior valleys and mountains remained clothed in virgin forest.

According to Marshall McLennan, the period from 1800–1920 was the "great era" of forest clearance in the central plain of Luzon.[8] But if deforestation in some parts of the Philippines progressed at a rapid rate in the nineteenth century, its economic origins must be sought in the eighteenth century when the colonial government loosened its mercantilist restrictions and gradually opened the islands to world trade. In fact, the earliest glimmerings of a new era in Philippine history can be traced as far back as 1745, several decades before the Philippines became an exporter of agricultural products to the industrializing world. In that year an agrarian revolt broke out on the religious estates near Manila, provoked by the orders' usurpation of land belonging to neighboring towns and their decision to alter custom by charging fees for collecting forest products and grazing on unused estate land. A few months later, after the revolt had been put down, members of the Filipino elite in the province of Pampanga, north of Manila, were reported to have usurped large amounts of uncultivated crown land.[9]

Both of these events were more than coincidental land grab attempts. They were very likely the harbingers of a new commercial conception of landownership—in which land was considered a commodity that could be bought, sold, and accumulated like other economic goods. Thereafter, it was progressively stripped of the communal associations it had had in medieval Spanish law and Filipino custom. The commercialization of agriculture not only increased the value of cultivated land but also the frequency with which it was exchanged, thus creating a market in land. It also conferred a speculative value on uncultivated land and encouraged those elements of Philippine society who were in a position to benefit from the export trade to acquire as much of it as they could.

These actions of the Pampangan elite were significant, for their province was the first in which cash crop agriculture took hold. As early as 1700 sugar cane was grown in the province for the domestic market. By the end of the century, when sugar was being exported to other Asian countries and Europe, the Pampangans had expanded out of their traditional homeland in the lower Rio Grande river

valley into the northern uplands, cleared large areas of forest and planted them to sugar cane.[10]

The growing of sugar cane on the religious estates was delayed because enterprising Filipinos naturally preferred land where they did not have to pay rent, but by the second decade of the nineteenth century the estate lands were also responding to the demands of the world market. Before this period, the uplands of the estates were almost totally uncultivated (and presumably forested) because the rent was too high for peasant slash and burn cultivators. But as demand for sugar increased and lands were taken up elsewhere, tenants began to rent these lands, clear them for sugar cane cultivation, and sublet them to sharecroppers who did the actual cultivation.[11] The tenants were usually members of the local Filipino elite or commercially aggressive Chinese mestizos.

Sugar culture exacted another kind of toll on Philippine forests. Sugar manufacture was a voracious user of wood to fuel the crude refining devices known as *trapiches*, and then the steam powered mills which became common in the islands in the second half of the nineteenth century. McLennan reports that as early as 1850 wood had become so scarce in some areas of central Luzon that planters were forced to burn the pulp of pressed sugar cane. So large was this impact that he compares it to the deforestation of England caused by the manufacture of charcoal for iron foundries in the same period.[12]

Until the second decade of the twentieth century more fuelwood than timber was harvested from the Philippine forests. The annual reports of the Bureau of Forestry under the American regime show that most of this fuelwood came from the forests of the central Luzon sugar provinces of Pampanga, Tarlac, and Bataan, and the Visayan Islands of Negros and Panay, where sugar production experienced a remarkable efflorescence in the latter half of the nineteenth century. These records document the subsequent decline of wood fuel in central Luzon as the last stands of trees were cut and the steam mills were replaced by modern and larger gasoline-powered centrals.[13]

In the southern Luzon provinces of the Bikol region and, to a lesser extent in parts of the islands of Samar and Mindanao, the indigenous abaca plant, commonly but improperly known as Manila hemp, was grown and processed into the strong, durable cordage prized for rigging nineteenth-century ships and for use in industrial machinery. Abaca was grown primarily on small farms, unlike the sugar haciendas of central Luzon and Negros, because there were no economies of scale involved in either its cultivation or manufacture. Abaca also had a smaller impact on its environment than sugar cane. Not only was wood fuel unnecessary to process the abaca but trees were occasionally left in the fields to provide some shade for the plant.[14] More important than either abaca's manufacture or its tolerance of some shade were the climatic conditions which it required. Abaca cannot abide a long dry season and must be grown in areas where rainfall is fairly evenly distributed throughout the year. Such a moist environment is unfavorable for the growth of fire-climax grassland, which was the major side effect of land

clearance in drier regions of the Philippines. By the turn of the twentieth century, the Bikol region, although it was densely populated in places, still had some of the best and most accessible virgin forests in Luzon and became the site for several of the earliest long term timber concessions under the American regime.

Other introduced cash crops, although not as extensively planted as sugar cane or abaca, also took their place in the nineteenth-century landscape. In this group were coffee, indigo (until its market was destroyed by the German invention of chemical dyes), and tobacco. (Coconut products, which today are the Philippines' leading exports, did not become significant until the early twentieth century.)

All of these crops, including sugar cane and abaca, have one important characteristic in common: they flourish best on uplands or on sandy, well-drained soils. Until the export revolution, the Philippine uplands had been a refuge zone for slash and burn agriculturalists and pagan tribes living on the margin of or outside of Spanish authority, or as a source of supplements for lowland Filipinos. In the nineteenth century the uplands began to have an economic life of their own. As Norman Owen has pointed out in his study of nineteenth-century Bikol, this new relationship between hill and valley meant that a region's population growth was no longer limited by its own capacity to produce food because it could now buy what it did not grow itself.[15] Consequently, the Philippine population, even in the absence of modern medicine (which did not begin to affect mortality rates until the twentieth century) was able to grow at an average annual rate of 1.5 percent in the nineteenth century, rising from less than two million in 1800 to more than seven million one hundred years later.[16]

As a result of the growth of export agriculture, the growing of rice, the traditional subsistence crop of the Filipinos, also became increasingly commercialized. In 1781 the colonial government, desirous of making itself independent of the Mexican subsidy, instituted a tobacco monopoly. Certain towns were given tobacco quotas and the crops were then sold to the government at dictated prices. Tobacco cultivation was banned elsewhere. Northern Bulacan, parts of the Ilocos region, and the Cagayan Valley of northern Luzon thus became rice deficit areas when they were included within the monopoly. As other regions began to specialize in cash crops, the market for rice was further widened. This demand provided much of the impetus for the colonization of the interior valleys of the Philippines and by the early twentieth century culminated in the virtually complete settlement of the central plain of Luzon.

I have thus far described the causes of deforestation on a general level. I now move to more detailed examination of the process in central Luzon. Fortunately, this is possible because of an excellent history of the cultural and economic geography of the central plain by Marshall Seaton McLennan, the only one of comprehensive scope that has been attempted for any region of the Philippines. The following is a brief summary of some of his research.

The central plain has been the "economic and cultural heartland" of the Philippines for the last one hundred years. It runs north from Manila to the Lingayen Gulf in Pangasinan for about 200 kilometers and ranges from 50 to 60

kilometers in width. It is bounded on the west by the Zambales Mountains, on the east by the Sierra Madres, and to the northeast by the Transverse Caraballo Mountains.

Today its landscape "consists largely of rice paddies, fields of sugar cane, and grasslands, seldom interrupted by a fence of any kind, with here and there some bamboo groves or sparse scrubby vegetative growth." Before the era of extensive land clearance, there existed four distinct forest types in the plain. Mangrove forests grew along the coast and in saline swamps. Because of their economic value for producing firewood, charcoal and tannic acid, they had largely disappeared from much of the region by the mid-nineteenth century. Farther inland flourished the nipa trees, which were adapted to brackish water, although they could also grow in fresh water. In 1911 the northern margin of Manila had at least 18,000 hectares of nipa, extending inland for about 5 kilometers. In 1819 the Spanish writer, Ildefonso de Aragon, said the stands were as much as 13 kilometers wide. They too have largely disappeared. Beyond the mangrove and nipa swamps, in areas not reached by tidewater but containing standing water, was the home of the tall plump stemmed buri palm. As late as the 1950s there were still some large stands of buri in Pampanga until they were opened to homesteaders. According to McLennan, the buri "remains endemic to much of the Central Plain today despite the increasing soil dessication that has accompanied deforestation."

Reconstruction of the fourth zone running from the central depression of the plain to the mountains is more difficult because the original vegetation is gone and documentary evidence is nonexistent. McLennan argues, based on knowledge of the climatic and edaphic requirements of Philippine forest types, that it consisted of open stands of hardwood molave trees where the dry season was pronounced and a modified molave or even a mixed dipterocarp (a family of softer-wooded trees) and molave association in better watered areas near the mountains. Because the grasslands in the mountainous margins of Nueva Ecija were large at the turn of the twentieth century, McLennan believes that it is quite possible that some of them had been created by shifting cultivators in pre-Hispanic times.[17]

At the end of the eighteenth century only the southern and northwestern fringes of the plain had been settled by lowland Filipinos. In the late seventeenth and early eighteenth centuries, Augustinian friars had established missions for converting Ilongot tribes near the Caraballo Mountains in what is today eastern Nueva Ecija. Faced with a shortage of priests, the Augustinians abandoned these missions over the next hundred years. When the Ilongots returned to the mountains, grasslands and second-growth forests took over the crop lands, adding to the amount which may have been there since the conquest. The interior of the plain was inhabited by scattered refugee populations but because their numbers must have been small, McLennan believes their impact was limited to the creation of second growth forests. Such was the situation in central Luzon until a relentless pincer movement converged on its forests: commercialized agriculture and ranching from the south, and mass migration from the Ilocano provinces to the north.[18]

During the nineteenth century, sugar cane culture made its way throughout the

sandy soils of Pampanga into the northernmost part of the province, which is today Tarlac. Here it met a predominantly wet rice zone in Pangasinan, which the expanded market for rice was pushing eastward. Sugar cane cultivation was under the control of the Filipino elite and Chinese Mestizos, who had begun sugar cane cultivation in the early eighteenth century. This movement was gradual (unlike the extremely rapid opening up of the virgin forests of Negros to sugar cane cultivation) because the planters of Pampanga acquired most of their lands from debt ridden peasants or down-on-their-luck landowners, who had already cleared the lands. As a consequence, many of the sugar cane holdings, while large, were scattered and did not form consolidated haciendas, except in certain places, such as Tarlac, where individuals could buy uncultivated crown land.[19]

Ranching, because it is an extensive form of land use, often had a more rapid, albeit more transitory, effect on the central Luzon landscape than sugar cane or rice. Filipinos had always raised some stock in Bulacan and Pampanga, and in the late eighteenth century the monastic-owned hacienda of Buenavista in northern Bulacan had 12,000 head of cattle. In the nineteenth century ranching began to move into the interior of the plain, pushed on by the march of agriculture behind it and fed by the growing demand for beef in the Manila market. Stock raising was given a considerable impetus in the 1850s when the crown granted extensive tracts of land in northern Nueva Ecija and eastern Pangasinan to several Spaniards, the first such grants made since the seventeenth century. Spaniards and some Filipinos were also to buy large amounts of land from the public domain at modest prices. Together, these grants and purchases led to the formation of consolidated estates which were stocked with cattle because of an absence of labor to cultivate them. The livestock frontier came to an abrupt end in the 1880s when settlers began to populate the estates and a rinderpest epidemic devastated the herds. Although the frontier had existed for only a few decades, it had done its part to eliminate forest land. Often a vista of grass and *parang* greeted the settlers who poured onto the estates and the areas surrounding them after the end of the wars of independence.[20]

The spread of tough-rooted, nitrogen-depleting grasses was more than just an obstacle to the plow. They were a favorite breeding place for locusts, which along with the rinderpest epidemic, caused much suffering for the central Luzon peasantry from the late nineteenth century to the second decade of the twentieth when the grasses began to be plowed up. The town history of Paniqui in central Tarlac reported locust plagues in 1804, 1805, 1809, 1815, 1839, and 1865, which McLennan takes as an indication that this region had some of the earliest grasslands on the plain.[21]

Despite the amount of grass and *parang* created by the ranchers, credit for forest clearing in the interior of central Luzon clearly belongs to the Ilocano migrants. During the eighteenth century, the Ilocos Coast, already well settled at the time of the Conquest, had one of the fastest rates of population growth in the Philippines. By the nineteenth century, population pressure, environmental degradation, the tobacco monopoly, and the decline of the Ilocos textile industry as a result of the importation of cheap European cloth, began to lower living standards. Many

Ilocanos then set off on a series of migrations which by the twentieth century would take them throughout the islands, to Hawaiian plantations and California farms, and give them the reputation of being the most frugal and industrious linguistic group in the Philippines.

Until about 1820, the Ilocanos had been gradually pushing back the northwestern frontier of the plain, but in the following decades whole communities, numbering in the thousands each year, uprooted themselves, leapfrogged the frontier, and made the trek into the interior. Arriving at a suitable place, they would cut and burn the forest, plant a swidden, move on, or gradually convert it into land suitable for plow agriculture. This movement, unlike those involving sugar cane and livestock, was made up of subsistence farmers. Since the Ilocanos had not brought along any wealthy patrons to support them in times of need, they sought out forest land from which they could derive an immediate subsistence rather than apply themselves to the time-consuming and difficult task of plowing up the grasslands, which were undoubtedly even further extended by their activities. Consequently, the grasslands only began to contract in the early twentieth century when the last forests had disappeared.[22]

Although the Ilocanos pioneered in making Nueva Ecija the "rice granary" of the Philippines, the lands they had cleared did not remain long in their hands, for they were too close to large haciendas and the market pressures emanating from Manila. By the early twentieth century, the *hacenderos* had either engulfed their lands or taken them over when the peasants fell into debt. Nueva Ecija, thus, became the province par excellence of the rice hacienda with the highest tenancy rate in the Philippines.[23]

The deforestation of central Luzon adversely affected the population in two ways. At the beginning of the nineteenth century, many lakes and swamps existed; most had vanished a century later. McLennan reasons that the loss of forest cover and the creation of hard pan in the rice fields damaged the water-retentive qualities of the soil, which led to the drying up of the lakes and swamps. In addition to the loss of these aquatic resources, floods grew in severity and frequency with the deforestation of the plain and the surrounding mountains.[24]

The Philippine Grasslands

If the nineteenth century was the great era of forest clearance in only some parts of the Philippines, such as central Luzon, it was undoubtedly the century in which grasslands experienced their most rapid growth throughout the archipelago. When the Americans arrived in the Philippines, they found large expanses of grasslands in central Luzon, northern Luzon, western Masbate, central Bohol, western and central Mindoro, central Panay, and Bukidnon province in Mindanao. Smaller grasslands dotted many of the provinces in the western parts of the Philippines where dry conditions prevailed during the summer months.[25] Because commercial logging was still in its infancy and agricultural land encompassed only about 10

percent of the land area of the Philippines, American foresters naturally fastened on the slash and burn agriculturalists as the main culprits in deforestation. This threat was, in fact, exaggerated. Perhaps this was because Americans, who had seen their country develop the most productive agriculture in the world, abhorred this seemingly wasteful and "primitive" form, or it may also have been the result of not having complete data on land use. They knew that about 40 percent of Luzon was covered with grass, but since other islands were not thoroughly explored and mapped for another twenty years, this figure was projected onto the entire country.[26] When land classification was completed in 1919, it was discovered that only 18.7 percent of the Philippines was grassland, a figure that stayed remarkably stable through 1957, the last year for which I have statistics.[27]

The Americans found the largest grasslands in the mountain provinces of northern Luzon, the home of pagan tribes such as the Kalinga, Apayao, and Gaddang who were slash and burn agriculturalists, and the Ifugao, Bontoc, and Benguet Igorot who practiced a combination of slash and burn and wet rice agriculture on mountain terraces. Most of these grasslands appear to have come into existence in the nineteenth century. The evidence for this assertion is admittedly slender for there exist no land use maps or statistics—only the brief but emphatic statement of a Spanish priest and some circumstantial evidence. In 1788 Father Francisco Antolin, who was familiar with what are today the provinces of Nueva Vizcaya and southern Ifugao, listed some of the lowland "evils" which were unknown to the uplanders. Deforestation was one of those on his list.[28]

A few years before the Father's observation, the colonial administration had begun the tobacco monopoly. When the monopoly was expanded to include the Cagayan Valley and the Ilocos region, which flank the mountains to the east and west, many Filipinos fled into the uplands rather than submit to the coercive measures of the monopoly officials, some to grow tobacco on their own. The mountains had always been a refuge for Filipinos fleeing Spanish authority, but the tobacco monopoly must have substantially increased their numbers. Growing population densities meant that many swiddens were not given sufficient time to become reforested before being cultivated again. Northern Luzon is the home of the Benguet pine which grows in open stands and it is the only forest type in the Philippines which is susceptible to large forest fires.[29] The increasing use of fire in agriculture and stock raising, which became important for some tribes in the nineteenth century, presumably led to the expansion of the northern Luzon grasslands.[30]

In 1831 a new element was added to the equation: Colonel Guillermo Galvey, a Spanish soldier cast in the mold of the conquistadores. Until that year, the Spanish military had operated only on the fringes of northern Luzon, but it now mounted an expedition under Galvey's command which penetrated into the interior of the region. For the next eight years Galvey marched back and forth through the mountains, destroying fields and villages, and becoming in the words of William Henry Scott, the "greatest despoiler of the Igorots Spain ever sent onto the Cordillera."[31] To the extent that he and later commanders forced mountain people

to abandon their towns and wet rice terraces, which were easy targets to attack, and to seek safety in the dispersal of slash and burn agriculture, they also contributed to the spread of the grasslands.

The evidence for the expansion of grasslands in other regions of the Philippines is equally sketchy, with the partial exception of central Luzon. Figures given by Spanish foresters, which cannot be completely relied on, indicate that between 1876 and 1890 the amount of grassland grew by 1,160,000 hectares or 3.8 percent of the land area of the Philippines.[32] If that rate is projected onto the entire century, it would mean that 27 percent of the Philippines had become grass, which is approximately 8 percent more than existed in the early twentieth century. However, it is quite likely that this rate gradually accelerated, and thus the figure for the nineteenth century should probably be lowered to between 10 and 15 percent, which would be consistent with the assumption that sizable grasslands existed in earlier times.

The grasslands appear to have reached their maximum extent at the end of the nineteenth century when they stabilized at between 18 and 19 percent of the land area. Thereafter, for every hectare of forest that was being converted to grass by a slash and burn agriculturalist or other user of fire, somewhere else in the Philippines a peasant was plowing up a hectare of grass.

I believe there are two reasons why the grasslands came into equilibrium. After decades of rapid population growth and land clearing, much of the Philippine forests had already been transformed into farms and grass. Thus, in many cases Filipinos had no alternative but to plow up the grass since the easier alternatives of burning the forest and planting a swidden and then moving on or gradually converting the plot to farmland were now closed to them. Secondly, when modern steam logging was introduced into the Philippines in 1904, American foresters made the decision to clear cut those forests which were deemed to be more valuable for agricultural use. Where this occurred, the land passed directly from forest to field without going through a grassland stage.

In a broader sense the grassland equilibrium was a manifestation of the Philippines' maturation as a producer of agricultural products for the world market. For more than a century the grasslands had expanded as the demands of the market gradually worked their way through Philippine society. By the early twentieth century, the Philippines was fully integrated into the world market and many of its lowlands had been settled, thus bringing an end to the era of net grassland creation.

The grasslands have not only been an intermediate stage in the social succession from forest to field. They have also helped to perpetuate traditional labor relationships in the Philippine countryside. Under Spanish law forests belonged to the crown. In practice, the Spanish system of land registration and titling was lax and open to many abuses, but it did manage to prevent all but a very small amount of forest land from passing into private hands. Of course, forests could be cut down and then claimed, but it was often simpler and easier for people who knew how to manipulate the legal system to claim grassland. American foresters complained

that wealthy Filipino *caciques* (a Caribbean Indian term for chieftain) would send their dependents into the forest to make swiddens so that they could later preempt what they alleged was agricultural land.

In 1909 Barrington Moore, a pioneer American forester and father of the distinguished Harvard historian and sociologist, Barrington Moore, Jr., made an investigative trip to the Philippines and reported that Filipino peasants avoided the grasslands because they were always claimed by *caciques*. He urged the colonial government to dispose of these invalid claims so that peasants would not always be compelled to cut down forests.[33] An examination of the 1918 Census reveals that in sparsely settled provinces, landowners had large estates, the great bulk of which were classified as being uncultivated agricultural land but which were most likely grasslands which had never seen a plow.[34] Once the area began to fill up, newcomers would discover that much of the potential agricultural land had already been claimed and would be forced to enter into sharecropping agreements or other forms of dependent tenure with the owners. It is probably no accident that at the turn of the twentieth century tenancy rates were the highest in central Luzon where extensive grasslands had existed and were relatively low in the Bikol provinces where they were very limited in extent. (This also may be one of the reasons why tenancy rates began a sharp climb throughout the Philippines in the second decade of the twentieth century.) Of course, the nature of the crops grown, the degree of their commercialization, and population pressure were also involved in determining tenancy rates and thus the above comparison could not be generalized throughout the islands. Moreover, it must be stressed that the grasslands could not have played this role if the Philippines had not had an export oriented economy, the benefits of which reached only a small portion of the society, making it extremely difficult for the impoverished and illiterate peasantry to contest the claims of their richer and more educated rural overlords.

Philippine Forest Conservation and Management: 1863–1920

The history of Philippine forest conservation and management begins in 1863 when the first bureau of forestry was established. Six years later the Suez Canal was opened, which greatly facilitated passage to the colony. Until then, the islands had been home to less than 2,000 priests, officials, businessmen, and soldiers. Now they began to teem with fortune hunters and office seekers, a few of whom found their way to the new bureau. Native Filipinos, on the other hand, were victimized by this influx of Spaniards, and, as in many other government departments, they were relegated to lower positions in the forestry bureau and were not given the education or training that would allow them to rise to professional status.[35]

The creation of the forestry bureau coincided with a general effort in the second half of the nineteenth century to modernize and reform the colonial apparatus, including the methods by which land was claimed and titled. Under a series of decrees, native Filipinos were enabled at least in theory to obtain title to crown

land, which they had done before largely through the right of occupancy and use. It was the job of the forestry bureau to determine if the lands claimed under the new laws were more valuable for agricultural purposes or if they should remain forested and in the public domain. Historians have found scant evidence that the bureau actually carried out this mandate or had any noticeable effect. In fact, they believe that the new land laws actually helped the wealthy in their quest for even more land.[36] However, an important principle of land management was established, which American foresters gladly inherited later on.

The Spaniards' work in actual forest management was even less successful. By 1870 the island of Cebu had already become severely deforested and eroded. This was due to the expansion of rice, corn, and sugar cane cultivation, as well as to the birth and rapid rise of a timber industry, which was supplying lumber for houses, warehouses, docks, and other manifestations of urban growth. Responding to this threat, the bureau decreed a ban on timber harvesting in Cebu but, instead of stopping it, the ban merely stimulated a traffic in contraband timber, which the understaffed (and perhaps poorly motivated) bureau could not halt.[37] Thirty years later American foresters found the densely populated island to be almost completely deforested. The bureau did have more success with a similar ban in the Ilocano province of Abra, which the Americans kept in force.[38] When Captain George P. Ahern began his work as the first American forester in the Philippines, he paid qualified homage to the Spaniards for having introduced the principle of forest conservation to the islands, but faulted them for failing to do much practical work beyond collecting fees for timber.[39]

Ahern graduated from the U.S. Military Academy at West Point—thirty-seventh in a class of thirty-seven. It was perhaps this poor scholastic showing which later in life made him relish the title of Professor of Forestry in the Philippine School of Forestry. After a tour of Army duty in Minnesota where he saw destructive logging of white pine, he was transferred to Montana. In 1884 he began his "formal association" with the conservation movement when he sent a report on a proposed Montana forest reserve to the General Land Office in Washington, D.C. He later visited the nation's capital and struck up a friendship with the German-born Bernard E. Fernow, who had become Chief of the Division of Forestry in the Department of Agriculture in 1886. In 1897 he guided Gifford Pinchot, who replaced Fernow a year later, on a tour of forests in the northern Rockies conducted by the National Academy of Sciences for the Secretary of the Interior. In the same year Ahern was transferred to the state agricultural college in Bozeman, Montana, where he gave courses in military science, and in forestry (in which he was self-taught). Pinchot would later call these courses the first systematic promotion of forestry in the newly-acquired colony.

Ahern served in Cuba during the Spanish-American War. He received a decoration and a leg wound that prevented further active field duty. Consequently, he began to think about turning his part time avocation into a full time profession. When Ahern was transferred to the Philippines in 1898, he and Pinchot had their first opportunity "to advance the cause of forestry" in the newly acquired colony.

Pinchot persuaded the Secretary of Agriculture, James Wilson, to appoint Ahern as a special agent to investigate Philippine forests. On 14 April 1900, the Military Government of the Philippines, which wanted to be assured of adequate supplies of wood, appointed Ahern as the first Director of the Philippine Bureau of Forestry, with responsibility over approximately 20 million hectares of forest. For the next four years he worked with regulations inherited from the Spanish regime, which were admirable in many respects but had been weakly enforced. Lawrence Rakestraw has noted the irony of this event. It came nearly five years before the forest reserves in the United States were transferred from the General Land Office in the Department of Interior, which had little ability or inclination to manage forests, to Gifford Pinchot's Forest Service in the Department of Agriculture, which had a staff of professional foresters.[40]

Ahern's five year lead was short lived, for his bureau had many problems unknown to the Forest Service, which, incidentally, had no formal jurisdiction over its Philippine counterpart. American foresters, who were just beginning to graduate from the new forestry schools at Cornell, Biltmore, and Yale, were reluctant to take on the rigors of life and work in the tropics while their field was expanding at home. Pinchot, his assistant Overton Price, and Henry Graves, the first Yale Forestry Dean, did their best to send him suitable personnel, but some of those who came did not prove to be very capable or else left after a short stint. (A few, such as Grant Bruce, who was sent into an unexplored, rebellious region of Mindanao, accompanied by an old Spanish botanist with whom he could not communicate, must have felt amply justified in making a quick departure.[41]) When Henry Graves visited the islands in 1905, he concluded that it would take a forester at least two or three years to acquire a working knowledge of the relatively new field of tropical forestry, and that it was essential for the bureau to attract a qualified staff with a long term commitment to the Philippines.[42] It was not until 1912 that Ahern could exultantly report that he had received more applications from qualified foresters than he could employ.[43] Despite these problems, Ahern assembled a small but dedicated staff of foresters who did enough good work to earn an eminent Dutch botanist's praise as the most productive group of foresters working in the tropics.[44]

Because Ahern could not at first get enough American foresters and also because he was committed to the eventual "Filipinization" of the bureau, he tried to attract Filipinos who had worked for his Spanish predecessors. However, until 1902 most of these Filipinos were either reluctant to serve in the field where fighting was still going on or had already joined the "Insurgent Government," which had its own forestry bureau.[45] Most of the fighting came to an end in 1902, and more Filipinos came to work for Ahern as clerks, rangers, and forest guards. (The dark skinned, diminutive Negritos, who roamed the forests in search of game and plants, provided valuable botanical help by identifying trees and plants. However, their work was temporary and probably was not compensated.[46])

When Gifford Pinchot visited the islands for three months in 1902 in order to draft a forestry bill (which became the Forestry Organic Law in 1904), he

suggested that Ahern establish a forestry school for Filipinos.[47] Ahern was thwarted in this project until 1910, but in the meantime Filipinos were given on the job training. Barrington Moore described how Filipinos got important practical experience while mapping the forests.

> For the interior of an island they go through lengthwise and cross-wise as many times as is necessary to cover it all, keep trail notes by hand compass and pacing every foot of the way. These notes are plotted on cross-section paper in the field on a scale of 1 to 10,000. The sheets are sent into the bureau and put onto the final map on the scale of 1 to 100,000. The forester who has done most of this work wisely made the rangers keep trial notes themselves. Believing that it is better to have them learn to do it, even though it may not be done quite so well at first, because once they have learned to do it, it is easier to do it right than to do it wrong. He himself examines the forests and collects specimens, sometimes as many as twenty a day. By this policy he is breaking in a force of useful rangers which he turns over to the administrative branch, with the exception of a few whom he retains to help break in the new ones next season.[48]

In the early days Ahern also had some political problems from which Pinchot rescued him on at least two occasions. He was on very bad terms with his boss, Philippine Secretary of Interior Dean Worcester, whom he suspected of wanting to have him replaced with a lumberman from Michigan (Worcester's home state) so that Worcester could further an alleged scheme to derive personal benefit from the public lands. When Pinchot came to Manila in 1902, the Governor-General, William Howard Taft, gave him a "royal" welcome and asked him to patch up this feud. Pinchot was impressed with Worcester, although he seems to have placed some credence in Ahern's charges. His work on the forestry bill, which required mediation between Ahern and Worcester, settled a problem which had threatened a premature end to Philippine forestry.[49] (Ironically, President Taft was forced to fire Pinchot in 1910.)

In 1905 Pinchot used his influence to forestall the first of several attempts by Filipino politicians to transfer forestry to the Department of Agriculture. In the United States the transfer of the forest reserves from the Department of Interior to the Department of Agriculture was a step forward for forestry because it took them out of the hands of unqualified political appointees and placed them under the care of professionals. In the Philippines such a transfer would probably have had the opposite effect for, with the vast American market opening up to Philippine agricultural products, there would have been tremendous pressure to open up the forests to immediate settlement and cultivation. An agricultural official writing in 1918 must have sent shudders down the backs of foresters when he predicted that the Philippines could support a population of 80 million if all the lands were opened up.[50]

On the other hand, Filipinos could not be faulted for a failure to show a whole-hearted commitment to conservation. (Worcester did so but he was always anxious to produce evidence of the Filipinos' supposed incapacity to govern

themselves.[51]) Americans were coming to a country which was still nearly 70 percent forested. It had taken the Americans themselves decades to face up to their own forest problems, so little more could be expected of the Filipinos, especially since most of the signals coming from the United States were telling them to expand their agricultural production. Moreover, some Filipinos were afraid that the bureau was preparing, in Taft's words, to let American capital "spring on the forests," which might further dim their hopes for eventual independence.[52]

Pinchot suspected that Ahern's difficulties with Filipino politicians were symptomatic of deeper problems in the bureau. Pinchot was immersed in the task of administering the forest reserves (renamed National Forests in 1907), newly acquired from the Interior Department, and he could not get away to visit the Philippines again. Instead, he asked his college friend and first forestry disciple, Henry Graves, then Yale Forestry Dean, to investigate the situation. Graves sailed to the Philippines in September of 1905 and, like Pinchot, spent three months in the islands. Upon his arrival, he discovered that the bureau had serious administrative and public relations problems. In a report to Pinchot, he quoted a saying common in the Philippines that if there were another revolution, it would be the Bureau of Forestry's fault. Graves found the bureau's work to be bogged down in red tape, with little real communication between the Manila office and the field. Morale was low, which Graves believed was responsible for the heavy turnover in personnel that had been crippling the bureau's effectiveness. Bureaucratic delays had prevented many people from making legitimate use of the forests, and when they did, they were often assessed fines for minor breaches of the rules. (Graves must have had a feeling of deja vu, for similar problems had afflicted the U.S. forest reserves before their transfer to the Forest Service.) He candidly told Pinchot that he could no longer recommend Philippine service to his Yale forestry graduates until these problems were solved.[53]

Graves proposed that Ahern institute a regular system of field inspection, similar to the one used by the Forest Service, which he did. Soon thereafter, the bureau also began to hold an annual week-long conference of foresters, which proved to be a great morale booster and quickly became the biggest event on the bureau's calendar.[54] Here they discussed common problems and thrashed out solutions. After meeting with their peers, the foresters returned to the relative isolation of the field, refreshed, stimulated, and better able to face another year of often frustrating work.

Graves also criticized the bureau's practice of collecting fees charged for the use of the forests. He strongly recommended that this task be taken over by the Bureau of Internal Revenue, which was done a few months later in legislation passed by the Philippine Commission. (Ahern had also wished to do this but apparently Graves' advice was needed to convince the legislators.) Divested of its revenue-collecting function, the bureau could now concentrate on managing the forests.[55] This change temporarily had a bad effect on staff morale because it resulted in the discharge of many rangers, guards, and a few foresters who were no longer needed. But in later years the bureau would date the real beginning of Philippine forestry

from the passage of this legislation. Another clause opened up the forests to free use by Filipinos for a period of five years. Foresters never admitted that this was a beneficial feature of the law, but it seems that it had been necessary to defuse the anger which had been building up against the bureau.

Once the political and administrative difficulties had eased, the bureau confronted the problem of how to manage the tropical forests about which virtually nothing was known. When Pinchot's travels took him beyond the tangled second-growth vegetation near the settled areas, he was impressed by the similarities between the virgin forests of the Philippines and those of the southern Appalachians of the United States. Of course, he observed the extremely thin humus layer on the forest floor, the much greater number of tree species, and the complete lack of knowledge about how they reproduced, but he came away reassured that the basic principles of forestry were the same the world over.[56] In 1909 H. N. Whitford, who later became a noted tropical forestry professor at Yale University, echoed Pinchot's observations: "Stripped of their showy forms the tropical forests of the Philippines are more nearly like temperate forests than they are different from them. In temperate regions, generally speaking, the nearer success that mature forest growth attains, the simpler the arboreal composition. From the above the conclusion can be drawn that in this respect tropical virgin forests are like those found in temperate zones."[57]

However, Whitford's qualifying phrase, "in this respect," was important for it undoubtedly represents the growing awareness that the conditions promoting forest reproduction in the Philippines were much different than those in the temperate zone.

During the first four years of the bureau's existence, this was not a pressing concern. Lumbering was done by man and water buffalo, which could not take out trees much larger than 50 cm in diameter.[58] The hardwood molave and narra species, which could withstand the gnawings of the ubiquitous white ant, were preferred and in many places had been completely culled out of the forests. On the other hand, trees of the dipterocarp family, which made up at least 75 percent of the Philippines' forest bulk, were rarely cut except for firewood. Timber harvesting carried out by these means could be somewhat destructive but seldom devastating. Moreover, the cost of transporting logs to the five or six small sawmills in Manila (the only ones in the islands) was often prohibitive. In 1917 Ahern summarized the general conditions that he had found seventeen years earlier.

> We found in the Philippine Islands, in 1900, vast stretches of unmapped and sparsely inhabited forests, which contained a large number of unknown and non-merchantable tree species. The country was blessed with a fine tropical climate very favorable to plant growth, fertile soil, and vast areas of virgin and second-growth forests. No effort had been employed to make any use of these great forests. Communities living in sight of virgin forests imported lumber from abroad. Near such forests were people living in houses of thatch and bamboo. The main reason for this nondevelopment was the great lack of transportation. Far from making any commercial use of the forests of these

> regions, the principal industry of the inhabitants seemed to be forest destruction by a system of shifting agriculture.[59]

Some Philippine foresters may have preferred to have seen this situation continue for some years until they could learn more about the forests, but the bureau was under pressure to produce revenue in order to justify its existence to a frequently skeptical colonial government and legislature. In addition, Ahern had dreams of making the Philippines the lumber emporium of the Far East, which would supply markets throughout the Pacific basin. That meant attracting as many lumber companies as possible to the forests and offering them terms that would give (some would have said guarantee) them a good profit.

Barrington Moore, who believed that long term concessions were being given on "ruinously favorable terms," thought he saw some deferred good in the rapid opening up of the Philippine forests.

> In utilizing the forests the most astounding progress has been made from a lumbering point of view. From the silvicultural point of view, it is unfortunate that conditions have forced the bureau to open up the forests so rapidly before more was known about how to cut them. But, considered broadly, the opening of the forests, though perhaps not such a rapid opening is the essential preliminary to their future management, without which nothing can be done, so that the amount of loss suffered in the beginning will be more than repaid in the end.[60]

Modern logging began in the Philippines in 1904 when the Insular Lumber Company was granted a twenty year renewable concession to log approximately 300 square kilometers of rich dipterocarp forest in northern Negros. This was an ideal site, for it was located on the coast, close to a large labor force that worked on neighboring sugar haciendas. The president of the company was W. P. Clark, who was also a prominent manufacturer of sawmill equipment in the United States. Thus, from the very beginning it had the best equipment, the equal of any found in the Pacific Northwest of the United States. By 1911 its sawmill could turn out 300 cubic meters in 10 hours. Its 18 American and 800 Filipino and Chinese employees had at their disposal 9 miles of logging road, 4 Shay-geared locomotives, 30 Seattle Car and Foundry Company logging cars and 7 Washington Iron Works steam donkeys.[61] Because it was the most advanced logging and milling company in the Philippines, it quickly became the leader in introducing dipterocarp lumber (mistakenly called "Philippine mahogany") to the world market. It also introduced a phenomenon which had been unknown in the Philippine forests (except those composed of Benguet pine)—fire in the woods. In 1912 a large slash fire in logged over areas of the concession provoked the bureau into issuing strict regulations governing slash disposal.[62]

Until 1905, the bureau had prescribed selection systems for harvesting timber.[63] Ahern personally had marked trees in the endangered stands of Benguet pine in northern Luzon. But as logging picked up steam and the small force of foresters

was spread thin making marks which were often obliterated in the Philippine climate, selection was dropped in favor of diameter-limit cutting, which foresters call harvesting by volume.[64] In Negros trees below 50 cm in diameter were to be left standing, while in Bataan, where the Cadwallader-Gibson Company was operating, the limit was set at 40 cm. Some sites deemed more valuable for agricultural purposes were clear cut.[65] Barrington Moore thought it was bad policy to clear cut forests that might be opened to settlement only in some unspecified future.[66] The bureau, however, argued that it did not have the funds nor the manpower to manage forests that were slated for eventual extinction.

The bureau, knowing that it was on shaky grounds in setting arbitrary diameter limits, set about investigating the ways in which Philippine trees reproduced. This was a formidable task because, with the exception of the ever-exceptional Benguet pine, they did not have annual rings. To do this the bureau established an experimental forest on Mount Makiling, south of Manila, where growth could be carefully observed. The bureau also sent investigators into logged over areas to check on reproduction. In 1914 this work bore fruit in a bombshell report by William H. Brown and Donald Mathews that upset the assumptions under which foresters had been operating for nearly ten years.[67]

They found that diameter limits of 40 or even 50 cm resulted in the virtual clear cutting of the forests. Barrington Moore, whose two short articles in *American Forestry* gave the best summary and analysis of Philippine forest problems, had questioned these limits four years earlier.[68]

According to Brown and Mathews' research, dipterocarp forests were unlike many of those in the temperate zone in that wood volume was heavily concentrated in the larger trees of the dominant story. When these were cut, the saplings and smaller dipterocarps, which had grown up under the protection of the thick canopy, quickly died as the result of insolation (overheating) while the number of seedlings was reduced disastrously, by a factor of eight. "Inferior" species inherited the site after the dipterocarp forest had been thus "completely and permanently destroyed." (In Bataan a very stable second growth bamboo forest had grown up in logged over areas.) Thus, Brown and Mathews concluded that a dipterocarp forest was a delicately balanced ecosystem that, if upset, could go into irreversible decline. Moreover, they found that above 600 meters in elevation, it would take dipterocarps 380 years to grow from 10 to 40 cm in diameter, thus rendering impossible the sustained yield logging of dipterocarps at high elevations. Brown and Mathews elegantly summarized the dilemma facing foresters in the Philippines where lumbering and silviculture were as inextricably intertwined as the tangles of a second-growth tropical forest. "We find the problem to be that of removing within the shortest possible rotation a large amount of accumulated wood capital which is not producing, but is perhaps deteriorating due to fungus and insect attack and which is, nevertheless, so integral a part of the forest that its removal endangers the very existence of the forest."[69]

The bureau immediately recognized the value of Brown and Mathews' work. Referring to the large concessions, the 1914 annual report said:

> When such areas are logged over by steam, a large percentage of the crown cover is, of course, destroyed and the young seedlings of most of the desirable species are unable to resist the intense insolation to which they are so suddenly exposed. . . . Thus it is that reproduction on the areas now being logged over under intensive methods is decidedly unsatisfactory. In those areas in which land thus logged over is to be put to permanent agricultural uses no difficulty exists; but in certain areas held under exclusive license agreements the land by its soil characteristics or topographical configuration is suited only for permanent forest cover, and it is on such areas that the Bureau has spent and will spend its principal efforts to arrive at some satisfactory solution.[70]

I am unable to say from the available evidence to what extent the bureau was able to solve this problem during the next few years. In some places foresters went back to selection systems. But, I believe, it can be safely asserted that in the first two decades of its existence, the bureau was not able to practice the kind of sustained yield forestry found in the U.S. National Forests. Instead, its work had resulted in intentional and unintentional clear cuts (at least on the large concessions which by 1920 took at least half of the cut), which were then opened to settlement, and the protection of other areas which were not heavily logged.

Of course, foresters in the Philippines had much greater obstacles to overcome than their counterparts in the United States. With exports beginning to boom under the stimulus of free trade with the American market, there was great pressure to open forests to settlers, while in the United States agricultural expansion was coming to an end by the time the Forest Service began in 1905. In addition, because of the warmer climate almost any forested area in the Philippines was potentially suited for some kind of agriculture, whereas in the United States land above certain elevations could not be forced to yield crops. And, as if that were not enough, U.S. foresters most often worked with coniferous trees, such as the Douglas fir and southern pines, that could not tolerate shade and actually required clear cuts in order for their seed to sprout and grow in mineral soil.

Between 1900 and 1919, the Philippines' forest cover dropped from about 70 percent to 67 percent of its land area.[71] How much of this loss was due to the bureau's opening up the forests to steam logging is impossible to determine, although it was surely less than 1 percent. On the other hand, the bureau undoubtedly protected other forest lands, which would have been cleared if it had not been around to protect them.

But there was a more ominous problem than the choice of silvicultural techniques, which was just beginning to appear on the forestry horizon. In the early 1920s, at a time when the export of Philippine wood products was just going into high gear, Forest Service Chief William Greeley warned foresters that the successful practice of forestry depended on a favorable economic environment.[72] In the United States, Greeley saw this coming about because internal industrial demand was pushing up the prices of wood products, thereby creating economic incentives for the conservative use of the nation's remaining forests. On the other hand, the

Philippines, after three and a half centuries as a colony of Spain and the United States, was not developing a strong internal market for its wood products. Consequently, there were no economic incentives which might have counteracted the growing demands of the world market. Sixty years later, the lack of real economic development in the Philippines would, tragically, bring its forests to the brink of extinction.

4. Deforestation in Southeastern Brazil

Warren Dean

The subject of study is a single vegetational climax: a forest that once covered some 500,000 km² of southeastern Brazil. It may be designated the sub-tropical Atlantic coastal forest. It occupied most of what is now the states of Espírito Santo and Rio de Janeiro, about a third of the state of Minas Gerais, and four-fifths of the state of São Paulo. Only a few patches of this primary forest remain, and all of them are to some degree disturbed. The rest of the vegetation in this vast area is composed of disclimaxes, mainly grasslands given over to extensive cattle raising. It is not possible that the climax forest will ever reestablish itself in any part of this region, because the degradation of vegetation and soils and the elimination of habitats is extinguishing hundreds or possibly thousands of plant, animal, and insect species, whose places are being taken by cultivated and weedy species of cosmopolitan or pan-tropical origin.[1]

The concern of this paper is ecosystem degradation through human intervention. The forest under study represents an especially serious case of biological loss since it was undoubtedly very complex and presented a high degree of endemism. It was related floristically and structurally to the Amazon rain forest, which is the richest biome in the world, and it was one of the "refugia" to which the neotropical forest retreated during glacial episodes. Its removal occurred almost entirely since 1500, and so historical sources are available which record that process.

The destruction of primary forest is a central problem in the history of Brazil, whose settlement occurred primarily on land once covered with forest. The agricultural regime most widely practiced was an intensification of that devised by Amerindians, requiring forest soils and humus to be effective. Brazil's principal exports—sugar, coffee, and gold—were extracted from land once forested. The region of subtropical Atlantic coastal forest is therefore the most urbanized and industrialized in the country. Only 6 percent of the land surface, it contains more than a third of the population.

This forest is bounded on the north by a tropical forest formation, the tropical Atlantic coastal forest, which has also largely disappeared. On the northwest the forest interpenetrated with the savannas—better described by a Brazilian term, *campo cerrado* ("closed field"), or more simply *cerrado*—composed of grasses, Compositae, and low, scrubby trees. The *cerrado* formation, resulting from a pattern of highly seasonal rainfall, is a fire influenced climax, rooted in a soil often made toxic by ionized aluminum. On the south, the forest under discussion is replaced by a temperate forest formation dominated by the Brazilian "pine", *Araucaria angustifolia* (in fact a more primitive genus of gymnosperm). The region of the forest is, aside from a narrow littoral shelf, elevated and mountainous.

The Archaean shield rises abruptly to 1000 meters, and there are peaks above 2000 meters. Precipitation is caused mainly by seasonal winds blowing inland from the humid tropical south Atlantic. Therefore the coastal escarpment receives the heaviest rainfall, and precipitation lessens and becomes more seasonal in the inland direction. The littoral shelf and the very humid crests of the escarpment possess somewhat distinctive flora, and have sometimes been subdivided into as many as three zones, besides those of the coastal dunes and estuaries. The upland area has also sometimes been divided into evergreen and "semideciduous" zones, according to the duration of the drier season, because farther inland a number of tree species, especially dominants, then shed their leaves. Local flora are influenced to a considerable degree by the characteristics of the substrates. Soils of the Archaean shield are highly eroded and poorer, soils of the Algonquian series are relatively richer in nutrients, and soils on basaltic and diabasic outcroppings are the most fertile. On the higher ridges and plateaus, where drainage is excessive, there are natural *campos*, some supporting a highly diverse and endemic flora.[2]

The forest under study was far more varied than any temperate forest, yet it was probably somewhat less complex than the Amazon rain forest, where as many as 235 arboreal species have been counted on a single hectare. Members of the family Leguminosae probably formed the largest contingent of large trees, and there were many Bignoniaceae, Lecythidaceae, Sapotaceae, Meliaceae, and Laurinaceae. The dominants reached thirty meters in height, though the forest of the ridges and mountain tops, and the drier inland areas, was less tall. Epiphytes, parasites, and lianas were numerous, and especially characteristic of the seaward escarpments and littoral forest. Since rainfall and temperatures are lower than in the Amazon basin, and since soils are generally richer under forest cover, the problem of nutrient leaching was not as great. Laterization of soils was less of a problem than in the Amazon region, therefore permanent cultivation is not impossible or even excessively difficult, considering the region as a whole. Erosion on deforested slopes is the principal danger. There is also a danger of the freeing of aluminum ions in the soil of the drier inland areas when ground cover is removed. This factor has been suggested as the principal explanation for characteristic cerrado vegetation, which is resistant to aluminum toxicity.[3]

Aboriginal Forest Clearing

Amerindians reached the forest about ten thousand years ago. They were hunters and gatherers who appear to have used fire in the region. It has been suspected that this practice extended the range of *cerrado* vegetation, since it is characteristically pyrophilic. The human invasion was coincident with the return to a climatic optimum, so that the net effect of burning by human populations may have been to retard the expansion of the forest. In any case the forest cannot be assumed to have been unaffected by humans, even at this very early date.[4]

About 1500 years ago, the region was invaded again, by a culture, the Tupi-Guarani, which practiced agriculture. They took over sites on the littoral once occupied by the hunter-gatherers, in some cases already abandoned, in others after

some kind of conflict, in which case the latter were driven to less productive highland environments. Even so the agricultural techniques of the Tupi were to some degree passed on to them, or were partly adopted even before the Tupi arrived.

The farming system of the Tupi was swidden, also known as slash and burn or shifting cultivation. The underbrush and the smaller trees of a small patch of forest, perhaps a half hectare in extent, would be cut away during the drier season. It would then be set on fire, killing all but a few of the largest trees, and reducing all the vegetation to ashes that sank into the humus layer with the first rains. Planting was then carried out with a digging stick. Their staple crop was manioc, *Manihot utilissima*, both bitter and sweet, grown in association with maize (limited to the highlands), beans, peppers, squash, peanuts, and other minor crops. Manioc takes up to two years to mature, and may be left in the ground for as much as a year thereafter. Thus the average minimum use of a patch might be three years, but it would then have to be abandoned soon after. If the cultivator persisted, the patch would be invaded by weeds and became unmanageable. Another patch would have to be cut and burned for planting, and the first patch left to grow back to forest. The system required a very large reserve of forest, since a satisfactory second growth took thirty to sixty years, and since the forest provided for the other subsistence needs of the cultivators, notably animal protein.

Swidden is highly productive, from the point of view of the cultivator, because burning makes immediately available to his crops all of the nutrients of the climax biomass, and neutralizes, at the same time, the strongly acidic litter layer of the forest floor. Burning also eliminates all the insect pests, even if temporarily—a very important advantage in the subtropical forest, where herbivorous insects are infinite in variety and explosively and uninterruptedly reproductive. Bird and animal competitors—herbivores inevitably attracted by the plantings—are easy prey of the swidden farmer, so that control of these larger pests is efficiently and cheerfully performed.

However, swidden is also prodigally wasteful of the potential value of the climax forest's complex biotic stockpile. Even so, as long as the swidden farming population remains very scattered, this regime is not very much more disruptive than natural occurrences like tree falls, since abandonment sets in motion the normal processes of succession. Analyses of swidden farming, both present day and historical, have taken human population density, not the forest, as the central object of concern. Therefore, calculations asserting a certain intensity of forest use have assumed a satisfactory degree of ecological homeostasis as long as forest regrowth was sufficient to assure undiminished crop output. It is possible, however, that at some level of human density the primary forest might disappear and be entirely replaced by secondary formations, even though agricultural output might remain steady. This is all the more likely to occur since secondary forest is generally more useful to humans than primary forest: its species are faster growing and therefore invite more game animals, for example. What is being suggested

here is that primitive swidden agriculturalists might be characterized as conservationists at best, not preservationists.

However, the Tupi may have desired, or at least tended toward, maintaining both kinds of forest reserves. They preferred to plant in secondary forest because it was less work to cut and burn. Secondary growth was somewhat less fertile and had to be abandoned more quickly, often after a single planting, because the seeds of weed species were already present in its soil. Although planting in secondary forest therefore involved more labor to cultivate, it was work carried out by the women in Tupi society, who were excluded from making decisions about shifting the patches. This strategy may have permitted the survival of primary forest, even with fairly dense populations. Furthermore, primary forest, though less productive than secondary growth, did contain a different mix of species not to be found elsewhere, and therefore worth sparing. Nevertheless, a preference for burning secondary formations placed a greater stress on limited areas of a tribal group's range, perhaps to the point that grasses and ferns took over in marginal soils.

Intensification of Swidden Farming

Portuguese and French navigators appeared on the Brazilian coast around 1500 and soon began to engage in a trade with the Amerindians based on forest extraction of a dyewood (*Caesalpinia echinata*), called brazilwood, after other red dyewoods native to Asia. The neotropical source plant was a large and fairly common member of mesic (moderately wet) communities in the littoral forest. Brazil, originally the Province of the True Cross, thus came to be named after a tree; characteristically, it is now an endangered species. Logging of a common arboreal species may be expected to damage a quarter to a half of the remaining trees, so that the littoral began to experience further decline. There may have been some other subtle changes on account of speculation in parrots, which commanded very high prices in trade, the rarer the species the more esteemed, and which were important seed dispersal agents in the climax forest.[5]

By 1600, more or less, the Portuguese had expelled their French competitors and subjected the Tupi of the littoral—who had meantime suffered the catastrophic population loss common to all Amerindian groups in contact with Europeans, on account of epidemics as well as warfare. Over the succeeding century the whites established themselves in the highlands of São Paulo. They expanded their hold and numbers and took the offensive against Tupi and non-Tupi groups of the interior. Raids, especially against the Jesuit-run Guarani missions in Spanish territory, netted a constant stream of slaves. The raids had a double effect: they emptied the nearer inland areas of Amerindians, the survivors fleeing to more remote regions and abandoning agriculture, and they gave rise to a mestizo farming population that adapted the Amerindian agricultural regime. The farming the mestizos carried out was for local barter and the supply of the principal towns of São Paulo and Rio de Janeiro as well as for subsistence.[6]

The swidden system was intensified and broadened by the introduction of iron

tools, cultivated exotics, and domesticated animals. The iron ax and machete reduced the labor needed to clear forest, and the iron hoe made weeding in patches reclaimed from second growth more practicable. The Portuguese brought pigs, which could be set to rooting in the forest, thereby solving the problem of lack of protein. Cattle were set loose in the natural *campo* formations, quite separate from the swidden fields, which could not be fenced in, since all the fields were temporary. Wheat was grown for a time, but was abandoned apparently because a local blight infested it early in the nineteenth century. Tree crops, mainly citrus, quince, and figs, remained resistant to local pests and fungi. Bananas and rice were introduced from the island of São Tomé, off the African coast, with great success.

The additions to the native swidden system lessened the utility of the forest, both primary and secondary, to the cultivators, and increased the area which could be kept under cultivation. The Tupi may have cut and burned about one hectare per family per year, while nineteenth-century discussions of swidden practices mention an average 3 hectares, or more if the soil was less fertile. The density of the human population increased in the highland areas occupied by the whites and mestizos, from about one person to three persons per km^2. The employment of the forest was no longer conservationist, if it had formerly been so. The forest came to be burned repeatedly in every dry season until the humus layer no longer supported the regrowth of anything but grasses and ferns. At that point cultivation ceased, cows were set loose on the "pastures," and the farmer moved on to still another forested area, by then unguarded by any but an extremely thin population of Amerindians. The alternative of burning primary forest had become unlimited, and the incentive to preserve it no longer existed.[7]

The resulting population distribution has been described as a hollow frontier, since density of population is greatest along the moving front of forest penetration. It is clear, in ecological terms, that the human population was behaving like a typical invasion species, consuming the output of the highly productive ecotone in a phase of disturbance. Unlike the other species who flock to join them, however, the humans themselves caused the disturbance. Unlike the other species, furthermore, they persisted in this strategy until the habitat was unable to recreate spontaneously the conditions that the humans found attractive in the first place.[8]

Clearly, the persistance of primary forest is a principal explanation of the failure to adopt a more intensive form of agriculture, and the failure to adopt more intensive systems of agriculture was the principal cause of the disappearance of the forest. An inquiry is necessary, however, to demonstrate exactly what were the advantages of swidden compared with more intensive techniques. The question remains problematical.

More intensive agricultural techniques, in this part of Brazil, required a heavy expenditure of labor on countermeasures against the saúva, or leaf-cutting ant. The genus *Atta* is neotropical, occurring widely in mesic and xeric (dry) environments, both forested and open field. These ants collect leaves to form a substrate for fungi which they cultivate in tunnels forty to fifty centimeters deep. The saúva prevented the introduction of many European cultivates, and was the principal

scourge of crops and pastures. Burning of the cultivated patch was carried out at least partly to keep down the ants, but various means were also attempted to attack the ants in their tunnels—flooding, digging, and fumigating—and sometimes other ant species that preyed on *Atta* were introduced. But mostly they were left alone. Once the saúva were firmly established, the field was abandoned.[9] Sedentary farming was mostly confined to lowland, very moist environments which the saúva avoided. Examples are the *várzeas*, or floodplains, of the lower Paraíba do Sul and Muriaé Rivers, and parts of the Campos district of the Paraíba do Sul delta. In the latter, even the plow, an astonishing novelty, was employed from mid-century onward. In spite of the special difficulties posed by the saúva in upland environments, it may be seen to a degree as the consequence of swidden, rather than a cause. Burning eliminated ant competitors and predators, and shifting cultivation, as a technique, failed to stimulate the accumulation of information concerning ant habits that would have made them easier to control.[10]

Although it seems roughly correct to suppose that swidden continued to be employed past the point that it could be maintained on a given tract of land because it represented the most economical use of labor, even that proposition may be questioned. In particular it seems strange that plows were not used, except rarely, until well into the twentieth century. Planting and weeding with the hoe was agonizing work, and a hoe worker could cultivate barely a fifth as much land as one equipped with a plow. It is true that on plots newly cleared of forest the plow could not be employed until stumps and roots had been removed or had rotted. Nevertheless, the greater productivity possible after stump removal would have fully recompensed the effort.

Furthermore, the form that labor intensification usually took, when it did occur in limited areas, was more wasteful of effort than even the hoe. This was the construction of *leiras*, or lazy beds, also called *matumbos, torrões*, or *valas*. Ditches were dug at intervals of a few meters, and the dirt heaped up on the space between, thus forming raised beds, in which manioc, beans, and maize were interplanted. This practice was carried out mainly to dry out soil that was too wet for manioc, but it had the effect of burying stubble and weeds and turning up the soil, just as would a plow. Since the *leiras* were built with hoes, however, they nearly doubled the already excessive labor time needed for planting. It should be noticed that *leiras*, employed only on soggy soils, were less subject to invasion by saúva.[11]

Swidden farmers, furthermore, subjected themselves to inconveniences and dangers from which stable cultivators would have been exempt. Cutting and burning were risky tasks. It was necessary to confront jaguars and snakes—deaths from snakebite may have accounted for 3 to 4 percent of the deaths among immigrant farmers in Espírito Santo. Clearing forest was one of a very few rural skilled specialties, rarely assigned to slave workers for fear that they would arrange seemingly accidental murders of their masters or foremen. The trees were felled so as to pull down as many as possible of their neighbors with entangling lianas, but often the unwary woodsman was crushed. Sudden turns of the wind might also

trap the woodsmen in their own fires. Fire, furthermore, was risky because it might not burn hot enough, wasting the effort and perhaps necessitating a year's delay in planting, or it might burn too intensely, incinerating the humus layer and wasting its nutrients. A sudden gust of wind might cause the flames to destroy more vegetation than was desired. In 1814 and 1815, years of drought, travelers observed fire everywhere running out of control, burning whole leagues of land in Minas Gerais.[12]

Conditions of Agricultural Stagnation

It has been hypothesized that swidden cultivation was the result of a deliberately condoned system of precarious land rights. During the colonial period the crown made usufruct grants, called *sesmarias*, of untitled land to persons who had some social standing, and who possessed the price of seeing their petitions through the bureaucracy (a cost of some 300 milreis by 1800, when 1 milreis represented the wage of two days of hoe labor). Since the grantees usually intended merely to sell, not to work, their grants, the same land was frequently claimed and granted repeatedly, providing infinite employment opportunities for lawyers and civil courts. The independent government abolished *sesmarias*, but never managed to impose an alternate legal means of divesting public lands, so that they were customarily expropriated privately by the squatters themselves—with those commanding the most followers, slaves, guns, and political influence always managing to gain final official recognition of their claims. The rest were evicted or became employees of the new owners.[13]

The expropriation of state property was also an expropriation of the value added by the first occupants, since cleared land was priced higher than uncleared land. The swidden farmer was thus an important element in the expansion of export-oriented plantations, but he had little incentive to make improvements on land that would finally be taken from him, especially since more productive forested land always lay ahead.[14]

Those who succeeded the first occupants did not behave differently, however, even when they held clear title. Plantation farming, as will be shown, was a form of shifting cultivation. In that one area of the forested region under discussion where the central government insisted on its authority over the public lands, upland central Espírito Santo, it installed immigrant Italian and German farmers who immediately took up the torch and the hoe. They then expanded their holdings, in the second and succeeding generations, by purchasing clear titles (both public and private) in forested land and continued to practice swidden, precisely like the native dispossessed squatters on the other forest margins.[15]

The persistence of swidden cultivation—carried out to the point that only grasses and ferns returned, and therefore causing an unstable and itinerant rural population—has been identified as the underlying cause of a series of social ills. The dispersal of the rural population hindered its cultural development—it was impossible to provide schools, churches, or courts. Nor could the rural economy

tend toward specialization; instead, self-sufficiency was essential to survival of the family. High transportation costs were unavoidable, because of expanding distances between populated fronts, and because population clusters were constantly changing their locations. Until the railroads were built, goods were carried on mule back, not in wagons, so poor were most of the roads. The indiscriminate burning of forest increased the cost of forest products essential for economic development, especially wood for firewood, charcoal, and construction, restraining the growth of railroads and smelters.[16]

Shifting cultivation determined land concentration, since its practitioners demanded immense grants from the governors, merely to sustain their families. One quarter of a square league—almost 11 km^2—was regarded as a small holding. Squatters complacently claimed much more, hundreds of square leagues in some cases. Although these grants and squatters' claims tended to fragment through inheritances, the inevitable decline in yields led to reconcentration, since smallholders would sell off, or be forced to sell off, to ranchers as their lands failed to provide means of family subsistence. Their modest compensation would be taken to the frontier, to purchase new lands.

The itinerant nature of farming resulted in itinerant cities. Towns rose and declined as the forests surrounding them disappeared. Capital improvement in the towns was minimal, since, as costs of food and fuel rose locally, the value of town real estate inevitably fell.

It is very significant that these calamitous influences have been seen, as well, as causal in the opposite direction. Swidden cultivation has been regarded as the inevitable result of an untrained and ignorant rural population, of high transportation costs—which discouraged competition and production for market, of land concentration, and of weak town markets—which were incapable of absorbing rural products or excess rural population, or of providing goods in trade for fuel and foodstuffs. The systemic nature of these causal links is obvious.

Forest Extractive Practices

The production of goods for export was clearly the essential purpose of the colonial enterprise, but a viable export regime was slow to develop in this part of the colony. Logging, after the departure of the French, was much reduced in scale. Local varieties of the brazilwood tree were considered inferior to those of the north coast, although Cabo Frio, east of Rio de Janeiro, was one of the earliest areas logged. Logging for naval construction does not seem to have been important along this littoral; possibly the Tupi had already eliminated primary forest along the shore. Logging for export could not be carried out further inland because the rivers, with the exception of the Paraíba do Sul, ran inland toward the Paraná, or were broken by cascades. In any case most of the species of the primary forest were too heavy to float. By the mid-nineteenth century, when the invention of aniline dyes nearly eliminated the trade in brazilwood, another minor trade took its place, in jacarandá, or rosewood, for furniture veneers.[17]

The most demanding extractive use of forest in the vicinity of cities and towns, however, was cutting for firewood and charcoal, to supply kitchens, bakeries, brick and tile works, and other small manufactories. The cutting was usually carried out in secondary formations and *cerrado*. In the vicinity of Rio de Janeiro the cutting was partly at the expense of mangroves. Mangrove encircled Guanabara Bay and all the other estuaries of the coast, to a depth of 500 meters or more. It was especially favored for tannin and for its slow burning quality. As it was removed, the bays developed mud flats and tidal bars that blocked the rivers and streams of the littoral, rendering them unnavigable and forming large marshlands. Enormous sums were expended by the state and federal governments in the twentieth century to try to free these channels of alluvial deposits. There seems to have been almost no understanding that the problem had been caused by the previous disappearance of the mangrove, nor any inclination to act on that knowledge.[18]

The mestizo backwoodsmen, like their Amerindian forebears, continued to practice hunting and fishing, but more thoroughly, since they bore guns and dynamite. They burned fields and woodlands to drive game. Their use of poisons to kill fish was enormously wasteful, and killed other animals and even humans downstream. Hunting was also a significant commercial activity. A jaguar skin was not quite as valuable as a cow hide, but was less work to get. Birds were killed for their plumage. In 1869–70 the customs listed 171,048 dried birds exported.[19]

Although European botanists who collected in the region in the early nineteenth century reported a variety of medicinal plants in use, and an even greater number that showed promise for cultivation (as fruits, dyes, essences, waxes, aromatics, resins, latexes, spices, teas, and fibers) these species were, with only three exceptions, altogether ignored, and continued to go up in smoke. Some of them may now be available to us only as withered, dried specimens in drawers of the herbaria of Paris, London, and Munich, their potential value as cultivars or subjects of chemical analysis and synthesis forever lost.[20]

The plants singled out for economic use were ipecac, sarsaparilla, and various false quinas, or cinchonas. In spite of great hopes and many trials, the local quinas failed to prove as effective a malaria cure as true Peruvian cinchona, and were not selected for cultivation. The local species of sarsaparilla—at the time the plant was valued as a remedy for syphilis—were also held to be less effective than those of the Amazon basin. Therefore the region's only significant medicinal export was the emetic, ipecacuanha, or ipecac. Ipecac is a forest plant and was collected in the wild, mainly by Amerindian tribal groups. The area around Rio de Janeiro was largely cleared of this plant by the early 1800s, and the trade shifted to the middle Paraíba do Sul valley. Gradually mestizo backwoodsmen edged Amerindians out of the business, probably with severe effect upon it, since they customarily picked the plant when it was in flower, because then it was easiest to find.[21]

A more destructive intrusion into the forest for the purpose of extraction was the gathering of orchids. Orchids were a passion of the nineteenth-century European bourgeoisie, who thrilled to the dangers that collectors had undergone to

bring them the beautiful epiphytes. Large horticultural firms arose, importing 100,000 or more of the flowers a year. In the forested region agents set themselves up in business, promising backwoodsmen the equivalent of a few cents to a dollar for each specimen. Since as much as the value of two days labor was involved, the latter did not hesitate to cut down a tree to get a rare type. The agent left when the orchids were all gone. (It is recorded that an English collector, operating in Colombia, once cut down four thousand trees to corner a particularly rare species.)[22]

Gold Prospecting and Mining

The complete removal of forest for the purpose of export production began in the highlands with the discovery of gold in large quantity in the 1690s in Minas Gerais. Smaller strikes had been made in São Paulo during the seventeenth century, but this discovery was of much greater importance for the survival of the primary forest. Gold-bearing streams were found all along the ridge line of the Serra do Espinhaço, for a distance of 350 kilometers, and northeastward to the Araçuaí River. Diamonds were found in the northern reaches of the Serra, near the present city of Diamantina. The gold fields did not play out for almost a hundred years, meanwhile the wilderness was transformed into a populated district, reaching a high point of about 350,000.[23]

It was the policy of the crown to restrict settlement in the gold mining district to persons directly employed in extraction—most of them African slaves—and to those engaged in feeding the miners. Settlement was prohibited to the east and west, and the routes south and north out of the district were tightly patrolled to prevent smuggling. Much of the Serra and areas surrounding it were burned to simplify the search for deposits. Tunneling was not attempted; instead the miners dug open trenches, forming immense excavations.

The food and fuel supply of the gold and diamond district spread out east and west from its margins and along the road leading to Rio de Janeiro. Cattle ranches were formed in the *cerrado* and *campo* formations, and farms were carved out of the forests. Burning was therefore also extensive in this border zone. It may be estimated that 20,000 km^2, most of it forested land, was burned away for mining, and perhaps another 25,000 km^2 of forest was burned for the planting of manioc, corn and rice—calculating one hectare per year at an average population of 250,000 for the century, and abandonment after ten years, on the average. A much larger area of *campo* and *cerrado* began to be burned continuously, perhaps 50,000 km^2, for cattle ranching during the first century of occupation. Gold fever lured uncountable thousands of persons to other highland valleys. Sometimes these wanderings located small deposits that have been recorded in local histories, as at Cantagalo in Rio de Janeiro. Other strikes were concealed from the colonial authorities, and still other forested areas were undoubtedly burned to no avail.

Meanwhile other large deposits had been located in Goiás and Mato Grosso. These remote interior areas were far beyond the forested region, yet they presented an additional strain of localized importance. They were supplied largely from São

Paulo by mule trains which followed a natural corridor of *campo* and *cerrado* formations northward from the provincial capital to Franca and Uberaba. The trains were supplied with foodstuffs by a new wave of squatters who chose sites at the forest edges. By the early nineteenth century several of these settlements displayed signs of decadence.

Sugar Cane Cultivation

Brazil, it has often been noted, was Europe's first plantation colony. Its vocation commenced with the arrival of sugar cane from Portugal's Atlantic islands to the area of Santos, in 1531 or possibly even earlier. The export of cane sugar was small from this region, compared to that from the northeast, for the first century at least. By 1709, however, Rio de Janeiro was shipping about 5,000 tons a year, about 20 percent of the colony's total. The sugar mills were located along the littoral, from Santos to Cabo Frio, but the center of production was Guanabara Bay.[24]

As tax revenues from gold and diamond mining waned in the late eighteenth century, colonial authorities once again promoted tropical agricultural exports. Sugar cane was one of the successful commodities, stimulated by the collapse of Haitian production. A new variety of cane was brought from Tahiti; it has always been called *cayena* in Brazil because it was introduced by way of French Guiana. Planting was expanded in the Campos region of the lower Paraíba do Sul valley, and north and northwest of the city of São Paulo. São Paulo's road linkage with the seaport of Santos was improved, and local resources, especially ox and mule breeding, were directed away from the mining region and toward sugar exporting.

In the highlands of São Paulo sugar cane raising was carried out preferably in primary forest, or at least in well-developed secondary growth. Usually subsistence crops were planted for the first two or three years after the initial burning, allowing for additional burnings to clear away fallen trunks and roots. Then the cane was planted. Since it is a fast growing grass which can be left in the ground for a second and a third cutting, competition from native weeds was not a severe problem. When the yield of the field fell below a certain level, second growth would be allowed to return. This growth was burned again after a few years and the cycle resumed. Each cycle might last fifteen years, for an indefinite number of cycles, perhaps only one, until the field was finally abandoned to pasture.[25]

Cane sugar planting was thus essentially similar to swidden cultivation for subsistence. The employment of slave labor implied a more rapid expansion into primary forest, however. Slaves were obliged to work harder for many more hours than free workers. The large-scale introduction of African slaves for the purpose of raising an export crop may have doubled the rate of consumption of forest; perhaps, considering labor time alone, it may have tripled that rate. Slaves, it may be noted, also permitted a degree of specialization within the plantation work force: some of the free workers became professional cutters and burners of primary forest, undoubtedly increasing the amount of land that could be cleared each dry season.

Sugar milling placed a further demand upon wooded lands. The crystallization of cane juice required the application of heat. This process—before the installation, late in the nineteenth century on a few plantations, of steam-powered vacuum pans—was extremely wasteful of fuel. The colonial government had therefore ordered, late in the seventeenth century, that mills were not to be built within half a league (3.3 km) of each other. This order was apparently not followed, because another decree had to be issued, threatening the leveling of the mills of offenders.[26]

Sugar growing in the Campos area assumed a more intensive character. This was the only place in the forest region where this occurred, and therefore deserves more study. The period of abandonment to secondary woodland was eliminated, and plows and manure began to be applied, by the 1860s and perhaps before. Some of the mills had begun burning bagasse—spent sugar cane stalks—for fuel by the late 1820s.

Coffee Cultivation

The new plantations of the São Paulo highlands might possibly have also adopted a more intensive form of agriculture, but by the 1830s planters of the region were turning away from sugar and beginning to grow coffee trees. Coffee was introduced to the hills surrounding the city of Rio de Janeiro in the late eighteenth century. By 1800 a small quantity was being exported from these initial groves. From there the plantings were extended along the coast toward Santos and into the highlands of the middle Paraíba do Sul valley. By the 1840s it had spread east and northeast several hundred kilometers into southeastern Minas Gerais—the "Zona da Mata"—suddenly a zone of rapid population influx because of the expiration of the colonial prohibition on the settlement and because of the quick success of Amerindian "pacification" there. Coffee then moved on to the southern highland of Espírito Santo, and westward to the "Sul de Minas" area and the upper Paraíba do Sul valley. By the 1840s there were some producing plantations in the district of Campinas, northwest of the city of São Paulo. This was the "Paulista West," and Campinas was to become the railhead of a large zone stretching toward Ribeirão Preto and extending westward all the way to the state of Paraná, all of it devoted to a single export commodity. The greatest expansion of coffee took place after abolition in 1888. This event made possible the shift to an immigrant plantation labor force, Italian, Portuguese, and Spanish. In the decade following 1890 the number of trees more than doubled, in the state of São Paulo, from 300 to 650 million.[27]

Coffee presented more problems of acclimatization and cultivation than had sugar cane. It was native to east Africa, and had been introduced to Brazil only in the third decade of the eighteenth century. The seeds were brought from French Guiana—like the Tahitian cane variety—and were tested with only modest success in Pará and the northeast. In the area of Rio de Janeiro it underwent a long period of trial and error.

It came to be the general belief that the plant required the soils of primary forest. Indeed coffee is demanding, but this analysis implied the extermination of the forest of southeastern Brazil, on all sites that were minimally accessible to cultivation. It was discovered that the tree could not withstand freezing cold for more than an hour, therefore high elevations and south-facing slopes had to be avoided, as well as low lying creek bottoms in the highlands where still air might collect. It was gradually determined that certain forest tree species were *padrões*, or indicators of good coffee soils, since their climatic and soil requirements were similar to those of coffee.[28]

One of the reasons why it was held that coffee required primary forest soils was that it was observed that groves nearest the forest edge bore the heaviest yield of berries. Some of the planters thought that this phenomenon was due to the *bafo da mata*—"the breath of the forest"—which passed over the trees and stimulated their growth. It takes little imagination to realize that the real effect was the higher pollination rate by forest dwelling wild bees. Planters in the mid-nineteenth century were unaware of this ecological relationship, but even today pollination in coffee and citrus groves in southeastern Brazil is left to wild species, and bee cultivation is limited.

Coffee trees require a mesic moisture regime, and therefore they could not be planted, in this region of heavy rainfall, in clayey bottomlands, no matter how preferable that strategy might have been for the prevention of erosion. In the Paraíba do Sul valley, in the South and Mata zones of Minas Gerais, and in the highlands of Espírito Santo the topography is dominated by abruptly rising hills called "half-oranges." These hillsides are dry enough for coffee, and were therefore preferred, with appalling results. Unlike Colombia and Costa Rica, where hillside planting was carried out after only selective forest clearing, in this region of Brazil the primary forest was entirely removed. Cutting and burning was a spectacular operation. The tree canopies were interlaced with lianas, so that batches of half-cut trees could be made to fall together when just a single one was cut all the way through. The trunks fell downhill, and survived the burning that followed. The seedlings therefore had to be aligned up and downhill. Cultivation was also carried out up and downhill. The erosion that followed upon this system of planting was devastating. Some of the groves lasted no more than fifteen years. One planters' manual provided an explanation for leaving the trunks oriented downhill: when trunks were allowed to fall crosswise to the slope, the roots and stumps that held them in place would finally rot, and then the logs would roll downhill like an avalanche, crushing coffee trees and workers together.[29]

The Paulista West was more favorable to the survival of the coffee groves than most of the Paraíba do Sul valley, or the South and Mata zones of Minas Gerais. There the terrain is flatter and the soil is deep and well-drained and extremely fertile where the substrates are basaltic and diabasic, the so called *terra roxa*, "purple earth." There the coffee trees survived longer, in spite of techniques of planting and cultivation that were apparently no different from those of the "half-orange" hillsides.

The planting of the coffee trees was done from seedlings, usually those that had sprouted under the parent. Seedlings were not selected. Indeed they were nearly always in short supply, so that all sprouts were considered suitable. The trees were not shaded, as they were in nearly all the other growing areas of the world. The coffee tree is subarboreal, originally of a forest habitat. It is therefore shade tolerant, and its berries have superior qualities of taste when shade grown. In the Paulista West experiments with shading were unfavorable, because the species of trees selected for shading were too competitive with the coffee trees for ground water during the dry season. This was to be expected, since the shade trees, if the grove was to be formed from a bare clearing, would have to be faster growing species than the coffee trees, and consequently somewhat more demanding of water. Had these experiments been tried in the wet bottomlands of the Paraíba do Sul valley and the other hill country lowlands, however, thirsty shade trees might have rendered those soils more amenable to coffee—an interesting speculation, since such a procedure would have lessened erosion and preserved the hillsides for other less intensive uses.

Cultivation of coffee was carried out almost universally with the hoe until well into the twentieth century. Until maturity, at four or five years, subsistence crops could be planted between the rows, thereby reducing labor input. Thereafter subsistence crops had to be located on separate fields, and weeding was done in the coffee groves one to four times a season. Vigorous hoeing with a heavy hoe was the rule, since exposure of the groves to direct sunlight also stimulated weed growth. However, it also stunted the trees, since the rootlets of the coffee tree are characteristically concentrated near the soil surface.

The total area of forest cleared in order to plant coffee over the course of the nineteenth century may be estimated at 30,000 km^2, in the forested area of southeastern Brazil. This estimate is based on coffee exports via Rio de Janeiro and Santos, calculating average output of 0.63 kg per tree, 920 trees per hectare, and an average twenty-five year life span.

Railroads and Land Speculation

The coffee trade was profitable enough to permit capital investment in railroads. In the 1860s rail lines were built from the port cities of Rio de Janeiro and Santos up the coastal palisades to the middle Paraíba do Sul valley and the city of São Paulo respectively. From these railroads the lines fanned out into the forested region: the Paulista West, the South and Mata zones of Minas Gerais, and along the Paraíba do Sul valley, linking Rio de Janeiro and São Paulo by 1890. Other lines followed the littoral of Rio de Janeiro state as far as Campos, and in Espírito Santo penetrated south and west from the port of Vitória. By 1900 there were about 6,000 km of railroads in the forested region of southeastern Brazil.

The railroads, it may be hypothesized, were an agent stimulating the continuation of extensive forms of agriculture, since vast new areas could be brought into production, and land prices in older areas would cease to retain value merely because they were nearer the ports. The incentive to intensify cultivation was thereby

partially eliminated, and the pressure on primary forest increased. The railroads were in a sense themselves forest-inhabiting creatures. They were restricted to the forest not only because the major export crop was grown there, but also because they burned wood as locomotive fuel. They also needed crossties—1,500 per kilometer—that had to be replaced every six years.[30]

The installation of railroads permitted the growth of large cities, since firewood and food could now be brought cheaply over longer distances to population nodes whose immediate hinterlands could no longer support them. The supply of city markets, therefore, continued to be carried out largely by farmers who remained shifting cultivators. The railroad permitted the transport of cattle to market over long distances without loss of weight. This innovation also imposed a new demand on the primary forest. Cattle were driven to railheads at points like Barretos, in São Paulo, which marked the boundary between *campo* and forest. There they were fattened for market on artificial pastures which had been carved out of the forest edge.

The linkage of this forest region with the world market and the growing world demand for coffee introduced a novel condition in the local rural land market: the expectation that the price of land would increase in value. The price of land within a swidden agricultural system, producing only for subsistence and local markets, would necessarily rise initially, reflecting the value added through clearing and the securing of title, and then would decline as the humus layer of the soil was worked out. Coffee made possible speculation on the future value of land, and speculation was an important stimulus for the further extension of railroads and the clearing of forest and planting of more trees. By the 1890s, it could be argued, speculation was the principal stimulus for these investments. The huge increase in planting during that decade provoked a crash in coffee prices in 1901. This made necessary an official prohibition on the planting of new trees and, in 1906, a cartel in exported coffee. That operation proved so successful, however, that coffee tree planting was soon resumed, as fast as ever, on the expectation—well-founded until 1930, at least—that the Brazilian government would continue to support the cartel.[31]

The destruction of forest represented an immediate economic gain to swidden cultivators, plantation owners, and speculators in real estate. It may be that society as a whole experienced net benefits during the expansionist phase of the coffee cycle—the abolition of slavery, the employment of at least half a million immigrants, by 1900, and the accumulation of capital in the form of railroads, dwellings, and factories. The offsetting losses were in the long run possibly of a similar magnitude, but the ideological predispositions of those who have taken upon themselves the task of weighing the historical costs and benefits have hindered the inclusion of these losses in the balancing of accounts. Satisfaction over the successful attraction of Europeans, for example, is a much larger theme in such accounts than is the simultaneous extermination of the last local forest dwellers and their cultures.

The benefits were largely immediately realized, while the costs were mostly long term. To some degree those who gained the benefit were aware of the long term

losses. It was clear that the continued practice of swidden, on most soils in the region, resulted finally in a clearing that not only would not support the reestablishment of secondary forest vegetation, but would not even sustain agriculture, since this outcome was attainable in some places in no more than ten years. Others of the effects produced by extractive agriculture were slower to make an appearance and were less direct, so that they did not appear to be in fact consequences. The stunning landscape of erosion in southwestern Minas Gerais is an example. There deep clayey, rather infertile soils, left bare by eighteenth-century swidden cultivators, have been carved by the rains into immense craters, called *voçorocas*. Whole hillsides give the appearance of having been strip mined. Early nineteenth-century travellers mention their existence, saying that the local inhabitants called this *terra podre*, rotten earth. The flooding of some rivers and the drying up of others is another unacknowledged result of swidden cultivation. Many that were called "Clear Creek" now run muddy to the sea, and since the 1820s at least the Paraíba do Sul River has every few years caused havoc in its valley. It may be that the previously mentioned steady cultivation of the delta of the Paraíba do Sul was made possible by the large-scale transportation of the nutrients of the upper valley to the river's mouth.[32]

Ideological views also played some part in the reluctance to link cause with effect. The immense outlays in the twentieth century for the dredging of the streams and draining of the marshes of the lowlands of Rio de Janeiro state were presented to the taxpayers not as an unavoidable corrective for the destructiveness of their ancestors, but as a sign of the expansive vigor of the republican government which would subdue the forces of nature and bring prosperity to a backward region. When the job had to be done again in the 1930s, it was falsely introduced as an agrarian reform measure.

Conservationist Beginnings

The loss of primary forest was not an important theme in government or scientific reports until the 1930s. Until then bureaucratic attention was directed toward a narrow range of resource issues or to certain social consequences of shifting cultivation which were inimical to the interests of the crown. The crown monopolized brazilwood and tried, with only partial success, to control standing timber suitable for naval construction. The Portuguese made few efforts to improve agriculture in Brazil. They showed little interest in cultivating native plants that were merely gathered wild and they prohibited absolutely the growing of any of the spice plants which formed the basis of their trade in the Indian Ocean. This attitude began to change only as the gold strikes played out, but was fully reversed only after the arrival of the royal court in Rio de Janeiro and the loss of most of the Asian empire.

Royal bureaucrats had inveighed against shifting agriculture from the beginning of the colony, it is true, because it attenuated their control of the population and hindered taxable enterprise. The Jesuits and other missionary orders sought

strenuously to concentrate their proselytes, on the coast if possible, so as to lessen their own labor inputs into the missionizing endeavor. They managed to inculcate Christianity, but not sound farming practices. The colonial governors were concerned mainly with collecting taxes and recruiting soldiers, neither of which was very effectively carried out as long as the subjects were scattered in a wilderness. Undoubtedly the exactions, or pretended exactions of the crown were a factor in maintaining swidden cultivation, another reciprocating element in a system that was political and social as well as economic and ecological.[33]

The first sign of interest in a more rational use of colonial resources was a pair of memoirs published by Domenico Vandelli, director of the royal botanical garden, in 1789. He condemned shifting agriculture, on the ground that it was destroying potentially valuable forest resources, and he recommended that native plants be cultivated and exotics be introduced. These recommendations were pressed forward by José Mariano Conceição Veloso, a Brazilian botanist, who published a series of research reports in the late 1790s, examining the potential of a number of species and advocating the establishment of botanical gardens. A small garden, in fact, already existed at Belem, and another was installed in Rio de Janeiro in 1810. Attempts were made to acclimatize several economic species, including tea, and European botanists were invited to collect and identify economically valuable native species. Unfortunately, after independence in 1822 and the establishment of a constitutional empire, these useful projects were largely abandoned. Laws protecting forests for purposes of naval construction were repealed and public land policy became a dead letter, permitting large scale squatters to engross crown land with impunity. Botanical study, confined to the Museu Nacional, was conducted at a very low level of intensity, and agricultural research was nonexistent.

The only effectively expressed concern regarding the degradation of forests, until the fall of the empire in 1889, was that of watershed protection near the city of Rio de Janeiro, then the seat of the imperial government. In the 1860s its city council, unwilling to spend ever larger sums of money to bring water to the city center as its streams dried up, decided to carry out a program of reforestation all along the hill of Tijuca. This massif rises immediately behind the city to a height of more than 600 meters. The project was highly successful; the city regained sources of potable water, and an artificial forest has formed of great beauty. Prohibitions on watershed deforestation were later extended, rather less effectively, to ranges farther inland and, near the city of São Paulo, to the Jaraguá and Cantareira hills.

In 1889 a republic replaced the empire. Its decidedly positivist leanings had implications for public policy, especially in public health, Indian policy, and agriculture. The major coffee-producing state of São Paulo, which gained control of its export revenues under the new constitution, began to expend very large sums on agricultural and botanical research. By the middle of the 1920s the present day forest preserves of Itatiaia, the highest part of the Mantiquera range, and of Alto da Serra, on the coastal escarpment above Santos, were beginning to receive a degree of protection as biological research stations. These, and the Serra dos Orgãos preserve in the state of Rio de Janeiro, were the only legally protected

public reserves in the region until the 1950s. In addition small scattered private reserves of primary forest were kept on some plantations, usually as hunting preserves.[35]

Shortly after 1900 public controversies began to emerge on questions of conservation. Euclides da Cunha, author of the masterful *Rebellion in the Backlands*, wrote articles in the *Estado de São Paulo* lamenting the destructiveness of plantation agriculture in the Paraíba do Sul valley. Other observers voiced the apparently widespread opinion that deforestation was causing not only erosion and depopulation but also climatic change. The weather, they charged, was becoming drier and hotter, and the rainfall more seasonal. The railroads became targets of this outcry, since their woodpiles, hundreds of meters long, lined their rights of way for all to see, even though their concessions committed them to use coal in their fire boxes. The larger cities, meanwhile, were suffering rising prices for fuel wood, so severe that the state legislature of Rio de Janeiro considered prohibiting the burning of woodlands on private property and the licensing of all firewood cutting.[36]

These concerns were taken up within a political context of changing economic interests and class relationships. The owners of decadent plantations, for example, wanted to sell firewood to the Rio de Janeiro market without competition from independent un-propertied contractors. The emergent city middle classes were searching for issues with which to challenge the planters and the planter-controlled railroads. The latter campaign was effective enough to provoke the Paulista railway to begin a program of reforestation, employing eucalyptus, though they continued to rely mainly on primary and secondary forest for fuel and crossties. Conservation and preservation, in spite of this public debate, gained almost no ground in government policy until the 1970s. The removal of the forest was to go on, at an even faster pace, with the introduction of gasoline trucks and portable steam powered saw mills, and the extension of the railroads to the farthest limits of the forest region, even though the region's elite by the twentieth century was sufficiently apprised of the degree and irreparability of the losses they were imposing upon their resource base.

5. Cotton Cultivating and Land Clearing in the Bombay Deccan and Karnatak: 1818–1920

J. F. Richards and Michelle B. McAlpin

Between 1818 and 1920 western India was fully incorporated into the British Empire. Its administration, land revenue system, trade, and transport and communication network were all shaped by the colonial power. As all of these parts of the economic environment shifted, the farmers of the area responded to changed opportunities by cultivating more land and changing somewhat the mix of crops they grew. By these very activities the region's ecology was altered so that all its peoples—tribals as well as settled agriculturists—were faced with different and perhaps more limited resources by the end of the period than they had enjoyed earlier. In this paper we will trace these processes. The first section describes the country as it was in 1818–21, the second analyzes the changes in cultivation in the Deccan and the Karnatak during the next century, the third discusses these same changes in Khandesh, and the fourth and final part focuses on the economic (environmental) costs of expanding cultivation.

I

In 1818, after the final defeat of the Maratha armies in a struggle stretching over forty years, the Governor-General of India appointed one of the East India Company's veteran diplomats and soldiers to a critical task. Mountstuart Elphinstone, one of the great proconsuls of British imperial history, arrived in Poona, the former Maratha capital, bearing the title of "Commissioner of the Deccan." His first tasks were to disband the Maratha armies, to reward those who had assisted the British, and to pacify and prevent resistance by Maratha aristocrats and generals. Having established the authority of the East India Company and restored public order, he was to consolidate the new administration. He and his subordinate officers achieved these goals in the course of two years of ardous effort.

At the close of this period, in 1821 Elphinstone summarized his work and his understanding of the present state of the vast area under his charge in a formal written report—since published and cited many times. The report, titled simply *Territories Conquered from Paishwa*, lucidly and succinctly describes the state revenue system of the Marathas, the indigenous civil justice and police system, and sketches out a history of the Marathas.[1] For our purposes, however, the most pertinent section is Elphinstone's "Description of the Country". The territories for which the Commissioner of the Deccan was responsible included the Maratha

homeland and the largely Kannarese districts to the south of it. The first of these was composed of the interior districts of the Deccan which stretched from the north-south mountain chain of the Western Ghats in the west to the Maratha / Telugu cultural and landscape divide in the mid-peninsula. The northern extremity reached beyond the Tapti river to the southern border of Gujarat. The Krishna river formed the southern boundary. The indigenous administrative divisions or districts included Khandesh (astride the Tapti river in the north), followed by Nasik (termed "Gungterry" by Elphinstone), Ahmadnagar and Poona districts, and finally Satara just above the Krishna. The second part of Elphinstone's charge comprised the lands below the Krishna to the border of the Raja of Mysore on the south and to Madras Presidency on the East. In this region Marathas and Marathi speech rapidly gave way to the Kannarese peoples and Kannada speech. Although the Marathas conquered the Karnatak lands, Elphinstone notes, they formed probably no more than one-eighth to one-tenth of the total population. These areas were inhabited "by Canarese, who retain their own language and manner."[2] Elphinstone "very roughly estimated" that his territories thus comprised 50,000 square miles and that "the population living in both the hill-range and on the Deccan plateau may be guessed at 4,000,000" persons.[3] From the Poona Elphinstone could survey the peninsular interior with its two principal topographical features: the Ghats and the Deccan plateau. In a concise passage he decribes the physical characteristics of the Deccan and the Karnatak:

> The grand geographical feature of this tract is the chain of the ghauts [the Western Ghats] which run along the western boundary for its whole length. . . . Towards the ghauts, the country is in most places extremely strong, divided by hills, intersected by ravines, and covered with thick forest. The range itself is from 2,000 to 4,000 feet high, extremely abrupt and inaccessible on the west. The passes are numerous, but steep, and very seldom passable for carriages. The tableland on the east [i.e. the Deccan plateau] is nearly as high as many parts of the ridge of the ghauts, but, in general, the hills rise above it to the height of from 1,000 to 1,500 feet. The tableland is, for a considerable distance, rendered very strong by numerous spurs issuing from the range, among which are deep winding rugged valleys often filled with thick jungle. Further east the branches from the ghauts become less frequent, and the country becomes more level till the neighborhood of the Nizam's [of Hyderabad] frontier, where it is an open plain.[4]

Within this dramatically varied landscape, although trade and industrial production were certainly important, the overwhelming mode of production in the early nineteenth century was agriculture. The Deccan was, and is, essentially the country of dry farming. Millets, not wheat or rice, are the major food crops. And here, natural conditions are somewhat paradoxical, for the potential for great fertility and productivity, and for great insecurity and dearth coexist. The soils vary from highly fertile to a medium quality—from the deep black soil found on

river bottom lands to the medium black soil formed by the weathering of the Deccan lavas (regur). This black soil is especialy conducive to moisture retention, and has long been favored for cotton and other cash crop cultivation. The black soils are in the majority, but are interspersed with thin black or red soils or even laterite.[5] A generally warm climate and much sun provides a long growing season.

Unfortunately, the most uncertain agricultural input has always been water. In the early nineteenth century (as in the present), most of the interior lands were dependent upon rainfall. Wherever possible state and peasant constructed dams, channels, and tanks (storage reservoirs) to tap the Tapti and other east-west flowing rivers. Wherever possible villages located at water points: wells, often deep and lined with masonry; and streams feeding tanks. But Deccan agriculture utlimately depended on the seasonal rains: the summer monsoon brings moisture laden winds across the Arabian Sea, over the Western Ghats to produce rain by June. If the monsoon was adequate and rain showers continued the cultivators could plant millets—the great food crop of western India—pulses, oilseeds, and cotton to be harvested in the early fall. Between mid-September and the first of November each year these districts received lesser amounts of rain as the monsoon retreated. Cultivators could sow wheat, millets, pulses, and oilseeds for a "winter" growing season which was likely to be less productive than that of the summer. The annual rainfall totals were usually low, rarely exceeding forty inches, but highly variable in sequential years.[6] In those years, periods of two to three, when the rains were severely diminished, the crops simply did not grow and dearth and famine resulted.

Before the annexation of 1818, Elphinstone had served as a diplomat and soldier nearly uninterruptedly either at Poona or at other Maratha capitals. He had thus seen at first hand the insecurities to which the areas were subject. Two decades of warfare, disorder and misrule devastated the rural countryside and the formerly prosperous towns of his new charge. A major turning point was the combined impact of a failure of the monsoon rains in the 1802 and 1803 seasons and the heightened military activity of those years (leading to the British-Maratha treaty of Bassein). While some fertile areas remained populous and cultivated after these years, some did not:

> The east of Gungterry [Nasik], though open and fertile, is almost entirely uninhabited since the famine in 1803; the country between that and Ahmudnuggur is better, and the plains south of Ahmudnuggur are for many marches in all directions one sheet of the richest cultivation. I do not know the state of the south-east of that district towards Solapore [Sholapur] but I imagine it is equally prosperous. The country beyond the Neera [river] is in a very different state, thinly peopled, and badly cultivated.[7]

Similar discrepancies prevailed in Khandesh to the north (see below) and in the Karnatak districts to the south, where in each case still well inhabited and productive tracts alternated with those areas deserted in the aftermath of famine or warfare.

Basing his statements upon his own experience and the reports submitted to him by his officers (some of which are appended to the report) Elphinstone submitted an economical account of early nineteenth century rural society in the Deccan and Karnatak.[8] The most important institution was the village community:

> Each village has a portion of ground attached to it, which is committed to the management of the inhabitants. The boundaries are carefully marked and jealously guarded. They are divided into fields, the limits of which are as exactly known, each field has a name, and is kept distinct even when the cultivation of it has long been abandoned. The villagers are almost entirely cultivators of the ground, with the addition of the few traders and artisans that are required to supply their wants.[9]

Clearly, although he found rural inequality, this was not a society composed of great estateholders who directed the labor of slaves, day laborers, or of share-croppers. It was instead a society in which the most important social class was formed by free peasant proprietors belonging to the Maratha, or Kunbi or other clear agricultural castes. The virtues of these sturdy figures, with a personal dignity, pragmatic nature, industriousness, and fixed attachment to their inherited lands within the village constituted a dominant motif within Maratha culture.

These "landed proprietors" within the villages (*mirasis* or *mirasdars*) actually managed and cultivated their lands themselves: "a large portion of the ryots are the proprietors of their estates, subject to the payment of a fixed land-tax to the Government; . . . their property is hereditary and saleable, and they are never dispossessed, while they pay their tax, and even then they have for a long period (at least thirty years) the right of reclaiming their estate, on paying the dues of government."[10] For the most part, the holdings of the proprietors were centered in a single village—possibly with extensions into several neighboring villages for the wealthiest. Villagers holding these tenures were usually linked into a kinship based lineage system which originated in the first settlement of the village. The proprietors or *mirasis* in other words divided between them cultivation of the originally settled and usually the most fertile lands of the village.[11]

A subordinate class of cultivators consisted of tenants who held short term, often annual leases, on surplus village lands. These could be fields which the proprietors could not till with their own resources or arable lands situated within the village boundaries rented out by the village headman. Most tenant cultivators were essentially unattached to the village unlike the village proprietors. Tenants may have been refugees or itinerant cultivators, or possibly simply more enterprising peasants in other villages. Their rents went to the village.[12] This form of tenancy seems to have met the demand for labor needed to exploit the village lands above and beyond that available to the village proprietors. Very few landless laborers existed. According to John Briggs, Elphinstone's subordinate sent to Khandesh district: "A third class of cultivators are those who have neither interest in the soil nor in the crops; those are labourers who receive according to the price of provisions, four, five or six Rupees monthly. This number is very small, and is merely mentioned to

include the whole of the classes respecting the husbandman."[13] Although the identity of these laborers is vague, they may have been drawn upon occasionally from the body of ten to twelve untouchable caste Mahar families resident in most Deccan villages. The latter who were reckoned as part of the body of hereditary "village servants," acted as village watchmen, crop watchmen, and boundary keepers in return for a fixed share of the gross produce of the village.

The cultivators of each village could also rely upon the services of other hereditary families - each from a different occupational caste. The village carpenter(s), blacksmith(s), and untouchable (Charmar) leather worker(s) fabricated and repaired virtually all farm implements required.[14] Potters, barbers, washermen, Brahmin astrologers, and priests and goldsmiths (for jewelry) supplied most necessary personal services. Despite this apparent self-sufficiency every village was clearly involved in a market economy for many essential items such as salt, textiles, spices, and metals. Monetary transactions within the village economy and the linkage of village into the larger market system of locality and region was facilitated by the goldsmith/money changer/treasurer, one of the cadre of village servants.[15] These officers and several others (depending upon the size of the village) carried on a moneylending business with the cultivators. Their fiscal connections with networks of brokers, moneylenders, and moneychangers in the ascending scale of market towns and district headquarters provided the mechanism whereby some produce of the village could flow out into extra-village markets and some cash could return. This fiscal service was essential for the village community to meet its collective responsibility for payment of the land tax to the state each year.

The most important single individual in each village was the headman (patel) who was usually a member of the oldest and most prominent landed family in the village. As Elphinstone summarizes it his responsibilities were manifold:

> The Patails [headmen]... hold their office by a grant from the government... are entitled in virtue of it to lands and fees, and have various little privileges and distinctions, of which they are as tenacious as their land. Their offices and emoluments are hereditary, and salable with the consent of the Government.... The Patail is head of the police, and of the administration of justice in his village, [and serves] as an officer of the revenue. In that capacity he... allots the lands to such cultivators as have no landed property of their own, and fixes the rent which each has to pay; he collects the revenue for the Government from all the ryots [peasants] conducts all its arrangements with them; and exerts himself to promote the cultivation and prosperity of the village.[16]

In his person the Patel or headman summarized all the virtues and the ethos of the *kunbi* or Deccan peasant proprietor. When they lived up to the ideal, he and the hereditary village accountant (usually a Brahmin) met the community responsibilities of the village to those inside it and to those who confronted it. He collected the intra-village tax in order to maintain the village temple, guest house, annual

festivals, and expenses for traveling entertainers. The patel and the accountant together kept the treasury and the village fiscal and land records. If necessary and expedient, the patel borrowed large sums as a debt upon the village in order to repair the walls or to pay a bribe to a marauding army or tyrannical official.[17]

The patels or village headmen also constituted the bottom stratum of a rural power structure found in the interior districts of western India. The next upward layer in this structure was that of the hereditary heads of subdistricts or groups of from thirty to one hundred contiguous villages and their lands. The heads (known as *Deshmukhs*) of these county-sized units usually were from the Maratha or Kunbi castes and often maintained direct kinship and other ties with the leading families in the villages under their jurisdiction. Although holding some lands tax-free which they cultivated directly with tenants or hired labor, these powerful men also obtained portions of the land tax paid as well as other essentially feudal perquisites.[18] But powerful and wealthy as they were, they were not owners or proprietors of vast estates. Insofar as can be determined, their identity and ethos was very much in sympathy with and akin to that of the wealthier, more prominent peasant proprietors in the villages.[19]

Rather than explore the formidable complexities of relationships between and the internal composition of these upper rural social groups in the Deccan, it is possible to summarize their prevailing concerns. The village and subdistrict headmen and their kin were deeply and passionately concerned for the land and for their rights over it. They were deeply concerned for their dharma or religious duty to preserve their society and religion, and if necessary to defend these values with force. We also find continuing anxiety for public order, for stability and for prosperity—all interlinked. Emerging from these concerns British officials—Elphinstone and others—observed that this body had a felt obligation to expand cultivation in cooperation with the dominant peasants in order to help insure the survival, and if possible, the increase of the community in an insecure social and physical environment. In other words pressure for agricultural expansion was a long-standing social dynamic found in individuals and corporate groups in the Deccan.

The activities of the communities of sedentary village cultivators met and sometimes collided with those of the forest and hill tribes. The area of settled cultivation always marched with that of the jungle or deep forest. The 1821 Report also refers to extensive areas (often hilly or ravine-covered scrub or forested) which occupied a large proportion of the less desirable land in the new conquests. These wooded or forest zones were sharply differentiated by Elphinstone (and by the Marathas) from normal areas of agricultural settlement—even if temporarily deserted and out of cultivation.

In these forest or jungle zones, Elphinstone's cadre of administrators confronted a problem long known to the Marathas: that of various non-Hindu tribal peoples. North of Poona as far as eastern Gujarat the principal tribal groups fell under the heading of the war-like Bhils ("Beels") to the south the "Ramoosees" or Ramosis, "a more civilized and subdued tribe."

> [The Bhils] are a wild and predatory tribe; and, though they live quietly in the open country, they resume their character, whenever they are settled in a part that is strong, either from hills or jungle. The Beels differ from the other inhabitants in language, manners and appearance; they are small and black, wear little clothes and always carry bows and arrows. . . . The Beels . . . when in the hills or strong places live under Naiks or Chiefs of their own, who have some influence over those [Bhils] in the neighboring plains. These Chiefs have in general been little interfered with by the Marratta Government, more than was necessary to prevent the depredations of their followers.[20]

Elphinstone clearly identifies the symbiotic, often uneasy relationship existing between the caste Hindu Marathas, sedentary cultivators of the plain, and the tribal, non-Hindu Bhils, hunters, gatherers and shifting cultivators. In more peaceful times the latter sold or bartered forest products to settled peasants. Groups of Bhils also settled in the plains to work as watchmen, messengers or hunters for Maratha village communities. In more troubled times they plundered travelers, groups of peasant refugees or disbanded soldiery. If the reach of government and public order faltered completely they might even raid settled villages.

Despite these problems the report conveys a sense of optimism for the future of the land and the four million people under British rule. In Poona and in the districts which he toured, Elphinstone saw a Maratha "nation" which, if given a proper, honest and effective government, would fructify under peaceful conditions. He was fully cognizant of both defects and virtues in the national character. The Maratha Brahmins "who have long conducted all the business [administration] of the country" might be "lying, corrupt, licentious," if they held power, but they are "mild, patient, intelligent on many subjects, even liberal and enlightened," and these Brahmins "are naturally very averse to cruelty and bloodshed."[21] The generals and nobles of the Maratha caste might be rapacious and oppressive in ruling foreign lands outside the Deccan. Nonetheless those aristocrats "settled in their own country [in the Deccan] and unconnected with courts and armies, bear a much better character; being sober, industrious and encouragers of agriculture."[22] But it was the Maratha (and Kannada) peasantry upon whom Elphinstone's hopes rested.

> The Marratta peasantry have some pride in the triumphs of their nation, and some ambition to partake in its military exploits; but, although circumstances might turn them into soldiers or robbers, at present their habits are decidedly peaceful. They are sober, frugal, industrious;—mild and inoffensive to every body,—and among themselves neither dishonest nor insincere. The faults of their Government have, however, created the corresponding vices in them, its oppression and extortion have taught them dissimulation mendacity, and fraud, and the insecurity of property has rendered them . . . careless of the future.[23]

That for the past few decades the state of government and public order in the Deccan had been debased is certainly correct. That Elphinstone did not admit nor

comprehend the extent to which misrule under the Peshwas had resulted from the strain of prolonged British military, diplomatic and economic pressure upon that regime is not at all surprising, nor does this vitiate the accuracy of his observations. He did recognize the potential for agrarian economic and social change and progress among the peasants of the new territories.

II

Elphinstone's optimism was seemingly well founded. The East India Company and later the Crown (after 1859) sustained unusual conditions of political stability and internal order over western India in the nineteenth century. In sharp contrast to political turmoil and warfare endemic in other areas of the world the Deccan and Karnatak shared in the tranquillity of the British Raj. Warfare, predatory raiding, and large scale political violence virtually disappeared. Even the savage conflicts of the 1857 rebellion against the British occurred for the most part outside the borders of the Bombay Presidency. This is not to suggest that social conditions were ideal or that in North and Central India small scale banditry or other violence completely vanished, but only to point out that human energy in the Deccan and Karnatak districts was not consumed in either making war or in repairing its ravages. The centralized structure of the colonial government, while certainly authoritarian and occasionally oppressive, was relatively predictable and bound by its own laws and published regulations bearing the force of law. The Bombay government, while sometimes slow to respond, was aware of political demands and issues raised by its subject population and did try to meet those demands within certain specified limits. On the whole, most of the inhabitants of western India could and did assume a certain security for their lives and property.

In the course of the nineteenth century, between 1818 and the First World War, Maratha and Kannada society responded dynamically to the imposed framework of political unity and stability and to government encouraged incentives for enhanced economic productivity. The Bombay government and private British business concerns transmitted accurately and efficiently these powerful impulses for economic change generated by the burgeoning world economy of the nineteenth century—an economy which found metropolitan Britain at its center. The result for the lands and the descendants of the peoples whom Elphinstone surveyed in 1818 were profound. By the turn of the century it is clear that dramatic changes in this society had resulted in a vastly increased level of productivity, in other words economic growth, and for some groups, if not all, in the society, a new level of prosperity.

The first systematic all-India census, taken fifty-four years after the annexations in western India, seemingly bears out this picture. By 1872 Elphinstone's estimated four millions in the Deccan and the Karnatak had doubled, to just over eight million population (see table 5.1). Overall population increased in the next two censuses of 1881 and 1891 (despite a drop in the Karnatak due to the famine of 1872) to over nine million. In the 1890s and the first decade of the twentieth century

Table 5.1. Population, rates of growth, and indexes for Deccan and Karnatak divisions of Bombay Presidency[a]

	Population in thousands	Rates of growth (compound annual)	Indexes of population change (1872 = 100)
		Deccan	
1872	5249		100
1881	5315	0.14	101
1891	6213	1.57	118
1901	5944	−0.44	113
1911	6387	0.72	122
1921	6061	−0.53	115
		Karnatak	
1872	2752		100
1881	2386	−1.57	86
1891	2861	1.83	104
1901	2843	−0.06	103
1911	2833	−0.04	103
1921	2787	−0.16	101
		Deccan and Karnatak	
1872	8001		100
1881	7701	−0.42	96
1891	9074	1.65	113
1901	8787	−0.32	110
1911	9220	0.48	115
1921	8848	−0.41	111

Source: Calculated from McAlpin, *Subject to Famine*, table 3.2
a. The region of the Deccan included the districts of Khandesh, Ahmednagar, Nasik, Poona, Sholapur, and Satara. The Karnatak included Belgaum, Dharwar, and Bjapur.

population continued to gain overall to a new high of 9.2 million. By this time it is clear, however, that in demographic terms at least the Deccan and Karnatak divisions were encountering new difficulties: one new (plague) and one old (famine). By the 1921 census continued epidemic disease enhanced by the great influenza epidemic left the combined population of both divisions reduced to slightly below nine million.

Population growth did not depend upon immigration by British settlers into India. A longstanding policy prevented acquisition of lands and the growth of a European settler class. Nor was population increase attributable to the growth of cities. Poona grew from perhaps 110,000 inhabitants at the conquest (Elphinstone's estimate) to 159,000 by 1911. Other smaller cities and towns grew commensurately. But the real increase was in the overwhelming majority of the populace living in the countryside.

Throughout the nineteenth century the extent of land placed under cultivation expanded at a steady rate. By and large this expansion resulted from the investment of capital and energy in land clearing, preparation and sowing by individual

peasant proprietors. Nor was it a response to opportunities created by the construction of large scale irrigation works (e.g. the Panjab in northwest India in the late nineteenth and early twentieth century). Instead Maratha and Kannada peasant landowners cleared unirrigated land to grow more crops for themselves (millets, pulses) and for their expanding markets (cotton, oilseeds, wheat).

We can compile reasonably detailed acreage statistics for the period 1856 to 1920. These statistics, presented in table 5.2, show both the growth of cultivation and changes in patterns of land use in these regions. Gross sown area—the amount of land annually planted with crops—increased from 12.3 million acres (5.0 million hectares) in 1871–75 in the Deccan to 14.0 million acres (5.7 million hectares) by 1916–20. For the fifteen years before 1871 it is not possible to separate out only lands planted with crops each year from those held as current fallows. However, it seems reasonable to estimate that in 1856–60, gross sown area bore about the same relationship to gross sown area plus current fallows that it did in 1871–75. If we make that assumption, then about 10.1 milion acres (4.1 million hectares) were planted with crops in 1856–60. Over the entire period then, we can estimate that planting increased about 40 percent. Gross sown area plus current fallows—the entire area on which agriculturists were holding and paying taxes—increased over the same period by 50 percent. In the Karnatak, gross sown area increased between 1871–75 and 1916–20 by 11 percent. If we make the same assumption that we did for the Deccan—that gross sown area was the same proportion of gross sown area and current fallows in 1871–75 as in 1856–60, then we estimate that over the entire period plantings increased from 3.8 million acres (1.5 million hectares) to 6.9 million acres (2.8 million hectares) or by 82 percent. The increase in the total of gross sown area and current fallows over the same period in the Karnatak was 93 percent. For the Deccan and the Karnatak together, the increases in gross sown area over the entire period was about 50 percent and the increase in gross sown area plus current fallows was about 60 percent (bear in mind that this is an estimate).[25]

For the period from Elphinstone's governance of the region until the middle of the 1850s the surviving data series are too fragmentary and too subject to questions about their meaning to make compilation of a longer time series seem reasonable. However, for most areas of the Deccan and the Karnatak the 1820s probably marked the low point of cultivation. By that time the full effects of the disruptions that accompanied the wars between the Marathas and the British had been felt; the extremely high levels of revenues that the British sought to collect from their new dominions had given cultivators ample reason to seek lands in princely states or to reduce their cultivation and take up other activities (such as herding) that were not subject to such high revenue demands. As the British made ad hoc reductions in the level of their revenue demands, cultivation first stabilized and then expanded. More dramatic increases appear to have come with the systematic reduction in demands that occurred as the Bombay Survey and Settlement system moved through the districts. However, because of the low quality of the data on cultivation before the new settlement, the expansion recorded in the revenue re-

Table 5.2. Five-year averages of acreages planted with selected crops[a]

Year	Rice	Wheat	Jowar	Bajra	Total food-grains and pulses	Cotton	Oilseeds	Gross sown area	Current fallows	GSA and CF[b]	Twice cropped	Net cropped[c]
Deccan												
1856-1860	133	815	4,139	2,939	8,902	341	594	NA	NA	11,424	NA	NA
1861-1865	250	1,016	4,702	3,329	10,201	606	718	NA	NA	13,923	NA	NA
1866-1870	274	1,095	4,713	4,776	11,738	696	648	NA	NA	16,048	NA	NA
1871-1875	152	722	4,233	3,870	9,894	660	285	12,298	1,563	13,860	93	12,205
1876-1880	167	627	3,241	4,080	9,590	683	749	11,262	1,742	13,004	128	11,135
1881-1885	218	950	3,754	3,719	10,491	990	976	12,695	1,887	14,583	169	12,529
1886-1890	201	1,181	4,330	3,609	11,240	973	1,120	13,609	2,156	15,764	273	13,335
1891-1895	220	1,055	4,242	3,712	11,344	1,197	1,127	13,968	2,023	15,991	325	13,644
1896-1900	217	672	4,107	3,257	10,135	1,091	1,009	12,517	3,583	16,101	363	12,154
1901-1905	203	642	3,707	3,765	10,220	1,345	957	12,782	3,393	16,175	368	12,415
1906-1910	228	548	3,451	4,003	10,350	1,611	877	13,121	3,344	16,463	308	12,812
1911-1915	243	664	3,485	3,909	10,255	1,791	746	13,396	3,268	16,663	405	12,991
1916-1920	276	741	4,388	3,214	10,468	1,602	510	14,082	3,033	17,115	436	13,644
Karnatak												
1856-1860	183	295	1,614	164	2,702	455	214	NA	NA	4,066	NA	NA
1861-1865	245	426	2,928	437	4,439	991	166	NA	NA	7,074	NA	NA
1866-1870	243	296	2,818	450	4,051	885	84	NA	NA	6,461	NA	NA
1871-1875	236	430	2,980	442	4,371	859	136	6,129	494	6,622	39	6,091
1876-1880	237	206	2,420	406	3,999	659	169	4,952	1,650	6,602	117	4,837
1881-1885	249	470	2,787	347	4,691	1,003	310	6,137	931	7,067	135	6,000
1886-1890	269	549	2,712	443	4,996	985	361	6,499	935	7,435	83	6,417
1891-1895	276	507	2,815	455	5,063	946	364	6,550	1,067	7,616	75	6,473
1896-1900	283	462	2,622	380	4,711	810	328	6,011	1,698	7,709	89	5,919
1901-1905	271	462	2,628	616	4,961	1,125	310	6,498	1,226	7,723	81	6,416
1906-1910	260	429	2,438	582	4,688	1,301	284	6,442	1,324	7,766	77	6,365
1911-1915	263	437	2,455	561	4,620	1,500	203	6,601	1,192	7,793	64	6,538
1916-1920	265	566	2,596	360	4,667	1,451	158	6,784	1,068	7,851	64	6,720

Table 5.2. Continued

Year	Rice	Wheat	Jowar	Bajra	Total food-grains and pulses	Cotton	Oilseeds	Gross sown area	Current fallows	GSA and CF[b]	Twice cropped	Net cropped[c]
Daccan and Karnatak												
1856–1860	316	1,110	5,753	3,103	11,604	796	808	NA	NA	15,490	NA	NA
1861–1865	495	1,442	7,630	3,766	14,640	1,597	884	NA	NA	20,997	NA	NA
1866–1870	517	1,391	7,531	5,226	15,789	1,581	732	NA	NA	22,509	NA	NA
1871–1875	388	1,152	7,213	4,282	14,265	1,519	421	18,427	2,057	20,482	132	1,829
1876–1880	404	833	5,661	4,486	13,589	1,342	918	16,214	3,392	19,606	245	1,597
1881–1885	467	1,420	6,541	4,066	15,182	1,993	1,286	18,832	2,818	21,650	304	1,852
1886–1890	470	1,730	7,042	4,052	16,236	1,958	1,481	20,108	3,091	23,199	356	1,975
1891–1895	496	1,562	7,057	4,167	16,407	2,143	1,491	20,518	3,090	23,607	400	2,011
1896–1900	500	1,134	6,729	3,637	14,846	1,901	1,337	18,528	5,281	23,810	452	1,807
1901–1905	474	1,104	6,335	4,381	15,181	2,470	1,267	19,280	4,619	23,898	449	1,883
1906–1910	488	977	5,879	4,585	15,038	2,912	1,161	19,563	4,668	24,229	385	1,917
1911–1915	506	1,101	5,940	4,470	14,875	3,291	949	19,997	4,460	24,456	469	1,952
1916–1920	541	1,307	6,984	3,574	15,135	3,053	668	20,866	4,101	24,966	500	2,036

Source: Condensed and/or calculated from Michelle Burge McAlpin, "The Impact of Trade on Agriculture Development: Bombay Presidency, 1855–1920" *Explorations in Economic History* 17 (1980); 26–47, Table A1 "Five-year Averages of Acreages Planted with Selected Crops," p. 44. Sources for the data in that table include: for 1855–1872, *Revenue Despatches to Bombay*; for 1873–1885, *Bombay Administration Reports*; and for 1886–1920, *Season and Crop Reports* published annually by the Government of India. McAlpin has corrected the latter by using other official series such as the *Annual Reports of the Director of Agriculture, Bombay Presidency*.

a. All values in thousands of acres.

b. This column is the sum of gross sown area and current fallows.

c. This column is the difference between gross sown area and twice cropped average.

cords may well be overstatement if cultivators had succeeded in concealing some cultivated lands before the cadastral survey made such concealment impossible. Therefore, while it seems highly probable that cultivation at the beginning of the nineteenth century was greater than in the first decade of British rule (1818–24), it also seems very likely that cultivation expanded between 1825 and 1855. Over the entire period from 1818 to 1920, the recorded increases in cultivation were certainly exceeded by actual increases, but by how wide a margin it is not now easy to tell.

To what extent did this increase in cultivation reflect increasing commercialization of agriculture in the region? To answer this question fully is an extremely difficult matter. Maratha and Kannada peasant cultivators had grown cotton, wheat, indigo, opium, oilseeds, tobacco, and other industrial and food crops for cash sale in local, regional, and in some cases transregional markets since the fifteenth century, if not before. The land tax system of the Hindu and Muslim regimes preceding the British had demanded a fixed share of each harvest in either cash or kind. This acted as a mechanism to force much of the agricultural production of these regions into a market economy. The question is not, therefore, whether the peasants of the Deccan and Karnatak had begun to move from subsistence to commercial agriculture, but instead, how much did the nineteenth-century colonial economy of western India move the Maratha or Kannada peasant perceptibly toward a more cash market oriented, less diversified and more capital intensive form of commercial farming? It is not possible to do justice to this complex issue in this paper, but, towards this end, we can briefly review certain trends in the production of short staple western Indian raw cotton—the leading cash crop produced on the black valley and alluvial soils of the region.

India began one of the great economic transformations of the modern age in the 1820s and 1830s when the imported machine manufactured cotton cloth of the Lancashire mills began to rapidly displace many of the higher grades of domestically produced (and exported) hand-loomed cotton cloth. But the subsequent slump in domestic handloom production did not by any means destroy the market for raw cotton. In fact the reverse happened. To a far greater extent than before western Indian raw cotton became a major commodity traded in the emerging world economy of the nineteenth century.[26] Rapidly increasing numbers of bales of pressed cotton from more accessible tracts in Gujarat and a bit later from the Karnatak and Deccan cotton soils began to pour into Bombay port for shipment. While Indian cotton was exported to the United Kingdom, it is not clear that much of it was used in the manufacture of textiles there. For instance, in 1831 nine percent of English imports of raw cotton came from India (76 percent from the United States), but reexports of raw cotton totaled 17 percent of imports. These reexports probably transferred most of the Indian cotton to Continental mills where its short staple was less of a handicap than in the English mills.[27] In general, the continental and the Chinese markets were more important for recipients of Indian cotton than the United Kingdom.[28]

Encouraged by spiralling market demand, and by various enabling devices set in motion by the Bombay government, the exports of raw cotton from Bombay

port moved from approximately 10 million kilograms annually in the 1790s to 27 million kilograms exported to Europe, the United Kingdom and China in 1825–26.[29] By 1847–48 this figure had more than doubled to over 61 million kilograms annual volume.[30] A number of factors encouraged this growing linkage between the cotton-growing districts of the interior and coastal ports such as Bombay: improvements in the structure of finance and credit by means of an intensified Indian owned brokerage system reaching into the countryside; improved roads and bridges which permitted a shift from pack bullock carriage to carts in some areas; improved coastal shipping; and the reduction or elimination of internal customs ports and duties.[31]

One major component of the state's enabling impact on cotton growing and other commercial agriculture in western India which should not be overlooked is the mid-nineteenth-century rationalization of agrarian administration and tax collection. By the late 1830s after three decades of trial and error experimentation and policy debate, the Bombay Revenue Department began a massive administrative effort to "settle" the land revenue of all the agricultural lands under its charge. In its essentials the Bombay land revenue settlement was a systematic definition of terms and conditions for assessment and collection of the annual land tax demanded as a share of agricultural production by the state of India. For well over forty years the British invested much of their energy and state resources in this effort.[31]

Heavily influenced by past experience in other parts of India, and by the newer impetus of Utilitarian principles of political economy, the Bombay government decided to make the individual peasant cutivator directly responsible for the land tax upon the fields which he owned. (This was in direct contrast to previous systems which "settled" with great landlords as in Bengal, or with village communities in the Indo-Gangetic plain. It was much closer to the practice in southern India in most of the Madras Presidency.) Under this ryotwari system (that is, peasant-wise system), the British first sent out teams of surveyors, who painstakingly, year by year, district by district, surveyed the lands and recorded the holdings of each peasant cultivator. Thereafter these fields were classified according to a complex formula involving (among other considerations) soil fertility and previous revenue rates in the locality. The next step was to fix and to publish the rates of assessment for each holder of land rights. Only after thirty years had elapsed were these rates to be changed in a continuing process of resurvey and reassessment.

The completion of the settlement operations in each district ended the collective responsibility of the village for payments to the state and made each peasant individually responsible for the taxes due from his fields. The Bombay Survey and Settlement system also removed the distinction between the *mirasdars*, or hereditary members of the village, and the *uparis*, or tenants of the village. Henceforth all held their lands directly from the state and on the same terms. In addition to altering responsibility for payment of land taxes and the nature of land tenure, the Bombay Survey and Settlement fixed the land tax on each field for a period of thirty years.

The general tendency of the survey in these interior districts of Bombay was to lower the rates paid. Coming as they did at the beginning of a long period of rising prices, the changes brought about by the survey created an environment in which farmers had every incentive to expand cultivation. They had been given clear title to their lands, so that investments they might make would be securely theirs. Lowered tax rates and rising prices further diminished the share of their crop that had to be sold to meet tax payments. Between 1840 and 1880 the Bombay Survey and Settlement system and changes in the general economic environment combined to create favorable conditions for the expansion of small scale capitalist farming.

The decade of the 1860s brought new demand for Indian raw cotton on the world market when the American civil war sharply raised the price of raw cotton. Consequently total Indian raw cotton exports, which had reached about 101 million kilograms annually in the 1850s, shot up to 177 million kilograms in 1861–62 and peaked at 402 million kilograms in 1865–66. In spite of a post-Civil War drop they remained at 260 million kilograms in 1870–71.[33] Harnetty argues that this export response did not occur at the expense of food grain production:

> The American war, by raising the price of cotton, stimulated a general increase in the amount of land under cultivation in India, both for food grains and cotton. This explains India's capacity to increase her cotton exports so dramatically. After the war, in most parts of India, the quantity of land given over to cotton fell in relative terms, but the steady rise in the total acreage under cultivation—sparked by the cotton boom—meant that more cotton was being grown. Hence the level of cotton exports after 1865 was sustained far above pre-war figures.

To support this hypothesis Harnetty presents provincial total cultivated acreage and cotton acreage data for Bombay, Central Provinces, Berar, the North-Western Provinces, Madras, and Panjab. For Bombay Presidency the decade of the 1860s saw the change, given in table 5.3.[35]

McAlpin's figures (see table 5.2) for the Deccan and the Karnatak divisions of Bombay Presidency affirm that a similar relative and absolute increase in cotton acreage accompanied a dramatic gain in total cultivation; these data are given in table 5.4.[36]

Increases in cotton production were also facilitated by construction of railways in the interior of Bombay Presidency. The new post-Rebellion government of India, under its first Viceroy, Lord Canning, encouraged the construction of over six thousand miles (four hundred kilometers) of Indian railway in the 1860s. The opening in the early 1860s of the Great Indian Pennsula Railway's line running from Bombay to Nagpur cut transport time and cost for shipment of bulk cotton to the coast from as much as three months to as little as one to three days.[37] Subsequent extensions of this line in the 1870s and 1880s further reduced transport costs for cotton and other cash crop shipments to Bombay. As a result, for brokers, ginners and processors, and not least for cultivators, access to price information

Table 5.3. Cotton cultivation in Bombay Presidency, 1860–70

	Total cultivated area[a]	Index of total cultivated area	Cotton acreage	Index of cotton acreage	Cotton as percentage of total
1860–61	15,677	100	1,002	100	6.4
1869–70	20,384	130	1,979	197	9.7

a. thousands of acres

Table 5.4. Cotton cultivation in the Deccan and Karnatak, 1856–75

	Five-year average of gross sown area and current fallows	Index	Cotton acreage	Index	Cotton as percentage of total
Deccan					
1856–60	11,424	100	341	100	3.0
1871–75	13,860	121	660	194	4.8
Karnatak					
1856–60	4,066	100	455	100	11.2
1871–75	6,622	163	859	189	13.0

and to fast, economical transport meant a much more direct linkage with the world commodity market. Thus, Michelle McAlpin concludes that even "when prices fell at the end of the Civil War, the railroad lines to some parts of the interior were sufficiently complete that they could provide transport to the coast at prices that meant profits could still be realized in the interior. For this reason, cotton cultivation continued above pre-1862 levels."[38]

Expansion to cotton acreage begun in the 1860s continued for the remainder of the century. Deccan annual cotton cultivation climbed from 660,000 acres (267,000 hectares) in the early 1870s to a high of 1,791,000 (725,000 hectares) in 1911–15, then dropped slightly (largely as a result of the drought in 1918–19 to 1,602,000 acres (648,000 hectares) in 1916–20 (see table 5.2). The proportion of cotton acreage to total cultivation moved from 4 percent in the 1870s to 11 percent during the First World War and dropped back to 9 percent by the 1916–20 quinquennium. Similarly, in the Kanatak annual cotton cultivation increased in absolute terms from 859,000 acres (348,000 hectares) in the 1871–75 period (14 percent of total cultivation) to a high figure of 1,500,000 acres (607,000 hectares) (19 percent of the total cultivation) in 1911–15. Acreage dropped slightly to 1,451,000 (587,000 hectares) (18 percent) in the next five year period.[39] Steady expansion in cotton production from 1860 to 1920 was a direct result of millions of managerial and investment decisions made every year in response to market conditions by free peasant proprietors or their tenants farming modest size holdings.

During the one hundred years between conquest and the First World War, peasant clearing of brush, shrub and forest in the interior districts of Bombay proceeded with few pauses. Some of the consequences of this agricultural expansion began to become apparent in the interior districts of Bombay Presidency well before the end of the first century of colonial rule. Increasingly, reports and memoranda filed by district officers commented upon the disappearance of land cover and its physical and social effects. These repeated observations found their way into the massive series of Gazetteers compiled from the 1870s on for every province and district of British India. Removal of the tree cover, especially in the hills, destroyed the forest's capacity to restrain the "heavy tropical down pours" of the summer monsoon. Flooding, silting, and watershed damage as a result of land clearing were of continuing concern.[40]

The value of forest and woodlands to the rural population for cattlegrazing, for firewood, for house building, and other durable materials, and for a myriad of forest products was well recognized. At the same time, as wooded areas in the Presidency shrank, that "ancient system by which each man took from the jungle all that he required to a great extent without supervision, and in many cases free of charge" also altered.[41] By the latter decades of the century all of the products of the woodlands had entered rural as well as urban markets at an increasing price. To cite just one important example, John Augustus Voelcker, in his influential 1893 report on Indian agriculture, argued strongly that the practice of using dried cow dung as a domestic fuel was primarily a forced necessity due to the high cost of firewood, and that if wood were available cow dung would be used to manure the cultivator's fields.[42] He found this to be true in the Deccan districts as in other parts of India:

> At Ahmedabad, firewood is scarce; it costs Rs. 1 for four maunds of 40 lbs. each, and the testimony of the cultivators is, that they gather all the stalks, etc. of their fields, and would not burn any dung if they could help it. Poona is another place where firewood is expensive. It has to be carted between 30 and 40 miles, and then costs Rs. 5 a cartload, where as a cartload of cow-dung cakes costs Rs. 3, and a cartload of loose cow-dung Rs. 1 only. It is not to be wondered at, then, that the cakes are burnt as fuel instead of the wood.[43]

Evidence such as this suggests that by the last decade of the nineteenth century, most peasant cultivators may no longer have had ready access to stands of brush or woodland as sources of household fuel. The "village wastes" of common grazing grounds so frequently mentioned by observers in the earlier years of the century were often bare ground with little forage for cattle.[44] The encircling scrub or wooded lands found in interstitial belts between Deccan villages had either come under cultivation or been cleared as demand for fuel and grass increased.

More and more alarmed by its rapidly shrinking woodlands and forests the Indian Government began serious attempts to save at least a portion of the subcontinent's forest cover. In 1864, the Government appointed Dr. Dietrich Brandis, a German forester, as Inspector-General of Forests, thus founding the

Imperial Forest Department in India. Thereafter Brandis organized a professional forest service, which, at its upper levels, was staffed by British officers trained in a three year forestry course at Cooper's Hill, the Royal Indian Engineering College in England (supplemented by European training tours). Beneath this British cadre (similar to the general administrative cadre of the Indian Civil Service) Indian subordinate officers trained at the Imperial Forest School at Dehra Dun (opened in 1878, in the Himalayan foothills) entered and served in the Forest Department. Forest guards, clerks, and other employees obtained employment on a local basis.[45]

Initial legislation passed in 1865 for forest conservation proved unsatisfactory. Therefore in 1878, the Forest Act (Act VII) of the Government of India set out a firm legal basis for assertion of the Forest Department's control and management of reserved forests.[45] In thus creating "reserved" forests the Government assumed legal rights of ownership over the land in question in order to preserve and systematically harvest the existing tree cover. By 1903–04 the Provincial Forest Department in Bombay Presidency managed a total of 29,525 km^2 of reserve forests (excluding Sind and the Indian States) or 16.5 percent of the total Presidency area of 178,035 km^2. Official figures for the same year put the total area under cultivation (including current fallows) at 122,603 km^2 or 68.8 percent of the total.[47] Much ordinary work for the professional foresters of Bombay and their subordinates lay in boundary marking and surveying and thereafter in planning and supervising the maintenance and controlled exploitation of the reserved forests. Fire control and prevention was another primary concern but as much or more of their efforts went into either preventing altogether or controlling human activity in the forests. The Bombay forest department, by restrictive licensing, systematically reduced shifting cultivation carried out by Bhils, Kolis, and other tribes. The department controlled (or prohibited) wood or other forest product gathering by a fee and permit system. It attempted to curtail and to license grazing of cattle, sheep, and goats in the forest tracts. To carry out these functions forest guards patrolled the reserved forests. The forest officers held limited magisterial and police powers which could include the levying of a fine on the spot for transgressors.

That the forests needed protection against uncontrolled human use, if not surprising, is nonetheless one further indication of a significant environmental change which had occurred in the Deccan and the Karnatak and elsewhere in western India. The intensity of demand for access to the government reserved forests was a consequence of steady, cumulative land clearing for the expansion of agriculture. For the Bhils and other tribal groups in the interior districts the disappearance of much of the overgrown jungle meant that a livelihood obtained in the government reserved forests was the only alternative to assimilation as landless laborers within the village communities of the Maratha or Kannada peasantry.

Traditionally, the Bhils had practiced shifting cultivation as well as gathering forest products for sale in wider markets. By the 1850s and the 1860s both of these means of subsistence were being disrupted. Revenue officials and foresters both attempted to settle them as permanent cultivators, primarily on their traditional

land, the hilly waste forest which kunbi peasants preferred to avoid. Given the poorest soils, the Bhils were no competition for their lowland counterparts; most of them totally failed as peasants. As wood gatherers, they might have expected to prosper as the market for building timbers and fuelwood expanded. But here too they were displaced or exploited by competition from social groups accustomed to the demands of a market economy. Financing and transport of the fuelwood trade was largely in the hands of *savkars*, merchant moneylenders from the plains districts who either brought their own crews into the Bhils' territories, depriving the local men of both employment and forest products. Or the traders hired Bhils for the work, but advanced them pay and the use of bullock carts on such exploitative terms that the tribals could never repay the loans or achieve any net income. Over the years, the Bhils were caught in the squeeze of seeing their forests degraded and their debts to *savkars* mount.[48]

For the various castes of graziers, the disappearance of much of the uncultivated "jungle" meant a serious diminution of pasture for their flocks of sheep or goats. For the peasant cultivator, the recession of the woodland meant that firewood and thatching materials largely available to his father and grandfather for the labor of cutting and gathering now had to be purchased. For the petty village trader, drugs, dyes, tanning materials, alcohol, fruits, honey, wax, and other forest products obtained cheaply, often on barter terms, from Bhils and other tribals, had become expensive and were no longer conveniently accessible. For all members of society the loss of nearby wooded lands eliminated one source of assistance for cattle and man in times of drought and dearth. In times of great extremity forage for cattle and food for humans could be found in the jungle.[49]

The expansion of cultivation and rising intensity of cultivation in the interior of western India in the nineteenth century unquestionably brought economic benefits to rural society. As in every similar change, there were costs as well.

III

A closer analysis of the process of agricultural expansion and land clearing in a single district may be helpful in assessing the interrelationship between these developments and their true impact upon the social and physical environment. The twenty six thousand square kilometer Khandesh district, northernmost of the Bombay Deccan districts, is an upland basin which contains the upper valley of the Tapti River. Although it was a march or frontier area located between Maharashtra proper and the areas of Gujarati and Rajasthani regional cultures, Khandesh during the early Muslim period had been a separate kingdom ruled by the Faruki dynasty. Later in the sixteenth century the region became a province incorporated into the Mughal empire. In the eighteenth century a gradual Maratha takeover brought it under Poona's control.

Khandesh probably reached the height of its pre-British economic prosperity and agricultural expansion during the mid-seventeenth century after reforms

instituted by the Mughal Prince Aurangzeb.[50] During the Mughal period the district prospered in times of peace because of its agricultural productivity; its textile production; its heavy through trade. The overland trade route from the ports of the west coast to Delhi and Agra passed directly through Burhanpur, the principal city of the province. Khandesh was especially noted for its fine quality cash crops: sugar cane, indigo, high-quality rice, and cotton. Irrigation water drawn from the various tributaries of the Tapti River by means of weirs, sluices and other devices contributed to the agrarian productivity of the district.

When British annexation occurred in 1818, Khandesh had apparently suffered greater destruction and depopulation than the more southerly districts. Elphinstone comments that:

> Though interspersed with low ranges of unproductive hills the bulk of the province [Khandesh] is exceedingly fertile, and it is watered by innumerable streams, on many of which expansive embankments have formerly been erected for purposes of irrigation. Some parts of the province are still in a high state of cultivation . . . but the greater part of Candeish is covered with thick jungle, full of tigers and other wild beasts, but scattered with the ruins of former villages. The districts north of the Tapty [River] in particular, which were formerly very populous, and yielded a large revenue, are now almost an uninhabited forest.[51]

The commissioner attributed the desolation of the district to the ravages of a Maratha army in 1802 followed by the famine of the next year. After these events the Beels . . . withdrew to the surrounding mountains, whence they made incursions and carried off cattle and prisoners from the heart of the province."[52] Although in 1821 the British official in charge of Khandesh, John Briggs, had pacified the Bhils and other predators of the district the "great want of Candeish is in population" to come and till the empty lands.[53]

During the first thirty years of British occupation the economic and social revival of Khandesh did not proceed as rapidly as the British thought it should. Population rose slowly from 332,370 in 1824–25 to 353,674 in 1839–40, and more rapidly to 685,619 persons in 1845–46 and then to 778,112 in the census taken in 1851 by revenue officials. Despite this increase the district was extremely thinly populated in mid-century with an average density of 25 persons per km^2 (total area calculated at 31,403 km^2.[54] As Captain (later Sir George) Wingate, one of the architects of the Bombay Survey and Settlement system, observed in his 1852 report:[55] "Out of the 2578 inhabited villages of the Collectorate [Khandesh] there are 587 with less than 50 inhabitants, and of these 181 have less than 20 inhabitants. In every such case the cultivation is confined to a few fields, and with this insignificant exception, the entire area of the village is waste, and covered with jungle."

Cultivation had more than kept pace with population growth. The initial survey and record of lands showed a five year annual average of cultivation in the years 1818 to 1823 at 705, 960 acres (285,688 hectares). Thirty years later in the 1847 to 1852 period the annual average acreage was 1,053,849 (426,472 hectares) or an

increase of over two-thirds in area.[56] Yet, according to Wingate's calculations the cultivated area in 1852 was only 14 percent of that potentially arable.[57]

Cotton cultivation followed a similar trend. The earliest figures apparently available show a five-year annual average for 1834–39 of 77,447 acres (31,341 hectares) under cotton. For the period 1847–52 this had reached 127,650 acres (51,657 hectares). The latter was just over 12 percent of the area of total cultivation in Khandesh.[58]

Given the intensifying demand for raw cotton exerted at Bombay in the 1830s and 1840s, why did not Khandesh cultivators respond by growing more cotton? And more generally why did district agriculture not develop more rapidly, especially in view of the generally conceded soil fertility and access to irrigation by means of traditional works in the river valleys? The primary cause of this underdevelopment seems to have been an administrative failure in the Bombay revenue department. The district remained heavily overassessed over three decades. One officer who reviewed the land revenue rates in Khandesh about 1830 asserted that it was the most heavily taxed of all the Deccan districts. Rates per *bigha* were from fifty to one hundred percent higher than in its neighboring districts.[59] Twenty years later Wingate argued that in the subdistricts near the Tapti river which contained the best black soil:

> The Ryuts [peasants] are ready and anxious to extend their cutivation, but dare not do so with their present rates. They are obliged to limit the extent of their farms as much as possible, and cultivate then highly, in order to be able to pay the existing assessment. A reduction would, I am satisfied, cause an immediate and great extension of cultivation in all the villages of the Talooks [subdistricts] along the Taptee where there is waste to break up.[60]

Prior to 1850 the colonial regime also did little to improve intradistrict transport in Khandesh. District officers made annual improvements in the great Bombay to Agra roadway which passed through the district, but they did next to nothing to improve access to that route by building cartable feeder roads. Nor was there any investment in bridges. Abolition of many of the customs stations and duties in Khandesh eased trade burdens somewhat, but this was clearly not enough.[61]

Curiously enough Khandesh remained a thoroughfare for the transport of cotton and other goods by vast herds of pack bullocks in the traditional manner. In 1826 military engineers improved the Thal pass over the Ghats to allow passage of carts and heavily laden bullocks. The Bombay-Agra trunk route thereby became economical for transport of raw cotton from the highly productive cotton tracts of Berar just east of Khandesh.[62] Between 1836 and 1845 an annual average of approximately 15,637,500 kilograms of raw cotton moved west across Khandesh south to Nasik and thence across the Pass south of Bombay.[63] Carriage was largely accomplished by herds of pack bullocks (estimated at 180,000 beasts employed). By 1844, when it became possible to use carts along the entire route, now improved, "so many Khandesh carts were employed that their earnings had an important effect upon the condition of the people."[64]

The take-off point for Khandesh came in the 1850s and 1860s. The Bombay Survey and Settlement System, extended into this area in 1852 and finally completed in 1870, was designed specifically to lower the rate of taxation on agriculture and to encourage extended cultivation.[65] The Great Indian Peninsula Railway began construction of a line from Bombay in 1852. Between 1861 and 1865, 227 km² of line were opened for traffic on a route which roughly paralled the old Bombay-Agra route.[66] In 1853 the district administration began to improve the feeder roads of the district by constructing 160 km of fair weather drained and gravelled roads.[67] A local tax provided funds to continue road and bridge building thereafter. In 1854 Act VII set up an all-India postal system under a Director-General, introduced postage stamps, and organized service in each province. By the 1870s the district possessed regular postal service from Bombay by rail and mail cart and a network of fifty-three post offices.[68] By 1855 a Bombay to Agra telegraph line was opened for paid message traffic. Bhusawal in Khandesh, the principal railway junction, was also the main intersection for the north-south lines.[69]

Population continued to increase. At the 1872 census Khandesh's population exceeded one million and rose by decades as follows: 1872, 1,1030,106; 1881, 1,237,308; 1891, 1,434,802; and 1901, 1,427,382.[70] But the most dramatic change occurred in the rural economy. The *Khandesh Gazetteer* observed with pride in 1878:

> To one who knew Khandesh twenty years ago, . . . the change seems wonderful. At that time a vast belt of good soil, covered with a tangled growth of *babhul* or *palas* trees, stretched for miles from the Satpuda Hills south towards the Tapti. In almost every sub-division were wide stretches of bush land broken by isolated patches of tillage. Now, . . . no tracts of good land lie waste. Scrub jungle there still is, but this is confined to rocky lines of hill or rolling stony ground that will yield no crop save grass. Cultivation has been pushed almost to the very slopes of the Satpuda hills.[71]

These observations, made by the Khandesh district officer W. Ramsey, are borne out by the trend of agricultural statistics (see table 5.5).[72] While the general increase in lands tilled over the seventy-five year period was certainly noteworthy, the trend in cotton acreage was even more remarkable. In absolute terms cotton lands increased six-fold. In relative terms by the first World War cotton acreage occupied one-third the land farmed in Khandesh district.

The shortage of cotton induced by the American Civil War, coupled with well timed enabling actions of the British colonial regime, clearly focussed human energy in Khandesh upon cotton production. Between 1847 and 1879, according to the *Khandesh Gazetteer*, the local price of cotton rose from 1 to 1.5 pence (English currency) per pound to 5 to 6 pence per pound.[73] Partly this was intensified demand, but in part this was also an improvement in the grade of much Khandesh cotton. District cultivators had adopted, in part, longer staple Dharwar-American or Amravati varieties in place of the short staple Khandesh cotton.[74] Also,

Table 5.5. Cotton cultivation in Khandesh, 1856–1920

	Gross sown area plus current fallows (thousand acres)	Index	Cotton acreage (thousand acres)	Index	Percentage of cotton to total
1856–60	1,692	100	201	100	11.9
1871–75	2,503	148	549	273	21.8
1901–05	3,287	194	1,163	579	35.4
1916–20	3,631	215	1,340	667	36.9

between 1847 and 1879 the cost of transport dropped from Rs. 13 to Rs. 11 a *khandi* (353 kg). As cotton prices increased 4 or 5 fold and transport costs dropped, industrial demand for cotton was easily transmitted to Khandesh.

Following the railway, Indian cotton brokers from Bombay (from the Bhatia caste) sent their agents into Khandesh to buy direct from local dealers and growers. Capital from these firms came from Bombay about six months in advance of the harvest to bind cotton cultivators to time contracts for delivery. Bombay capital also established eleven full steam presses for baling cotton (although the cotton still was ginned or cleaned by hand).[75] Not surprisingly the main cotton market centers in Khandesh were also railway station towns: Bhusaval (the main junction point) Chalisgaon, Jalgaon, Raver, and Savda. In these towns merchants "deal direct with Bombay and other large markets, collecting and exporting cotton, grain, and other local produce, and importing hardware and cotton goods [textiles]."[76] By the late 1870s each year 115,000 bales of cotton at 126 kg to 144 kg went by rail from Khandesh to Bombay.[77] Part of Khandesh's output was also consumed by the Khandesh Spinning and Weaving Company at Jalgaon which used about 970 tons of raw cotton each year on its 220 looms and 18,000 spindles.[78]

During this seventy year period rural society in Khandesh engaged in a massive effort to clear, to plow, and to plant an additional two and one half million acres (one million hectares) of land (the approximate difference between the area cultivated in 1850 and that cultivated in 1920). This increase in permanently tilled land, just over 10,140 km^2, represents nearly four-tenths of the entire surface area (26,107 km^2) of the district. Although economic change of this sort is often portrayed as an unhindered advance for human society, there were costs as well as benefits to this alteration in the environment and society of the district. It is relatively easy to assess the material benefits of increased agricultural productivity—especially for commercially or market oriented crops. It is a bit more difficult to see possible losses.

Certainly the British colonial administrators saw this expansion as an important contribution to the "Moral and Material Progresses" of India under their guidance. Elphinstone, Briggs, Wingate, and their colleagues all had a strong sense of waste. That is, to permit highly fertile land to remain idle and unplowed was wasteful. Any land either untilled or ungrazed was "waste" land. Implicit in virtually all their

assessments of Khandesh is also the notion that a scanty population was necessarily poor and unproductive. At the same time it is not at all certain that the pre-1850 population of Khandesh was impoverished or denied economic opportunity in contemporary terms. For example, in discussing the high revenue assessments of Khandesh, Wingate observed that the rates appeared higher than they really were if the resources of the Khandesh peasant were taken into consideration:

> The cultivators of Khandesh are, from all I could see and learn of their condition, in much more easy circumstances than those of the Deccan. They possess numbers of cattle, which cost them positively nothing, owing to the abundant free pasturage. These provide more than sufficient bullocks for agricultural purposes, so that the cultivators have rarely occasion to purchase any.... Light two-bullock carts are to be found in great numbers in almost every village of Khandesh, and almost every cultivator possesses one or more.... The vast traffic passing through the Province to Bombay, had, since the improvement of the Tul and Chandore Ghauts, brought a great accession of employment to the population of Khandesh. Independent of agriculture, nearly all the carts used in bringing down Cotton and other produce from Berar and Khandesh to Bhewndy belong to Khandesh, and are mostly owned by cultivators there. As soon as the harvest is got in, many of the cultivators either start off for Khamgaon, in Berar, or look about at home for a fare to Bhewndy, from which they seldom return with their carts empty. A trip of this kind occupies them about six weeks, and they usually net from 20 to 25 Rupees, clear of all expenses, if they are at all fortunate. Some of them make two trips before the rains.... In proof of the comparative abundance of money in Khandesh, I may also instance the fact that all labour there, agricultural as well as other, is paid for in cash, whereas in the Deccan and Southern Mahratta Country agricultural labour is almost universally paid for in grain.[79]

What then disappeared, diminished or changed as the Kunbi peasants of Khandesh cut, burnt, plowed, and tilled more land every year?

For most of the region the natural forest cover was dry deciduous monsoon forest. For this type the upper rainfall limit is about 100 cm annually and the lower about 50 cm. Species in this forest can withstand drought for several months in the hot season (when most of the trees lose their leaves for six to eight weeks). The upper canopy of this mixed forest is closed but not dense with a height running at maximum to 18 meters. Canes, palms, and evergreens are absent (or very few in the case of the latter). "An undergrowth of shrubs is usually present but enough light gets in to permit . . . grass growth, and with burning this tends to become more strongly developed.[80] Some bamboo may also be present.

Apparently in the north of Khandesh district in the Satpuda Hills the dry deciduous forest included teak (*Tectona grandis*) in the nineteenth century, as it does today.[81] Much of the Satpuda Hills forest was preserved by vigorous conservation measures undertaken by the Bombay Forest Department beginning

in the late 1870s. Some teak also existed on the plains as well but the more important tree species include khair, catechu and mahua (*Bassia latifolia*), but particularly the *babhul*.

In the Bombay Deccan, dry deciduous forest merges gradually with dry tropical thorn forest at under 30 inches (76 cm) of rainfall. Here the *babhul* (*Acacia arabica*) is most prominent and is associated with black soil conditions in Khandesh. According to the 1880 *Gazetteer:* "*Babhul* . . . *Acacia arabica*, the commonest and most generally useful tree in Khandesh, is very hardy, and grows rapidly in black soil. As a shrub it used to cover all the waste lands of Khandesh. It grows to a considerable size."[82] Commonly *babhul* can reach a mature height under the best alluvial soil conditions of up to fifteen or even eighteen meters, but can dwindle in size to a three meter shrub-like tree in less favorable conditions. It is a gregarious tree which often grows in thick clumps. Its spreading but light foliage is conducive to the growth of grass on the woods floor. The *babhul* is extremely drought resistant due to its long taproot and strong lateral roots. It is also capable of rapid maturation. In Poona the Indian Forest Department estimated the rate of growth at 15–20 years to reach a height of 9–10 meters and a diameter of up to 25 cm.[83] Thus, it would be conceivable that if lands had fallen vacant and out of cultivation in the early nineteenth century, within twenty to thirty years a sizeable regrowth of *babhul* jungle could have occurred.

Contemporary comments, nineteenth century *Gazetteer* descriptions, and twentieth century vegetation classifications all suggest that the land cover in Khandesh was wooded with deciduous trees with varying degrees of density. And that these wooded or jungly areas contained grassy floors—although on the whole the impression is not one of great space as in a savannah.

What then did the rural society of Khandesh give up in return for the clearing of this type of woodland? Some of the more obvious assets include easy access to wood for fuel, building materials or implements. Secondly, and perhaps as important was ready access to grass for cattle grazing or cheap supplies of fodder. By the 1870s cutting grass for cattle feed and wood for fuel was an important component of the livelihood of landless laborers. During February and March at the close of the winter harvest "laborers bring headloads of grass and fuel from waste lands for sale."[84] By 1920 it is doubtful if this expedient were possible for most laborers.

Less obvious, but in the aggregate significant for rural household budgets, was the profusion of what are usually termed "forest products." Most of these products were originally gathered by Bhils in Khandesh and sold, or bartered at a low price either in a semi- or fully-processed state to the consumer or to peddlers and small dealers. Thus the *moha* (*Bassia latifolia*) "found all over Khandesh" had "a pulpy bell-shaped flower, which, when dried, . . . is distilled into the common spirit of the country."[85] (This liquor was not subject to excise tax control as were other narcotics.) Other products included: a wide range of drugs and medicines; dyes, and tannins for leather working from bark of various trees; fibers for ropes and nets; etc. When supplies of these products diminished and grew more expensive

there was a cost. Nor should we overlook the importance of the woodland as the ultimate refuge and source of some food for man and cattle in the onset of dearth.

One of the most important costs attached to the clearing of the Khandesh jungle was not immediately apparent. This was the longer term impact of forcing a number of specialized groups from their traditional livelihood onto the land. Among these were the greater number of the 120,000 Bhils (1872 census) who found their resources receding as did the jungle. Forest Department restrictions also pushed them out of the reserved forest tracts in the Satpuda hills. In the period of agricultural expansion the Kunbi peasantry clearly benefitted by a growing pool of agricultural labor which in large measure was formed by dispossessed hillmen. Over the longer period, rural society in Khandesh is beginning to pay a considerable price for this change in the social and economic role of the Bhils.[86]

IV

Throughout the Deccan and the Karnatak the process of expansion of cultivation during the second half of the nineteenth century brought both benefits and costs. The benefits of expanding production per capita are easy for us to understand because they are the very stuff of economic progress. Our usual conceptual models make it somewhat more difficult to grasp in a systematic fashion the costs of expanding cultivation. It may be easiest to overcome this problem if we habitually use the framework developed by Ester Boserup in *The Conditions of Agricultural Growth* (1965). Boserup argues that *all* the land in an inhabited region contributes to the support of the agriculturists in the region. At one extreme, where slash and burn cultivation is practiced, only 5 percent or less of the available land (in a stable system) is *cultivated* each year. But the remainder of the land, lying under *long fallow*, is regaining its capacity to bear crops again for a season or two. At the same time, the land under long fallow supports animals and wild plants that supplement the diets of the primitive cultivators. Slash and burn cultivation can give very high yields per hour of labor *if* enough land is available to take advantage of nature's regenerative powers. When too little land is available, and no more can be gained, cultivators must either switch to a more intensive form of cultivation (requiring harder work) or watch their land erode if they try to cultivate it too often with the old techniques.[87] This is the dilemma that faces every agricultural system—as more land is cultivated more often, agriculturists must either work harder to maintain yields per acre or watch the destruction of their soils.

In the Deccan and the Karnatak most cultivators in the first half of the nineteenth century practiced some version of short fallow cultivation with part of their land fallowed each season. They also relied, to differing degrees, on the uncultivated forest and scrub to contribute to their overall welfare by providing grazing lands, timber for buildings and implements, firewood, and wild foods. As cultivation expanded, these agriculturists had to work harder: they stall fed their

draught animals and kept the minimum necessary number, and they either fertilized more or faced declining yields. Their options, particularly in times of stress, were reduced: neither could they shift from settled agriculture to pastoralism (lacking both animals and adequate open lands), nor could they rely heavily on wild foods. Their interactions with the larger society became more complex and more risky: they bought grass, firewood, food, draught animals that once they might have collected or raised without cash outlays. The government became their refuge in times of stress. In sum, expansion of cultivation forced even agriculturists, the main beneficiaries of this expansion, to alter the way they organized their lives. For the tribal peoples whose livelihood required large expanses of uncultivated land, the benefits (if such there were) were fewer and the costs higher.

6. Colonization, Commercial Agriculture, and the Destruction of the Deltaic Rainforests of British Burma in the Late Nineteenth Century

Michael Adas

The Forests of Burma and the Advance of British Imperial Control

Centuries before British merchants and timber entrepreneurs began to cast covetous eyes on the vast and highly variegated forests of the region that makes up the contemporary nation of Burma, the forest products of the area were renowned throughout much of the Southeast Asian segment of the great Asiatic trading network. As early as the fifteenth century, Asian and European travellers commented on the importance of the kingdom of Pegu, which then ruled the coastal areas of the Irrawaddy delta region, as a shipbuilding and ship-exporting center. As the Portuguese traveller, Tomé Pires, observed, this preeminence in ship construction and export was based on an abundance of woods suitable for shipbuilding, especially teak (*Tectona grandis*) and ironwood (*Xylia dolabriformis*), in the forests within and bordering on the kindgom of Pegu. In addition to ships and timber, Burma was known as a major producer of lac, cutch, sandlewood, and other forest products in high demand overseas.[1]

The importance of teak and other forest products in the precolonial era is also indicated by the fact that forests were traditionally declared the property and exclusive preserves of Burmese monarchs. The rulers of the last Burman dynasty, the Konbaungs, went beyond these general claims (that were, of course, difficult to enforce against peasants who lived on the edge of forest areas and shifting cultivators who lived within the forest zones) by reserving to themselves the monopoly over the cutting and sale of teak and other valuable hardwood trees. Because it was Burma's major export in the precolonial period, duties on teak proved a major source of government revenue in the early decades of Konbaung rule.[2] From the 1840s, the farming out of forest areas to British entrepreneurs became a lucrative, but increasingly troublesome, source of revenue both for Burman rulers like Mindon and ministers of state like the Yanaung Mintha who entered into contracts with British merchants mainly for personal gain.[3]

Interest in Burma's forest resources was also to prove one of the fatal links that contributed to a long series of confrontations between the British, based in their expanding Indian Empire to the west and north, and the Burmans, who grew more and more anxious to limit contacts with the assertive British and to restrict their

activities within the Konbaung domains. Due to the depletion of the oak forests in England by the end of the eighteenth century, the British grew increasingly concerned to find new sources and kinds of hardwoods for the extensive ship construction that was essential to the maintainence of their global naval supremacy. After unregulated and often highly destructive exploitation of the teak forests of Malabar and other areas on the western coast of India had greatly diminished the already limited supplies of timber in these regions, the British turned to the fabled teak of Burma and Siam which proved ideal for the ship size and design of the day.[4] Though the British desire to harvest teak in the forests of Tenasserim and Martaban had little to do with the outbreak of the first Anglo-Burman war in 1824,[5] within a year after the British annexation of the Tenasserim province in 1826, the superintendent of the Calcutta Botanical Gardens, Dr. Wallich, was sent to study the forests of the area and estimate their potential for teak and hardwood production. After extensive travel in the newly acquired areas. Wallich concluded, "our ceded Provinces are second to no other part of the Honourable Company's possessions with which I am acquainted; in point of timber forests they stand altogether unrivalled."[6]

In the decades that followed, Wallich's hopes for strict government monopolies over and close regulation of the extraction of valuable timbers such as teak, ironwood, and *thengan* (*Hopea odorata*) went unrealized as the deciduous monsoon forests of eastern Tenasserim were opened to unchecked exploitation by private European contractors and their Burmese agents. In the absence of government supervision and in the pursuit of the highest possible profits, these speculators ravaged the Tenasserim forests—overcropping, cutting down young trees, and making no effort to replant the areas which they worked.[7] Having decimated the teak stands of Tenasserim in the 1830s and 1840s, the British timber merchants began to exploit the forests that fringed the Sittang and Salween river valleys, often employing Burmese agents to direct harvest operations in Burman controlled areas. The quarrels between British merchants at Moulmein and Konbaung officials that resulted from the extension of commercial cutting into the Burman domains contributed to the onset of the second Anglo-Burman war and the annexation of the Irrawaddy delta region (Lower Burma) to the Indian Empire in 1852.[8] After 1852, the forests of Lower Burma were thrown open to private companies, which soon sought to extend their operations into the rump Konbaung state in Upper Burma as well. Again in the 1880s, quarrels between Burman officials and British timber merchants, specifically the agents of the Bombay-Burma Trading Corporation, heightened the mounting tensions that led to the final Anglo-Burman War and the British annexation of the remaining portions of the Burman kingdom.[9]

From the 1840s onward, the efforts of concerned British officials to set aside forest reserves and regulate commercial cutting in Burma were concentrated almost exclusively on the evergreen rainforest and deciduous monsoon forest areas where European speculators had centered their activities and forest depletion

had been the most severe. After several attempts by British officials assigned to Burma to establish effective safeguards to protect the invaluable forest tracts of the newly acquired province were overruled by their superiors in Calcutta or London or frustrated by the lobbying efforts of merchant groups based in India, major conservation efforts were mounted in Burma as a result of the 1855 memorandum issued by Lord Dalhousie, the Governor-General of India. The memorandum declared all of the teak trees and a number of other species the property of the Government of India and made it a criminal act to cut them without government permission. Dalhousie also called for the establishment of a Forest Department in Burma which began in the 1860s and 1870s to regulate leases to private timber firms, to demarcate permanent forest reserves, to limit the forest areas worked by shifting cultivators whose slash and burn methods of cultivation were viewed as extremely harmful to Burma's forests by British administrators, and to take the first steps necessary to conserve and replenish the province's forest resources. In 1894, as a result of a policy applied to India as a whole, special protected forest tracts were set aside from those that could be worked commercially under government supervision. After 1923 the Forest Department formed a separate ministry in the Government of Burma and employed over two thousand rangers and foresters.[10] The considerable success of British conservation efforts in the areas set aside as reserves is amply demonstrated by a 1956 Food and Agriculture Organization estimate of the United Nations that 39 million ha or nearly 58 percent of the total land area of the modern state of Burma was covered with forests.[11]

While British officials struggled to set aside large areas of the Burma highland and monsoon forests as protected reserves, they adopted a completely opposite policy with regard to the great evergreen monsoon forests of the Irrawaddy delta lowlands that had come under British rule in 1852. From the first months after the British annexation of the area to the Indian Empire, the colonizers pursued policies aimed at bringing this vast area under cultivation with little thought for the forests that covered much of the delta whose depletion was inevitable if their designs were to be realized.

The success of British efforts to transform the Irrawaddy delta wilderness into a productive agricultural zone, is evidenced by the fact that Lower Burma had become the world's greatest rice exporting area by the end of the nineteenth century. This enormous increase in agricultural productivity has diverted scholarly attention from the cost of this transformation in terms of the rain forest and wildlife resources that were lost as "jungles" were cleared to grow rice in great quantities for the market. No mention is made of the destruction of the lowland delta forests in recent studies of British conservation efforts in colonial Burma. Little, if anything, is said of this process in the many works which deal with the agrarian development of the region under British rule—including those that are highly critical of the policies followed by the colonial administration and their social and economic consequences.[12] Only the growing concern in recent decades

over the effects of the depletion of the world's tropical rainforests renders an analysis of the deforestation of the Irrawaddy delta (hitherto regarded simply as a side effect of economic growth) a desirable, if not necessary, task. Central to that analysis of the process and consequences of deforestation in a specific region is a more general question relating to alternatives to the choice between preserving valuable tropical forests or encouraging the spread of cultivation, whether for subsistence or market production.

The Forest Environment of the Irrawaddy Delta Region

Most of the 98,000 square kilometers that the British annexed to the Indian Empire after their victory in the second Anglo-Burman war in 1852 was well watered, lowland terrain that was ideal for agriculture. For millenia the mighty Irrawaddy river had carried rich alluvium from the highlands of south China and the Southeast Asian mainland interior down to the deltaic plains that had in part been formed in the Bay of Bengal by this massive transfer of fertile soil. From the flatlands that were innundated by as much as 330 cm of rainfall per annum in the lower reaches of the delta to the drier, but still well watered, districts of Henzada and Prome to the north, two major types of forest developed. Along the coast and the edges of the lower sections of the nine main branches of the Irrawaddy, as well as fringing the myriad small islands that were formed by *chaungs* or creeks fed by the tides, dense mangrove or *Rhizophora* forests formed. In the brackish waters of the mangrove belt, which played a vital role in the advance and consolidation of the alluvial delta, a wide variety of tree, vine, and plant species thrived. The mangrove forests, in which the dominant trees ranged from twelve to twenty-one meters in height, were a major source of timber for construction, firewood, and charcoal for the inhabitants of the lower delta. In addition, the various species of palm which had adapted to the swamp environment, particularly the *dhani* (*Nipa fruticans*), were used for thatch in house construction.[13]

Inland from the coastal swamps, in the low lying areas that formed the centers of the saucerlike islands of the lower delta and throughout the flat expanse of the upper Irrawaddy plains, evergreen rain forests covered the landscape in the pre-British period. Dominated by *kanazo* trees (*Heritiera fomes*) that sometimes reached a height of over forty-five meters in freshwater areas, these forests, like the mangrove swamps, displayed a wide variety of tree and plant species. Initially the *kanazo* forest areas had been occupied by lower-growing kambala (*Sonneratia dipetala*) trees which were the first major tree species to appear in the new lands formed by the silt deposits laid down by the Irrawaddy river. *Kanazo* forests displayed two main patterns of growth. In areas away from the coast, where tidal waters were less saline, *kanazo* trees grew to their greatest height, but the forest as a whole tended to be less dense. Here the *kanazo* was associated with a wide variety of other trees, ranging from the *pantagama* (*Amoora cuculata*) and khaya

(*Acantus ilicifolius*) to the towering *thabaw* (*Pandanus foetidus*) and the increasingly dominant *myinga* (*Cynametra ramiflora*) at higher elevations. Nearer the coast, where the tidal waters were brackish, the *kanazo* trees were shorter, but grew in thicker stands. Here they were associated with different and fewer tree species, particularly the kambala and mangrove, and a wide variety of palms and bamboo grasses.

These great forests were sources of timber for construction, firewood and charcoal, in addition to thatch and bamboo that were preferred by the Burmese over hardwoods for housebuilding over most of the delta. The forests also provided rattan for roping, bamboos for spears, arrows, and household utensils, resin, gums, camphor and lac, as well as important dietary staples and food supplements. The *kanazo* forests provided a suitable habitat for diverse forms of animal life, ranging from elephants, tigers, and wild buffalo, to snakes and wildfowl.[14]

Those delta areas that were not covered by rain forest or mangrove swamps and had not yet been brought under cultivation were overgrown with tall, thick *kaing* (*Saccharum spontaneum*) or elephant grass. Though it grew to a height of up to three meters, the grass was more easily cleared than *kanazo* forest, and thus *kaing* areas were normally the first to be cultivated in newly settled areas.

The poor quality of statistics available for the pre-British period make it difficult to determine with any degree of accuracy how much land was cultivated or covered with forest or *kaing* grass before the area was transformed into a booming rice export economy in the decades after 1852. The extent of the evergreen rainforests that once covered much of the region is thus unknown, and therefore the ecological consequences of their depletion are difficult to quantify with any precision. The best sources on the condition of the delta in the pre-British period are the accounts of European travelers who passed through Lower Burma on their way to the Konbaung court in Upper Burma in the late eighteenth and early nineteenth century, and a detailed topographical map of Lower Burma that was drawn by Ferdinand Fitzroy in 1862. When combined with information gleaned from the Burmese *sittans*, or revenue inquests, these sources allow us to locate the areas where cultivation was concentrated and make an approximate estimate as to how much land had been brought into agricultural production and how much remained in its wild state at the time of the British annexation. They also make it possible to locate the areas where rainforest growth was concentrated in the Konbaung era.

According to these sources, cultivation in Lower Burma in the decades before 1852 was confined for the most part to areas along the upper Irrawaddy river between and near major towns like Thayetmyo, Prome, and Henzada. Extensive tracts of cultivated land were also reported in the area around Bassein town and north along the Bassein river, in the areas surrounding the towns of Rangoon (though the sources give varying impressions of conditions in this area) and Myaungmya in the lower delta, and around Toungoo town in the Sittang river

valley. On the basis of statistics compiled in 1856–57, it is possible to estimate that the total area cultivated in Lower Burma was over 264,000 ha. If cropped lands not listed due to underreporting by Burmese officials (which was widespread in this period) are included, the total cultivated area must have equalled at least 320,000 ha. The rest of the delta region was covered with forests or *kaing* grass plains, and large tracts, especially along the Irrawaddy river, were flooded during the monsoon season due to lack of embankments. These latter tracts were unfit for habitation for several months of the year.[15]

The area covered by evergreen rain forest or mangrove swamp when the British annexed the delta appears to have been a great deal larger than that which had been brought under cultivation. By comparing the Fitzroy map with travelers' accounts, the *Sittans*, and passages from land revenue settlement reports, which were compiled decades after 1852 but commented on the condition of the areas surveyed when they were first settled, the most heavily forested areas of Lower Burma can be identified. Such a comparison indicates that most of the Bassein, Myaungmya, Maubin, and Pyapon districts in the west and central portions of the lower delta were covered with *kanazo* forest inland and mangrove swamps near the coast, though low-lying areas prone to flooding were overgrown by *kaing* grass.[16] A series of special surveys carried out by British officials in 1855 revealed that the area north of Rangoon town along the Panlang creek was overgrown with *kaing* grass with scattered patches of forest. Some decades earlier John Crawfurd had reported that the land away from the river was covered with a "thick" and continuous forest.[17] The southern stretches of the Tharrawaddy district were also covered with thick forest which gave way in places to some cultivation. As one proceeded up the Irrawaddy, alternating stretches of *kaing* grass and thick "jungle" dominated the landscape. Between Rangoon and Pegu town to the northeast along the Pegu river similar conditions prevailed, with dense forests near Rangoon giving way to more cultivated tracts as one approached Pegu.[18]

According to surveys made in 1886–87, after three decades of feverish agrarian expansion, just over 22 percent of the land area of Lower Burma was cultivated or fallow, with the greatest concentration of cropped hectares in the upper delta and in the *kwins* or circles around Rangoon town. In the west and central delta the percentage of cultivated land had fallen to 10 percent. The area set aside for forest reserves, almost all of it deciduous monsoon woodland, equalled about 16 percent of the total land area of Lower Burma. The remainder of the land area of the delta region, some 62 percent, was *kaing* grass plains or *kanazo* and mangrove forest. Using a low estimate that at least one half of this area was covered by *kanazo* forest, or some 31 percent of the total land area of Lower Burma, excluding Toungoo and Thaton which were not listed, then the area that still remained under evergreen rain forest after decades of deforestation and new settlement was approximately three million hectares. If *kanazo* forest areas in Toungoo and Thaton are added and areas not cultivated but forested in the pre-British period are included, the area covered by deltic monsoon forests in the precolonial period would have equalled between 3.5 and four million hectares.[19]

Agrarian Expansion and the Deforestation of the Lowland Evergreen Forests of Burma

In contrast to the concern shown by British officials for the protection and replanting of the deciduous monsoon forests, particularly stands of teak and ironwood, colonial administrators regarded the *kanazo* forests of the Irrawaddy delta plains as impediments: barriers to economic development that must be removed. Parallelling a process that was occurring across the globe, the world market—in this instance a growing, and apparently insatiable, demand for rice—had become the arbiter of land values in colonial Burma. The following description of the area that had suddenly come under British control in 1852 is typical of official attitudes throughout the British period: "[Lower Burma] consist[s] of low lands covered with elephant grass, scrub and red[?] jungle which is waist deep for more than six months in the year, relieved by thicklier [sic] jungle nearer the sea parallel to which a belt of forest trees form a pleasant contrast to the apparently interminable and notorious waste lands."[20] In the British view the presence of so much wilderness or "wasteland" in an area that had long been occupied by Burmans, Mons, and other groups was proof of both the injurious effects of despotic "Asiatic" government, which numerous travellers had depicted at its lurid worst in Burma, and the "slothful" nature of the Burmese peoples who had shown so little initiative in bringing the area into production. As one official wrote in 1855–56: "The difficulty in raising the masses from the sloth of ages, would in any case have been considerable. . . . As the feeling of distrust among the people subsided, the country began to feel the benefit of the change of Government and the machinery having once been set in motion, the improvement has been rapid."[21]

British administrators had little doubt as to what needed to be done. Reflecting a sentiment that was widespread among European leaders and writers in the late-nineteenth century age of high imperialism,[22] they concluded that if the Burmese would not develop their own lands, it was the mission of the more progressive and energetic British to prod them into action and provide the necessary governmental structure, communications network, and market incentives that were seen as essential to economic growth. As Captain McMahon, an early settlement officer, wrote in the 1860s: "We are dealing with a semi-civilized race; we should assist them in advancing themselves; they cannot without our assistance; we should induce them—I go further, we should press them—to accept our system beneficial to advancement; our superiority as a nation warrants us to do this."[23]

Despite the allegedly "slothful" nature of their Burmese subjects, British officials were confident from the first years of their rule in Lower Burma that good government and the suitability of the delta region for the cultivation of a wide range of export crops would soon result in the clearing of forests and the planting of marketable and revenue-producing crops. By 1857, the Governor General of

India, Lord Dalhousie, who had played a major role in the annexation of the delta region to the Indian Empire, noted that the increasing revenues, internal peace (which was in fact far from established at this point), and rising migration into Lower Burma all "bear undeniable testimony to its prosperity and to the vast improvement which the introduction of British Rule, and the efficiency of the administration have effected."[24]

One would, of course, be guilty of the most blatant ex post facto reasoning if he were to judge British officials like Dalhousie and McMahon harshly for their complete disregard of the forests that their agrarian policies had doomed to destruction. Though, due to the benefit of hindsight and our better (but by no means complete) understanding of the social and ecological consequences of forest destruction, we can regret their oversight, it would be absurd to hold them accountable for it. This is all the more true in view of the fact that they were quite correct in seeing the forests as having been a major barrier to the settlement and development of the Irrawaddy delta area in the precolonial era. The great labor involved in clearing the rain forest and lack of incentives, either social or economic, to do so had been key factors discouraging migration to and settlement in Lower Burma before the British period.

The importance of these barriers was especially apparent in the Konbaung era when both the heavily populated and drought prone areas of the Dry Zone of Upper Burma and the sparsely inhabited delta were ruled by the same dynasty. Though the Konbaung monarchs sought to encourage the migration of cultivators to the delta,[25] until the British period the formidable hardships involved in migrating to what the Burmans considered a backward and uncivilized frontier area,[26] and the lack of incentives to do so, had resulted in only a very limited southward flow. In addition to the forests which had to be cleared if the land was to be permanently cultivated, new settlers faced a number of hazards: wild animals which thrived in the forest and *kaing* grass environment; periodic monsoon flooding over large tracts of the delta that were not protected by embankments; decimation by dysentery, malaria, and other diseases endemic to the area, and in the case of malaria epidemic in newly cleared districts; and the onslaughts of insects, wild pigs, deer, crabs, rats, and a multitude of wild birds that delighted in devouring the newly planted crops of migrant settlers.[27] Not only were credit sources, which were essential to agrarian expansion, extremely limited in precolonial Burma, but marketing outlets were stunted by a Konbaung ban on overseas exports and government monopoly control over surplus production, which was mainly shipped to Upper Burma for sale and storage in state granaries designed to relieve periodic crop shortages in the Dry Zone.[28] Konbaung sumptuary laws relating to dress and housing, which greatly restricted the consumer amenities that cultivators might purchase after the sale of their surplus production, also discouraged the extension of cultivation or efforts to improve the productivity of fields already cropped.[29]

To condemn the British for policies that would lead to the destruction of the deltaic rainforests would not only hold them accountable for consequences that

the state of contemporary knowledge and awareness could not have allowed them to forsee, it would also obscure the very positive and benign (if paternalistic) thrust of the policies they actually pursued in Lower Burma. As I have argued, the British had long been aware of the ideal conditions the delta provided for agricultural production in terms of the fertility of its soil, the regularity and abundance of its rainfall and riverine water supply, and the quality of its climate. Though motivated in large part by the prospect of increased government revenues, the British also sought to encourage agrarian expansion in Lower Burma to benefit the great majority of their new Burmese subjects, as well as the Indians in the densely populated and famine-prone districts across the Bay of Bengal. Burma's potential as a rice granary that could serve to check famines in India proper was clearly recognized by British officials, as was the possibility of encouraging migration from overpopulated districts in India to the sparsely populated, but potentially highly productive province.[30] Equally important, British officials viewed the vast and rich, but scantily populated, delta region as something of a *tabula rasa*—a frontier zone in which decades of frustrated policies and attempts to create a viable peasant proprietor and market oriented agrarian system in India proper could at last be realized.

In pursuit of these ends, in the 1850s and 1860s British administrators concentrated on introducing systems of land tenure and taxation that would attract peasant migrants to Lower Burma, permit them to gain and hold title to the lands that they cleared from the "wilderness," and at the same time prevent the rise of the sort of landlord class that had so often blocked the effective implementation of their designs for social and economic reforms in rural India.[31] Contrary to our notions about the dominance of laissez-faire principles in government circles in the mid-nineteenth century, British administrators intervened directly and systematically to build a peasant proprietor based, export economy in Lower Burma. Immediately after 1852, they lifted the ban on the export of rice and other products imposed by the Konbaung monarchs, abrogated sumptuary laws, and negotiated an end to Konbaung restrictions on migration from Upper Burma. In the next decades the government financed the building of embankments to prevent flooding over large areas of the delta, and built roads, railways and canals to transport settlers to areas to be opened up to cultivation and carry to the mills and wharves of Rangoon and other port towns the products of these pioneering cultivators' labors. The colonial government also sought to improve port facilities and encourage private steamship lines to extend their services to Burma for both human migrants and export and import goods.[32]

Beyond these measures to build up the overall economic infrastructure of the delta region, the government gave direct assistance to specific groups of needy settlers, attempted to introduce better implements, such as the Malay plough, and supplied water buffalos to cultivators clearing new lands, which the latter contracted to pay for out of the proceeds from the sale of the surplus of their first harvests.[33] Equally remarkably, in the early years of British rule the colonial regime made efforts to avert the growth of a monocrop economy, which in

retrospect has proven one of the greatest liabilities of the colonial era for the new nations of Asia and Africa. Through experimental stations and model farms, the British sought to encourage the cultivation by Burmese peasants of a variety of export crops, including cotton, tobacco, and sugar cane.[34] Unfortunately, their efforts met with little success because the Burmese showed virtually no interest in growing any market crop other than their staple, rice, which thrived in the delta climate and soil. In contrast to many other colonized areas where forced labor or special taxes were required to induce cultivators to produce for the market, in Burma the peasantry willingly and enthusiastically took up the cultivation of rice for the export market. A steadily increasing overseas demand and the influx of cheap consumer goods which the cultivator could purchase with the cash he earned for his surplus production led to the rapid extension of cultivation throughout Lower Burma in the last decades of the nineteenth century. Government land policies which strongly favored the smallholder meant that peasant producers were normally well rewarded for their labors at least in the early decades of British rule.[35]

British land policies and measures to stimulate commercial production in Lower Burma succeeded in attracting large numbers of migrants to the delta from both Upper Burma and India proper. The population of Lower Burma as a whole rose from less than 1,500,000 in 1852 to over 4,000,000 by 1900. This increase was fed by both a high rate of natural increase among the population resident in the delta and a steady flow of Burmese in-migrants and Indian immigrants. At the time of the 1901 census, over 400,000 Burmese migrants were living in the districts of the delta. Though Indian migration to Lower Burma peaked in the first decades of the twentieth century, by 1900 there were nearly 300,000 Indians in the delta region, compared to a few thousand in the Konbaung period. Delta towns, particularly Rangoon where rice milling and marketing and the colonial bureaucracy were centered, also grew rapidly. The land required to house and support this growing population itself meant the clearing and planting of tens of thousands of hectares of rainforest and *kaing* grass plains. As the British had hoped, however, migrants poured into the delta primarily to engage in the production of rice for the world market in order to share the profits that were to be made during the late nineteenth century boom in the rice trade.[36] Dramatic increases in surplus production for the rapidly expanding export market of Lower Burma resulted in deforestation on a much greater scale than subsistence production would have required. Market demand, much more than subsistence needs, doomed the *kanazo* rainforests of the Irrawaddy delta.

Colonial administrators, Indian migrants, and Burmese peasants all became so caught up in the rewarding process of clearing, cropping, marketing, milling, and exporting rice that no one, not even the sharpest critics of British policy in Burma like J. S. Furnivall, gave a thought to the destruction of the great rainforests that was a central consequence of the delta's development. As one administrator observed as early as 1856–57: "The whole population is intent upon increasing the production of their staple cereal—everywhere old neglected arable fields are being

reclaimed and large tracts of virgin soil are for the first time being cleared of the primitive forest."[37] To participants at all levels the forest was seen only as an obstacle. To British officials it was a striking symbol of precolonial backwardness, ignorance, and neglect. Its tranformation into rice paddies was repeatedly cited by colonial administrators as clear proof of the superiority of European over indigenous rule: of the benefits of colonialism and participation in the capitalist, market oriented global economy.

The extension of cultivation proceeded unevenly, affecting different areas at different times, and gathered momentum in the last decades of the nineteenth century.[38] Before 1880, most of the new lands that were brought under cultivation were located in the northern districts of the delta (Prome, Henzada, and Tharrawaddy) and around the towns of Rangoon, Bassein and Pegu which were the most heavily settled areas in the precolonial era. A substantial percentage of the increase in cropped area in this period was due to the reclamation of fallow lands or those that had once been cultivated and were covered only by secondary forest growth rather than true rainforest. In addition, the areas where expansion was concentrated were those that precolonial accounts indicated were overgrown with *kaing* grass or seasonally flooded swamps. The available accounts from the early colonial period also indicate a preference on the part of pioneer settlers for areas other than those occupied by *kanazo* forest which was costly in terms of time and labor to clear.

In the 1880s, and especially the 1890s, there was a decisive shift in the areas where the extension of cultivation was concentrated to the heavily forested districts of the lower, central delta region. In this period the addition of over 1,200,000 hectares of cultivated land in Lower Burma was largely due to the clearing of virgin lands, predominately forest areas, and not to the reclamation of once occupied or fallow tracts. The process of settlement and forest clearance was so swift and complete that settlement officers in the first decades of the twentieth century wrote of the once heavily forested districts of the lower delta that "scarce a tree was to be seen", even on the water's edge where land hungry peasants had cleared the mangrove swamps to plant rice. Only in the southernmost tracts of the Myaungmya district, for example, did any forest remain, and there—as settlement officers recounted with no little satisfaction—"the sound of the pioneer's axe is heard daily as the forests are cleared to prepare for the rice crop."[39] By the first decades of the twentieth century, the *kanazo* forests of the Irrawaddy delta had virtually disappeared. No precise statistics relating to the forests that remained are available (in itself testimony to the lack of government concern for their fate), but an eminent British geographer estimated in the early 1920s that only "several hundreds" of square miles or several hundred thousand hectares were left standing in all of Lower Burma.[40]

Although they fell victim to agrarian expansion, the rainforests that once covered large portions of the delta proved the most resistant of all areas to settlement and required much greater investments of time and labor to bring under cultivation than *kaing* grass plains or formerly occupied areas covered with secondary growth. Normally, settlers opening up new areas, cleared and cultivated

less densely vegetated higher ground and *kaing* areas first, even though they were well aware that the soil was much less fertile in these tracts than in the low lying areas that were covered with *kanazo* forest. The brush or *kaing* was burnt off and, in the early years of settlement, the paddy was often broadcast sown, rather than transplanted, because a high yield was not anticipated. When the *kanazo* areas were finally taken on, they were normally flooded for several seasons—in some cases the building of special bunds was required for this task—in order to kill the larger trees by suffocating the aerial roots and to induce root rotting. Trunks and large branches were used for construction or firewood, but roots had to be laboriously hacked out of the ground and hauled from the fields. Frequently, sugar cane rather than paddy was planted in the flooded fields during the first years of cropping. In the lower delta, rice was normally sown broadcast after the tree stumps and roots had been removed, which was at times as long as ten to fifteen years after the land was first cleared. Cultivators switched to transplanting only after the deterioration of the soil, due to the lack of manuring and constant cropping, had begun to seriously affect their output. *Kanazo* tracts did not normally reach full productivity until the seventh or eighth year of cropping in contrast to the *kaing* areas which did so in the third or fourth.[41]

The rather primitive and decidedly uninnovative techniques of forest and *kaing* clearing and paddy cultivation were typical of the process of agrarian development in Lower Burma as a whole. The dramatic growth of the rice-export economy in colonial Burma was based almost wholly on "horizontal" expansion or the extension of cultivation to new lands. Though production was geared to the market rather than subsistence, as it had been primarily oriented in the precolonial era, and paddy was transplanted rather than broadcast sown on a much higher proportion of cultivated area than had been the case in the Konbaung period, in-depth innovations in cropping techniques or agricultural technology were limited to very small numbers of cultivators who adopted new ploughs or introduced new varieties of seeds. When the "open" lands ran out in the early 1900s, all strata of the colonial society paid a heavy price for their failure to experiment and innovate and in most cases their refusal to replenish the soil with fertilizers.[42] The greatest price was paid, however, by the delta rainforests that were sacrificed to provide the new lands that were essential to the continued growth of an economy that was based on constant inputs of land and labor, rather than technological innovation. Assuming that well over three million hectares were covered with *kanazo* forest when the British annexed the delta in 1852, agrarian development in Lower Burma resulted in the deforestation of at least three million hectares of *kanazo* forest alone, plus uncounted hectares of mangrove swamp.

The Consequences of Deforestation in Burma

We have only begun to understand the long term consequences for Burma's ecosystem and that of the entire globe of the deforestation of regions such as the

Irrawaddy delta area. Some of the short term effects, however, are clearly documented, while it is possible to suggest others that are not specifically recorded by colonial recordskeepers simply because they were oblivious to them.

Malarial epidemics were among the most immediate adverse effects of widespread deforestation in Lower Burma. Though malaria was (and is) endemic to most areas of deltaic Burma, it became epidemic in newly cleared areas. Settlement officers reported that entire families and at times whole villages were wiped out attempting to clear and cultivate forested tracts in the lower, central delta. Malaria often debilitated new settlers to the point where they could not work their lands and were thus forced to abandon areas cleared with great effort, or to borrow the money needed to hire laborers and see them through to the time when they had sufficiently recovered their strength to resume work in the fields. For many cultivators the latter option meant the beginning of ever increasing indebtedness and often the loss of their hard won lands to moneylenders or land grabbers. Settlement officers also observed that after an area had been worked for some time the death rate and general malaise of the population declined. They attributed this drop to immunities developed by settlers who survived the initial malarial attacks and a decrease in the number of mosquito vectors as stagnant ponds were drained and brought under cultivation. Recent research bears out their observations, for it has been shown that the *Anopheles hyrcanus* mosquito, which is the principal vector in Lower Burma, becomes extremely prolific in areas where forest has recently been cleared. If such areas are in tropical climates, the species has been known to produce serious malarial epidemics.[43]

The destruction of the delta's forests also meant a loss of the timber, bamboo, palm, and vine derived products that were essential to peasant households and had once been obtained free in the forest areas. Coupled with the government's closure of deciduous monsoon forest areas, the depletion of the *kanazo* woodlands forced cultivators to turn increasingly to market sources for building materials, wood for implements and even firewood. Though this market involvement may have been viewed favorably by colonial officials, it was certainly a factor in the decline in the standard of living of the great mass of Lower Burma's cultivators in the first decades of the twentieth century.[44] In fact, lack of access to the many products once gleaned in the forest was one of the causes of the agrarian unrest that signaled the breakdown of the peasant proprietor based economy in Burma in the last decades of British rule.[45] The destruction of the mangrove forests may also have contributed to the flooding that was recorded in many areas of the lower delta in the 1890s and early 1900s, to the decline of the fishing industry that once flourished in Lower Burma, and to the virtual extinction of thatch making and other handicraft industries (whose decline or disruption in the colonial era has been suggested but not yet fully studied).[46]

Because most of the forest land cleared in the Irrawaddy delta was immediately brought under wet rice cultivation, many of the negative effects of forest destruction that have occured in densely populated areas such as Java, China, and India or in the hilly tracts of monsoon Asia were not significant in Lower Burma. The

cultivation of wet rice meant that most of the area cleared for agriculture was protected by water cover for much of the year. It also meant that nutrients carried by the Irrawaddy and Sittang rivers to the delta lowlands were supplied to cultivated areas on a regular basis,[47] except in areas where embankments designed to prevent flooding also blocked nutrient bearing river waters from reaching the fields. It can be argued that the sharp decline in soil fertility recorded after decades of cultivation in tracts not irrigated by river water was one of the most serious adverse effects of the manner in which Lower Burma was brought into agricultural production. Like forest clearing, poorly designed embankment and irrigation systems can lead to rapid soil deterioration in the tropics. Embankments and water cover, however, protected the areas cleared of forest from leaching and, ultimately, from the widespread laterization that has occurred in similar tropical lowland environments where extensive forest clearing and lack of water cover has forced the abandonment of densely populated centers of civilization.[48]

The uniformly flat nature of the delta plains and the continuous cultivation of most areas cleared of *kanazo* forests meant that soil erosion was not a serious consequence of woodland destruction in Lower Burma, as it has been in Java, India, and China. Though forest clearing in Lower Burma may have contributed to severe drought and famine which struck the Dry Zone in Upper Burma in the late 1890s[49], and over a larger period to the gradual expansion of the Dry Zone area, little definite evidence of a connection between these processes has been produced to date. The destruction of the *kanazo* forest, however, certainly had a devastating effect on the wildlife of Lower Burma since the habitat of large mammals—such as tigers and elephants—and smaller animals, as well as insects, was destroyed by fire and axe as the delta was brought under cultivation.

The consequences of forest clearing in terms of plant life were, if anything, even more devastating. As many writers have observed,[50] tropical rainforests are the richest and most complex of all ecological zones in terms of their plant life. Though the forests of Lower Burma contain fewer species than areas further to the south in Malaya and Indonesia, they still nurture a great variety of plant species, some of which are found in few other areas of the globe. For example, British botanists have estimated that the evergreen rainforests of Lower Burma contained as many as 300 to 350 tree species within 26 square kilometers.[51] As Longman and Jenik have argued, in terms of total organic matter or biomass generated and the net primary production of plant life, no type of vegetation system is superior to evergreen rainforests of the kind that were destroyed in the Irrawaddy delta.[52] As in other areas of Southeast Asia, Africa, and Latin America, the destruction of these great forests foreclosed important resource options that might have proven highly beneficial to man. The preservation and wise use of their rare and delicate plant life could contribute significantly to the development of new drugs and medicines, ecologically safe pesticides, and a wide range of chemical compounds useful to man.[53] The depletion of the forests also means a loss of valuable woods and timber that, if conserved and cropped judiciously, could provide vital materials for construction, paper, furnishings, and tools.[54] In addition, rainforests contain

potential sources of human food and animal fodder—including leaf protein that may prove decisive in the struggle to support the exploding population that the global environment has been forced to carry as a result of demographic processes that have occurred within a rather restricted span of time.[55]

As P. W. Richards has so eloquently argued, the most far-reaching impact of the depletion of tropical forests such as those destroyed in Lower Burma will be upon the process of plant evolution itself. His conclusions merit lengthy citation:

> The rain-forest flora with its immense wealth of species belonging to thousands of genera and scores of families has acted in the past as a resevoir of genetical diversity and potential variability. During at least the more recent epochs in the earth's history it has been a centre of evolutionary activity from which the rest of the world's flora has been recruited. . . . The tropical forest has thus played a part different from that of the other plant formations. . . . This role, of a source of supply of genetical material for evolution and of new forms of plant life, the tropical rain forest will play no longer, or only in a much diminished degree. The area of the rain forest itself has been so much reduced and the adjacent formations which served as the path of plant migration from the wet tropics to other regions have been so much modified or destroyed, that the invasion of the subtropical and temperate regions by plant lineages evolved originally in the topics must, if it has not already ceased completely, become of small importance. It is therefore likely that the destruction of the Tropical Rain Forest accomplished during the past 100 years has changed fundamentally the future course of plant evolution and closed many avenues of evolutionary development.[56]

The other long term effects of deforestation in Lower Burma on the global environment in terms of shifts in rainfall, wind currents, temperature, and the oxygen-CO_2 cycle are more difficult to quantify, or even describe with precision, since virtually no records relating to these vital processes are available. It should be kept in mind, however, that the process of agrarian expansion and the development of a rice export economy that I have described for Lower Burma was also occurring in roughly the same time period in both the central valley of the Menam Chao Phraya river in Thailand and the Mekong delta region of Vietnam.[57] Though the evidence provided by Lucien Hanks and others[58] indicates that in Thailand, at least, rice cultivation was extended mainly at the expense of grassy plains rather than rain forests, the ecological consequences of forest clearing in Lower Burma must be multiplied to take into account the impact of agrarian expansion in mainland Southeast Asia as a whole.

In all three cases deforestation occurred so that food crops could be grown, and any discussion of the impact of forest clearing must be set against the gains in food production that resulted from the great expansion in cultivated area in this period. Forests were cut down, but hungry people in North Vietnam and Upper Burma, and as far away as India and China benefited from the bounty of the rice granaries that were created where the forests once stood. Burma then, and mainland Southeast Asia as a whole, provide cases of economic development that raise

interesting ethical and environmental questions pitting food supplies against forest reserves – questions that need to be seriously considered. On the basis of hindsight one can wish that those who shaped colonial policy in Burma or in other forested areas might have developed ways to both preserve large portions of the forest and encourage rice cultivation. To expect them to have seen these options or to know how to handle them, however, would be, as I have argued, to resort to the worst sort of ex post facto judgement. This is especially the case because over a century later little of this sort of accommodation of forest and cropped areas has been successfully attained anywhere and the methods for doing so are still in the experimental stages.

7. Deforestation in Modern China

Rhoads Murphey

It is not known, or discoverable by any means, what China's forest cover was at any point in the nineteenth century, or the extent of net depletion in the course of that century. This information gap is of a different order from that for other areas dealt with by the other essays in this collection. Even now, it is not known what China's total forested area is, and there are severe unresolved definitional problems about what "forests" or "forested areas" really mean. Probably the best hope for progress toward resolving these ponderous unknowns lies in the increasing range and information content of satellite and aircraft photography, a technology only now beginning to be available and which can of course tell us little or nothing about the nineteenth century except as a set of hints on the cumulative 5000 year history of deforestation. We do know in a general way that that process was greatly accelerated from the seventeenth century onwards, but this was the result almost exclusively of mounting population pressure, in combination with a general deterioration of the economic, social, and political order.

In brief, nineteenth-century increases in trade and commercialization, which were proportionately much smaller in China than in almost any other part of the world, came too late to destroy China's forests. For China proper, they were already largely gone by 1820, almost wholly by 1860, but mainly as a result of peasant subsistence cutting, clearing for agriculture and for local sale as both wood and charcoal. Very little of what was cut in the nineteenth century was exported,[1] and the relatively modest proportional increase in cash crops did not take place, with few exceptions, at the expense of forested land.

The Chinese Landscape

Let me first sketch briefly the physical outlines of the Chinese base, and stress that this paper deals almost entirely with the area known as China Proper, south of the Great Wall and exclusive of Manchuria, Inner Mongolia, Sinkiang, and Tibet. Except for Manchuria (which is dealt with to a minor extent even though it was really for the most part outside the zone of Chinese occupancy during the nineteenth century), these are and have always been largely treeless areas—the only exceptions being the Tien Shan range in Sinkiang, parts of the edges of the Ili valley in Dzungaria (north of the Tien Shan), and the extreme eastern edges of Tibet, below the tree line and in isolated valleys. Most of Sinkiang is true desert, while most of the rest of it is, like Inner Mongolia, semi-arid grass steppe and has been so since at least the beginning of the historic period. Most of Tibet is both too high for trees, and too cold and dry, in effect an alpine desert. The area north of the

40-inch (102 cm) isohyet is characterized by recurrent drought, with high annual variability in precipitation (greatest where the annual averages are least), and with rainfall concentrated in summer, often in the form of violent showers but often also with long dry intervals. Most of the north is covered deeply with fine-grained calcareous loess (deposited by wind and re-deposited by stream action and flooding), highly fertile given adequate moisture but also very easily erodible when exposed, and hence especially susceptible to the violent showers of summer. The eastern half, more or less, of the north is generally level, composed mainly of the flood plain of the Yellow River in its various courses and of other northern rivers; the western half, most of which is also thickly covered with loess, has been deeply dissected by stream action and runoff and has high vertical relief with relatively little level land. Most of the north was probably never, since at least 3000 B.C., heavily forested, given its marginal climate for trees and the continued deposition of loess, although there is still some controversy about this. It seems most likely that there were at most some scattered forest stands in the higher or more mountainous sectors, a few pathetic remnants of which still remain in the remotest areas. Lower slopes were probably however far better covered in the past with bush-brush-grass and perhaps occasional coppices. This cover has been progressively removed over the past 5000 years as the human population increased in numbers and technical ability; by the beginning of the nineteenth century it was largely gone.

South of the 40-inch (102 cm) isohyet, rainfall is both more adequate and more reliable, and is also better distributed throughout the year. The growing season lengthens from about 220 days to a full 365 in the southernmost section, and rainfall totals also increase southward to reach over 100 inches (204 cm) along the south coast. As a result, the soils of south China, outside the immediate alluvial flood plains of the rivers, are badly leached and of low natural fertility. Both leaching and erosion are accelerated by the steep slopes characteristic of most of the south, where level land is scarce and occupies only about 15 percent of the total. From the Yangtze valley south the land was originally heavily forested, and much of it remained so until the Ming Dynasty (1368–1644) or early Ch'ing Dynasty (1644–1911). Species were highly varied, and included a number of subtropicals. Growth rates were and are high, and regeneration vigorous, so that deforestation rarely left slopes bare for long. Many species of trees could sprout from stumps, or their places would be taken fairly rapidly by brush and grasses. Nevertheless, the steep slopes and heavy rainfall of the south meant that deforestation produced serious erosion, and siltation of watercourses.

Subsistence Agriculture and Deforestation

Especially after about 1400, there were very few large landowners or large units of land. Land use was predominantly in the form of small peasant proprietorships (although the tenancy and part-tenancy rate increased rapidly in the nineteenth century as far as we can guess at it, at least in some areas). Villages might communally share and manage parcels of land for woodlots outside the cultivated fields

and adjacent to the village, but such areas were small and far from universal. Peasant attention was concentrated on cultivated fields, and areas which could not be cultivated, even with terracing, tended to be neglected or abused.[2] Within China proper there was very little free grazing of animals. What animals the system made room for were either scavengers, fed on household wastes or crop residues (pigs, chickens, ducks), or essential draft animals, fed for the most part similarly on a household rather than grazing basis. There were extremely few sheep or goats and almost no dairy animals, although sheep and goats (yaks in Tibet) were the mainstay of the pastoral economy of the outer areas of Mongolia, Sinkiang, and Tibet. What few there were in China proper were usually kept penned and fed on grass cuttings or crop residues.

As pointed out in more detail below, this was predominantly a subsistence system. Except for small special areas (e.g., silk, tea) cash crops were of very minor importance and, where present, commonly pursued on a sideline basis (true even of silk).[3] Tobacco was grown mainly in highly specific small areas in Shantung and elsewhere in the east, far from any even originally forested region. Cotton was somewhat more widespread, like tobacco (and opium, spatially more limited) often sharecropped, but like them also grown only on fertile level land and hence involving no deforestation. These and other cash crops (t'ung oil—see below) remained a minor part of the agricultural system. We cannot measure the increase of cash cropping even for the nineteenth century, but can probably assume that it was *relatively* small (judging only from trade figures, such as they are) and in any case, given the nature of the crops, that it did not take place at the expense of forests. The main possible exception would be tea, but there is little evidence that much new land was deforested for tea in the nineteenth century (unlike the story in Assam, e.g.) since all of the major tea districts had been established long before and were apparently able to meet increased foreign demand for tea without any great expansion in acreage.

Most deforestation in China proper was subsistence cutting by peasants for fuel, local building, coffins, and perhaps some cash sale in nearby markets for the same purposes. The acute shortage of low cost long distance transport for so bulky a commodity as wood meant that large scale commercial cutting was limited by the nineteenth century, confined (except for Manchuria after 1890) to the very few areas penetrated after 1890 by the minimal railway network, which also had some small tree cover remaining. Roads usable by powered vehicles did not exist outside the immediate vicinity of the treaty ports before about 1920; those used by man- or animal-powered carts, and the tracks used by porters and pack animals, had small capacity for carrying wood except on the shortest of local hauls, and even there at very high unit cost per kilometer. The role which increased commercialization, let alone foreign trade, played in increasing deforestation was almost certainly minor; most of it was limited to Japanese-controlled Manchuria after 1905, and concentrated in the period of full Japanese control after 1931.

What wood moved in trade more than a few miles in the nineteenth century did so almost entirely by water, as it had done for centuries. This meant that it was

almost entirely limited to the Yangtze valley and south China, the only part of the country where there were both navigable waterways and some at least partially forested areas. Those at all close to usable waterways had been largely deforested by, mainly long before, the beginning of the nineteenth century, with a few minor exceptions dealt with below. "Usable" waterways included, as they still do, streams which carry water only for a short period in the year or which provide depths, for shorter or longer periods, of only three to four cms. This may sound ridiculous or impossible, but in the 1940s, in many areas, one could still observe rafts, as well as individual logs, being floated downstream in parts of west and southwest China, usually only in the spring and early summer, on barely three centimeters of water, the rafts sometimes carrying up to a ton of cargo. The rafts themselves were always broken up and sold for timber at the end of the stretch of waterway where they were the only possible carriers, and gave way to sampans or junks—built of course of wood. This was in mountainous areas, where any other form of transport was impossibly expensive, and is no doubt a tribute to Chinese ingenuity and their capacity for hard work, but it illustrates the relentlessness and severity of the human pressures on forests in China, in a pattern which we know is of very long standing. That is why the bottom of the barrel was being scraped by the 1940s. Already by 1914, on the Min River in western Szechuan, where it emerges from the Tibetan massif and is broken by rapids as it runs through one of the remnant forest areas of China proper, a contemporary account of logging and water transport there says, "The work is considered so dangerous that the provision of coffins for the raftsmen is written into every contract for labor supply."[4]

Peasant cutting for fuel and building in China proper was accompanied in many areas, especially in the hilly or mountainous south and southwest, by annual burning of the hillsides (a practice which has persisted, despite efforts at control, into the post-1950 period). From the peasant point of view, once the usable or locally marketable wood had been cut—in most accessible areas several centuries ago—the hillsides were of little use except as a source of ashes from burning, which rains would then wash down onto their fields to provide additional fertilizer for a system where land was worked uniquely hard and in a virtually mono-cultural system. Burning the hillsides also discouraged banditry, it was often said, and removed cover for predatory wild animals while at the same time encouraging grass and low bush growth which could be useful as cut fuel and as fodder for penned animals. In a few cases sheep or goats were grazed on deforested slopes, thus completing their denudation. Population density was so great, especially by the nineteenth century, and levels of subsistence so low, that for the most part peasants could not afford to use land for anything but high-yielding annual crops; tree farming, with its long delayed returns, was for them beyond practicality, and tree crops presented the same problem, with the additional deterrent of the high cost of transport and the limitations of the market.

The only significant exception was tea, a bush crop which yielded several marketable pickings each year, and was of low density and high value by weight. Tea not only tolerated but preferred slopes, for better drainage, and was also

thought to benefit from cooler temperatures at higher altitudes. These considerations, plus tea's intolerance of cold and its relatively high water demands, meant that it was limited to hills in the south, concentrated in the mountainous area back from the southeast coast (the Bohea Hills) and in the divide between the Yangtze and West River drainages. But its presence there, and in smaller areas elsewhere, was at the expense of the original forest cover, which had been progressively removed from T'ang times (eighth and ninth centuries) through the eighteenth century, with probably only limited further expansion of tea. There was consequent deforestation on more difficult or more remote slopes during the nineteenth century with the increase in overseas markets from about 1780, and especially after the opening of the treaty ports beginning in 1842. It is symptomatic of the general lack of data that even in this commercially important area of study, there is no readily available information on the extent or location of new tea areas in the nineteenth century.

There were two other tree crops of major importance: mulberry and t'ung, but both in close juxtaposition to areas of intensive field agriculture and hence almost certainly occupying slopes which had been deforested centuries earlier.

Mulberry leaves were used to feed silkworms, an extremely labor-intensive enterprise which was pursued only in areas of dense population. Mulberry was grown mostly on slopes immediately adjacent to villages, where household labor could provide a continuous supply of leaves from daily picking. Silk production was heavily concentrated in the landward edges of the Yangtze delta, the Canton delta, parts of Shantung, and parts of the so called Red Basin of Szechuan, where all the necessary conditions were present.

The t'ung tree yielded nuts which were the source of t'ung oil, a basic ingredient of paint, varnish, and industrial oils. Production of this crop probably increased substantially in the course of the nineteenth century with the widening of overseas markets, although again we have no data beyond the figures showing a steady increase in exports of t'ung oils, as in all other export commodities. As with tea, however, it remains unclear how much of these increases represented new production and how much merely a diversion of existing production into external trade, for which we have no even rough measures before about 1850. The trade figures after 1844, when a more or less continuous series begins, and after 1864, with the establishment of the more ambitious series of the Maritime Customs, are an unreliable guide in the sense that each decade, often each year, saw the opening of new treaty ports or customs stations and a consequent increase in recorded trade, but not necessarily in actual flows, much of which had not been measured or recorded earlier.[5] T'ung trees were not grown on plantations, or on newly cleared land, but rather along field borders and on slopes adjacent to villages and agricultural areas, and the nuts were gathered primarily as a windfall or casual crop. At least in the nineteenth century, little or no new inroads into forested areas resulted from whatever increase may have taken place in t'ung production. The same considerations apply to tree crops of lesser importance such as fruit, edible nuts, and lacquer.

The Chinese attitude toward and use of slopes has often been criticized as wasteful and destructive, but the nineteenth century peasant really had little alternative. He could not survive on low yield slope agriculture, on tree crops, or on grazing animals except in each case as a marginal side line to which he could not afford to give large amounts of labor or other investment. As it was, the (limited) herding on slopes, the collection of windfall tree crops (i.e., apart from tea), and the (far more important) collection of brush, twigs, and grass for fuel and fodder, were almost entirely the work of small boys not yet strong enough for agricultural work. Their efforts were however more than sufficient to prevent any regrowth of forest. Here is an early twentieth century description from Shantung: "All the boys of the village big enough to walk and carry a basket are sent out over the hillsides to collect grass, twigs, and any kind of herbage that can be used as fodder or as fuel. Each boy carries an iron grubbing hook, and thus equipped he clambers up the slopes, working away at his task with cheerful energy. Through the industry of this army of human locusts the mountains are denuded of herbage and even roots often grubbed up."[6]

The gentler slopes were pressed progressively into the agricultural system through terracing, an enormously laborious technique with discouragingly small returns, although perhaps a third or more of total cultivated land in south China as a whole is terraced. Terracing does have the virtue of retarding, even if not wholly preventing, erosion, but even under the growing pressure of population it could not be made viable on more than moderate slopes. By the beginning of the nineteenth century in most areas, terracing had probably reached or even exceeded maximum rationality even for hard pressed subsistence peasant farmers. Beyond the terraces, most accessible slopes had also by then been deforested, and the land thus exposed used, if at all, only in the ways detailed above, or annually burned over to provide ash run off for cultivated areas downhill (and, as mentioned, to deprive bandits and wild animals of cover). This was of course ecologically both wasteful and destructive. Peasants undoubtedly knew this, but had little choice, even though they could easily observe the negative consequences. The evils of deforestation were commented on very early. Mencius (372–289 B.C.) included in his commentaries what he referred to even then as traditional proverbs, and which are still repeated as such: "Mountains empty, rivers gorged"; and, "Once the skin is gone, where can the hair grow?"

Peasant and elite attitudes and behavior toward the natural environment were different, and often dissonant. The elite view—celebrated by poets, painters, and philosophers, and still enormously appealing—centered on reverential admiration of nature and stressed man's lesser status, which required him to adjust to and respect the natural world, not to despoil it. Nature was seen as the source of virtue, wisdom, and internal peace, especially for those able and willing to contemplate rather than combat it. This was of course a view limited to that 5 percent or less of the population whose means and status freed them from manual labor. The overwhelming peasant majority had little choice but to alter and manipulate

nature for their own survival, and over time probably have changed or destroyed the Chinese environment on a greater scale than in any other part of the world, if only because there have been so many more of them at it for so much longer. Short run peasant survival, especially as population increased, had to take precedence over long run public good or even the good of the peasants' own coming generation. Deforestation was by far the most destructive human impact. Given China's size and the superficial nature of government control in local areas, there were few checks on peasant pursuit of short run survival at the expense of the forests. Even in the days of imperial greatness, government powerlessness or inattention in these terms contrasts with the much closer local supervision and control exercised for example by Tokugawa Japan or by the Indian Forest Service under British management. Probably the largest single restraint on tree cutting was the exorbitant cost of transport to even local markets, and the proliferation of local transit taxes, factors which also retarded the deforestation of Taiwan even after de facto Japanese control. Nevertheless, the camphor forests there were decimated by the end of the century and much of the tree cover even on steep slopes removed to feed wood-hungry Japan or for sale in the world markets. In China proper, as pointed out, there was little or no export of wood abroad and a rapidly growing import after about 1860 (much of it from the North American west coast), although this also reflected high internal and much lower ocean transport costs.

Pre-Modern Population Trends

The almost complete denudation of China by the nineteenth century took place over a very long preceding period, beginning as long ago as 3000 B.C., accelerating with the diffusion of first bronze and then iron tools, but most of all as a function of expanding population. By Han times (202 B.C.–220 A.D.) the total population was probably between 70 and 90 millions, a figure probably not much exceeded until the fourteenth century (with large ups and downs in preceding centuries correlated with dynastic changes). The massive modern growth of China's population seems to have begun under the Ming, especially from about 1380 to 1600, falling back as the Ming order weakened and collapsed and the Ch'ing conquerors restored order (roughly 1600 to 1680), and then resuming a still more rapid rise from about 1700 to 1850. The population probably doubled between 1650 and 1850, when it was checked by essentially Malthusian controls, most importantly the enormous devastation attendant on the Taiping Rebellion and its suppression (1850–64). Net incremental growth above 1850 levels probably resumed by about 1880, may have stabilized again about 1920, and then resumed especially rapid growth after 1949, probably reaching one billion by about 1975.[7] Although these are of course the grossest kind of estimates (and although national totals and trends may have much or little to do with what was happening in particular local areas), there seems little question that this has been the predominant factor in the progressive deforestation of China (exclusive of Manchuria).

Forest Cover In the Early Nineteenth Century

In any case, increased commercialization and foreign trade, although both did take place especially in the nineteenth century, are unlikely to have been important factors in this connection,[8] if only because there were virtually no forests left to exploit on a commercial basis. The trade figures we have show a net import of wood, lumber and pulp into China during most of the years covered by the data, as Thomas Cox's essay in this volume also indicates. When the Summer Palace (and later the Temple of Heaven) in Peking was burned by British troops in 1860 (in response to "Chinese perfidy" and disregard of supposed treaties and agreements), no timber could be found in China to replace the large pillars of the original buildings; replacements were imported from Oregon. This of course suggests that not that long ago, Chinese forests were able to provide large timbers, since the life of any wooden building, or its structural members, was relatively short. And we have a variety of impressionistic evidence that this was indeed so. The accounts of Marco Polo, Ibn Batuta, and other Western travelers to China during the brief Pax Tartarica of the thirteenth century contain references to dense forests, and to the danger of wild animals therein, over large stretches of the provinces they crossed, including even Hopeh, Shantung, and Kiangsu, although their chief references are to Anhwei, Chekiang, and areas farther south. Nearly all of the forests mentioned or described were gone by the time of the first detailed observations by the new set of foreigners after 1842. Observations reported by the Jesuits resident or traveling in China in the sixteenth and seventeenth centuries deal (as might be expected) hardly at all with such matters, but here and there suggest that then too the remaining forest cover was considerably more extensive than it was by 1800 or by 1850.[9]

A possibly better check, and one much closer to our period, is the account of the Macartney mission to Peking in 1793, its journey southward after the failure of the mission, and the journal kept by George Staunton, son of Macartney's deputy, who traveled with it as a sort of errand boy/interpreter. Staunton also accompanied the equally abortive Amherst mission to Peking in 1816, and left a detailed account of that as well. Both groups went northward to Peking via Tientsin by sea, but returned to Canton by inland routes. The Macartney mission was routed down the Grand Canal to Hangchow, and thence to Canton, while the Amherst party was instead sent up the Yangtze from the southern terminus of the Grand Canal to Poyang Lake and thence up the Kan River to the Meiling Pass. Staunton's account of both journeys is full of fascinating observations, partly because this was really the first modern penetration of China by Westerners and it was still a virtually unknown country, partly because Staunton had a keen eye and was curious about everything he saw, but also because his accounts give us a picture of the country close to the height of its power, wealth, and success, just at the onset of the decline which was to become so precipitous especially after 1850. His mentions of forested areas are of course only in passing, and very general, but

he says enough about the landscape along both routes to make it clear that in both periods there were still some forests in many places along the southern edge of the Yangtze valley, and elsewhere in south China, in locations which by the latter part of the nineteenth century were denuded of trees. Both missions traveled, as all Chinese did too, as much as possible by water, with portages when necessary along their routes. Even then along the waterways, forests had long since been cut (although Staunton does comment on the rows of poplar and willow which lined the banks of the Grand Canal along much of its length, and which had largely succumbed to uncontrolled peasant cutting by 1900). It was during the portages through hilly or mountainous areas in the water divides that both groups passed through forests, although even there they observed heavy cutting in progress, especially noted in the account of the 1816 Mission.

Political and Military Disruptions and Their Ecological Impact

The Taiping Rebellion, which both signaled and accelerated the deterioration of the economy and the political order (and which was in large part also a response to the privation produced by extreme population pressure), laid waste huge tracts of country, most of them along the routes followed by the Macartney and Amherst parties. Between thirty and fifty million people are thought to have died as a result of the rebellion and its bloody repression over a period of nearly fifteen years. It began as a bandit action in the mountain country just north of Canton, spread northward from there, eastward to the coast and westward into the lake basins of central China, capturing Nanking and laying siege to Shanghai, but was largely checked in its farther northward advance. Accounts of the time, and later histories, repeatedly mention wanton destruction of forests by the Taipings, and equally massive assaults by the Imperial forces in their effort to deny shelter to the rebels. The major weapon seems to have been fire. There are descriptions of former forests which by the 1860s consisted only of blackened stumps over hundreds of square miles. All of this activity was concentrated in the remaining area within, or around the edges of, the major center of population in China proper which still had some vestigial forest cover. The mountainous far west was unaffected, but forests there were of little use to the rest of China, where the vast majority of the people lived. Those forests were in their turn heavily exploited in the course of the great Muslim rebellions and their suppression, concentrated in Yunnan and in Shensi-Kansu, between 1855 and 1878.[10]

Although the imperial government preserved its life and even had a brief revival of vigor, its control, especially over local affairs, never recovered and it was challenged repeatedly by spreading banditry and open rebellion until the entire political order collapsed in 1911. Large troop movements, banditry, and civil war became endemic in the last decades of the dynasty, adding still further to the destruction of forests, while an increasingly impoverished peasantry continued its own destructive hacking away at what little cover was left on slopes.

A former student of mine, Kui-on Louie, a native of a village about thirty miles from Canton, wrote a paper for me in the early 1960s based on his grandfather's

recollections of the village in the nineteenth century. These included comments on what had happened to the village wood lots on the slopes surrounding its fields:

> In the 1880s, when I was young, we had a brick kiln in the village, and most of the houses were made of brick. We had to range rather far up into the hills to get wood to fire the kilns, and the older people in the village said they remembered in their own youth that there was more wood closer. They also said that the village used to keep a certain area protected as a wood lot so they could have larger timbers for building. That was all gone by my time, and we would often be away all day and until after dark in our search for small twigs, brush, and other such things. The village also began to have trouble with bandits, and then with armies. Both of them cut into the few stands of trees the village kept behind the houses, and by the end of the dynasty there was nothing left. Wood for any purpose became so expensive, or so hard to get, that the brick kiln could no longer operate. Whatever we needed for building, or for coffins, we had to buy in the market, but most of us could not afford much. Some of the villagers planted tea on the hillsides where the trees used to be, and for a while that prospered, but the soldiers became more numerous after about 1900 and they ruined the tea bushes too. They also cut down the small fruit orchard some villagers had planted, and used the wood for their campfires. When I left for Hong Kong in 1942, there was nothing left but bare hills around the village fields, although we still could cut some grass there for cooking fires.

Clearly, the progressive collapse of the civil order and the depredations of marauding armies played an important role in the completion of China's deforestation in the last decades of the nineteenth century. What trees remained were mainly those inaccessible even to subsistence cutters or to those desperate for cash income. As of about the time of World War I, remnant forest areas were confined to steep and remote mountain slopes. These included extensive and heavily wooded areas over most of the western third of Yunnan Province and perhaps the western fifth of Szechuan (in effect the edge of the great Tibetan escarpment), plus smaller and more scattered stands in the remoter mountain districts or interprovincial watershed areas of Kwangtung, Kwangsi, Kiangsi, Hunan, Hupeh, Fukien, and Chekiang, with still smaller patches in the mountains of southern Anhwei, western Kueichou, eastern Yunnan, eastern, northern, and southern Szechuan, and small parts of Shansi. Somewhat more extensive forests remained in the steep mountain spine of central Taiwan and central Hainan, in the Tien Shan range in Sinkiang, and most of all in the Chang Pai Shan and Khinghan ranges of Manchuria, plus major stands in northern Heilunkiang and in the mountains fringing the Sungari Basin, both in northern Manchuria.

The total Manchurian forest cover was probably five or ten times the total forest cover for all of the rest of China. Manchuria had been officially closed to Chinese settlement by the Ch'ing dynasty, which tried to preserve it as the traditional Manchu base and Imperial hunting grounds. As Ch'ing authority weakened and population pressure mounted, Chinese settlement began to spill northeastward

beyond the Great Wall into the Liao valley, after about 1870, but was still small relative to Manchuria's size and potential until well into the present century. Russian building of rail lines and exploitation of Manchuria's resources did not begin on any significant scale until the 1890s, and was still in its early stages at the time of the Japanese takeover in 1905.[11]

Railways were very belatedly begun, and heavily concentrated in Manchuria, never an operative part of China until 1949.[12] The few lines in China proper were until the fall of the Ch'ing Dynasty in 1911 almost wholly confined to the eastern corner of the north (connecting Peking and Tientsin with coal mines in Hopei and Shantung provinces and with contested sections of Manchuria), a generally level and by then almost entirely treeless area. Lines in the south, and the first (incomplete) east-west lines into equally treeless Shansi, Shensi, and Inner Mongolia were not completed until later, the first through north-south line to Canton via Wuhan being finished only a matter of weeks before the Japanese invasion in 1937. Western China as a whole, and the coastal province of Fukien, both mountainous areas with some consequent remaining forest cover, had no railways at all until the 1950s (the single spur built by the French in 1910 from Hanoi to Kunming was not really an exception). Except perhaps for Hopei, Shantung, and Kiangsu (where Shanghai lies), the remaining provinces had at most a single line until the 1950s. This very limited growth of railways (much more limited as of 1900) no doubt slowed or even prevented the completion of deforestation in those areas where some trees remained, but the major point here is that commercial logging was virtually impossible. Some perspective on this is available from the Manchurian experience after 1890 and again after 1931, with intensive Russian and then Japanese railway development, almost on a European density scale, including spur lines (and later motorable roads) up into the Chang Pai Shan (mountains) and the Greater and Lesser Khingans which fringe the eastern and western borders of Manchuria. As of 1890 these forest reserves had hardly been scratched, even by subsistence cutting, given the very small population of Manchuria (about 1 million in 1900) and its concentration in the level and fertile lower half of the Liao valley, over 200 miles from either of these mountain ranges. With modern transport and mechanical equipment available (including port facilities built by the Japanese at Dairen [Dalien, LuTa]) and a huge drainage-style export trade to crowded and industrializing Japan with its immense appetite for wood, both forests were heavily invaded and have probably now only about 10 percent of the late nineteenth-century forest stands remaining, if one compares contemporary estimates with what can be reconstructed for 1900.

The fall of the old dynastic order in the revolution of 1911 was unfortunately not succeeded by any single central regime, but rather by a relapse into chaos, banditry, and civil war. These were the warlord years, when successive efforts at government from Peking were overshadowed by the contesting power of regional rulers, each with his own army. Out of this confusion emerged in 1927 a new effort at a national government under the control of the Guomintang (Nationalist Party) and its military and political leader Chiang Kai-shek. Allied with the Chinese

Communists Chiang had commanded a united front whose military and political campaigns fought their way from Canton to Peking in the name of common Chinese nationalism. Chiang placed the capital of the new Republic of China at Nanking, and the period from then until 1949 is known as the Republican period. Later in the same year of 1927 Chiang turned on his erstwhile Communist allies in a fascist-style putsch in Shanghai, the chief base of both parties, and nearly eliminated them; a remnant survived and from their ultimate base at Yenan in the northwest emerged after the anti-Japanese war in 1946 ready to contest national supremacy with the Kuomintang. Japan invaded Manchuria in 1931, really the beginning of the Second World War for China, and launched full scale military operations at Peking and Shanghai in 1937, capturing and burning Nanking in 1938. The Nanking Decade, as it is called, was far too brief to make much impact, and during this height of its power and effectiveness the Guomintang government was nevertheless able to control much less than half of the country, the rest of it remaining divided among the many still thriving warlords. In broader terms, one may say that the political order collapsed into ruin by about the turn of the century, and was not effectively restored until 1950. Banditry and civil war dominated the intervening years. War against Japan was followed after the briefest of intervals by civil war from 1947 to 1949.

The Republican Period, 1927–49: Further Ecological Crisis

Estimates of national and provincial forest area totals vary so widely for the period of Republican control as to underline the unreliability of all of them. Most of the figures given for provinces, as a percentage of total area covered by forest, are so implausible, especially in the light of so many detailed descriptions and observations, as not to be worth citing here.[13] Part of the problem is the ambiguity, or complete lack, of definition of *forest*, which in turn was part of the Guomintang government's very poorly developed statistical system and inadequate surveys or data base. Since it was also unable to conduct a census or to establish even by estimate any reliable measure of the total population, it is not to be expected that its (varying) figures on forest resources would be any better, if as good.

Probably the best of the Republican period estimates, made by the American-trained forester D. Y. Lin and referring to the 1940s, suggested that about 9 percent (88,921,700 hectares) of China's total area, including Manchuria, Inner Mongolia, Sinkiang, and Tibet, was covered by forests of some sort, but that probably no province within China proper except for Yunnan, Szechuan, and possibly Hunan and Fukien, reached such a figure.[14] This is, however accurate, a very low percentage for adequate protection of the natural environment, especially since forests were confined to remote areas, and contrasts with the 30 percent forest cover recommended by the F.A.O. Lin estimated the annual timber cut between 1925 and 1950 at 9.4 million cubic meters, or less than 0.02 per capita, as compared with an all-Asia average of 0.3 and a European average of 1.0; over a third of this timber came during that period from Manchuria, and much of that was in turn exported to Japan. Throughout the period, there were heavy net

imports into China of both timber and pulp. Annual cutting, mainly of smaller trees, for fuel and charcoal during this same period was estimated by Lin as averaging over 20 million cubic meters, plus another 10 million equivalent in the form of shrubs, twigs, coppice sprouts, and grass.

Despite the growing scarcity and high price of wood, however, W. C. Lowdermilk suggests that most deforestation during his long period of observation as a forester in China from 1908 to 1936 was for agricultural clearing and terracing rather than for commercial sale; he found "thousands of cubic feet of good lumber rotting beside oat fields in the mountains of Shansi in 1924 and 1925. The same process has been found in southern and central Ahwei, and is likewise reported in Kueichou, Yunnan, Szechuan, Hunan, Hupeh, and Hopeh."[15] Twigs, branches, and litter were, however, used as fuels, and often even roots were dug up; it was presumably the unsolvable problem of transport which kept the larger timbers from being marketed. Lowdermilk suggests that ownership of slope areas was often vague and that controls over the use of slopes were weak or nonexistent except in special local cases, so that wanton destruction of trees on slopes was widespread.

Around the villages, close to the houses, small and scattered stands of trees were often preserved, or were continually planted so as to provide the village with a source of wood, as in the case of the village near Canton cited above. This was common even in the north, and although bandits and marauding armies took heavy toll, small plantations of fast growing poplar and willow were still to be seen in the 1920s in many villages on the flat and otherwise treeless plains of Shantung, Hopeh, Honan, and other parts of the north. But the mountain slopes of the north, where protection was far more badly needed, were bare. Other isolated small groves, sometimes just lone trees, were preserved around temples and even small wayside shrines, and also in cemetery precincts, where they were protected both by custom and by superstition, since disaster was expected to overtake anyone who violated them. Even these trees were progressively whittled away in the troubled years of the end of the dynasty, and in the civil war and invasion years which followed, but some still remained in 1950 and provide some evidence of what the original forest cover may have included. Most of the larger temple groves were, however, like the most famous temples or monasteries, in mountainous areas or on steep peaks, away from the hurly burly of the plains, and hence doubly protected by the difficulty of getting the trees to market. In general, the groves or forests which remained were remote from densely settled or farmed areas, and thus of little benefit either as a source of wood or as protection against erosion or water loss on the slopes where these problems were most dangerous, close to the areas of heavy settlement and agriculture.

Especially in central and south China, trees would continue to sprout from their stumps once cut, and as long as the area could be protected from burning (which as pointed out was very widespread) could go on providing coppice growth for annual or semi-annual cutting as a source of fuel and for charcoal burners. For a time at least, this method might, in fact, be quite efficient as a means of satisfying

local subsistence needs, and the fuel produced would present only modest transport problems, especially if reduced to charcoal on the site as was commonly done. Eventually, however, the life of a continually lopped tree would be exhausted, and the area would revert to low bush and grass cover (with a much lower yield of fuel). If people (and in some areas grazing animals) could have been kept off of these deforested slopes, many of them might have regenerated. Purple Mountain Park, in the suburbs of Nanking, provided a striking illustration when it was fenced and guarded as a memorial to Sun Yat Sen beginning in 1928 when his mausoleum was built there and some 50 square kilometers around it established as a natural preserve. The area had long been deforested, and extensive plantings of pine were made. Within a few years, the pines were being crowded out by twenty other species, mainly deciduous and dominated by oak and maple, sprouting from stumps and then regenerating naturally by seed. By the 1940s they had largely taken over the park, and now make a truly impressive display, perhaps an indication of the nature of the original forest cover of this part of central China.

The consequences of deforestation are well known, even to the premodern Chinese, who had ample evidence. They were most serious in the north, where bush and grass cover did not replace trees nearly as quickly as in the south or could not survive at all, and where the soils were almost entirely composed of the soft, highly erodable loess. The result has been mounting disaster not only in eroded slopes but in damage to lower areas and in greatly worsened flood problems. Streams became choked with silt, as did irrigation works. In the Wei valley of Shensi, (the capital of the Ch'in, Han, and T'ang dynasties) extensive irrigation systems originally constructed by the Ch'in to support highly productive agriculture in the valley were progressively destroyed by siltation as all surrounding slopes were deforested. The main project, the Cheng Kuo Canal, irrigated 40 million mou (about 2.8 million hectares) in the third century B.C. The building of Emperor Ch'in Shih Huang's Palace was said to have completed the deforestation of the Tsin Ling range, China Proper's major discernible mountain chain running east-west just south of the Wei valley. By T'ang times, in the eighth century A.D., that had shrunk first to 10 and then to 2 million mou. After the T'ang, the Wei valley could no longer support the imperial capital, and it has since that time been a poor and backward area. W. C. Lowdermilk estimates that deforestation of slopes in Shansi and Shantung has increased superficial runoff fifty times, and the erosion rate one hundred to several thousand times.[16]

These problems are bad enough in themselves, but they also enormously increase the incidence and destructiveness of floods. Ancient China, with its principal base in the north, had flood problems even then, as recorded since at least 2000 B.C., but they have multiplied many times as expanding population and agriculture have progressively removed the probably sparse original forest cover. There is no need here to give a detailed account of the Yellow River problem,[17] but much of it is attributable to deforestation. Measures in 1946–47, when the river was rediverted into its former channel in a massive U.N.R.R.A.-Chinese Government joint project, showed a 40 percent silt content at flood stage in many

stretches. This was the major cause of floods, as silt built up the river's bed, behind its dikes, above the level of the surrounding country, and then inevitably choked the channels so that the ultimate outbreak was catastrophic. It is no exaggeration to say that increasingly frequent and destructive floods in the north, including the drastic change of course of the Yellow River in 1853 which killed millions of people and destroyed millions of hectares of farm land in Honan and Shantung, was a major factor in the collapse of the Ch'ing dynasty and of the economy over which it feebly presided. What was true of the Yellow River was true to varying degrees of all of the rivers of north China. Floods not only killed people and crops but often left behind sand and gravel over very wide areas of formerly highly productive farm land which rendered it useless. The foreign press in treaty ports after about 1870 ran frequent articles urging reforestation as the only cure for flooding, but given the mounting chaos of the period and the powerlessness of the Chinese government, exhortations could produce no action.

In addition to erosion and flooding, deforestation had the predictable effect of lowering the water table, especially critical in north China with its heavy dependence on shallow traditional wells, which increasingly ran dry. Without adequate cover, especially on slopes, to retain and absorb rainfall, ground water reserves were not recharged as they should be by slow release and seepage. Streams were choked with immediate runoff, plus silt, following every rain, and then would run dry, removing the basis for irrigation works dependent on at least some maintenance of stream flow. While such problems were most acute in the north, they were present also everywhere in the south where deforestation had gone full course. There too floods were more frequent and violent, streams were siltladen, water storage areas and water tables shrank, wells ran dry, and slope erosion accelerated. Vegetation, including grass and brush, did regenerate more rapidly in the south, but far more of the land was sloping than in the north, and rainfall was far heavier, so that much more protection was needed. As Norman Shaw put it in his forest survey published in 1914: "On the waste hills of east China the rains rush off from the barren surfaces, flood the valleys, ruin the fields, and destroy towns and villages. No water is retained at higher levels, so that none is fed underground to the lower soils or the springs. As a result, even on the plain the water level is too far beneath the surface to be used."[18] E. A. Ross, in a more fanciful passage a few years earlier on his travels in Shansi, remarks:

> I never saw a boy disporting himself in the water. The springs dry up and no late-summer pastures are freshened by seepage from wooded hillsides. Dismally the muddy streams wander in the sun over wide shallows . . . no leafy path or mossy log invites lovers, though to be sure China does not believe in lovers. [Only in procreators?] Millions live life through without knowing sylvan glades, the glories of October leaves, or the boyhood pleasures of nutting, bird nesting, and squirrel hunting . . . brick or mud is the sole building material. Brick benches or tables replace wooden furniture . . . and the highway stretches glaring hot and dusty to where the lone locust by the tea house offers a patch of shade. Thus with the woods vanish most of the sources of beauty, the founts of

poetry and inspiration dry up, and life sinks to a dull, sordid round of food-getting and begetting.[19]

Eliot Blackwelder, in the 1906 account already referred to, provides further descriptions of the north, including the very few surviving stands:

> When the trees are gone they still have the saplings, shrubs, and lesser herbage; and no one knows better how to utilize every bit of material that does the Chinese. Poles for the support of roofs and for various other constructional purposes are made out of the larger shrubs and the remainder is either sold for fuel directly or is reduced to charcoal in the mountains and is thence carried down to the market towns, where it commands a good price. . . . For the forest there is substituted a grassy or largely bare slope upon which thorny bushes are the only herbage.
>
> In many provinces one may travel hundreds of miles without seeing even a small grove of trees upon the hillsides, and I have never seen anything deserving the name of a forest. . . . Around their homes and villages the Chinese plant poplars and fruit trees. Graveyards and temple courts contain twisted cedars which not infrequently are centuries old, preserved through the force of public opinion. . . . The poplars belong to individual villagers and are therefore protected as private property immediately under the eyes of the owner . . . but the supply is so small it hardly suffices for the barest necessities. Aside from such village or temple groves, the forest, both great and small, has utterly disappeared, at a time so remote that in many areas we found no traditions or its occurrence, while in others we were told the trees had been cut off centuries ago.[20]

Yet even in the north, the possibilities for and benefits from reforestation were demonstrated by the German effort, brief though it was, in the hills around their concession area based on Tsingtao between 1898 and 1914. Erosion was checked, streams began to clear up, the water table rose, and a supply of timber began to be available.[21] Such efforts had however to be enforced by armed guards and police dogs to protect saplings, and later trees, from the peasant hunger for fuel and wood. The Communist government since 1949 has encountered the same problem in its much more sweeping efforts at reforestation, and there have been continual reports of indiscriminate peasant invasions of new plantations, often at night, with destructive or even catastrophic results.[22] Shaw's 1914 account[23] mentions the Weichang Forest in northwestern Hopeh, preserved, like Manchuria, as an Imperial hunting ground close to the capital. Although already badly eaten into by 1914, it still showed something of what the original forest cover in the hills of northeast China must have been: birch, pine, larch, willow, cypress, and oak, plus a thorny undergrowth, but with harsh grasses replacing the trees as they were cut. On all sides of the shrinking Weichang Forest in 1914, the surrounding hills were totally denuded. Shaw notes, especially in Shansi, how old stone bridges across streams showed the rapid increase in siltation; their arches were partially or entirely blocked by silt, although they had clearly been designed originally to

accommodate a deeper, more concentrated, and more regular flow of water. One might in fact have derived a rough measure of the chronology of deforestation and siltation in many areas by fixing the date of the bridges (many of them as old as Ming, some more recent) as an indication of the time when the streams were less siltladen and comparing this with the depth and apparent recency of deposition since. Alluvial silt and sand, plus wind-borne dust, have also raised the ground level at all premodern city sites throughout north China as forests have been removed, but at a rate and to a degree far greater than archeologists are accustomed to confronting. The city of Kaifeng, (capital of the Northern Sung [907–1127]), near the great bend of the Yellow River, was for many years threatened by the advance of sand dunes resulting from Yellow River floods. This development was finally halted only with the planting of closely spaced shelter belts beginning in 1947, to anchor the dunes and to check the velocity of the wind.[24]

In south China, although deforestation was nearly as great, the consequences were not as serious, although serious enough. In addition to the coppice sprouting of stumps and the far more vigorous growth of brush and grasses (plus the more rapid growth rate of trees where they survived), the south was the home of several species of bamboo, a member of the grass family rather than a tree, but a plant of almost infinite uses, and an excellent and very rapidly growing cover for slopes, including those which had been deforested. Bamboo can survive in specially protected locations into the southern margins of the north, but from the Yangtze valley southward it grows luxuriantly and can to a large extent make up for the absence of trees, both as erosion control and as a source of building material, fuel, paper, and even as food (shoots). Unfortunately, its value for all these uses meant that it was rarely permitted to cover large areas, and could not be protected from relentless cutting, especially given the ambiguous ownership status of most sloping land and the disastrous practice of burning over slopes annually in many southern areas. Most bamboo thus played all too small a role in protecting the steeper slopes against erosion in the heavy rainfall of south China. The major commercial timber tree of the south was (and still is where it survives) *Cunninghamia lanceolata* (*sha mu*, or Chinese fir), whose range extended from China's southern borders to the northern edge of the Yangtze valley. It is fast growing, has a straight vertical growth habit, reaches fifteen meters in thirty years, and can sprout from cut stumps. Throughout the nineteenth century and up to the present, *Cunninghamia* probably accounted for over 90 percent of commercial lumber from the Yangtze valley south.[25] Unfortunately it became increasingly scarce, especially mature specimens, and by the end of the nineteenth century there were almost no extensive stands remaining. With this kind of devastation, slopes in the south were also eroded, streams became silt laden, floods more frequent, wells ran dry, and irrigation systems were damaged or destroyed.

Francois Garnier in his reconnaissance of Yunnan in 1866–68 reports being told by old men that they remembered as children when all slopes in the west of the province were covered with dense forests and the streams ran clear, as they no longer did in the 1860s, when many slopes were bare.[26] In the rest of China, where

deforestation was of much longer standing, a common expression for "never" was "when the streams run clear." It seems reasonable that Yunnan, and western Szechuan, should have been among the last parts of China proper to be deforested, given their remoteness and the difficulty and inaccessibility of their mountain landscapes. Yet when I lived there from 1942 to 1946, driving charcoal-burning trucks carrying medical supplies over the very few roads of west China from the Burmese and Vietnamese borders through Yunnan, Kueichou, and Szechuan and into Shensi, we found charcoal for sale (though at high prices) even in the smallest towns; nearly all of it was made from small branches or even twigs and presumably came mainly from coppice cutting on surrounding hills, never far from any human settlement in that mountainous landscape. In the more remote and mountainous areas through which the roads passed one could even then still see occasional patches of forest, fairly large timbers and boards for sale or in transit, timber moving down the streams wherever possible, and the skins and furs of wild animals for sale. There were stories of tigers, and even an occasional sighting of a tiger or leopard. All of the roads, however, were then very new, at least in their utility for wheeled, let alone powered, vehicles. This was the so-called Burma Road (plus a few short feeder roads), constructed mainly *de novo* between 1935 and 1939, usually paralleling the old Imperial road system which had never been designed for wheeled vehicles but which was in any case long in disrepair and used only by porters and pack animals. (The Imperial roads were traditionally referred to as "Good for ten years and bad for ten thousand.") We were thus among the first to penetrate much of this area with new demands for, and new means to transport, charcoal and wood, and we accordingly found some of the last forest, or at least wood, resources remaining partly untapped.

But this was a small and remote part of China, quite atypical of the bulk of the country. By the time of the First World War, forests had vanished over nearly all of China (except for Manchuria), the end of a process begun some 5000 years earlier. China now must try to cope with the consequences, and try also to restore at least some of the protection which only forests can provide if its environment is to remain usable, let alone to support its more than billion people.

8. Forest Preservation in Tokugawa Japan

Masako M. Osako

There are historical precedents to the energy crisis of the twentieth century not only in Europe, but also in Asia. The shortages of lumber and fuel in early modern Britain and Mediterranean regions are widely acknowledged, but forest depletion in Japan occurring about the same time is virtually unknown to Western scholarship. This is so despite the fact that in Japan deforestation was extensive and generated highly advanced conservation technology and programs.

As in England, Japan's early modern energy shortage was triggered by the combination of warfare, international expansion, intensified agriculture, urbanization and, to a lesser extent, the population increase.[1] In the sixteenth century, trees had been chopped down excessively to supply decades of internal warfare and a few attempts at the invasion of Korea. Particularly after the Tokugawa hegemony was established (1600), the demand for lumber escalated, because the feudal lords began extensive construction of castles and towns. Soon many government officials and scholars became alarmed about the widespread deforestation. For instance, a Confucian scholar of the time, Kumazawa Banzan, lamented, "Eight out of ten mountains in the nation are deforested."

The consequences for the early energy crisis took radically different courses in Britain and Japan. In the former, the forest ceased to be important as the supplier of fuel and lumber, because Britons turned to coal and imported timber. The forest and pasture became regarded primarily as a landscape and habitat for animals. The Japanese did not have such an option. They knew about coal but did not consider it an acceptable substitute for wood. The national isolation policy of the Tokugawa regime (1600–1868) eliminated the possibility of international lumber and fuel trade. Thus, in Japan, forests continued to be the major source of fuel and timber until the twentieth century. In these circumstances, the Japanese had little choice but to preserve the woodland as carefully as they could.

The lack of choice alone does not explain how the Japanese managed to conserve forests. To understand this matter, it is necessary to examine how the physical fact of resource depletion led to ecological awareness, policy formation, and implementation.[2] The purpose of this paper is to delineate such processes and to examine the conditions in the Tokugawa society that facilitated or discouraged forest resource conservation.

Tokugawa Society

A brief description of the geographic characteristics of Japan is in order.[3] Its four main islands, strung out in a great arc along the coast of east Asia, lie between

approximately 30 and 40 degrees north latitude (equal to the distance between Jacksonville, Florida, and Montreal, Canada). Its seasons, temperature, and rainfall are comparable to those of the American east coast, except that the island nation experiences somewhat less extreme temperatures. Throughout all four of the main islands are great stretches of towering mountains and jumbled hills. The combination of rugged coastlines, precipitous mountains, and lush vegetation makes the whole country one of the beauty spots of the world. This fact appears to explain its people's profound attachment to the beauty of nature. But such terrain leaves little for the Japanese farmers, who find less than 20 percent of the land area level enough for cultivation.

Much of the level land was already farmed in the Tokugawa period. The area under cultivation had been gradually expanded through reclamation and the productivity per acre of land was also increased through the era. The tilled area in 1598 was 1.5 million cho (1.49 million hectares), whereas by the Kyoho era (1716–30) it had risen to 2.97 million (2.94 million hectares).[4] The improved yield was achieved by better plant varieties, improved methods of farming, and greater use of fertilizers. Agricultural production in 1598 was estimated at 15.8 million koku (27.7 million hectoliters), whereas by the Genroku era (1688–1703), it had risen to 25.78 million (45.1 million hectoliters) and by 1834 it had reached 30.43 million (53.3 million hectoliters).[5]

In relation to the growth of crop production, the population increase was more moderate. It is estimated that during the first one hundred years of the Tokugawa period, it increased by several million from 18 million for the period 1573–91.[6] But from 1721 to the Meiji restoration in 1868, the population remained basically stable, fluctuating between 25 and 27 million (excluding the samurai class). Historians commonly attribute the stagnation of population growth during the latter half of the Tokugawa period to the expanding economic inequality in the villages as well as the escalating tax burden imposed by the feudal administration.

Japan during the Tokugawa period was divided into some 300 "fiefs" of various sizes, spread out over the main islands excluding the northernmost, Hokkaido.[7] Each fief was a compact, well-defined political unit governed by a feudal lord, called the daimyo, who was largely independent of the central authority represented by the shogun ("generalissimo"). Each daimyo, however, was subjugated to the shogun and expected to comply with the latter's requests whether it was a provision of goods or a case of politically motivated matchmaking. The daimyo was aided by a class of officials and military officers (samurai), who lived on hereditary lands or received salaries from him. According to the Tokugawa hierarchy of social classes, beneath the samurai class, there existed three other strata composed of the peasant, the artisan, and the merchant.

To finance the fief administration, the daimyo depended primarily on rice and increasingly specialized crops and manufactured goods. The system of *sankin-kotai*, in which every other year he alternated the residence between the fief and the capital, consumed a large budget. The daimyo family's compulsory residence in the capital of Tokyo not only burdened the fief finances but also spread the

luxurious urban lifestyle throughout the fief, except among the peasantry. Gradually, the daimyo became dependent on the merchants to secure revenue, since the transaction of grains, lumber, and other commodities required special skills and facilities. Consequently the merchants' power increased despite the fact that the Confucian disdain of money and profit placed them last in the social order.

Peasants, composing over 80 percent of the Tokugawa population, were tied to the land.[8] Except for a small number of wealthy rural entrepreneurs and landlords, most peasants cultivated small plots of land which yielded barely enough to keep them from starving. The ruler taxed them heavily (up to 60 percent) and regulated their lifestyles by forbidding the consumption of silk and other luxuries. A common saying of the time, "Peasants are like sesame seeds; the more you squeeze, the more oil you get," vividly expresses the fief's view of farmers. With periodic famines, floods, and earthquakes, their lives were precarious. In the well-known Temmei famine in the late eighteenth century, nearly 40 percent of the rural population in the Tofuku district perished.

The village was the basic administrative unit in which peasants collectively managed water, forest, and pasture. The use of the communally owned resources was strictly regulated with formal rules.[9] Within the village, the neighborhood group (buraku) assumed joint responsibility for tax payments and offenses committed by its members. The shogun, as well as daimyo, issued many orders concerning village life, which were conveyed to peasants by the district magistrate, a samurai. But the village relied primarily on its own machinery of control for the execution of regulations. The village social control was effective because the authority of village officers (headman and elders) was based on the fief appointment as well as the community's traditional respect for and trust in the office holders who generally came from the established landlord class. Only when the matter could not be handled within the village or it concerned two or more villages would government officials become involved.

However, many villages in the late Tokugawa period, particularly in commercially and economically developed rural regions, gradually diverged from the generalized picture presented above. New rural entrepreneurs gained in wealth and power, while some of the landowners, by mismanagement and fortune, were reduced to small peasants. Meanwhile, despite the government ban on the mobility of peasantry to the city, a considerable number of landless peasants, seasonally or permanently, emigrated to cities. It is in terms of these dynamic circumstances that the village's management of forest and pasture must be understood.

Forest and Pasture Usage by the Peasant

The forest and grassland in Japan supplied several commodities essential for daily life, namely, lumber, fuel, and green manure. Lumber was in great demand throughout the Tokugawa period for the construction and maintenance of castles, houses, boats, and bridges. In particular, earthquakes, typhoons, and fires necessitated frequent and extensive rebuilding. By bulk, however, charcoal production doubled that of lumber. Japanese cuisine required fuels for daily cooking. And

heating was necessary at least for a few winter months. Finally, grasses from the pasture were used to fertilize the field. The two crop system which was widely practiced by the late middle age required ample application of fertilizer. As the commercial ones were costly, animal manure and green grasses were widely applied.[10] Consequently, the condition of forest and pasture significantly affected the life of the peasants as well as fief finance.

Prior to the Tokugawa era (1600–1868), villagers had free access to the forest or pasture (commonage or *iriaichi*) which they shared among themselves or with the members of neighboring villages. Only the custom which was built upon their respect for fellow villagers and nature regulated the manner and amount of their extraction. But deforestation rarely developed. It was in the seventeenth century that an increasing demand for forest products began to have impact on the village life. The tightening financial condition, suffered by nearly all the fiefs, resulted in heavy rice tax, which in some cases amounted to 60 percent of the expected yield.[11] To increase production, peasants applied green manure more intensively and developed new fields (*shinden*). Mikiso Hane estimates that the area under cultivation doubled between 1598 and 1716.[12] Reclamation aggravated the shortage of green manure because not only was the pasture converted into an arable land but also an additional field meant an increased need for fertilizer. Adding to this development, the nationalization of forests by the shogun and the daimyo, as will be discussed below, often deprived peasants of the right to collect logs, leaves, and firewood from the woodland. The resulting plight of the villagers is witnessed by numerous appeals to the fief government requesting the relaxing of regulations.

To survive in the face of the aggravating circumstances described above, the village tightened control over the members' usage of commonly owned forest and pasture.[13] Rules were made more specific, and penalty for the violation more severe. The type and amount of products harvested, cutting instruments, and the timing of harvest were all specified. The violators and their village were charged with penalty in the form of rice, sake, or money. But even the tightened regulations failed to regulate the villagers' competition for wood products. When an *iriaichi* was shared among more than one village, an increasing number of lawsuits were brought against neighboring villages, charging the violation of *iriaichi* usage rules or territorial boundaries. (An example of the conflict is shown in the next section).

Frequent lawsuits brought about a number of changes. The village official began to document rules and bases of his village's claim rather than to depend on unwritten customary usage. Some *iriai* groups decided to divide among member villages a forest once jointly used. The division was apt to be accompanied by considerable intervillage friction, often involving intervention by the fief administration. In some localities, the subdivision of *iriaichi* did not stop at this level; it was further subdivided into individual households.

Daimyo's Usage of Forest Resources

The condition of woodlands affected the feudal administration of Tokugawa era both directly and indirectly. The forest supplied lumber and other products for

domestic use as well as for export to other domains. And the level of agricultural production on which the fief's finance was primarily based was closely related to the availability of green manure and the regulation of water flow.

The dominant trend in the forest and pasture usage during the Tokugawa period was the daimyo's successive attempts to take over previously village owned grassland and forests.[14] When the lord needed a large volume of lumber for the construction of his castle, he restricted the peasantry's use of the high quality woods, designating them as "the lord's forest." The takeover was justified with the premise that he had the right to every corner of his land as the Tokugawa shogunate appointed him the lord of the territory. The incorporation of the wooded land by the daimyo further continued, as he began to realize that lumber was a profitable market commodity. By the beginning of the eighteenth century, virtually all the high quality forest in Japan fell into the hands of the shogun and daimyo. At the same time, in many cases, wood products became an important source of the public revenue. For instance, in Shimazu fief, 16.5 percent of the government revenue, excluding tax on rice, came from the transaction of lumber, charcoal, lacquer, and other forest goods.[15]

A commercialized lumber industry developed as the fief administration contracted the enterprise to lumber merchants.[16] The contract ordinarily began when an entrepreneur proposed to the fief administration the production of lumber in a certain area. The proposal specified the volume and type of lumber, timing of delivery, rate of the profit shared by the entrepreneur, and financial liability in the case of accident. Generally the entrepreneur obtained 40 to 50 percent of the merchandise as his share from which he paid necessary expenses. Upon the successful delivery of logs at a designated location (usually a port in the castle town), he could sell his share on the commercial market.

By the Genroku period (1661–1710), there emerged a nationwide network of lumber distribution with Tokyo and Osaka as the two major centers. In these two cities, lumber merchants developed specializations such as wholesale, resale, large log, small log, etc. In each of these specialties, the traders formed a guild, monopolizing the transaction being protected by the government license. Their operation was rather extensive, for by early eighteenth century over 7 percent of the Japanese population lived in urban areas, and Japanese houses were basically built of wood and paper.

The commercialization of lumber further intensified the peasant's desire for forest and pasture goods which had already become scarcer as a result of the daimyo's forfeiture of communally shared forests and the increased demand for grass fertilizer. This intensified scarcity frequently caused an open confrontation among villages that shared the usage of *iriai* land. The fierceness of intervillage conflicts, as shown in the next section, reveals the critical importance of forest resources for their survival.

Illustration 1: Intervillage Conflict in Iriaichi Usage. Tanba fief, located in the southwestern part of Japan, was known for high quality lumber including oak and beech.[17] The plight of Tanba villages exemplifies the condition prevalent at the

time, as they were struggling to deal with an increasing demand for forest goods in the face of static supply. The present case illustrates a conflict between a village called Yoshima located on the plain side of the *iriaichi* and two other member villages situated in its mountainous area. The conflict was triggered by a Yoshima resident's alleged violation of the rule regarding cutting instruments.

In 1820, Yashima village, located in the Tanba Plain, appealed to the fief authority:

> As a member of the iriaichi, our village has been enjoying the privilege of collecting grasses, bushwoods, and stumps without any restriction on the kinds of instruments we can use. However, on December 5, a peasant from our village called Maemon, was attacked by several men from the mountain villages. He was gathering firewood at the Azanemeka valley in the iriaichi. On his way from the valley, he was stopped by ten or so men from these villages. They forcibly took away Maemon's firewood and saw, claiming that he had been using the instrument forbidden to the residents of the plain villages. This incident occurred at a place called Sochi Nakamura.

The elders of Yashima vilage argued that this sanction was unjustifiable, because even though their village had been a member of the *iriaichi* for a long time, it had never been restricted in the usage of cutting instruments.

To this charge, the mountain villages responded that it was quite legitimate that different types of wood cutting tools would be permitted for the two groups, because in contrast to the plain villages, whose members were full time farmers, the mountain villages depended on farming and firewood production for their livelihood. One village on the mountain further commented that the Yashima village (to which Maemon belonged) was allowed to become a member of the *iriai* commanage only in 1703, contrary to the village's claim to long-standing status in the iriai.

It took two years before a compromise was achieved. The settlement consisted of the following conditions: "Three-fourths of the iriaichi shall be reserved for the exclusive use of the mountain villages. Residents of Yashima village are entitled to use the remaining one-fourth of the land, where they can use grass cutting knives and sickles at all time. But the use of saws is limited only to the fourteenths of the iriaichi allocated to Yashima village."

The truce between the villages was short-lived. Only two years after this compromise was reached, two mountain villages sued each other about another case of rule violation. Similar frequent and continuous intervillage conflicts were common throughout the Tokugawa period. The persistence of villagers may be explained by their intense demand for grasses and timber. Overexploitation of woodland was an understandable consequence of this circumstance.

Deforestation

Overexploitation by the peasantry only partially explains the extensive deforestation which occurred in Tokugawa Japan. Large-scale city and castle construc-

tion in the seventeenth century also contributed substantially to the deforestation. During the sixteenth century, which historians term the warring period, buildings and towns were torn down extensively as feudal lords fought numerous battles protecting or expanding their territories. Thus, when Tokugawa shogunate finally established hegemony over the nation in 1600, a majority of some 300 fiefs in the new regime badly needed to rebuild their castles and towns.

Enormous amounts of lumber were consumed in the rebuilding. For example, the construction of the Nagoya castle (completed in 1612) required 100,000 koku of lumber. The Edo castle, which served as the official headquarters of the Tokugawa regime, was several times as large as the Nagoya counterpart. It took some twenty years and over 700,000 koku (1,225,000 hectoliters) of lumber to complete.[18] For beauty, grandeur, and strength, these buildings required a substantial volume of large, flawless logs. Ground cypress was the most favored material but on the average it took 250 years to mature.

After the construction boom of the seventeenth century, forest depletion was blatantly obvious in many regions of Japan. Evidence suggesting the depletion of trees was abundant. For example, in numerous mountains, the woodcutters had to go further and further into the mountains to secure the needed amount of lumber.[19] (The further the extraction site moves from the stream, the higher the transportation cost and greater the chance of damage to the lumber.) At the same time, the dominant type of wood produced changed from slow growing and high quality trees such as cypress, oak, and cedar, to pines and chestnut which are low grade but fast maturing. Probably the most telling sign of the shortage was the reduction in the standard lumber size. In the Ina district, it changed in 1718 from 111.8 cm by 11.4 cm by 7.6 cm to 106.7 cm by 7.6 cm by 3.8 cm.[20] Even these measures were not sufficient for the woodcutters to fill the quota ordered by their lords. Consequently, in 1735, several villages in the Ina region appealed to the government to allow them to pay tax in money rather than in lumber. Acknowledging the reality of wood scarcity, the shogunate government accepted this appeal. Similar changes in the medium of tax payment were also reported elsewhere.

A drastic overexploitation and the fief's reaction to the consequence can be illustrated by the developments in the region currently called the Japan Alps. Located between Tokyo and Kyoto, the area was well-known for steep mountains and rich, valuable trees, such as ground cypress, cedar, and oak. The Tokugawa shogunate annexed the area to its domain immediately after the unification of the nation. To supply lumber for the construction of castles and other housing, a large scale production of timber began immediately after the incorporation. By the mid-seventeenth century, adult trees in the Kiso mountains were nearly exhausted. Then, the cutting site was moved to Ina district on the east side of the Tenryu River. But soon, Ina forests also ran out of large and high quality trees. The incidents of depletion are vividly indicated by the sharp fluctuations in the number of logs annually transported through the Tenryu River: it decreased from over one million logs in 1704 to less than 50,000 in 1716, back again to 250,000 in

1738, and to the low level of 20,000 in 1740.[21] In the 1740s, being forced to acquire another lumber force, this time the shogunate annexed nearby Hida mountains, forcibly transferring the original daimyo of the area to another fief.

Conservation

Becoming aware of the seriousness of forest resource depletion, by the mid-eighteenth century, nearly every fief had instituted some type of measure to protect trees.[22] Judging from the timing and frequency of such measures, the ecological awareness that natural resources must be used wisely, appeared to have spread rapidly and nationally. Several conditions facilitated the development of this consciousness. First, the impact of forest resource depletion was felt immediately, as it meant a curtailed or expensive supply of wood. In areas where accurate records were kept, the perception was particularly acute. Second, the ruling class of the time was the major consumer of lumber. Thus, the knowledge of forest depletion easily became a major administrative issue. Third, according to some historians, the dominant political ideology of the Tokugawa period, Confucianism, with its emphasis on the harmony between nature and society, sensitized the people to the danger of ecological imbalance.[23] Since there was a nationwide network of Confucian scholars, the new awareness was transmitted to even remote localities.

In the face of forest resource depletion, the fief administrations one by one adopted conservation measures directed to the peasantry. There were three major types of methods: (1) curtailment of production, (2) licensing of consumption, and (3) afforestation.

In the beginning, the common preservation method was to place the whole or part of the lord-owned forest under a ban. The most complete prohibition, under which no one but forest guards was allowed to set foot in the wooded area, was rare. Where the peasants had been accustomed to obtaining daily necessities such as charcoal, firewoods, nuts, and grasses from the land, they needed continual, albeit restricted, use of the land for survival. The restrictions on the partially banned forest varied greatly; in one extreme, villagers were allowed to gather only fallen leaves, while in the other they were free to cut down any trees except a few of the most valuable kinds such as cypress and oak.

Prohibiting peasants from harvesting certain species of trees was widely instituted throughout Japan. The selective list of forbidden trees compiled by Tokugawa Munechika (cf. table 8.1) indicates a clear regional difference in the timing of instituting bans.[24] In northern and central areas (i.e., the Japanese Alps region), formal forest policies appear to have developed as early as the seventeenth century. In contrast, with the exception of Wakayama and Kochi fiefs, southern domains issued orders to protect valuable trees only after 1707 or even later. Five of the fiefs in this region were indeed 100 years behind some of the northern daimyo. Assuming that the banning of trees is one of the earliest conservation measures, the differential timing expressed in the chart may indicate a wide regional variation in the development of formal forestry policy.[25]

Table 8.1. Banned trees by period and fief

	Early period 1646–1703	Middle period 1707–1751	Late period 1752–1868
Northern Honshu			
Hirosaki	9	17	16
Morioka	6	6	6
Sendai	8	16	17
Shinsho	0	11	11
Shomai	9	10	(10)
Akita	0	17	15
Middle Honshu			
Aizu	14	8	8
Nagoya (Kiso)	6	11	11
Fukui	5	(5)	5
Kanazawa	11	(11)	7
Southern Honshu and Shikoku			
Wakayama	8	6	6
Okayama	0	0	8
Hiroshima	0	8	13
Yamaguchi	0	0	7
Kochi	17	(17)	8
Kyushu			
Fukuoka	0	0	4
Kumamoto	0	0	4
Hitoyoshi	0	14	23
Kagoshima	0	0	6

Source: Adapted from Muneyoshi Tokugawa, *Edo Jidai ni Okeru Zorin Gijutsu no Shiteki Kenkyu* (Historical Analysis of Afforestation Technologies), 1941: 358–65.

Also indicated in table 8.1 is another kind of inter-fief difference. The number of trees banned in each territory changed over time. Generally speaking, the number increased, but in Morioka, Shinshu, and Fukui, it remained constant throughout the Tokugawa period. A more striking case is presented by Aizu, Wakayama, and Kochi fiefs in which the list of forbidden trees was shortened by the middle and late Tokugawa era. The shortening probably indicates success in forest administration, because it means that fewer tree species needed protection. As suggested by the early initiation of the conservation program, these three fiefs were more advanced than others in forest administration.

The licensing of the peasantry's consumption of forest products was another measure employed to encourage forest conservation. An official permit was usually necessary for the construction or repair of a house, bridge, or other structure—even a small barn in the backyard. In the most restricted case, the peasant needed an official permit for cutting down a tree in his own garden.[26]

When the fief restricted the use of its forests by the peasants, it had to assign the task of enforcing the restriction to an appropriate group.[27] Commonly, the responsibility was assigned to a hamlet or village located in or near the woodland. In return for the assignment, it enjoyed certain privileges, such as the right to

gather firewood, nuts, and leaves prior to the other villages' entrance to the forest. Since the forest covered a large area and was not fenced, it was extremely difficult to protect the land from theft. Nonetheless, the guarding village (or hamlet) had to pay for the damage when the offenders were not identified.

The theft of the forbidden forest goods was punished severely (see appendix). The severity varied by fief, period, magnitude of the offense, and the social position of the offender. At times, an illicit felling of a tree cost a head, while in other instances, it claimed only a small sum of money. When the village leader of the forest guard stole from the forest, he received particularly severe punishment. This was not rare, because the most profitable of such operations required the participation of a sizeable number of people.

It became clear to many administrators and agriculturists that the curtailment of the peasants' consumption alone was not adequate to counteract the forest product shortage caused by the fiefs' mounting financial needs and consumption. The Genroku period (1688–1704) marked a turning point from passive to more active conservation measures, including afforestation.

At first, the afforestation effort was carried out on a hit-or-miss basis. For example, in 1671 Lord Tsugaru Nobumasa in northern Japan initiated a project to plant one million saplings of pine and cedar.[28] His efforts were repeated four and ten years later on a smaller scale. Gradually more systematic conservation measures developed, such as compulsory afforestation after felling a tree and systematic rotation of the tree cutting sites.

Beginning with the eighteenth century, many fiefs resorted to the system of compulsory reforestation.[29] In some fiefs, the lord simply ordered that after felling trees, enough new seeds should be planted to insure the continuing supply of lumber. Other fiefs specified the type of trees: "whenever pine trees are cut down, cedar seeds must be planted" (Simoda fief, mid-eighteenth century). Some lords demanded more by insisting that the peasants care for saplings. A document from the early nineteenth century reads: "The peasant must provide the seeds of cedar and cypress to meet his quota in afforestation" and "if the sapling withers, he must repeat seeding and caring until the new tree securely takes root" [Kochi fief].

A special type of compulsory replantation program is called *daishoku*. This method specifies the number of seedlings to be planted per felled tree. A Sendai fief document produced during the Tenna period (1681–83), contains this statement: "At times, priests request the harvesting of lumber at the fief-owned forest. They need cedar, cypress, pines, chestnut, and so forth to construct and repair their shrines. For felling one tree with a diameter of 60 cm or longer, they must plant 25 seedlings."[30] Similar regulations are found in many parts of Japan from the eighteenth and nineteenth centuries: "100 pine saplings must be planted whenever one mature tree is chopped down" [Suo fief]; "Anyone applying for a license to harvest 1000 trees must first plant 2000 seedlings before his application is accepted" [Sendai fief]; "To replace one felled tree, two saplings must be planted at the site of the felling" [Morioka fief]. The ratio of saplings to adult trees ranged from two to one hundred.[31]

The implementation of the forestation program appears to have been rather difficult, even though quantitative evidence designating the exact extent of negligence is rare. The following record from Hirosaki fief in northern Japan reveals a glimpse of such a problem. During the second half of the eighteenth century, Lord Hirosaki was obliged to issue several decrees ordering compulsory replantation following every tree cutting. But none of these orders was closely observed. In 1808, having finally run out of patience, the daimyo issued an ultimatum to his subjects: "As of this year, many shrines, temples, and peasants are behind the schedule in afforestation. They owe the fief the planting of 508,552 seedlings. These saplings must be planted within three years. If anyone should fail to complete his share of planting, he shall no longer be granted permission to chop down trees."[32] It is not clear whether this decree brought about the compliance of the tree harvesters. But the episode suggests tremendous difficulty in implementing the afforestation policies.

Although the concept of the rotation of cutting sites was known to some regions even prior to the Tokugawa period it was not until the eighteenth century that many fiefs adopted this technique. This method divides the forest into a number of subdivisions and rotates the cutting site each year. Frequency of the extraction in one location varied by the types of trees harvested and the climate of the region. For instance, Kumatoto fief in southern Japan adopted a twenty-year cycle, but in the northern Sendai fief, a forty-five-year cycle was common. At a locality in Morioka fief, lumber was harvested every year at 10 to 15 units out of a total of 220 subdivisions. During the Kansei period (1789–1800), Yonesawa fief recommended that every year only 200 to 300 white flag pines be cut, for this system would enable many trees of the kind to grow past 100 years.[34]

The site rotation system has a number of advantages over other conservation approaches previously mentioned. First, this is a comprehensive tree resource. Second, since the years needed for a tree to mature can be precisely calculated, the program contains relatively little room for miscalculation. Another comparative advantage of this system is that the administration of the plan is less complicated. When trees of only certain types and sizes are banned, it is extremely difficult for the forestry officials to check the illicit harvesting. A peasant might go into the mountain with the pretext of cutting down only permitted trees, but he might "accidentally" or "mistakenly" chop down forbidden trees. Furthermore, if the officer discovers a violation after the tree has been cut into smaller pieces, it is rather difficult to prove the size of the original tree. Technically it was possible to do so, but such a detection would have required an enormous amount of administrative time.

Illustration 2: Stealing in the Lord Owned Forest.[34] Historical data reveal numerous incidents of the peasants' negligence in the afforestation of the thefts from government owned forests. As the recording of the illegal behavior was not exhaustive, it is impossible to document the extent of such activities. But evidence suggesting widespread violation is abundant. For instance, the 1858 incident in the

Ina district, reported below, was rather familiar to both villagers and forest administrators of the time.

Iida district, located between the Tenryu River and Ina Mountains, was composed of twelve villages which were licensed to produce forest goods such as lumber, charcoal, and mushrooms. Since most of the Ina Mountains were incorporated into the shogun's domain, these villages were permitted to work in or along the lord's forest. The Oshima hamlet in Ogawa village, one of the twelve units in the Iida district, was responsible for guarding the shogun-owned forest located east of the district. At the same time, the hamlet was licensed to gather smaller lumber (to be used for roofing, geta slippers, and firewood) from the outskirts of the woodland.

There was an understandable tension between the Oshima hamlet, which guarded the forest from illegal entrances, and the neighboring villages. Judging from the numerous apology notes submitted to the government office the forest rules were frequently violated. Antagonism towards the Oshima hamlet grew when other hamlets and villages suspected that Oshima people themselves committed thefts in the shogun-owned forest. In fact, they were reported to have earned most of their living by the sales of illegally procured timbers. They were relatively unhampered in their illicit activities, because they were the official guardians of the area. Furthermore, since they had permission to harvest small trees at the base of the mountain, they did not arouse the neighbors' suspicion even when they walked toward the mountain with tree cutting instruments. In addition, the mountains were too steep for the government officials' frequent visits.

However, the neighboring hamlets eventually located some proof of Oshima's wrongdoing. They immediately requested the government office to visit the region and inspect. On 7 December 1858, two hamlets in Ogawa village received a message from the local fief office announcing the arrival of the official site visitors on the very next day. The Oshima hamlet was taken by surprise, for no forewarning had been sent to its leaders.

Several officers arrived to survey the mountain. After one day's inspection by two teams, they identified in total 58 violations (cf. table 8.2). The offenses varied in seriousness from peeling of pine bark to the felling of an oak tree.

The list of violations was long. But the visiting officers did not intend to prosecute the offenders. Despite the request of the hamlets critical of the Oshima residents, the officers stated that the identified offenses were not serious enough to be prosecuted, and left the village on the following day. One of the magistrates wrote in his site visit report: "So far as the area we inspected today is concerned, there were hardly any major thefts and mistreatment. I would suppose that the conditions in the rest of the mountain resembles the one we observed today. Having had to climb up the steep slopes where people seldom set foot, I am very exhausted today."[35]

Thus, no action was taken against the Oshima hamlet as a result of this inspection. Not until four years later, probably pressed by its neighboring hamlets and villages, did the government issue an order forbidding the Oshima residents to

Table 8.2. Thefts discovered by official inspection team, Ina District, 8 December 1858[a]

Type of tree	Size in feet	Volume	Remarks
Fir	11.9 × 0.6 × 0.6	3 pcs.	Offender: Tokutaro
Japanese cypress	Circumference: 8.9	1 tree	Chopped down about 3 years ago
Fir	same as above	1 tree	"
Hemlock-spruce	same as above	1 tree	"
Pine	same as above	1 tree	"
Chestnut	Stump diameter: 3.7	1 tree	"
Hemlock-spruce	× 0.4 × 0.4	1 pc.	"
Hemlock-spruce	11.9 × 5.4 × 4.5	1 pc.	Cut down about 10 days ago
Chestnut	plank	1 pc.	
Hemlock-spruce	Length: 12.0, dia: 0.8	1 pc.	
Fir	Stump circumference: 1.6	1 pc.	
Fir	Stump circumference: 8.7	1 pc.	
Ground cypress	—	1 location	Bark peeled
Walnut	—	1 location	Bark peeled
Ground cypress	—	1 tree	Chopped down
Clog tree	—	4 locations	Enough wood for making 3 pairs of geta clogs

Source: Adapted from Kiyoto Hirasawa, *Kinsei Iriai Kanko no Seiritsu to Tenkai* (Formation and Development of Iriai Practice in Early Modern Times), pp. 280–1.
a. In total fifty-four cases of theft were uncovered in the forest. In addition, four cases of the possession of unaccounted lumber (ranging from one piece to thirty pieces) were identified in the villages.

obtain wood products near the shogun owned forest. It is doubtful that this action effectively curbed the Oshima people's illegal harvesting in the forest, because they maintained their position as the guardian of the woodland. Also it is possible that the government tolerated the infringement as long as it was within a reasonable limit. Their leniency was probably influenced by the fact that since the Oshima hamlet had only a small piece of arable land, its residents had to earn much of their living by extracting and processing forest products.

Effectiveness of Conservation Measures

How successful were various conservation measures? Even though formal evaluations of the ecological programs were rarely conducted, there is enough indirect evidence to suggest a wide range of results. On the one hand, the shogun owned Ina forest was successfully reforested after a period of depletion in the early nineteenth century. This success was due primarily to a sharp curtailment of harvesting which was made possible by the shogunate's having acquired a new cutting site in a nearby forest.[36] As mentioned before, the log chart recorded at a nearby port on Tenryu River clearly indicates a sharp drop in the production at the Ina site. Wakayama fief was another successful example.[37] It continued to

enjoy surplus lumber, and had only a lax control over the private consumption of tree products. (With stable population, underdevelopment of cities, and rich products from the ocean, this fief enjoyed relative financial stability.) On the other hand, Shimazu fief was once a large exporter of cedar timber, but in the nineteenth century, it was obliged to import lumber from other fiefs. Shimazu fief, located in the southern end of Japan, suffered from severe financial difficulties due to a large samurai population, long distance travel to and from Tokyo at the time of *sankinkotai*, and the expenditure needed to maintain its highest ranking status among the daimyo.[38] Historians attribute this circumstance to the excessive exploitation of the forests which never fully recovered. And we have already referred to the frustration of the forest administrators at Hirosaki fief which carried a large backload of unplanted saplings despite frequent public orders from the daimyo office. In sum, the historical data indicates a wide regional variation in the success of forest preservation efforts.

And yet, it appears legitimate to conclude that when all things are considered, the forest administration during the Tokugawa period was a fair success. To be sure, after the Meiji restoration, the officers of the Ministry of Forestry grieved over the extensive damage done to the forest during the Tokugawa period.[39] Tokugawa peasants increasingly supplemented grasses with commercial fertilizers such as sardines and soybean skins.[40] On the other hand, no village site was abandoned because of green manure shortage or extensive soil erosion. No Japanese mountain was literally bald at the time of Meiji restoration. And for several decades after the restoration, Japan was virtually self-sufficient in the supply of fuel and wood products.

Forests During the Meiji Era

As soon as the imperial rule was restored in 1868, after nearly three centuries of Tokugawa dominance, Japan began a wholehearted effort toward "modernization." Within four decades, she attained what economists call an industrial "take off", growing into a major world power. Did the tradition of forest conservation survive the nationwide effort towards industrialization undertaken by the Meiji regime? In order to answer this question one must first examine the larger economic context of the Meiji era (1868–1914).[41] The major concern of the rulers of the new regime, particularly after the quelling of political and social turmoils accompanying power transition, was to make Japan a strong modern nation. This concern reflects their preoccupation with gaining diplomatic equality with the occident. To attain this goal, they devoted themselves to building factories, acquiring fuels and raw materials, constructing warships, importing modern technology, and so on.

In all these efforts, forest products were needed. Lumber was used for constructing buildings, bridges, ships, and many other modern artifacts. Timber, a major fuel for industrial production, was an acceptable energy source for the major industries of the time, namely textiles and other light industries. Furthermore,

farmers continued to use green manure throughout the Meiji period. Adequate agricultural production was essential for successful industrialization, because it was a prerequisite for the supply of labor and because it enabled the nation to import modern commodities rather than foodstuffs. Another forest product, silk, also contributed significantly to improving the international trade balance, as it was the major export item throughout the Meiji era. According to Lockwood, "raw silk trade financed no less than 10 percent of Japan's entire imports of foreign machinery and raw materials utilized domestically from 1870 to 1930."[42]

The most crucial policy which influenced the impact of industrialization on forest usage was the heavy concentration of woodlands in the hands of public institutions. After the restoration of the imperial rule, most of the forested land previously owned by daimyo as well as village commonages were reclassified as the property of the Imperial Household, national government, or local municipal units. Thus, by 1900, more than two-thirds of the wooded areas were owned by these public bodies.[43]

This massive transfer of ownership was met with tenacious and, at times, violent resistance on the part of the peasants. Their traditional rights to use the daimyo's and the village's forests were frequently eliminated or curtailed with this reclassification, leaving them acutely short of timber, charcoal, and grasses.[44] In nearly every prefecture (which was formerly designated as a fief), peasants resorted to arson, theft, neglect of afforestation, and even revolts to retain their traditionally guaranteed rights. But as the Meiji government became stabilized, with the help of the newly created military and police forces, it managed to negotiate with them or, more commonly, suppress their resistance.

There are reasons to believe that the concentration of forest ownership helped to avoid extensive deforestation.[45] First, the publicly owned woodlands were protected from the pressures of demands for lumber and fuel generated by the emerging industrialization and expanding commercial markets.[46] Second, the government could enforce afforestation more efficiently in the public domain than on privately owned plots. Finally, the condition of woodlands owned by Meiji peasants also supports the above interpretation. The new government policies, such as the freedom of geographical and occupational mobility and a new taxation system by which the household, rather than the entire village, was held responsible for the payment, undermined the village solidarity.[47] Moreover, the commercial economy which penetrated the countryside tempted the peasants to obtain cash by selling forest products. Due to these circumstances of the early Meiji years, the exploitation of woodland became widespread.[48] In fact it was the numerous reports of forest degradation that led the government to legislate conservation as the "privilege and duty" of the peasants living near the woodland regardless of its ownership. In short, these historical circumstances indicate that the extensive public ownership of forested lands helped to regulate the lumber and fuel production and prevented the overexploitation of their resources.

This regulation of production was achieved in part because the great expansion of the demand for fuel and lumber was yet to come. The demand for energy was

still moderate during the Meiji years, indicated by the fact that Japan was a net exporter of coal. For example, in 1913, with a total production of 21.3 million metric tons, she exported 3.5 million metric tons of the mineral.[49] Furthermore, the substantial import of lumber did not begin until after 1915.[50]

Discussion

The above analysis of forestation during the Tokugawa period (1600–1868) reveals that the conservation of forest resources was a major economic issue for most of its era. Japan was not penetrated by Western colonialism during this period. Yet urbanization, improved living standards, and the financial needs of the fief government indigenously created a pressing demand for lumber and charcoal, making the preservation of trees a major local and national issue. The Tokugawa government regulated the consumption and conservation of forest resources, resorting primarily to coercive measures imposed upon the peasantry and self-regulation within the village community.

This pre-modern Japanese experience has several implications for the theory of resource usage. First, this is a case in which the society experienced deforestation in the absence of either industrialization or the intrusion of Western colonialism, which are commonly held responsible for large-scale environmental deterioration. Second, the Japanese experience is unique in several ways: a massive amount of historical data is preserved; tree censuses were taken by government officials; the volume of transported logs was measured at major ports; afforestation orders were recorded by the fief lumber office; rules about the usage of commonage were written down by village chiefs; and numerous court cases, in which villages sued each other, were also recorded. As a result, it is possible to reconstruct with considerable accuracy the efforts needed to preserve forest resources. Third, these historical materials indicate the considerable difficulty encountered by the Tokugawa government in reducing the consumption of wood products and enforcing afforestation efforts. This finding undermines the validity of the widely held notion that, in the Far East, Buddhism and pantheism made environmental preservation an accepted way of life. To the contrary the Tokugawa society fully shared the perennial problem of ecological management, that is, the protection of the long term interest of the group from the immediate self interest of individual members.

Appendix: Examples of punishment for thefts of forest goods

Fief	Penalty
Kochi	The theft of high quality timber shall be punished by fine, imprisonment, banishment or death penalty depending on the seriousness of the offense. Anyone found guilty of illegally felling a low quality tree shall pay the penalty in labor service.
Hikone	When a peasant steals from the lord's forest for the first time, he will be fined, but on the second violation he shall face imprisonment and his village chief and elders shall be fined. The offender might be put to death if he repeats the act.
Okayama	Anyone who is found guilty of stealing a tree (which is large enough to yield timber) shall be beheaded. The illegal collection of grasses and leaves in the lord's forest shall be sanctioned with the suspension of the right to enter the iriaichi (commonage).
Mito	A villager who has committed the crime of cutting down trees without a permit shall be fined or imprisoned. If the theft is of a large scale, he might be banished from the village. When the offender of a major forest crime cannot be found, whoever is in charge (the forest administrator, chief ranger, village head or hamlet chief), shall be branded and banished from the area. In addition, the village (or hamlet) which is responsible for the guarding of the woodland must pay twice the market price of the stolen timber, if no violator is identified.
Shinsho	When the offender of an illicit felling cannot be found, the entire guarding village must share the responsibility for the damage. One *ryo* shall be charged for the theft of a zelkova tree, Judas-tree, or a cedar, and 0.1 *ryo* for a less valuable kind such as oak and chestnut.
Honai	When the forest-guarding village cannot discover the timber thief, each household of the community must pay the penalty of 100 *mon*. Also, as a punishment for a violation committed by the villagers (or their failure to guard the woodland properly), the government might suspend their privilege to gather leaves, firewood, and other goods from the lord-owned forest.

Source: *Collection of Historical Data on Forest Administration*. Adapted from Michio Tsutsui, *Nihon Resei Shi Kenkyu Josetsu* (Introduction to the History of Forest Administration in Japan), pp. 184–9.

9. The British Colonial System and the Forests of the Western Himalayas, 1815–1914

Richard P. Tucker

Within the past decade the countries which share the Himalayan mountain system have become increasingly alarmed at the processes of ecological degradation which are in motion in the region. The mountains are experiencing an inexorable decline in the resource base for local subsistence and are sending increasingly frequent floods and eroding soil downriver into the densely populated Indus, Ganges, and Brahmaputra basins. The consequences in the Ganges system alone are felt as far away as the delta region around Calcutta and major population centers in Bangladesh.

In New Delhi both the Government of India and independent resource planners now recognize that the Himalayas are both a unique resource for the life of India and an extremely fragile ecosystem which must be managed both as a coordinated development system and as a high priority in its own right, not just as an appendage to the economic and political interests of the north Indian plains.

The environmental pressures on the western Himalayas have been building for at least a century and a half. The region, once largely isolated from the outside world, has moved to close integration with the world economy and international administrative networks. Much of this pattern was set during the century or more of British rule in the region. The colonial regime left not only a complex set of traces on the mountain lands but also the most extensive range of archives relating to resource exploitation for any mountain region in the colonial world.

Those records tell an intricate and paradoxical story. The British Raj not only contributed to the decline of the region as an ecosystem but also, in response, it established the most sophisticated forestry service in the colonial world. In turn, that service harvested vast regions of timber from the Himalayas; in addition it began systematic sustained-yield forestry management and soil stabilization on the lands under its control, even before World War I brought sudden new pressures to the region. Finally, as the foresters well knew, their efforts to exploit and preserve the Himalayan timber lands operated within a much broader system over which they had little control. The destinies of the forest and their users were profoundly influenced by the international economic ties of British India. Even though almost no products of the western Himalayas, either timber or other crops, were exported beyond India's borders, human use of the mountains was tied closely to the worldwide dynamism of nineteenth-century Britain and cannot be fully understood except in that broad context.

Landforms, Vegetation, and Subsistence

The area of this study is the mountain region which lies between the present border of Jammu and Kashmir to the northwest and Nepal to the east.[1] Politically and geographically it is divisible into two segments. The eastern is Kumaon and Garhwal in the Ganges watershed, two subregions which together comprise the hill districts of present day Uttar Pradesh state. The state was known before independence in 1947 as the United Provinces; hence it is referred to as U.P. both before and after independence. Kumaon reaches eastward to the Sarda River, which defines the Nepal border as it descends to join the Ganges system. Beyond, the mountains of Garhwal are drained by the Bhagirathi and Alaknanda rivers, which join to form the main stream of the Ganges. The western gorges of Garhwal form the upper Jumna River, the westernmost branch of the Ganges system, which determines a portion of the border of U.P. and later flows past the capital, New Delhi. Just northwest of New Delhi, and on a roughly northerly line into the mountains from there, runs the demarcation between the Ganges and Indus river systems. The western half of the region under analysis is the upper watershed for three branches of the Indus system, the Jhelum, Beas, and Ravi rivers. Rising in the hills which were part of Punjab until they were separated into their own hill state, Himachal Pradesh, after independence, these three branches water the fertile plains of Punjab.

The lower ranges of the western Himalayas form one of south Asia's critical ecological regions. Along the southern edge of the Himalayas the hills rise abruptly from the heavily populated alluvial plains. The first hills, the Siwaliks, stand at 600–900 meters. Behind them lie a series of transverse valleys including Kangra and Dehra Dun, where Hindu rajas based small kingdoms on prosperous subsistence agriculture during Mughal times, unstable in their allegiance to the emperors below in the plains. At the base of the Siwaliks on the Himachal border, the lowest hills are composed mostly of a deep and highly unstable alluvium, and are susceptible to severe, rapid erosion if their forest cover is stripped. Farther southeast in U.P. runs the *bhabar*, a line of talus gravel slopes deposited by the Himalayan rivers over the millennia. For much of the year the streams subside beneath the bhabar for fifteen to twenty-five kms, emerging again to carry finer alluvial silts more slowly into the plains. Where the rivers emerge they form the *tarai*, a marshy, malarial belt of dense jungle poorly suited in the nineteenth century to agriculture and permanent settlement. Except along river channels the *tarai* formed the mountains' most effective defense against overuse until the 1950s when chemical pesticides became available.

Beyond the low valleys rise the outer Himalayas, northwest-to-southeast ranges rising abruptly to 2,500 meters and more. The Himalayan river gorges provide only occasional, difficult access routes to the inner mountains. Beyond the outer

ranges lie another series of valleys and then finally their headwaters in the glaciers and permanent snows of the great Himalayan peaks, which rise to 5,000–7,000 meters, many of the highest peaks in the Indian Himalayas. These youngest and highest of the world's mountains are also among the most unstable. In large parts of Himachal and northern U.P., natural geological processes, even without any human assistance, have produced extremely high rates of soil erosion and riverbed siltation.[2] Rock formations, extremely varied in type, are shattered in intricate and unstable striation; the threat of landslides and earthquakes is constant.

Mountains of this scale succeed in dividing the monsoon climate of south Asia from the cooler drier climate of central Asia. From mid-June into September monsoon storms swirl northward into the lower Himalayas leaving 70–120 mm of rain in the warm valleys and up to 250 mm of rain on the southern slopes of the outer Himalayas beyond. The northward-facing slopes receive a lower total accumulation of rain, but the storms pound less intensely on their vegetation and soils. The heavy monsoon clouds do not penetrate beyond the great Himalaya; north of there is one of the planet's great rain-shadow regions, the Tibetan plateau. Coming from the north, winter deposits heavy snows on the high ranges, closing the alpine passes even to traders and shepherds for several months and sealing off the high country. The spring runoff into the Indus and Ganges systems provides the year's second source of water for the valleys and plains to the south.

Within this region, as in any major mountain system, lie an almost infinite variety of micro-climates. Human habitation has had to adapt to highly specific equations of elevation, exposure to sun, soil patterns, slope contours and precipitation. This great variety, added to the remoteness of most mountainsides and gorges, meant that before the British colonial system appeared, local subsistence was virtually the only economic pattern in the region.

The Pahari people of the hills (*pahar* in Hindi means mountain) have traditionally sown a mixed pattern of crops in the kharif season, planting wheat, barley, maize, rice, gram, and millet from April to July. Below elevations of roughly 2,000 meters, a winter, or rabi, crop of wheat, barley, and gram has also been possible.[3] Above that, to 3,000 meters or so, villages have had to depend on one crop annually, often elaborately terraced on steep slopes. Until well into the nineteenth century, when the plains began to make major demands on the mountains' resources, this was enough to provide survival for the sparse population of the hills. Typically, small villages farmed their acreage in the alluvial soil along river beds and grazed their domestic animals on common lands in pastures and forests above. Demarcation of ownership in the pastures and forests was usually unnecessary; broad belts of virgin forest meant that boundary or usage quarrels were rare. The local rajas in theory owned all land and arbitrated the use of noncultivated land; their demands on the forests were minimal until the gradual development of a market economy in the nineteenth century.

Even under the British regime, though the acreage planted to crops expanded greatly, there was little market agriculture geared for commercial export to the plains before 1947 except in the low valleys. The major export crop was timber:

deforestation was the principal economic and ecological change in the hills during colonial times.

The history of timber operations has reflected the pattern of tree species in the hills.[4] In the moist deciduous forests of the foothills and *tarai*, dense thickets of tall bamboo became commercially important for many small traders in the nineteenth century, but this was timber only in a very limited sense. The most desirable hardwood was sal (*Shorea robusta*), then and now the great timber tree of the submontane tracts from U.P. eastward. Its fine grain and hardy resistance to the ravages of white ants placed it in prime demand for most timber purposes. Overcutting of sal in the lowlands districts as the century wore on was the key to the increasing search for other hardwoods in the mountains.

In the outer Himalayan ranges, from 1,500 to 2,300 meters, the chir pine (*Pinus longifolia*) dominated many slopes. Like most other conifers, its wood was unsuitable for use as railway sleepers (crossties). Though relatively accessible to rivers, it did not become an important commercial tree until after 1900 when it became the chief plantation tree for the resin industry of the foothills.

The great tree of the mountains is the deodar (*Cedrus deodara*), whose hard and elegant wood was ideal for construction and railway uses. It grows at altitudes of 1,600 to 3,000 meters in the moist temperate zone. Most of the massive cuttings of the nineteenth century were in the deodar forests; silviculturists learned only slowly that it is not only slow growing but also difficult to propagate. Unfortunately, it had no ready substitute, for the other conifers, though faster growing, were all far less durable. Mixed with the deodar, and increasingly dominant in the middle ranges at 1,800 to 2,600 meters in recent decades, is the kail or blue pine (*Pinus excelsa* or *wallichiana*). Above that, into the alpine zone, the Himalayan spruce (*Picea* or *Abies smithiana*)[5] from 2,100 to 3,300 meters and the Himalayan silver fir (*Abies webbiana* or *pindrow*) from 2,200 to 3,300 meters were not under severe commercial pressure until the advent of high elevation roads after independence in 1947.

One other type of tree became commercially valuable in the nineteenth century, the broad-leaved oak (*Quercus*), several species of which grow at widely ranging elevations in open stands on drier slopes. They have been used commercially primarily for building and furniture, but this has conflicted with villagers' needs for oak leaves as fodder and mulch. Some of the most severe soil erosion in the region has resulted from deforestation on south-facing slopes—where only oaks grow well—on soil which is very dry until the monsoon rains pound it.

British Rule and the Expansion of Agriculture

British administration of northern India took nearly a century to evolve into a relatively integrated system of land revenue, agricultural development and timber harvesting. Beginning with the conquest of the lower Ganges basin in 1765, British power moved slowly upriver. The entire Ganges and Indus basins were not firmly

in their hands until 1858. The hill districts of the western Himalayas were also annexed in stages. In 1816 British armies annexed Kumaon and Garhwal, expelling the Gurkhas, the ruling ethnic group of Nepal. Upper Garhwal they left as Tehri-Garhwal State under the autonomous control of the Raja of Tehri; the rest of the region became Kumaon Division of British India. The Punjab hills fell to the British only in 1849, after protracted maneuvers and finally open war against the Sikh kingdom of the Punjab.[6] Here too the British took direct control over only part of the region. A treaty with the Raja of Kashmir left that region as a princely state. Immediately to its southeast, Chamba in the Ravi valley was also left to its ruling family, as were several smaller principalities in the hills around the new British summer capital of Simla. By the 1860s the modern political boundaries of the region were set in place, nearly in their present form except for the integration of the princely states into larger units after 1947.

Forest depletion in the region, in both plains and hills, evolved in the wake of the expansion of agriculture. Before the British era large tracts in the lowlands had already been transformed from forest into agriculture, though in times of political and military disruption some of this land had reverted to degraded second growth forest. The richest and best watered lands in the U.P. districts below the *tarai* were the most fully exploited and densely populated. Districts in northwestern U.P., in the Ganges-Jumna Doab region, were marginally too dry for reliable annual wheat cropping and suffered periodic droughts. Population was thinner there and land clearing less systematic. The *tarai* itself supported extensive forests until long into the twentieth century.

As soon as the British defeated local powers and dispersed their armies, they turned to improving agricultural yields and encouraging trade. They particularly fostered the expansion of marketable cash crops in the plains, primarily wheat, cotton, indigo, opium, and sugar. Cotton, indigo, and opium were marked primarily for foreign markets; as the century wore on, wheat and sugar also began to respond to demand from Europe.[7] Not only was existing arable land turned to the newly profitable crops; previously fallow land began to come under the plow as well, wherever the Revenue Department could stimulate the hard labor of breaking new soil.

Gorakhpur district in the northeastern corner of U.P., just below the Nepal border, typified the processes at work, though the scale of its transformation was greater than in many districts.[8] There the British took control in 1801 and busied themselves with increasing the acreage under cultivation and harvesting the resulting profits for their friends, both princely and European. By 1830 an estimated one million trees had been felled and many others killed by the peasants' slash and burn fires. In that year the District Commissioner reported that the district, until recently densely forested, held no more valuable timber, only overaged and scrub growth. His proposal was to give large land grants to British investors in order to bring more land under marketable crops. One entrepreneur, John Bridgeman, purchased 28,000 hectares in Calcutta in 1836, over half of

which he brought into cultivation before 1850. A Mr. Finch bought 36,000 hectares of second growth sal forest for cultivation, but his project failed after a few years' effort.

The most vivid expression of the land mania of the era was Lady Malkin's purchase of 9,389 hectares in the district. She held the land for a few years but did nothing to change its use. One commentator wryly observed, "One wonders what the dainty Lady Malkin thought she was going to do with the 23,200 acres of Nagwa. Doubtless she was a regular visitor at Government House in Calcutta and had heard at dinner what a good thing was going for the asking."[9] Detailed studies of the long range changes in land use and rural social structure which resulted from this giddy era remain to be carried out, with the help of Revenue Department *Proceedings*. For now we can confidently conclude, on the basis of later Forest Department records, that the chief biological loss was tens of thousands of hectares of mixed hardwood forests whose primary cash earning species was sal. The railway builders who began work there in the 1860s found the supplies of sal far from adequate for their needs.

The most dramatic change which the British introduced in the landscape in the first half of the century was an elaborate system of canals, designed to irrigate these districts and turn them into productive agriculture, especially in the Doab where rainfall was unreliable.[10] Beginning in 1830 British civil engineers planned major canal systems to channel Himalayan waters through the northern Gangetic plain. By 1860 four hundred thousand hectares were irrigated by canal water in the Northwest Province; by 1878 that figure rose another 50 percent. Most of this land was turned to production of cash crops.

Under these peacetime conditions the population of the northern plains, both rural and urban, increased steadily through the middle years of the century. Markets increased for timber, both for building purposes and for the fuelwood and other subsistence needs of the peasants. No statistical data of any sort were ever collected in the early colonial decades; but when the first Forest Department reports were written in the late 1860s, they reflected the small scale but very widespread inroads on the forests which an era of steady economic expansion entailed. Any woodlands adjacent to navigable streams or bullock cart roads were susceptible to clearing of the trees. And on any private land where trees were felled to make way for the plow, the owners were willing to sell the trees at low rates to local merchants, eager to have these impediments to agriculture removed.

From the perspective of the towns the timber trade was socially complex, providing occupation for a variety of specialized traders. A report from Lucknow in 1875 gives our best insight into the small scale timber trade of the era.[11] It would still be recognizable to anyone who knows the small scale timber and fuelwood trade today, for it has persisted alongside the larger scale transactions of a more highly technological age. Bamboo traders represented one caste, bringing bamboos down to Lucknow by boat. Charcoal burners bought miscellaneous wood in small lots for processing into charcoal and shipment to the city. They bargained almost

exclusively with the *zamindars*, landowners willing to sell mixed timber from their private forests. This trade was monitored only when it crossed provincial boundaries, where amounts exported were measured and recorded. In the city the *lakriwalas* were a socially mixed group who traded only in timber, buying both milled lumber and unprocessed logs wholesale at river depots and retailing them around the city. Fuelwood, a separate specialization, was controlled by *talwalas*, who purchased odd lots of second growth trees from private forests, speculating on probable firewood prices in cities such as Lucknow. Shipping this wood by river or bullock cart to Lucknow, they wholesaled it to vendors of grain, salt, oil, flour, timber and so forth for final sale around the city.

In the hill districts of Kumaon and Garhwal the impact of the colonial system in the years between 1815 and 1857 was essentially similar. Traill, the British Commissioner who organized civil administration after the fighting was over, reported that the dense sal and bamboo forests of the *tarai* had hardly been cleared at all in previous years, but the Siwaliks and the valleys behind them had been considerably exploited. This was so despite the fact that the only communications in the hills were by a set of footpaths, often deteriorating and unreliable, through glens and up riverbeds. Several of the ancient trade routes into Tibet linked the only four towns of Kumaon, none of which had a population of more than 3,000. Many villages in the Kumaon hills had been depopulated under military pressure from the Gurkhas from the east and Rohilla soldiers from the submontane districts. The Gurkhas had levied heavy "taxes" on agriculture in order to pay their soldiers. Many villagers had left their homes; the result by 1815 was crumbling terraces and fallow farmlands. It was Traill's challenge to reverse the tide.

The British left northern Garhwal, present day Uttarkashi and Chamoli districts, to the Raja of Tehri. In lower Garhwal and all of Kumaon they resolved land ownership records and revenue rates over the following decade, culminating with the first detailed cadastral survey of the hills in 1823. The major challenge was to encourage peasants to resettle the deserted villages and fallow terraces. The British commitment to maximum expansion of arable land, which these conditions elicited, rested on the regulation that anyone who cultivated fallow or waste land would be declared its owner and assessed taxes at a nominal rate.[12] Further, the 1823 Settlement established the basic modern system for control of waste land, including both grazing lands and forests. Vast tracts of mountains, technically designated waste, lying between one village and another, had been used for subsistence grazing and gathering of fuelwood and other forest products. These lands, never a source of revenue under pre-British regimes, had never been surveyed or laden with any restrictions, since they were far more extensive than the hill population could use. In monetary terms they had no value. Under the rationalized administration of the British, village boundaries were demarcated in 1823, often along high, remote ridges. Villagers were guaranteed unrestricted use of the waste and encouraged to bring under the plow new lands adjacent to existing croplands.[13] Once established by the Revenue authorities, this system for

turning waste into plowed land remained in place until 1955; it was the first key to forest depletion in Kumaon and an important legal basis for peasants' defense of their subsistence rights in the twentieth century.

In addition to maximum encouragement of agriculture, Traill shared his generation's determination to foster trade and transport. He repaired the small scale irrigation canals which had crumbled under the Gurkha occupation, and repaired and widened many hill paths, making even the road north to Almora passable for some bullock carts. He minimized and regulated the system of transit taxes which had inhibited trade in the hills as in the plains. By the late 1820s this policy was clearly effective when measured in terms of expanded economic activity. Revenue, tilled land and population had begun the steady increases which have marked the region with minor disruptions ever since. By the late 1860s in Kumaon as a whole, both cultivated land and net revenue more than doubled in most subdistricts.[14]

Rural population also began the inexorable rise which by 1890 put severe pressure on food production on the small portion of the mountainous land which could be farmed. In Dehra Dun, for example, one of the less mountainous districts, the 1865 census showed 270 square kilometers under cultivation out of a total land area of 2,655 square kilometers. There the population had been estimated at roughly 17,000 in 1816 and 25,000 six years later. By 1865, at the first careful census, it reached 66,299.[15] In the 1891 census the official figure for the district's population was listed as 117,438. Because of the severe difficulty in the hills of calculating any statistics of humans, livestock or land, these figures must be taken as gross approximations. But they suggest steadily increasing pressure on both arable and forest lands, as do all their accompanying descriptive reports. The major escape valve in the twentieth century has been a massive migration of hill people into the cities of the plains, searching for salaried employment.[16] No figures are available for the outmigration of the nineteenth century, but the 1896 settlement report for Garhwal revealed that the region, even the drier areas in its southwestern hills, had met all its grain and food needs throughout the century until the early 1890s. In 1890, and again two and four years later, the hills of Garhwal for the first time since 1815 could not meet their own needs for grain. The resulting inflation in market prices for grain seems to have precipitated the first large scale migration of hill men into the plains, setting a permanent pattern which linked the money economy of the hills to the wider economy of north India, in the peasants' household budgets.[17]

The success of their early efforts to achieve economic expansion, extension of agriculture and rising revenues led the Commissioners into new commercial ventures by the 1840s and 1850s. The first was to encourage plantation cropping for export to the plains. Thus, by the mid-twentieth century there was massive cultivation of fruits and potatoes for markets throughout India. But before World War I the only plantation crop of any significance was tea, for which the Siwalik hills of Kumaon, Dehra Dun, and Kangra north in the Punjab hills seemed well

suited. In the Outer Himalayas farther east tea was already becoming a major source of export earnings, as Darjeeling and Assam teas began conquering world markets. In the 1840s many individuals with capital to invest in the western hills began speculating on tea there. These hills were well watered, their soil was adequately fertile, they were high enough to be protected from the worst intensity of plains climate, and they were easily accessible from many north Indian cities.

In Dehra Dun the first private tea plantation was established in 1847, on one hundred twenty fertile hectares. Similar small plantations were organized in the hills farther east. Robert Fortune, who surveyed the region for its tea growing potential in 1851, reported that land was "plentiful, and of little value either to the natives or the Government."[18] North of Almora, in central Kumaon, he focused attention on village lands which even then were formerly but no longer cultivated and had reverted to scrub jungle. He argued that land brought under tea cultivation would become productive once again, bringing profit not only to the investor but to the poverty stricken villagers as well. Describing the typical villager in the Almora region, he asserted, "A common blanket has to serve him for his covering by day and for his bed by night, while his dwelling-house is a mere mud hut, capable of affording but little shelter from the inclemency of the weather." By working on a tea plantation, "he would return home with the means in his pocket of making himself and his family more comfortable and more happy."[19]

Eighteen years later a progress report on tea production in the region reported a total production of 18,684 kilograms, 7,522 kilograms from the Kaolaghir factory in Dehra Dun. Total net income for the plantation owners, both British and Indian, was Rs. 82,280 in 1869. This was not as rapid an expansion as its backers had hoped; several difficulties had become evident. The best soils seemed to be in Dehra Dun, but inadequate water supplies restricted tea cultivation. Considerably more ambitious canal and irrigation systems were a prerequisite of much more expansion of tea production. There were also labor problems, for the hill people had no experience in the complex work of growing and harvesting the tea.[20] Finally, beyond Dehra Dun's relatively easy access to marketing networks in the plains, the hills remained virtually as remote as in Traill's time. One assessment saw Almora as the ideal tea processing center, but Traill's road south to Naini Tal and then down the steep hills to the *tarai* would have to be further improved, at an expense which tea marketing alone could not afford.

Nonetheless, over the next half century tea production continued to increase slowly in the U.P. and Punjab hills. By 1911 a total of 6,880 hectares were under tea, producing 1,810,800 kilograms of tea. No other plantation crop in the western Himalayas even approximated that extent before Independence, though this production did not remotely rival the transformation of the Bengal and Assam hills, where in 1911, 203,000 hectares of former forest were producing 109,668,000 kilograms of tea, dominating the export market.[21]

In the same period one other expression of the commercial and technological impact of the British empire made some inroads on the natural resources of the

western Himalayas; this was mining. When the British arrived in Kumaon, they found scattered copper and iron mines there, all operated on very primitive, small scale methods. The first geological and mineralogical assessments of the region were very tentative and ineffectual, in view of the enormous complexity of the Himalayan rock. But the very scale of these mountains led mining engineers to predict that great mineral wealth was waiting in the Himalayas, asking only for aggressive investment of funds and technique. Captain Herbert, the Chief Surveyor, reported in 1829 that in Kumaon's copper, lead, and iron mines "the actual produce . . . is trifling in quantity, and inferior in quality," producing only Rs. 1,500 in total annual revenue for the government.[22] But improved methods could easily change this picture. In particular he recommended that the use of coal for smelting, which was the standard British method, must be set aside in favor of the Swedish technique of using charcoal. With this change in method and the import of a better blast furnace design from Europe, the Kumaon mines could be made more productive, rewarding both investors and government. Herbert assumed that the adjacent chir pine forests would be entirely adequate for the necessary supply of charcoal; he was in no position to see that problems of charcoal supply would soon become a major difficulty for smelting operations.

Fourteen years later and a hundred and sixty mountainous kilometers to the north, G. S. Lushington presented a more ambivalent assessment of copper mining prospects on the Alaknanda branch of the Ganges, where the rajas of Tehri had mined for many years. On the one hand, "the climate is excellent, admirably adapted to the European constitution; water is good, and oak, fir and other timber trees abundant."[23] But copper reserves there were evidently close to being worked out, and transport difficulties down the Alaknanda gorge were formidable. On Lushington's recommendation the government invested nothing further in prospecting in the higher ranges, centering its interests in the iron mines of the Siwaliks.

By 1855 W. J. Henwood, chief surveyor and assay master of the tin mining industry of Cornwall, was brought by the provincial government to assess the Kumaon iron mines. His report on the forests and mines there was the first to lay urgent emphasis on the growing shortage of timber for charcoal in the vicinity of the mines. Anything over fifteen kilometers of transport was hardly feasible or economic for charcoal in the rugged terrain, and the combination of local and British charcoal production had ravaged the chir forests. The lower bhabar slopes were still heavily forested, but higher, near the mines, only a few stands of large trees too grand for charcoal production remained. Local operators using traditional methods and machinery lopped limbs from even the largest trees, crippling the giants by the thousands. British methods could exploit pine trees more fully, but even then only systematic replanting of the chir pine forests would assure a future supply of charcoal. This the provincial government had no capacity to do as yet, but in its capital, Lucknow, it was not easily deterred by Henwood's fears. In response to his report, the Lieutenant-Governor insisted he was "satisfied that, for

mining operations on any extensive scale, the supplies of fuel, both within the hills and on their borders toward the plains, will be found to be abundant for a long course of years."[24]

The search for commercial expansion, agricultural production and increased revenue could lead both officials and investors to dismiss the issue of ecological degradation. But Henwood's warnings proved correct before long. By the 1860s Kumaon's copper and iron mines were in decline; their best seams of ore were running out and timber for charcoal was becoming prohibitively expensive. The opening of the Suez Canal in 1869 made it more profitable to import processed iron from England, even to markets in north India, than to continue investing in the Kumaon mines. Mining in these hills subsided to trivial levels thereafter;[25] recent mining operations in the Siwaliks begun at independence have been more of limestone and other minerals which require no timber or other fuel for smelting. The main significance of the brief era of iron and copper mining was that it helped catalyze the discussion of long range forest planning, and thus the establishment of a professional forestry service.

Timber Harvests in the Pre-Railway Era

In the midst of the debate over the mines' impact on Siwalik forests, J. H. Batten, then Commissioner of Kumaon and the most influential person in the region, sharply attacked Henwood's assessment of the chir forests. "I venture . . . to declare that the forests of Kumaon and Gurhwal [sic] are boundless, and, to all appearance, unexhaustible; and that they require no human care to preserve them. . . . The lower hills and Bhabur, at every iron locality . . . can supply sufficient charcoal for the largest English furnace for a hundred years to come."[26] Nonetheless, even this enthusiastic developer by 1855 concurred that restrictions must now be placed on some types of forest. The sal forests of the bhabar, though still vast, must not be wastefully used for fuelwood or charcoal; carefully harvested and replanted *chir* pine would be far more prudent. In higher elevations the deodar stands should be preserved against further exploitation. Even in the chir zone no more cutting of pine should be allowed by the government except for landowning peasants' house building needs and the charcoal demands of iron smelters. Something must have happened to the Himalayan forests by 1855 to elicit Batten's unprecedented call for government intervention in forestry management.

Revenue demand, agricultural expansion, and commercial development had indeed influenced the pattern of timber use in the mountain districts, although these factors were not so dominant there as in some other regions, such as the districts which Richards and McAlpin analyze elsewhere in this volume. In the western Himalayas changes in vegetation patterns resulted far more from large scale timber harvesting. The first era of deforestation was the 1840s and 1850s, a period of uncontrolled cutting before any systematic forest use planning began. In

those years timber was demanded primarily for construction of the expanding cities of the Indus and Ganges plains.

The extent of virgin forest cover in the vast Himalayan region at the beginning of this era was such that no one at first could imagine how quickly it would be threatened. The first British travellers in the mountains, who explored and mapped the region even before formal annexation, reported deep, lush coniferous forests in the mountains, guarded by the *tarai's* redoubtable marshes, mosquitoes, and tigers.[27] The first warning against this euphoria came from the observant Bishop Reginald Heber on his tour of north India in 1824–25, who noted in the bhabar and Siwalik tracts:

> Great devastations are generally made in these woods, partly by the increase of population, building and agriculture, partly by the wasteful habits of travelers, who cut down multitudes of young trees to make temporary huts, and for fuel, while the cattle and goats which browse on the mountains prevent a great part of the seedlings from rising. Unless some precautions are taken the inhabited parts of Kemaoon will soon be wretchedly bare of wood, and the country, already too arid, will not only lose its beauty, but its small space of fertility.[28]

Heber was correct. Even when the British first occupied Dehra Dun in 1815, private Indian timber contractors were transporting timber to the nearby plains at the rate of some 50,000 trees per year. In 1819 the Commissioner established transit duties on timber, farming the collection of these fees to merchants from the foothills towns. For example, for the years 1839–44 Atmageer, a contractor from Hardwar, purchased the right to collect timber duties for Rs. 35,500 per year. He was reported to have grossed Rs. 80,000 per year over that period, for there were no restrictions whatever on forest cutting.[29]

The result of this trade with urban markets was a steady depletion of the woodstock in the outer hills and the first interest in conifer timber from the higher mountains. By the early 1840s enterprising timber men, both British and Indians from major towns such as Lucknow and Meerut, began studying ways of using the Himalayan rivers to transport timber. At first there was little experience to draw on; timber cutting was entirely haphazard and unregulated. In the higher hills, where soils were less fertile and stable, major and even irreversible damage to standing timber could be done in a very short time.

It seems likely that in British districts the deforestation was less sudden and severe before 1860 than in the adjacent princely states of the hills where civil administration of any sort was still rudimentary and the rajas as yet had little experience with modern marketing systems. The hill rajas, who were traditionally accepted by consensus as outright owners of all their forested lands, had usually used them as a source of rewards for their courtiers and payment for military service. Systematic harvesting of timber was a concept from another world.

In the early 1840s an Englishman, a Mr. Wilson, first exploited the great potential connection between the rajas' methods of business and the lucrative

markets downriver. The first to succeed by floating large numbers of deodar trees down the turbulent mountain rivers in the high water months, Wilson negotiated a twenty-year lease in 1844 with the Raja of Tehri-Garhwal, which for Rs. 400 annually allowed him to fell an unspecified number of trees.[30] Later forestry reports refer to Wilson with ambivalence, admiring his entrepreneurial drive but appalled by the impression that in little more than a decade he managed to decimate the major stands of deodar in Tehri.

Wilson's deodars, destined for the expanding urban markets of the upper Ganges region, made their commercial profit and ecological loss as a reflection of the general economic expansion of the colonial era. In contrast, the deodars of the upper Chenab gorges of the Indus system farther northwest built the military defenses of the northwest in the early 1850s, immediately after the British conquest of the Punjab. As such, devastation of these superb stands was an immediate expression of the British imperial system. In 1849 the British occupied Sialkot, an old town strategically situated to control the upper Punjab plains from the gateway to Kashmir and the Northwest Frontier. British military authorities commissioned private traders to buy and fell timber from the western hill regions. The great deodar forests of Kashmir were harvested later to help build the prosperity of the Punjab. But deodar stands in nearer Chamba state were more accessible at first. By 1852 an Armenian entrepreneur named Aratoon negotiated with the Raja of Chamba, whose title to his estate had recently been confirmed by the usual treaty with the British, for the sale of large tracts in the Pangi area of the upper Chenab. Aratoon's timber provided some material for the Sialkot cantonment, but the hazards which beginners faced in floating timbers for hundreds of miles down its dramatic gorge resulted in the loss of a large majority of the felled trees. A year later the British designated one of their own military engineers to take charge of the project. For many years still, the losses of logs on the Chenab, as on the other Himalayan rivers, were often a majority of the trees cut each season. But the military defense of the British Raj demanded this expense and sacrifice; the price of forest depletion seemed reasonable enough at the time.[31]

In sum, by the middle 1850s severe depletion of the then commercially valuable timber trees of the western Himalayas was already evident to many policy makers, and a debate had begun as to the most effective means of conserving the remaining hardwood forests. But the demand on the Himalayan forests was just beginning to be felt on a truly massive scale.

The Railway Building Era and the Forest Department

The key to India's integration with international commodity markets on a massive scale was the construction of a network of rail lines across the subcontinent beginning in 1853. This in turn was the key factor in the depletion of and later the systematic management of the Himalayan forests. The ecological consequences of railway construction were immediate and severe, beginning with India's first line

from Bombay on the west coast through the coastal hills in 1853, for which the teak forests of the Malabar coast, already severely reduced to meet the British Admiralty's needs, were further decimated to produce sleepers.[32]

In the following years, as much in the effort to expand export production of cotton, wheat and other crops as for any reason,[33] the government of British India and private investors in England together created the greatest railway network in any colonial country. As one historian of India's railways puts it,

> By 1860 there were 838 miles of track; by 1870, 4,771 miles; by 1890, 16,401 miles; and, by 1920, 37,029 miles . . . India's railway mileage by 1910 was six times that of China. In the broadest sense the system was designed for the purpose of connecting the principal ports with the major agricultural hinterlands and urban centers in order to draw goods out for export and to provide markets for imports.[34]

In 1859 the line up the Ganges from Calcutta was opened for 942 km to Allahabad, and by 1870 the principal cities of Punjab and U.P. were connected to the main lines. The first line to Bareilly, the eighteenth largest city in India, near the Kumaon foothills, opened in 1872. All of these lines were vital to the establishment of a regionwide and ultimately international market for lowland crops including cotton and grain.[35] Secondary railway lines to more remote areas including the mountains were built later. Western Himalayan timber, bulky and very expensive to transport over long distances, did not therefore become an export commodity, nor could it compete with timber from other hill regions, such as the Vindhyas of central India, for use farther south.

The primary impact of the railways on the Himalayan forests in the nineteenth century resulted from timber felling for production of sleepers and railway fuel. Some teak was still available from the Malabar coast for railway construction in the western region. And by the 1870s the great teak forests of upper Burma began to be harvested for export to India and elsewhere.[36] But, as an official assessment concluded in 1877, "for the great Railway system of Northern India, teak sleepers cannot be thought of."[37] The costs of transport even on existing railway lines were prohibitively high. Some source of sleepers had to be found in north India itself to free the crop-marketing potential of the rich northern plains.

The rich sal forests of the submontane districts were splendid candidates for this. They stretched on a thousand mile arc from the western *tarai* down into Bengal, they were easily accessible to the plains, sal's tough fibers were particularly resistant to the white ants, and their lands—at first seemingly abundant—had soil and climate ideal for growing food crops. Revenue officials were eager to expand agricultural production; Railway Department planners were interested in maximum harvesting of sal stands for their uses. But by 1860 the sal forests were already badly depleted by the mixed market demand and totally unregulated system of cutting which the previous half century had witnessed. What sal forests remained were rapidly depleted in the submontane districts for production of sleepers.[38] As yet no one had responsibility or authority to replant sal forests.

Hence sal production dipped in the last third of the century and rose again only after 1900 when the first fruits of new sal plantations were mature enough for marketing. This was one of the major achievements of the Forest Department after its formal founding in the 1860s.[39]

Faced with the depleted stocks and rising costs of both sal and teak in the 1860s, the railway builders of northern India set their sights farther into the mountains. Men such as Wilson had shown over the previous twenty years that the deodar was also well suited to their needs. But the deodar stands were far more remote, situated only above 1,600 meters from western Nepal into Kashmir. Reliable large scale harvesting of deodar demanded far more complex processes of felling and transport than local timber contractors could manage by themselves. Exploitation of the deodar forests soon became the central focus of the first half century of the Forest Department's work in the Himalayas, first for the continuing depletion of the deodar stands and later for the gradual stabilization of commercially valuable timber lands in the system of Reserved Forests.[40]

The height of demand on deodar for the railways came in the 1870s and 1880s, when the major lines were built in northwestern India. The single largest project of the early 1870s was the Rajputana Railway, which stretched 640 kilometers southwest from Delhi and required 800,000 sleepers. Nearly all were deodar, partly from the Jumna and partly from the adjacent Bhagirathi, the westernmost branch of the Ganges.[41] Simultaneously the deodar forests of the Punjab hills and Kashmir were requisitioned for the new line northwest from Lahore to Peshawar on the Northwest Frontier, and then for the longest line of all, the Lahore-Karachi railway, which was designed primarily for the export of Punjabi wheat to Europe.

The pressure was now at a maximum on the deodar forests of the upper Ganges and Indus basins. In all, by 1878, 2,495 km of railway were in use in northern India and 372 km more were under construction.[42] For management purposes the railways' needs had first claim on government forests; their demand could be planned and regulated for several years in advance. But when this demand was added to the markets for construction timber and urban fuelwood supplies, there was great difficulty in planning and financing annual timber harvests and maintaining consistent inventories. The annual harvest of trees in western U.P. fluctuated between a low of 78,000 and a high of 147,000 in the years around 1870; in the Punjab hills it fluctuated between 29,000 and 67,000.[43] By the early 1880s the figures rose to approximately double that figure in both parts of the north.[44]

Faced with the intricate organizational challenge of regulating this production and increasingly aware of the danger that the Himalayan and submontane forests might soon be totally depleted, the Government of India designated Dietrich Brandis as its first Inspector-General of Forests in 1865. By then he had more than a decade's experience in south Asia, primarily in the teak forests of upper Burma, where the British had first assigned him in the early 1850s. In the years after 1865 one of Brandis's major concerns was to place controls on the logging of the Himalayas and use the urgent demand for those forests as leverage to establish a

permanent management system for those states as part of the new national Forest Department system.

Thirteen years later Brandis summarized the results of his early efforts to supply the northern railways, showing that the empire's railway system had been inexorably extending its ecological frontier farther into the mountains. One must be prepared, he wrote, to negotiate systematically with the governments of Kashmir and Nepal for major future supplies of deodar and sal timbers respectively. For further construction and maintenance of the railways over 500,000 sleepers annually would be needed for some years to come. The forests remaining would be grossly inadequate for meeting that demand. If no alternative supply is found it may be necessary to cut "the last remaining stock of mature sal and deodar in the Government forests. Such a contingency must by all means be avoided; the few remaining forests under the control of Government in Northern India, which still contain large quantities of mature sal and deodar timber, must now be worked with sole regard to their maintenance and improvement as permanent sources for the supply of these woods."[45]

Fortunately, technical innovation promised the hope of a more satisfactory long term solution to this impasse. By that time several railway lines around India had begun to use sleepers imported from Europe, either creosoted conifers or even iron sleepers from England's foundries. By 1880 this numbered nearly 200,000 units annually. Some specialists in India were coming to the view that in time all lines should be laid on iron sleepers; this task might well be undertaken by the fledgling iron industry of eastern India. But the Forest Department immediately saw that softwood conifers from the Himalayas offered an abundant supply of raw timber, if only a satisfactory creosoting system could be designed using local raw materials. For many years after a beginning in 1863, the Forest Department experimented with methods of creosoting the abundant softer woods of the western Himalayas, specifically chir and kail pine, Himalayan spruce and silver fir. Brandis's 1878 report predicted that technical problems could be solved, thereby providing "almost any quantity of sleepers . . . annually, for the forests of the species mentioned are very extensive, well-stocked, and nearly untouched."[46] For forestry management this would be the key to the otherwise contradictory goals of maximizing profits from timber sales and improving the quality and sustained yield of the Himalayan forests. "The object will eventually be gained of utilizing the trees associated with deodar in the forests, and of thereby placing the working of these deodar forests upon a sound and satisfactory footing, while at the same time largely increasing the supply of indigenous sleepers."[47] Unfortunately for this strategy, pines, spruce and fir ultimately proved to be not viable as sleepers. The softer woods failed to last well under the rails and had to be replaced too often to be used on any large scale. In consequence the chir pine forests of the Siwaliks and lower hills, and the Himalayan spruce and silver fir remained largely intact until World War I or later. The technological capacity of the colonial system was not yet capable of more than a selective impact on the vegetation of the mountain region.[48]

Timber Marketing and the Sociology of Forest Depletion

The structure of the colonial administrative system and its associated technologies and marketing systems were one dimension of the ecological transformation of the western Himalayas. But in order to clarify how that system penetrated to any specific town, trade route, village or mountainside, the analysis must also note the indigenous socio-economic system of the region, in particular the social composition of the timber merchant class and that of the employees, the contract labor, as they interrelated with the colonial regime on one side and village society on the other. This discussion can only begin to describe this intermediate level of the human systems which struggled for the use of the forests; fuller treatment will have to await a subsequent occasion.

As the early years of British rule had already revealed, under the prevailing laissez-faire ideology policy makers preferred to encourage private timber contractors for meeting the empire's needs. The Forest Department developed a variety of harvesting and marketing arrangements with private contractors, all of which also reflected the fact that the Forest Department could not possibly carry out each phase of the timber harvest and marketing by itself. Two alternative systems were used, with several variants on each; they were broadly labeled "departmental agency" and "private agency."

Under the first system, which the department often preferred if it could staff the work, its employees harvested the trees and transported them to depots, usually at the foot of the hills. Periodic auctions of the cut timber brought the department its major source of revenue and handed the wood to the merchants for transport and final sale. Under the second alternative, contractors bought the right to fell specified timber standing in the forests. Either the department marked each tree selected for harvest, or the right to all timber in a designated area was auctioned for clear cutting—a far less desirable alternative. The winning contractor then organized the entire operation, from mountainside to market.[49]

Either variation on the auction system placed responsibility for long range care of the forests entirely on the Forest Department's shoulders. Contractors organized a single felling in each tract; their rights and responsibilities ended there. They did not own the timber lands themselves, and their operations were almost always on a small scale, with no long range financial investment in what was a very volatile commercial market.

Furthermore, the pattern of their ecologically destructive operations reflected the social structure of Indian trade and entrepreneurship. Fragmentary studies give some insight into the social composition of the timber merchants as a group. For the inland timber trade of northern India after 1860 British merchants were rare; the trade thereafter was almost entirely in Indian hands.

The purchase and marketing of timber was the occasion for intense competition

among various merchant castes and religious communities. An 1897 summary of Punjab's timber trade indicates that there were a few "wealthy" contractors but does not stipulate who they were, what the scale of their capital was, or how many stages of the trade they controlled.[50] A few were Sikhs, from the non-Hindu entrepreneurial sect of the region. Others represented several Hindu merchant castes, who invested in timber as only one of several lines of trade. They included Agarwal Banias, Khatris and Aroras. From about 1900 the smallest Hindu merchant sect, the Suds, began moving toward their later dominance in the timber trade of eastern Punjab.[51]

Within this fragmented system each trading operation was controlled by a single kinship group, partly to assure control and secrecy in its internal network of commercial information. Contractors from the same caste or religious community frequently cooperated closely with each other in competition with members of other social groups. This helped solve the problem of the dearth of capital. Within each caste network a man's name and his caste ties sufficed as collateral for short-term funds at the auctions. Without this, the ready cash for this highly competitive and speculative business would not be available, except occasionally at exhorbitant interest rates.

The Labor Force

The transformation of society and economy which resulted from the gradual integration of the Himalayan hills into regional and international systems affected the labor force as much as the employers. We must not overlook the composition of the work force for the timber harvest: which groups were recruited for the labor, and how the relatively highly differentiated tasks of felling, dressing and transporting the timber functioned. Through the nineteenth century, labor for timber operations was primarily local in origin. Peasants who owned their land, as well as the landless service castes, the Doms, traditionally were required to provide begar, or unpaid labor for transport and trail maintenance.[52] They were the primary wage labor available for timber operations, and anyone who owned land would resist timber work at crucial times in the agricultural cycle. In the late nineteenth century, as road networks improved in the mountains, a two-way shift in the labor force began to occur. Sons of peasant families in the hills began leaving for work in the cities of the plains or for the military. In the other direction landless laborers from western Nepal and later eastern U.P., Bihar and central India began to appear in Kumaon looking for day labor.[53]

There was also significant specialization of labor, particularly among the sawyers, which led to further competition between the mountain people and outsiders. Roughly for a century sawyers from foothills districts in Punjab have been reputed as the most reliable and skilled in the region. But their availability was unpredictable; in Kumaon they were supplemented by others from Himachal and local sawyers. Other parts of the process had a very mixed and competitive labor force. In the Almora area, for example, Garhwalis from the higher moun-

tains were used for carrying timber to stream beds or road depots, while increasing numbers of itinerant laborers from western Nepal were also hired.

Increasingly the principle among the labor contractors was to use labor from a distance, to gain the advantages of controlling a rootless rural proletariat. Contractors increasingly concluded that local laborers were unreliable as well as insistent on higher wages than their competition. They were still tied to subsistence agriculture, less completely at the mercy of daily wages for their survival, and determined to harvest their own crops rather than trees at summer's end. In consequence, the forests probably suffered as much as did local villagers when increasing numbers of itinerant loggers with no stake in the future of the forests were hired for their exploitation.

The Early Twentieth Century

Brandis's report on the Himalayas as a source of railway sleepers was written in 1878, the same year as India's first fully developed Forest Law, which provided the legal basis for systematic management of government forests. From that year onwards the system of reserved forests allowed the government to designate forests which were not yet used for subsistence and had potential commercial value as being under the Forest Department's full control and management. The reserves were lands already under government ownership; they were to provide both the major supply of commercial timber and India's major guarantee of ecologically stable forest cover permanently into the future. A second category was protected forests; this was a transitional legal category, designating government woodlands which would be surveyed and given full working plans or other final status in future years. Other forest lands, which have gone under various legal designations since then, included private holdings and village communal lands, whose permanent designation and uses would be determined later.[54]

In the following thirty-six years until the onset of World War I, forest use in the western Himalayas as elsewhere in the Indian subcontinent saw few dramatic changes. The Forest Department's funds and energy were largely consumed in the intricate task of implementing their powers in the reserved forests. Timber had to be surveyed and boundaries marked; paths, access roads and foresters' huts had to be constructed; all of this had to be enshrined in each stand's working plan. Endless disputes over nearby villagers' access to the reserves had to be resolved, in settings in which Forest and Revenue departments often had conflicting interests. Time and again authorities had to negotiate at length with private owners to consolidate government holdings in forests which had been fragmented into many small holdings over the years.

All of this had to be done simultaneously with maintaining the annual supply of timber for railway sleepers, the construction trade and fuel for the sugar refineries, urban marketplaces, and individual hearths.[55] The railways' demand remained

relatively high and steady. Although fewer major lines were constructed after 1880, many small feeder lines remained to be built to extend the network into more remote rural areas. Further, by the 1880s as many second-generation sleepers as new ones were required for replacing those that had deteriorated on original lines. All this demand guaranteed the Forest Department with a basic flow of funds with which to finance its full range of professional activity.

Shortly after the turn of the century came the next major breakthrough in the exploitation of the Himalayan forests, when improved methods of processing chir pine resin from the lower hills became available.[56] Lower Kumaon became the major source of resin for many commercial and industrial uses, both in India and abroad. The resin industry remained on a small scale until 1920 when the government's major processing factory was built near Bareilly in the aftermath of the war's intense industrial demands. Hence, even this change falls largely outside the scope of our present project.

Some of those funds were invested in the old sal forests below the hills in the form of north India's first modern forest plantations. Reforestation had been the subject of intensive discussion within the Forest Department from the start. But the proper silvicultural techniques took some years to establish, and it was always difficult to find both funds and a labor force for the actual work of replanting. Sal proved relatively easy to regenerate, in contrast to the low rate of success in the early deodar forests. By 1914 in Punjab and U.P. together some 10,000 acres of forest lands were replanted. The showpiece plantation was the Changa Manga forests in a newly irrigated tract in Punjab, where as early as 1880 roughly 80,000 trees annually were harvested for the railways.[57] Aside from Changa Manga nearly all successful reforestation in these years was in submontane districts along the *tarai*. In the mountains reforestation was far more difficult and its rate of success less predictable. Replanting at higher elevations came only later, under conditions of increased population of towns and villages and inexorably deteriorating conditions in village forests and grazing lands and private woodlands.

Reserved forests were established one by one over the decades after 1880; few were demarcated in the mountain districts before the mid-1890s. Gradually the reserves were stabilized; the main focus of any analysis of deforestation processes in the hills must be those forests which were left under the Revenue Department or confirmed as village lands. These forests, extensive throughout the mountain region, were to see virtually no planned silvicultural management until well after independence. Their changing vegetation cover was never documented in any detail; it is far more difficult to see with any precision. The key questions are difficult to assess: at what rate they became inadequate to the region's subsistence needs and to what extent they contributed to soil depletion and disruption of water flow in the rivers. This study remains to be done, if it can be with any precision.

In the villages, subsistence use of forests contributed primarily to the gradual deterioration of quality in nearby woodlots and grazing land, a very gradual process. While shifting agriculture, never as widespread in these hills as in some

other parts of the subcontinent, steadily diminished over these years, the grazing of sheep, goats, and cattle became a massive threat to the growth of young trees and thus to the continued viability of the forests.

The urban population of the hills was also rising steadily, bringing with it expanding demand for building timber, charcoal, and fuelwood. The first useful census figures come from 1872; from 1881 onward the regular decennial censuses were taken. They show that between 1872 and 1911 the old center of Almora grew from 6,260 to 10,560, while the new British hill resort of Naini Tal grew from about 7,000 to 10,270. Rural population data are far less reliable, but some indication of the trend is shown by districtwide data.

1914 was to initiate new pressures which took the Himalayan region into a dramatically different and more difficult era, for both its human population and its natural ecology. The war brought sudden and unprecedented demand for military timber. The understaffed Forest administration worked overtime to provide that timber without irreparably decimating the Reserves; there were disagreements after the war as to how successful they had been. The labor force of the hills was also severely strained until 1919 because these districts provided many of the recruits for the Indian Army. By the end of the war, relations between the Forest Department and the hill people were seriously strained. Shortly thereafter, when Mahatma Gandhi initiated the first nationwide non-cooperation campaign against the empire, the hill people turned their protest on the restrictive forest laws as the expression of the colonial system which most directly touched their lives. From 1921 onwards the issue of forest use became more highly politicized, and the ecological viability of the western Himalayas more seriously endangered.

10. The Precolonial Woodstock in Sahelien West Africa: The Example of Central Niger (Damagaram, Damergu, Aïr)

James T. Thomson

This essay briefly surveys the condition of the nineteenth-century West African sahelien woodstock. It uses a north-south swath—Aïr, Damergu, Damagaram—of what is now central Niger to illustrate factors influencing the character of that woodstock.

The Sahel as a region escaped colonization until the late nineteenth century. This chapter therefore offers a benchmark description of a tropical African arid environment in fairly pristine condition, rather than an analysis of deforestation processes and consequences which only occurred in the Sahel after the turn of the twentieth century.

The essay is organized in the following way. It begins with cursory examinations of the Sahel as a geographical region, and of the sahelien renewable natural resource base. After describing soils, water and climate, this section depicts the woodstock at mid-nineteenth century as observed by a German geographer-explorer, Heinrich Barth. A third section details causes of the extremely limited, localized deforestation which occurred in pre-colonial, nineteenth-century sahelien environments. Sahelien milieux in this period, it is asserted, faced no real threat of deforestation or desertification at the hands of man. Fourth, political and economic relations in the region's dominant pre-colonial polities are reviewed. The Damagaram kingdom and a Tuareg pastoral confederation operating in the Aïr-Damergu-Damagaram corridor offer examples reasonably typical of political forms then current in other parts of the Sahel. Land tenure relations within these two units are examined next. A final section briefly alludes to external politico-economic relations which affected the Sahel at the close of the nineteenth century, and prepared the way for important changes introduced by the twentieth-century colonial regime.

A brief comment on terminology is now in order. "Woodstock" seems a more appropriate term than "forests" to designate the ligneous cover of an arid region such as the one under study. The Sahel fringes the West African Sahara Desert. Large trees do exist in the southern Sahel, but woody material in the northern part consists primarily of bushes and stunted trees. While it might well be reasonable to dismiss such dwarf tree forms in analyzing a more richly forested area, it is inadvisable here because they critically affect sahelien ecological balances. Thus "woodstock" as a global term designates both the meager brush of the high steppes

and the larger trees of the southern, moister Sahel. The essay will discuss both kinds of vegetation.

The Sahel Region

The West African Sahel is variously defined. But all definitions share an emphasis on the Sahel as the arid border region between the Sahara Desert and the more humid Sudan. If one uses the 100 mm and 600 mm isohyets to set north-south limits, then the West African Sahel includes parts of six countries: Senegal, Mali, Mauretania, Upper Volta, Niger, and Chad. Roughly outlined by latitudes 14° N and 20° N and longitudes 10° E and 23° E, it encompasses approximately 2,500,000 km^2. This is a bit less than half the total area of the six countries in question.[1]

The Sahel can be subdivided into two parallel east-west zones, the first, further north, defined by the isohyets 100–300 mm. This area is commonly referred to as "sub-desert Sahel." The second lies between the 300–600 mm isohyets and is often termed "sudano-sahel." Until quite recently pastoralism dominated the drier steppe zone. Transhumant herders, principally Tuareg in the nineteenth century, ruled the sub-desert Sahel. Agriculture centered in the sudano-sahelien zone. There, shifting cultivation of millets and sorghums on high dune lands generated the bulk of the sedentary diet. Intensive gardening in moister valley bottoms produced important food supplements: vegetables, condiments, etc. Cotton was also grown in substantial quantities in the heavy valley soils.

Sahelien Renewable Natural Resource Base

Soils. Soils in the Sahel are largely ferruginous,[2] but also include clay sands and sandstone, as well as granite outcroppings.[3] At scattered sites the Sahel is rock-covered; more is surfaced with sand, much of it in the form of relatively deep stabilized sand dunes.[4] Valleys between these dunes often contain seasonal water-courses. When these streams run dry, sub-surface water tables typically remain high and can be tapped by shallow, hand-dug wells and by vegetation, woody or otherwise, having deep root systems.

Water. Surface waters are severely limited: three major permanent river systems—the Senegal (1700 km), the Niger (4200 km), and the Komadougou-Yobe (1000 km)—drain the area. The Senegal originates in the Guinea Highlands, and then loops east, north, and finally west to empty into the Atlantic Ocean at St. Louis, Senegal. The Niger, which also rises in the southwestern mountains of the Guinea coastal region, moves east and then south in a long arc which carries it through most of southern Mali and the southwestern corner of Niger, before it enters the increasingly moist regions of Nigeria. It terminates in delta mangrove swamps on the Bight of Benin. The Komadougou, small by comparison with the two preceding systems, runs east along the border between Niger and Nigeria, and ends in Lake Chad, the only sizeable lake (25,000 km^2) in the entire West African Sahel.

All three rivers permit flood-retreat agriculture,[5] and have been so used to some extent since the era of the Mali and Songhai empires in the thirteenth through sixteenth centuries. They also provide extensive bottomland pasturage for sahelien livestock during the long annual dry season.

In addition to these major water systems, several smaller rivers and numerous streams flow on a seasonal basis throughout the region. These serve as water sources for men and animals, and often irrigate bottomland gardens. During the rainy season, ponds appear almost everywhere in the Sahel. Particularly in the sub-desert sahelien zone these temporary water points enable herding peoples to exploit otherwise inaccessible pastures during the height of the rains from August into October.

Climate. In the Sahel as elsewhere rainfall patterns structure ecological possibilities. In a desert-fringe area such as the Sahel, rainfall variations do not entirely explain deforestation, but they can play a critical role in the process.

The year consists of a short wet period and a long dry period. The latter corresponds to the fall-winter-spring sequence of the northern hemisphere. It begins hot, then turns cold, and then hot again. Aridity increases from October through the end of March, at which point the prevailing easterly *hamattan* winds are deflected by the northward movement into the intertropical convergence zone of monsoon winds off the Atlantic Ocean. These sweep up into the Sahel from the south and west, eventually producing rain in the arid interior.[6]

Annual rainfall patterns vary wildly. In the Sahel, total days of rain, storm intensity and distribution change dramatically from one area to another, from one rainy season to the next. Isohyets shift noticeably southward during droughts. Perennial vegetation thus faces severe stress on an irregular basis. Evidence suggests this contemporary pattern characterized the nineteenth-century Sahel as well.[7] Few question dessication is gradually spreading in the Sahel. But the rate of dessication remains a hotly debated issue.[8]

Clearly, if aridity is increasing, vegetation patterns will change in the future as they did in the past. Once lush central Saharan woods and swamps, for instance, were eliminated by growing aridity from 7000 B.C.–3500 B.C.[9]

Forest resources. As noted, calling sahelien ligneous vegetation "forest" smacks a bit of hubris. "Woodstock" better describes the character of local tree and shrub populations since it carries no particular connotation of height. Though few trees, especially those of the sub-desert sahelien zone, attain great stature, they do much to maintain and stabilize the region's environment. Indeed, contemporary assessments of sahelien ecological problems stress the role trees play in rejuvenating soils, preventing wind and water erosion, and facilitating water infiltration. They also provide arboreal pastures for some livestock species, notably goats and camels. In addition to these on-site services, trees supply a variety of products for human consumptive uses.[10]

In the nineteenth-century Sahel, trees served these same ends, but more efficaciously because the environment faced less pressure in that era, before colonial and

post-colonial policies induced additional pastoralists, agro-pastoralists, and simple farmers to migrate onto the steppes from the more southerly sudano-sahel zone.

An excellent source of information about nineteenth-century sahelien woodstock distribution and composition is the three-volume work by the German explorer-geographer Heinrich Barth. During 1849–55, while on a voyage of discovery for the British Government, he descended into Central West Africa from Tripoli. Barth visited all the then-significant cities in the region between Masena in Bagirmi (Chad) and Timbuktu on the Niger River (Mali), then successfully returned to Europe to produce a detailed account of his journey. Besides describing travel conditions, he analyzes politics, economics, and military affairs in the Central West African region, presents rudiments of a number of African languages, and offers many passing remarks on plant life in the region. In particular, during the first phase of his trip, he chronicles changing vegetation as he moves south through the Aïr Mountains of north central Niger to Agadez, from Agadez into the sub-desert Sahel (Damergu region, of which the major town is now Tanout) and then into the sudano-sahel.

The southern Aïr Mountains contained significant stands of vegetation, particularly acacias. From 20° N latitude, some 150 miles north of Agadez, he recorded numerous valleys (wadis) where *Acacia seyal* were plentiful, some even "very luxurious" in appearance; occasional dum palms (*Hyphaene thebaica*); *Balanites asgyptiaca*, a thorny tree which produces a small, edible fruit; a species of *Capparis*; and *Calotropis procera*, a broad-leaved, woody plant with a latex sap.[11] Many of these trees also occurred further north in the Aïr Mountains.[12] During this period—as now—the Aïr region was a relatively hospitable desert mountain environment. Broken terrain there afforded ample opportunity for water to collect in depressions and bottom lands, enabling vegetation to maintain inself despite the general aridity of the climate.

As Barth moved below 17° N latitude, he crossed a desert region and then entered, close to 15° N and 8° E longitude, the Tegama region, where two new species of trees appeared. These were *Zisyphus jujuba*,[13] which produces a flavorful little nutty fruit, often ground into meal and cooked, and a short shrub, *Euphorbia balsamifera*,[14] frequently used for live fencing around gardens, other enclosed areas and along cattle tracks because it transplants with extreme ease. In addition to these species, specimens of other small shrubs were now to be seen here and there.

South of the 15° parallel, Barth moved into a rapidly increasing woodstock, which became at the same time much more complex in terms of species. It also for the first time included trees of larger than dwarf stature. The initial specimens of each species almost always appeared as stunted individuals, e.g., *Tamarindicus indica*, the tamarind tree,[15] but fifty miles further south, most attained their full normal height. Characteristic of this region, in addition to the tamarind, were, according to Barth, *Prosopis africana*, an extremely hard wood used as charcoal in iron working; *Parkia biglobosa* (the *nere*), which produces a highly valued edible fruit; *Bauhinia reticulata*, still very common today, and *Adansonia digitata*,

a species so valued (food, rope, etc.) by indigenous Saheliens that they regularly planted it.[16]

Acacias—*A. albida* and *A. scorpioides*, varieties *nilotica* and *astringens*—are also recorded by Barth. He does not however produce an exhaustive list of all species he must have seen.

Of significance are the explorer's comments about the relative abundance of trees below the 15° parallel. The region was not thickly forested. Farming had reduced the woodstock in many places, and indeed some areas were barren of anything but rocks or grasses. However, in valley bottoms, and occasionally on dune lands as well, trees were plentiful enough that Barth's account is peppered with terms such as "grove", "thicket", "dense underwood", "forest" and even "dense forest".[17] Such vocabulary is simply irrelevant to description of the same region in the 1980s.

Barth's account largely agrees with the much fuller analysis of Nigerian vegetation provided by André Aubreville in 1936, mid-way through the colonial era when cash cropping still had done little to change the character of the central Nigerian woodstock. Aubreville divided the colony along isohyets from north to south into several lateral zones. Of interest here are the "presahelien" (600–500 mm) and the "sahelien." The latter extended north from the 500 mm isohyet to merge imperceptibly with the "saharan" zone, which lacked trees altogether.[18] He also noted that lateritic soils predominated in the western third of the colony. The woodstock there differed appreciably from that found in the sandy areas which compose the eastern two-thirds of Niger, even within the same isohyet-defined lateral bands.[19] Aubreville treats the Aïr Mountains in a separate section, because of the very different conditions which prevailed there.

In the sahelien zone, Aubreville observed only four species in large pure stands: three of the genus *Acacia* (*A. seyal, A. raddiana* and *A. senegal*), and *Commiphora africana*. The last is a smallish tree easily transplanted as live fencing. Other species, some noted by Barth, also occur, but interspersed with other trees.

Flora noted in the presahelien zone again differ little from Barth's observations eighty years earlier.

Nineteenth-Century Patterns of Deforestation

Throughout the nineteenth century human-caused deforestation in the Sahel remained a highly localized phenomenon. It was so localized in fact that the term "deforestation" is inappropriate to describe what occurred. Four factors contributed to temporary reduction of the woodstock in pre-colonial society, but none of them had any long term effect on the ecological balance of the region. Increasing aridity, on the other hand, may have contributed to gradual desertification. However, at least in the central Niger subregion here taken as example, weather in the nineteenth century was probably too good, in terms of rainfall quantity,[20] to have destroyed much of the woodstock.

The first of the four factors was farming. It will be treated in greater detail below. Here it need only be noted that farmers rarely clearcut a piece of land since

larger trees were too difficult to remove, and they wanted certain species growing in their fields. Furthermore, shifting cultivation and rotational bush fallow farming systems incorporated long periods of natural regeneration to restore soil fertility. Fallows of fifteen to thirty years were not uncommon, periods long enough for many species to mature fully.

Second, pastoral activities may have contributed, in isolated instances, to deforestation. Generally however the transhumant forms of herding practiced in the Sahel—dictated as they were by climatic cycles common across the entire region—imposed a fairly constant pattern of movement.[21] Thus no one segment of the total pastures used—neither the dry season ("home") range nor the rainy season ("summer") range—faced consistent heavy grazing pressure. In normal years the woodstock easily supplied the limited demands of pastoral peoples and their animals. Those demands consisted mainly of fuelwood and housing materials (both largely supplied by small trees and bushes), and aboreal fodder. Camels and goats foraged for themselves, cropping leaves and smaller twigs of bushes and trees within their reach. Sheep and cattle required the herder's assistance to obtain such fodder. Fulbe herders in particular lopped large branches towards the end of the dry season for their sheep and cows wherever ground level pastures were inadequate. In drought years, such cutting undoubtedly increased; countercyclical trees bearing edible leaves in the dry season (e.g., *Acacia albida*) may have suffered somewhat from heavy pruning.

A third cause of deforestation was the creation of intensive, permanent cultivation bands around small and large communities. This practice frequently derived from the fourth factor, political instability. In areas where attacks were likely—the case in varying degrees throughout much of the nineteenth-century Sahel—people cleared land immediately around the settlement to preclude surprise assaults and to enhance the defenders' strategic advantage.[22]

The sahelian region, with the exception of French-dominated Western Senegal, remained a heavily contested region, bitterly defended by many local groups, particularly Tuareg, against the colonial incursions which commenced about mid-century. Indeed, it was not until 1895 that the French made significant inroads into the regions of contemporary eastern Mali, Upper Volta, Niger, and Chad. Military columns only reached Zinder, and then Lake Chad, in 1899; several years of scattered skirmishing remained before the Sahel was finally pacified.[23] In consequence, the colonial presence throughout most of the Sahel remained almost entirely military through the close of the nineteenth century. Attempts at economic development, embodied in colonial policies to induce cash cropping, followed only after World War I. The remainder of this essay thus in a sense sets the scene for twentieth-century developments.

Pre-Colonial Sahelien Polities

The nature of sahelien terrain facilitated movement. Open, rolling landscape and the Niger River waterway enabled energetic rulers to dominate events at long

distances. Thus pre-colonial sahelien polities tended to be outsize by comparison with those of the more densely forested regions further south towards the Atlantic coast. By 1000 A.D., two major empires were functioning. In the western Sahel, the state of Ghana, based at Kumbi-Saleh in present day southern Mauretania, controlled much of the area occupied by contemporary Senegal, Mauretania, and Mali. Further east, the Kanem-Bornu empire was expanding out from Lake Chad. During the thirteenth through sixteenth centuries, first the Mali, then the Songhai empires established hegemony over all the area ruled by Ghana, and progressively added territory in the form of tributary states. At its height, Songhai collected tribute across the entire Sahel from the Senegal coast to the Aïr Mountains. But after the Moroccan invasion in 1591 broke the Songhai empire and its hold over the western Sahel, the area became politically fragmented and unstable. However, the succession of states which competed for power throughout the Sahel remained fairly sizeable entities, and occasionally, as in the waning centuries (sixteenth to nineteenth) of Kanem-Bornu or in the Fulbe emirates established across Northern Nigeria early in the nineteenth century, units of impressive size were again formed.

Pre-Colonial Trans-Saharan and Sahelien Trade

In this changing mosaic of empires, large states and smaller tributaries, and congeries of small, competing chiefdoms, production for and participation in the trans-Saharan trade were vital economic activities. The process is well illustrated by the nineteenth-century Damagaram kingdom and the Kel Ewey Tuareg confederation which cooperated with Damagaram rulers and carried much of the trans-Saharan trade during that period.

Two basic elements fueled Tuareg interest in the nineteenth-century Sahelien regional trade from which Damagaram profited so much: millet, the staple grain of the area, and salt, essential to human health. Along with trade in these two commodities went lesser traffic in a host of other items flowing through trans-Saharan network: dates, guns, hides, skins, ostrich feathers, hand-tooled leather articles, hand-written qurans, cloth, kola nuts, slaves, imported European manufactures, etc.

The fundamental basis of daily life in sedentary Damagaram communities was millet production.[24] Sorghum, cotton, peanuts, indigo, and other vegetable and condiment crops were also produced. From these, as well as from livestock raising activities came a variety of products which flowed—along with slaves, ostrich feathers and civet cat musk[25] into the trans-Saharan trade. Kel Ewey federation tribes organized the trade, often times with goods financed by North African merchants.[26] In addition, as noted, salt produced at two oases—Tegidda-n-Tesemt, west of Agadez, and at Bilma, on the east central border of contemporary Niger—bulked large in the trade.[27] Dates from the same places, as well as from North African oases, also entered commercial circuits destined for eventual consumption in Sahelien communities.

Production systems. Production systems which fed goods into this trade included varieties of relationships binding freemen, serfs and slaves if various categories to Tuareg ruling castes, on the one hand, and to the Damagaram royal line and its affiliates, on the other.

Damagaram began the nineteenth century as a tiny vassal community, dependent upon the ancient Kanem-Bornu empire for protection and obliged to render Bornuan rulers an annual tribute. It wound up the pre-colonial era as an independent, rapidly expanding state located astride the still valuable trans-Saharan trade route between Kano and Tripoli. Its fortune had been made by an astute leader, Tanimu, who ruled for the thirty years after mid-century. He negotiated an entente with the Kel Ewey Tuareg, which secured for the allies dominance of trans-Saharan trade and also reinforced their joint military efforts.[28]

Both Tuareg and Damagaram ruling groups used their role in the north-south trade to acquire European and North African arms and so magnify their military strength. As the two expanded together, in a series of dry season forays against other Bornu vassal states to the east and Fulbe emirates to the south, they acquired numerous slaves. The bulk of these went to campaign participants.[29] Those allocated to Damagaram people were typically resettled in rural slave villages to produce for their masters.[30]

In Damagaram, plantations were allocated to nobles, slave officials (many of whom served as military commanders in nineteenth-century sahelien states), religious officials and court musician-troubadours, as well as to those who administered the kingdom at the regional and local levels. All of these individuals participated in the campaigns. They were military as well as civilian clients of their immediate superiors; if they fought, they had some claim to share in the booty. Slaves were so valuable, however, that they were rarely allocated to commoners or lower-level officials.

Free peasants typically owed allegiance to the official exercising immediate control over the area in which they lived and farmed. Much of the population of rural Damagaram was formed by residents of sedentary villages, mainly Hausa or Beriberi (Kanuri) in ethnic composition. Such villages were given as fiefs by the Damagaram *sarki* or king to court members.[31] Fiefs attached to an official title were typically scattered about in different sectors of the Damagaram heartland, to frustrate rebellions by ambitious members of the royal family.

Those resident in a fief paid a series of taxes to the fiefholder. These were collected by subordinates whom the fiefholder appointed to administer the various villages and districts under his or her control They acted as tax farmers, courtholders and subordinate military commanders as the occasion demanded. Taxes and other forms of tribute were passed up the hierarchy, the official at each level retaining part to meet expenditures connected with duties of his position and maintenance of his immediate entourage.[32]

Those who cultivated under the authority of the sedentary Damagaram regime—the Hausa, Beriberi (Kanuri) and slaves of all ethnic groups held by free individuals or other slaves—did so either as owner-cultivators producing both for

subsistance and for the market,[33] or as plantation slaves, or again as sharecroppers. Those who cultivated under Tuareg authority were slaves, sharecroppers, or owner-cultivators depending upon the extent to which the pastoral economy was flourishing or suffering setbacks. In periods of retrenchment, higher caste individuals, reduced to farming by loss of their herds, might become directly involved in supervising production processes.

Slaves taken by the Tuareg were initially kept under close control as domestic slaves in their masters' camps.[34] Others herded Tuareg livestock. Still others were settled in specially constituted agricultural communities in the southern sahelien and in the sudano-sahelien zones where farming was feasible. In many cases, these Bugaje slave farming communities held substantial amounts of livestock for their masters and/or for their own account.[35]

Freed Tuareg slaves and their descendants pursued many of the same activities as the slaves, but owed their lords only annual tribute and lodging when the latter came into the area. More highly trusted individuals in this group engaged in transhumant herding and long-distance caravan traffic for their lords, as well as for their own account.

Tuareg free men usually become nobles' clients.They received animals from their lords, and exercised some political power, but had to respond to demands made upon them by their lords.

As Henri Raulin has argued, labor was the scarce factor of production in pre-colonial Niger.[36] This argument is generally supported by others.[37] Development of slave plantations offered both Tuareg and Damagaram nobles as well as lesser members of the chiefly establishment opportunities to capitalize on slaves who came into their hands following the throttling off of transsaharan slave trade after 1850.[38] Furthermore, as Baire has recently demonstrated, slavery and the social gradations up to free client status permitted Tuareg nobles to expand and contract their domestic economies in function of varying climatic conditions. Droughts cut back sharply the number of people who could be supported in the subdesert and desert zones. In such periods, those at the bottom of the status hierarchy were cut loose to shift for themselves. When times again improved, they were reincorporated into the revived and expanding pastoral economy.[39]

Land tenure rules. Since labor constituted the limiting factor in pre-colonial local production processes, access to land posed few problems.[40] Political heads of Islamized sahelien states such as Damagaram claimed control of all lands under their jurisdiction.[41] Tanimu of Damagaram deliberately used his authority over free bush land to attract Tuareg supporters,[42] Effective authority to allocate lands could be decentralized to subordinates. Chiefs sought to swell their followings, as the surest route to enhanced economic and political power. Thus an individual who wished land could almost always obtain it, whether from the king (*sarki*) or from a lesser official. He could then establish a usufructory claim by developing the land. However, if he moved elsewhere and left it, title reverted to the controlling official.[43]

Land typically passed, on the death of the family head, to male offspring who chose not to establish new homesteads elsewhere. But the facility with which land could be obtained, and indeed the systems of shifting cultivation and rotational bush fallow imposed at least intermittent movements and the process of clearing new land or overgrown bush areas in order to obtain satisfactory yields.[44] Thus in practice title to a specific piece of land had relatively little value. It was rather ability to mobilize people to work land which counted.

Stock raising, carried on by sedentary peoples and by pastoralists, involved different land tenure rules from those controlling agricultural activities. During the nineteenth century most Damagaram villages were surrounded by virgin or fully reconstituted bush, some of which was usually suitable for pasturage. Animals owned by sedentary peoples either roamed freely in these areas, or were guarded by herders who took them to and from pastures. If an area contained but a single water point, wild animals did not pose a threat to stock, and rustling was not a problem, animals could be allowed to roam at will because they returned regularly to the water source. If not, stock had to be guarded.

Pastoral peoples, particularly Fulbe, herded their stock full time and moved frequently in search of adequate fodder and water.

Bush land, as well as ultimate title to all other lands within the Damagaram kingdom, belonged to the *sarki* or king. Herders, like hunters and woodsmen, exploited bush as a common property resource. Non-Tuareg stockowners paid grazing taxes to the Damagaram administration.[45] Tuareg who ran animals within Damagaram territory paid no direct taxes on them to the Damagaram rulers, though they did pay some indirectly in duties on the salt and date traffic carried by regional caravans.[46] Their animals followed transhumant patterns typical of the region, moving north to the Aïr region during the summer rains and then back south during the long dry season, when northern water supplies and/or pastures would no longer support the herds. According to Barth, nineteenth-century Tuareg had fixed abodes, located in their dry season ranges.[47] Within these areas, stock belonging to the group apparently used the pasture as a commons. In areas where water sources were relatively isolated from one another, a natural geographical subdivision of a group's total home range would have occurred.

The External Economy and Colonization

The central sahelien and sudanic zones were not, until the very end of the nineteenth century, incorporated directly into colonial political institutions being developed by Europeans. Thus cash cropping in the sense of production for export to an overseas metropolitan center was nowhere a significant activity in the region. The trans-Saharan trade, after flourishing for centuries, progressively lost out to seaborne competition during the nineteenth century, although routes in the central sahelien area held their own until the late 1890s.[48] Europeans pushed down the Atlantic coast, and then around 1850, began to penetrate the Nigerian interior in increasing numbers and establish improved communication networks. As a result, groups closely tied to the trans-Saharan trade suffered severe reverses late in the

century. For them, colonial penetration into the central sahelien interior in 1899–1904 constituted a major turning point. For others in the same society, colonial demands forced fundamental adjustments, but at a slower rate. The impact of colonialism did not hit sedentary rural populations until some decades later, in the mid-1920s, with the advent of peanut production. The nature of that development and others related to it, and their consequences for the local environment will be examined in a subsequent essay.

Suffice it here to say, by way of conclusion, that the pastoral and agricultural societies typical of the pre-colonial West African Sahel lay lightly on the land. With few exceptions, population pressure remained limited until the advent of the twentieth century. The relatively small groups of humans which did inhabit the area so arranged their economies that they rarely overtaxed the capacity of wood, pasture and soil resources to meet local demands while at the same time renewing themselves.

Herders made scant use of the steppe woodstock since they typically did not remain overly long on any given pasture. Agricultural communities used the land more intensively, but almost never to the extent of clearcutting large areas and stripping them entirely of woody cover. Most of these sedentary societies were moreover also occasionally "mobile." Entire villages moved their sites, pushed by declining soil fertility and falling crop yields on fields currently under cultivation, and beckoned by the promise of better harvests for the price of clearing new fields in the abundant neighboring bush.

Notes

1. Ohio: Agricultural Clearing

1. The actual figures for lumber production in Michigan are 1869–2.3 mill. b.f. or 17.6 percent; 1879–4.2 mill. b.f., or 23 percent; 1889–5.5 mill. b.f., or 20.2 percent; and 1899–3.0 mill. b.f., or 8.6 percent; 1909–1.9 mill. b.f. or 4.2 percent.

2. For an interesting development of these ideas see Evelyn M. Dinsdale, "Spatial Patterns of Technological Change: The Lumber Industry in Northern New York", *Economic Geography*, 41 (1965): 252–74.

3. For overviews and details of Michigan lumbering see George W. Hotchkiss, *History of the Lumber and Forest Industry of the Northwest* (Chicago, 1898); Rolland H. Maybee, "Michigan's White Pine Era, 1840–1900" *Michigan History*, 43 (1959): 385–432; and William G. Rector, *Log Transportation in the Lake States Lumber Industry 1840–1918* (Glendale, Ca., 1953).

4. For the probable distribution of the early vegetation in Ohio, see Paul B. Sears, "The Natural Vegetation of Ohio," *Ohio Journal of Science*, pt. 1, 25 (1925); 139–49; pt. 2, 26 (1926); 128–46; and pt. 3, 26 (1926); 213–32. See also E. Transeau and H. Sampson, "Map of Primary Vegetation Areas of Ohio", in Sitterly and Falconer, "Better Land Utilization for Ohio", *Ohio Agricultural Experimental Station*, Mimeo, Bulletin No. 108 (Columbus, 1938), 18.

5. Unless otherwise stated all figures are based on the federal census publications, in particular the calculations of the amount of land cleared being based on the county statistics of land improved in predominantly forested and non-forested areas at each census.

6. For accounts of early farming in Ohio see, Charles W. Burkett, *History of Ohio Agriculture: A Treatise on the Development of Various Lines and Phases of Farm Life in Ohio* (Concord, N.H., 1900); Robert H. Jones, "Ohio Agriculture in History," *Ohio Historical Quarterly* 65 (1956) 229–58; W. A. Lloyd *et al., The Agriculture of Ohio*, The Ohio Agricultural Experiment Station Bulletin 326 (Wooster, Ohio, 1918); and Francis P. Weisenberger, *The Passing of the Frontier, 1825–1850*, vol. 3 of *History of the State of Ohio*, ed. Carl Wittke (Columbus, Ohio, 1941).

7. George Perkins Marsh, *Man and Nature: or Physical Geography as Modified by Human Action* (New York, 1864); another edition, Cambridge, Mass., 1965, with introduction, ed. by David Lowenthal; Thomas Starr, "American Forests: Their Destruction and Preservation," United States Department of Agriculture; *Annual Report for 1865*, pp. 210–34; Increase A. Lapham, J. G. Knapp, and H. Crocker, *Report of the Disastrous Effects of the Destruction of Forest Trees now Going On in the State of Wisconsin* (Madison, 1867).

8. United States Department of Agriculture, *Annual Report for 1872*, "The Forests of the United States," and *Annual Report for 1875*, "Statistics on Forestry." In both the data on forest area within farms is mapped for each state by county, and copious details are printed of local resources of wood and timber, the most abundant species, the condition of the forests and rate of growth, the home prices of wood and lumber "and other practical points."

9. For Brewer's maps see Francis A. Walker (ed.), *Statistical Atlas of the United States Based on the Results of the Ninth Census*, part 1, plates III and IV, and accompanying commentary. The commentary was also published in USDA, *Annual Report* for 1875, 352–58.

10. Daniel Millikin, "The Best Practical Means of Preserving and Restoring the Forests of Ohio," *Ohio Agricultural Report*, Second Series, (1871); 319.

11. Rev. George Pinney, *An Essay upon the Culture and Management of Forest Trees*, pp. 5–15.

12. For a comprehensive account of the Adirondack movement see Roger C. Thompson, "Politics in the Wilderness," together with details in Arthur S. Hopkins, "Within and Without the Blue Line" (1951). For the original proposals concerning clearing and watersheds see Verplanck Colvin, *Report on a Topographical Survey of the Adirondack Wilderness*, (1873). Colvin produced another three reports on the topic in 1874, 1879, and 1884.

13. John H. Klippart, "Condition of Agriculture in Ohio in 1876," *Ohio Agricultural Report*, Second Series (1876): 486–538; quote on p. 508.

14. Franklin B. Hough, "On the Duty of Governments in the Preservation of Forests," *Proceedings of the American Association for the Advancement of Science*, (1873). The story of the formation and progress of the Division of Forestry is outlined in USDA, *Annual Reports for 1877, 1878 and 1880*, 20–22, 27–32, and 653–56, respectively.

15. Franklin B. Hough, "The Decrease of Woodlands in Ohio," pp. 174–80 of Nathaniel H. Egleston, ed., *Report upon Forestry*, IV (Washington: GOP, 1884).

16. Hough's figures must be treated with caution because he assumes that the figures for "improved woodland," "unimproved woodland," and "unimproved other lands" (abstracted from Ohio county Assessors' reports) apply to the whole of a county whereas they apply only to the land in farms. The figures were first abstracted and calculated by Klippart in 1876 (see note 13 above), but they were calculated inaccurately and then slavishly copied by Hough. Hough's statistical diagrams are hopelessly inaccurate in places. However, despite the inaccuracies in detail, the general conclusion that large areas of woodland had been cleared was quite correct.

17. *Ohio State Forestry Bureau, First Annual Report*, (1886), hereafter *Ohio Forests* (1886). This report of 314 pages was a detailed survey of the past and present condition of the forests of Ohio, and of the consequences of cutting.

18. Wilbur Stout, "The Charcoal Iron Industry of the Hanging Rock Iron District—Its influence on the Early Development of the Ohio Valley," *Ohio Archaeological and Historical Quarterly* 42 (1933): 72–104; and Janice C. Beatley, "The Primary Forests of Vinton and Jackson Counties, Ohio" (unpublished Ph.D. dissertation, Ohio State University, 1953).

19. Robert L. Jones, "The Beef Cattle Industry", *Ohio Archaeological and Historical Quarterly*, 64 (1955): 176–83; and Paul C. Henlein, "Cattle Driving from the Ohio Country, 1880–1850," *Agricultural History*, 28 (1954): 90.

20. These and the following quotations are taken from *Ohio Forests* (1886) and are to be found under the appropriate county heading, pp. 28, 30–31, 101–3, 138, 212, 219, 282, and 286.

21. For a detailed study of the draining, clearing, and settlement of the Black Swamp, with many details about the early vegetation, see Martin R. Kaatz, "The Black Swamp: A Study in Historical Geography," *Annals, Association of American Georgraphers*, 45 (1955): 1–35.

22. Based on Martin Primak, "Farm Formed Capital in American Agriculture, 1850–1909" (unpublished Ph.D. dissertation, University of North Carolina, Chapel Hill, 1963), appendix tables 3, 4, and 5.

2. North America's Pacific Coast

1. Richard C. White, *Land Use, Environment, and Social Change: The Shaping of Island County, Washington* (Seattle: University of Washington Press, 1980), pp. 14–34, demonstrates significant Indian impact on the natural environment, but primarily from agricultural practices, not the felling of trees. Indian-set fires also caused environmental change. See John B. Lieberg, "Cascade Forest Reserve, Oregon, from Township 28 South to Township 37 South Inclusive; Together with the Ashland Forest Reserve and Adjacent Forest Regions," in *Twenty-first Annual Report of the United States Geological Survey, 1899–1900*, part V (Washington: GPO, 1900), pp. 276–93.

2. Thomas R. Cox, *Mills and Markets: A History of the Pacific Coast Lumber Industry to 1900* (Seattle: University of Washington Press, 1974) traces this theme in considerable detail.

3. Descriptions of forest geography of western North America are numerous. Good general accounts are in Henry Gannett, "The Forests of the United States," in *Nineteenth Annual Report of the United States Geological Survey, 1898–1899*, part V (Washington: GPO, 1899), pp. 22–47, 61–66; Raphael Zon and William N. Sparhawk, *Forest Resources of the World* (2 vols.; New York: McGraw-Hill, 1923), II, 499–502, 525–26; Michael W. Donley et al., *Atlas of California* (Culver City, Ca.: Pacific Book Center, 1979), 146–53; Richard M. Highsmith, Jr., *Atlas of the Pacific Northwest: Resources and Development* (4th ed.; Corvallis: Oregon State University Press, 1968), pp. 49–60. The description that follows is distilled from these and other sources.

4. The differential becomes less as one moves southward. See Lieberg, "Cascade Forest Reserve, Oregon, from Township 28 South," 267; Henry Gannett, *Forests of Oregon*, United States Geological Survey, Professional Paper No. 4 (Washington: GPO, 1902), p. 13; Fred G. Plummer, *Forest Conditions in the Cascade Range, Washington between the Washington and*

Mount Rainier Forest Reserves, United States Geological Survey, Professional Paper No. 6 (Washington: GPO, 1902), pp. 9–10.

5. Highsmith, *Atlas of the Pacific Northwest*, pp. 31–37; Kenneth L. Gordon, *The Natural Areas of Oregon* (Corvallis: Oregon State College, 1953); Jerry T. Franklin and C. T. Dyrness, *Natural Vegetation of Oregon and Washington*, USDA, Forest Service, General Technical Bulletin PNW-8 (Portland: Pacific Northwest Forest and Range Experiment Station, 1973).

6. Jack McNairn and Jerry MacMullen, *Ships of the Redwood Coast* (Stanford, Ca.: Stanford University Press, 1945); Karl Kortum and Roger Olmsted, " '. . . It Is a Dangerous Looking Place': Sailing Days on the Redwood Coast," *California Historical Quarterly* 50 (1971); 43–58; Cox, *Mills and Markets*, pp. 161–98.

7. William A. Bowen, *The Willamette Valley: Migration and Settlement on the Oregon Frontier* (Seattle: University of Washington Press, 1978), pp. 59–64; Donley, *Atlas of California*, p. 28.

8. USDA, Forest Service, *Timber Depletion, Lumber Prices, Lumber Exports, and Concentration of Timber Ownership*, Report on Senate Resolution 311 (3rd. ed.; Washington: GPO, 1928), pp. 23, 31–35. The figures should be treated as rough estimates. The Forest Service admitted that its knowledge of existing stands was incomplete, while some areas of the Willamette Valley that had never been forested appear to have been included in the acreage given for original stands. The figures for 1914 would not have been far different. In 1906, California's state forester noted that "The area of forest land in the State to-day is practically identical with the original area, very little having been turned to other uses. The changes, therefore, have resulted solely in a reduction of the area of merchantable timber." California State Forester, *First Biennial Report, 1905–1906* (Sacramento: State Printer, 1906), p. 7.

9. Cox, *Mills and Markets*, p. 301, Table 1, provides a summary of production, broken down by political subdivisions, for the period 1849–1900.

10. Sherwood D. Burgess, "The Forgotten Redwoods of East Bay," *California Historical Society Quarterly* 41 (1962); 237–48.

11. Cox, *Mills and Markets*, provides the fullest discussion. See also James N. Tattersall, "The Economic Development of the Pacific Northwest to 1920" (unpublished Ph.D. dissertation, University of Washington, 1960), p. 137 and passim; Edwin T. Coman, Jr., and Helen M. Gibbs, *Time, Tide and Timber: A Century of Pope & Talbot* (Stanford, Ca.: Stanford University Press, 1949), pp. 75–89.

12. For fuller discussions, see: Thomas R. Cox, "The Passage to India Revisited: Asian Trade and the Development of the Far West, 1850–1900," in John A. Carroll, ed., *Reflections of Western Historians* (Tucson: University of Arizona Press, 1969), pp. 85–103; Eliot Grinnell Mears, *Maritime Trade of the Western United States* (Stanford, Ca.: Stanford University Press, 1935), pp. 80–116.

13. John Lieberg, *Forest Conditions in the Northern Sierra Nevada, California*, United States Geological Survey, Professional Paper No. 8 (Washington: GPO, 1902), p. 17; H. D. Langille et al., *Forest Conditions in the Cascade Forest Reserve, Oregon*, United States Geological Survey, Professional Paper No. 9 (Washington: GPO, 1903), pp. 19–23, 32–33, 91; Phil F. Brogan, *East of the Cascades* (Portland: Binfords & Mort, 1964), pp. 234–256; Philip Cogswell, Jr., "Deschutes Country Pine Logging," in Thomas Vaughan, ed., *High & Mighty: Select Sketches about the Deschutes Country* (Portland: Oregon Historical Society, 1981), pp. 235–59.

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25. Technological changes are discussed at length in Cox, *Mills and Markets*, pp. 227–54.

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28. Forest Service, *Timber Depletion*, pp. 40–58; Cox, *Mills and Markets*, pp. 297–300.

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33. John Cox, "Organizations of the Lumber Industry," pp. 137–65; Alexander Norbert MacDonald, "Seattle's Economic Development, 1880–1910" (unpublished Ph.D. dissertation, University of Washington, 1959), pp. 96–103, 180–83; and Thomas R. Cox, "Lower Columbia Lumber Industry, 1880–1893," *Oregon Historical Quarterly* 67 (1966); 160–78, all discuss the rail shipments, each from a slightly different perspective.

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"Fuels and Fire Management: Prescribed Fire Use on the National Forests in the Pacific Northwest Region," *Tall Timbers Fire Ecology Conference Proceedings Annual* 15 (1974); 119–25.

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40. Thornton T. Munger, "The Cycle from Douglas Fir to Hemlock," *Ecology* 21 (1940); 451–9; Langille, *Forest Conditions in the Cascade Reserve*, pp. 35–37, 40–41; William B. Greeley, "Twenty-Five Years: Cutover Lands Come into Their Own," *Loggers Handbook* 5 (1945); 73–77; Stephen Haden-Guest, John K. Wright, and Eileen M. Tetcalf, *A World Geography of Forest Resources* (New York: Ronald Press, 1956), p. 76. Conditions in the Douglas fir forests led to widespread use of clearcutting and subsequently to much controversy over the wisdom of such practices, especially during the 1970s. For introductions, see Keenan Montgomery and Clyde M. Walker, "The Clearcutting Controversy: A Forum . . ." *Journal of Forestry* 71 (1973); 10–13; James S. Bethel, "Clearcutting in the Pacific Northwest and Alaska," in Eleanor C. J. Horwitz, *Clearcutting: A View from the Top* (Washington: Acropolis Books, 1974), pp. 126–48.

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3. Marshall Seaton McLennan, "Peasant and Hacendero in Nueva Ecija: The Socio-Economic Origins of a Philippine Commercial Rice-Growing Region" (unpublished Ph.D. dissertation, University of California, 1973), pp. 26–35. Brown, *Vegetation of Philippine Mountains* (Manila: Bureau of Printing, 1919), p. 18.

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4. Deforestation in Southeastern Brazil

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14. José de Souza Martins, "Frente pioneira: contribuição para uma caracterizaçáó sociológica," *Estudos Historicos* [hereafter *EH*] 10 (1971): 33–42.

15. Jean Roche, *A colonização alemã no Espírito Santo* (São Paulo: 1968).

16. Silva Guimarães, *A agricultura*, pp. 16–18.

17. Sebastião Ferreira Soares, *Estatística do commercio maritimo do Brazil do exercicio de 1869–1870* 3 vols. (Rio de Janeiro: 1874).

18. Antonio Cândido do Amaral, *Questões de silvicultura: notícia sobre as matas do Municipio Neutro e sua exploração* (Rio de Janeiro: 1890).

19. G. W. Freireyss, "Viagem ao interior do Brasil nos annos de 1814–1815," *Revista do Instituto Histórico de São Paulo*, 11 (1906): 158–228; Muniz de Souza, *Viagens*, p. 24; José

Ferreira Carrato, "O primeiro polo de criação de gado que houve no triângulo mineiro," *EH* 12 (1973): 99.

20. Auguste de Saint-Hilaire, *Plantes usuelles des brésiliens* (Paris: 1824); Ladislau Netto, *Apontamentos relativos à botanica applicada no Brasil* (Rio de Janeiro: 1871).

21. Theodor and Gustav Peckolt, *Historia das plantas medicinaes e uteis no Brazil* (Rio de Janeiro: 1888–1899); "Guido Thomaz Marlière [Documents]," *Revista do Arquivo Público Mineiro*, 10 (1905): 492–93. Bernardino Antonio Gomes, "Memória sobre a ipecacuanha," in *Plantas medicinais do Brasil* (São Paulo: 1972).

22. Eddy Stols, "A flora brasileira e os naturalistas e horticultores belgas no século XIX," *Revista de História* 44 (1972): 155–72; Alvaro da Silveira, *Flora e serras mineiras* (Belo Horizonte: 1908); Tom Sterling, *The Amazon* (Amsterdam: n.d.).

23. John Mawe, *Travels in the Interior of Brazil* (London: 1812); J. Silva Resende, "A formação territorial de Minas Gerais;" in III Congresso Sul-Riograndense de História e Geografia *Anais* (Pôrto Alegre: 1940), 2: 684–91; [José Joaquim da Rocha], "Geographia historica da Capitania de Minas Geraes [1780?]," *Publicações do Arquivo Público Nacional* 9 (1909): 13–100); João Antonio Andreoni [André João Antonil], *Cultura e opulência do Brasil* (São Paulo: 1967).

24. Andreoni, *Cultura*, p. 231.

25. Francisco Friere Alemão, *Memoria: Quais são as principais plantas que hoje se acham aclimatadas no Brasil?* (n.p., 1856); Corcino Medeiros dos Santos, "Algumas notas para o estudo da economia de São Paulo no final do século XVIII," *EH* 13–14 (1975); Daniel Pedro Müller, *Ensaio d'um quadro estatistico da provincia de S. Paulo* (2nd. ed.; São Paulo: 1923); João José Carneiro da Silva, *Estudos agricolas* (Rio de Janeiro: 1872).

26. Paulo Ferreira de Souza, *Legislação florestal* (Rio de Janeiro: 1934–1935), 2: 57–59.

27. Milliet, *Roteiro*.

28. On coffee techniques, see João Joaquim Ferreira de Aguiar, *Pequena memoria sobre a plantação, cultura e colheta de café* (Rio de Janeiro: 1836); Francisco Peixoto de Lacerda Werneck, *Memoria sobre a fundação de huma fazenda na provincia do Rio de Janeiro* (Rio de Janeiro: 1847); F. L. C. Burlamaqui, *Monografia do cafeseiro e do café* (Rio de Janeiro: 1860).

29. S. V. V. Jousselandière, *Manual pratico de agricultura intertropical* (Rio de Janeiro: 1860).

30. Edmundo Navarro de Andrade, *Questões florestais* (São Paulo, 1915) and *Utilidade das florestas* (São Paulo, 1912).

31. Anibal Villela and Wilson Suzigan, *Política do governo e crescimento da economia brasileira, 1889–1945* (Rio de Janeiro: 1973).

32. R. J. da Cunha Mattos, *Itinerario do Rio de Janeiro, Pará e Maranhão pelas provincias de Minas Gerais e Goiás* (Rio de Janeiro: 1836). On floods: Brazil, Ministério de Agricultura, Indústria e Comércio, *Questionario sobre as condições da agricultura . . . Rio de Janeiro* (Rio de Janeiro, 1913).

33. Pasquale Petrone, "Os aldeamentos paulistas e sua função na valorização da região paulistana" (Livre-Docência Thesis, Department of Geography, University of São Paulo: 1964); Luiz Felipe Baeta Neves, *O combate dos soldados de Cristo na terra dos papagaios* (Rio de Janeiro: 1978).

34. Domenico Vandelli, "Memoria sobre a agricultura deste reino e das suas conquistas . . ." and "Sobre algumas producções naturaes das conquistas . . ." both in *Memorias Economicas da Academia Real das Sciencias de Lisboa* 1 (1789): 187–206; also see Baltasar da Silva Lisboa, *Discurso histórico político e economico dos progressos, e estado actual da filosofia natural portuguesa . . .* (Lisbon: 1786).

35. Alberto J. Sampaio, ed., "Primeira Conferencia Brasileira de Protecção a Natureza: Relatorio," *Boletim do Museu Nacional* 11 (June 1935); José de Saldanha da Gama, *Discours prononcé au Congres International des Economes Forestiers à Vienne en 1873* (Rio de Janeiro: 1874).

36. Euclides da Cunha, "Fazedores de desertos," and "Entre as ruinas" in *Obra completa* (Rio de Janeiro: 1966), 1:181–85; Mauro Victor, *A devastaçao florestal* (São Paulo, 1976).

5. The Bombay Deccan and Karnatak

1. Mountstuart Elphinstone, *Territories Conquered from Paishwa* (New Delhi [reprint edition], 1973).

2. Ibid., p. 9. The Konkan coastal region, based upon rice cultivation with its own culture and Konkani language, was excluded from Elphinstone's charge.

3. Ibid., p. 1.

4. Ibid.

5. Elphinstone presumed a certain degree of previous information on the major crops and rainfall conditions etc. Nor did he describe the soils. We have relied upon O. H. K. Spate, *India and Pakistan, A Regional Geography* (London, 1954) for much of what follows. See pp. 644–55 for the Maratha regions, and especially Figure 128 for the distribution of soils and figure 129 for crop associations in the twentieth century. Most of the region is within the 25 inch rainfall isohyet.

6. Michelle Burge McAlpin, *Subject to Famine: Food Crises and Population Change in Western India* (Princeton University Press, forthcoming). Rainfall data are supplied in chapter 2, "The Famine Phenomenon: Insecurity and Adaptation." Annual rainfall at Poona has varied from a low of 12.37 inches to a high of 47.42 inches in the years 1875 to 1945. The average annual figure is 27.42 inches.

7. Elphinstone, *Territories*, p. 6.

8. Modern historical research has made few emendations to Elphinstone's account. In part this reflects Elphinstone's acumen, but it also reflects the paucity of modern attempts to work in those records which might generate contradictions. See Ravinder Kumar, *Western India in the Nineteenth Century* (London, and Toronto 1968), chapter 1 "The Poona Districts in 1818," pp. 1–42.

9. Elphinstone, *Territories*, p. 21.

10. Ibid., p. 24.

11. See Kumar, *Western India*, pp. 16–33 for a composite picture of the Maratha peasant village in 1818 based upon contemporary accounts and records which amplifies and supports Elphinstone's comments. The question of rural tenures and society was of immediate practical concern to the British administration. East India Company administrators with experience in the region continued to make detailed studies of these issues. In so doing a good many developed into what today we would term social scientists, who reported their findings in the scholarly journals. For one example of this see William H. Sykes, "On the Land Tenures of the Dekkan" in *Journal of the Royal Asiatic Society* 2, (1835); 205–33. Sykes provides a detailed picture of rural society in the Deccan which refines Elphinstone after another fifteen years of reports and analysis.

12. Cf. Sykes, "Land Tenures,": "a very numerous class of occupiers is the Upari. The proper meaning of this term is a stranger, or one who cultivates land in a village in which he has not any corporate rights. In practice, he holds his land on the Ukti tenture, which is a land-lease by a verbal agreement for one year. . . . Formerly the Patels [village headmen] and the village corporation had the disposal of the . . . abandoned lands." (p. 216)

13. Elphinstone, *Territories*, p. 120. A letter from Briggs to Elphinstone dated 22 December 1818 which the latter reproduced in his appendices.

14. See the letter from Briggs in Elphinstone, pp. 118 and 119. See also Kumar, *Western India*, pp. 29–30. Kumar suggests that the village craftsmen (*bullotedars*) received as much as one-eighth the gross produce of the village. Also Sykes, "Land Tenures," p. 225.

15. "The Potedar, besides being the village silversmith, assays all money paid, either to Government or individuals." Elphinstone, *Territories*, p. 23.

16. Ibid., p. 22.

17. Ibid., p. 26.

18. Above the village "is a Turruf, composed of an indefinite number of villages, with perhaps an addition of uninhabited mountain and forest land (there being other land not included in some village). A Turruf is under no particular officers: several of them make a Purgunna [i.e., a subdistrict] which is under a Daishmook . . . , who performs the same functions towards the Pergunna as a Patail [headman] towards the village." Elphinstone, p. 27. As for perquisities: "The Daishmook's profits are very great; generally, I am told, about five percent. Not only on the revenue, but on the land; five acres in each hundred, for example, . . . he has also various claims in kind, as a pair of shoes every year from each shoe-maker." Ibid., p. 28.

19. Elphinstone comments that in revenue negotiations with the Government the village headmen could expect to be supported by the Deshmukhs "all hereditary officers being considered as connected with the Ryots [peasants]." Ibid., p. 34.

20. Ibid., p. 2. The Ramosis "have the same thievish habits as the Beels, but have no language of their own; and are more mixed with the people, and in dress and manners are more like the

Marrattas." In other words in the early part of the nineteenth century the Ramosis were much closer to an untouchable group within the Hindu caste system in this area than were the Bhils. It may be worth noting that the term jungle is in origin an Indian word from the Sanskrit which simply means "any tract overrun with bushes or trees, or suffered to be overspread with vegetation." H. H. Wilson *A Glossary of Judicial and Revenue Terms* (report of 1855 edition New Delhi, 1968), p. 231.

21. Elphinstone, *Territories*, p. 7.

22. Ibid.

23. Ibid., p. 8.

24. McAlpin, *Subject to Famine*, abstracted from table 3.2, chapter three. These figures apply to the districts directly administered by the British, not to the several enclaves known as Indian States in this region.

25. The difference between the expansion of land actually planted each year (GSA) and of that held for cultivation (GSA & CF), to the extent that it represents a real phenomenon and not some of the underlying problems with the statistics, is interesting. These changes may reflect the attempts by some cultivators to protect themselves from the increasing scarcity of free grazing land by laying claim to (and paying taxes on) previously uncultivated fields. This desire to appropriate for private use one of the resources formerly used communally was a cost of the increasing scarcity of grazing land as cultivation expanded.

26. For a full discussion of this important process see Amalendu Guha, "Raw Cotton of Western India: 1750–1850," *Indian Economic and Social History Review* 9 (1972): 1–42.

27. Statistics on percentages of imports from India and U.S. from William Woodruff, *Impact of Western Man* (New York, 1967), table facing p. 302. Statistics on imports and re-exports from B. R. Mitchell (with the collaboration of Phyllis Deane) *Abstract of British Historical Statistics* (Cambridge: 1962), chapter on overseas trade.

28. Guha points out that the China market for Indian raw cotton really only began to boom after 1770 when the East India Company and private Indian traders began to acquire large sailing vessels designed to sail from Bombay to Canton with a bulky cargo. The impetus for this change lay in the need for a commodity to pay for the import of Chinese tea into Britain. Guha, "Raw Cotton," p. 3.

29. Guha, "Raw Cotton," p. 8.

30. Arthur Silver, in *Manchester Men and Indian Cotton, 1847–1872*, (Manchester: 1966) reproduces a table from a contemporary source which shows the progression of imports of Indian raw cotton into England. From a total of 2.7 million pounds in 1806, annual imports rose, with some oscillations, to 84.1 million pounds in 1848. Silver, *Manchester Men*, p. 28. Silver details in his study the efforts of Manchester manufacturers to obtain improvements in the quality of Indian cotton so that India might replace the United States as a source for Lancashire. Guha basing his estimate on a contemporary assessment of cotton cultivation and output in western India, suggests that the average annual total output of western India was about 300 million pounds in 1850. "One-third to about one-half of this constituted the exportable surplus. The remainder entered into commodity circulation within India." Guha, "Raw Cotton," p. 12.

Important as these cotton exports were to the Indian economy, it is well to remember that Indian cotton was, at most, an emergency source of supply for English mills. Their primary supplier was and remained the American South. U. S. production of cotton rose from 2 million pounds in 1790 to 366 million pounds in 1826 to 1,308 million in 1848. In 1840, the earliest year for which such data are available, U. S. domestic consumption of cotton was only 118 million pounds; by 1850 it had risen to 288 million pounds. *Historical Statistics of the United States* (Washington, D. C.: 1949), pp. 109, 187. Obviously, exports of American cotton grew at a much more rapid rate than those of Indian cotton could. And it was precisely this dependance on American cotton that prompted English mill-owners to seek improvements in Indian cotton that would mitigate their need for American supplies.

31. See Guha, "Raw Cotton," pp. 1–22 for details on these points.

32. This is a cavalier treatment and summary of one of the most difficult issues in British-Indian history. The literature on land policy and its effects is gigantic. See Kumar, *Western India*, pp. 84–332 for an overview and for discussion of the major issues in the Bombay system. Kumar's summary comments on the social changes which occurred by 1918 are certainly representative; "Within half a century of the British conquest the village communities were . . . fragmented into discrete, indeed antagonistic social groups. . . . True, the growth of a small class of rich peasants

whose acquisitiveness and ostentatiousness created the illusion of a general improvement in rural society, appeared to vindicate the utilitarians." Ibid., p. 325.

33. Peter Harnetty, "Cotton Exports and Indian Agriculture, 1861–1870," *The Economic History Review* (1974); 414–29. See also by the same author, *Imperialism and Free Trade: Lancashire and India in the Mid-Nineteenth Century* (Vancouver: 1972).

34. Harnetty, "Cotton Exports," p. 415.

35. This data is abstracted from Harnetty's table 2 and table 3, pp. 416–7.

36. Calculated from McAlpin's data presented in table 5.2.

37. See Michelle Burge McAlpin, "Railroads, Cultivation Patterns, and Foodgrain Availability: India, 1860–1900" *The Indian Economic and Social History Review* 12 (1975): 43–60 for a fuller treatment of the role of the railroads in commercializing Indian agriculture.

38. Ibid., pp. 56–57.

39. See McAlpin, "Impact of Trade," pp. 38–39, table five.

40. For a typical statement of this view see the article on forests in *The Imperial Gazetteer of India, The Indian Empire*, Vol. 3, "Economic," pp. 104–105.

41. Ibid., p. 110.

42. John Augustus Voelcker, *Report on the Improvement of Indian Agriculture*, 2nd ed. (Calcutta: 1897), p. 101. Voelcker's report was based upon data systematically gathered during two extended tours of India and several years of writing. It probably should be required reading for all present day development specialists concerned with the subcontinent.

43. Ibid., p. 102.

44. "Throughout the Deccan the village grazing ground is nothing more than 'cattle standing-room.' I have frequently examined these 'village wastes,' and have generally found them to be bare during the cold and the hot seasons, and during the rains to have little more than a covering of annual weeds." Ibid., p. 173.

45. *Imperial Gazetteer of India, The Indian Empire*, 3, pp. 108–109. The India Office closed the Cooper's Hill Engineering College in 1906. Thereafter probationers for the Forest Service selected from a competitive examination completed two years of study at Oxford and a year in Europe for a diploma before they joined the Indian Forest department as Assistant Conservators. Ibid., p. 127. The Dehra Dun Forest School continues its existence to the present day.

46. For details of this and other forest legislation see E. P. Stebbing, *The Forests of India*, 4 vols. (Oxford: 1925–1962).

47. These figures are taken from *Imperial Gazetteer of India*, 8, "Bombay Presidency," pp. 321–3 and 385. The Bombay official forest establishment consisted in 1904 of 24 Imperial Service (British); 23 Provincial Service (Indian) Foresters; and an Indian staff consisting of 47 rangers, 168 foresters and 3,394 guards.

48. W. H. Horsley, "The Khandeish-Satpura Forests and Their Bhil Inhabitants," in D. Brandis and Arthur Smythies, *Report of the Proceedings of a Forest Conference at Simla* (Simla: 1875), pp. 23–27. Further details of these processes, on the Bombay government's ineffectual efforts to defend the tribals against the pressures of the market economy, are in: Western Bhil Agency, Khandesh, *Annual Reports*, 1881/82 to 1905/06 (London: India Office Library, unpubl.). The authors are indebted to Richard Tucker for these references.

49. The most complete study of these increasing tensions anywhere in nineteenth-century India was by a Bombay government commission, which reported on the explosive tensions in the nearby hill districts of the Western Ghats: Government of India, *Bombay Forests Inquiry*, 4 vols. (Calcutta: 1887). See also: Richard Tucker, "Forest Management and Imperial Politics: Thana District, Bombay, 1823–87." *Indian Economics and Social History Review* 16: 3 (July 1979): 273–300.

50. See J. Burton-Page, "*Khandesh*" in *Encyclopaedia of Islam*, second edition. Richards is currently working on a more precise estimate of the extent of settlement and cultivation in Mughal Khandesh using archival data. His colleague, Stewart Gordon, is engaged in a similar task for Khandesh under the Marathas in the post-1760 period. Our impression at this point is that the high point of agricultural expansion prior to 1850 occurred early in the reign of the Emperor Aurangzeb (1658–1707). It is doubtful that cultivation in the Maratha period reached that peak.

51. Elphinstone, *Territories*, pp. 3–4.

52. Ibid., p. 4. This defection was especially serious as Elphinstone notes because the Bhils "had, as village watchmen, been the great instruments of police throughout Candeish." Other marauders were the notorious Pindaris who made annual raids into the province.

53. Ibid., p. 5. Elphinstone reproduces some of Brigg's reports from Khandesh. Others may be consulted in the collection of documents from the Poona archives for the Bombay Deccan and Karnatak edited by R. D. Choksey titled *Period of Transition (1818–1826)* (Poona: 1945).

54. These data are taken from the *Gazetteer of the Bombay Presidency*, vol. 12, (Khandesh District), 1880, p. 289. This is hereafter cited as *BPG-Khandesh*. The total area and population density figure is taken from Selections from the *Records of the Bombay Government* (old series), "Report by Captain Wingate, Revenue Survey Commissioner, on . . . the province of Khandesh . . . No. 1 (Bombay: 1852). Cited hereafter as Wingate, "Report."

55. Wingate, "Report," p. 6. According to Wingate the waste land was "covered with thorn jungle."

56. Calculated from data supplied in *BPG-Khandesh*, p. 289. The indigenous *bigha* measurement has been converted to acres at 0.75 *bighas* per acre. This is the conversion given in the Gazetteer note.

57. Wingate, "Report," p. 5. Later works give the area of the district at just over 26,000 km².

58. The cotton acreage figures are calculated from Guha, "Raw Cotton of Western India," appendix V, p. 40. Guha drew upon several different sources for his compilation and suggests that appropriate caution be used.

59. *BPG-Khandesh*, pp. 284–5.

60. Wingate, "Report," p. 12. He further commented that "In a good many villages of Sowda and Yawal [subdistricts] there is no waste, but any surplus capital accumulated there, through lowering the assessment, would soon find its way elsewhere." Ibid.

61. In 1820 John Briggs managed a customs establishment of private revenue farmers which levied duties on trade travelling through Khandesh and upon internal traffic as well. At that time 275 customs posts existed which paid 162,000 rupees to the state. See Choksey, *Period of Transition, 1818–1826*, pp. 63–69. The Khandesh Gazetteer notes the abolition of these duties, *BPG-Khandesh*, pp. 322.

62. *BPG-Khandesh*, pp. 207, 214–15.

63. Ibid., p. 214.

64. Ibid., p. 215.

65. See Wingate's "Report" cited above and the summary of the settlement operations given in *BPG-Khandesh*, pp. 289–97.

66. *BPG-Khandesh*, pp. 210–11.

67. Ibid., p. 207.

68. Ibid., pp. 212–13.

69. *Imperial Gazetteer of India, The Indian Empire*, 3, pp. 437–40.

70. Census data from *Imperial Gazetteer of India* (Oxford: 1908) 15, "Khandesh."

71. *BPG-Khandesh*, p. 297 citing a letter from Ramsay.

72. This table is calculated from annual data compiled by Michelle McAlpin. The sources are the same as those listed for table 5.2.

73. *BPG-Khandesh*, p. 222.

74. Ibid., pp. 221–22.

75. Ibid.

76. Ibid., p. 217.

77. Ibid., p. 220.

78. Ibid., p. 231.

79. Wingate, "Report," p. 14.

80. Harry G. Champion and S. K. Seth, *A Revised Survey of the Forest Types of India* (Nasik: 1968), p. 174.

81. Ibid., p. 175. See also Spate's adaptation of Champion.

82. *BPG-Khandesh*, p. 24.

83. R. S. Troup, *The Silviculture of Indian Trees* (Oxford: 1921), 2, "Acacia," p. 443.

84. *BPG-Khandesh*, p. 198.

85. *BPG-Khandesh*, p. 26. See the discussion on this and the accompanying pages of various goods obtained from tree species in Khandesh.

86. See P. V. Paranjape, "Kulaks and Adivasis, The Formation of Classes in Maharashtra," *Bulletin of Concerned Asian Scholars*, 13 (1981): 1–20 for an informed discussion of the role of the tribals (Adivasis) in Khandesh district in the twentieth century.

87. The destruction that resulted when the Forest Department allocated too little land to a

group of slash and burn agriculturists in Belgaum District in the Karnatak is described in *Gazetteer of Bombay Presidency*, Vol. 21 Belgaum (1884), p. 56.

6. Deltaic Rainforests of British Burma

1. Tomé Pires, *Suma Oriental* (London: 1944), vol. 1, pp. 17, 97–98, 195; vol. 2, p. 98. For a general discussion of the position of Pegu in Asian trade, see M. A. P. Meilink-Roelofsz, *Asian Trade and European Influence in the Indonesian Archipelago between 1500 and about 1630* (The Hague: 1962), pp. 69–70, 87–88, 103, 109.

2. E. P. Stebbing, *The Forests of British India* (London: 1922), pp. 65, 206, 244; William J. Koenig, "The Early Kòn-baung Dynasty, 1792–1819: A Study of Politics, Administration and Social Organization in Burma" (Ph.D. dissertation, University of London: 1978), p. 135.

3. Charles Lee Keeton III, *King Thebaw and the Ecological Rape of Burma* (Delhi: 1974), chapters 2, 3, 7.

4. E. Stebbing, *Forests of India*, pp. 62, 63, 65, 136, 160; and John Nisbet, *Burma under British Rule and Before* (London: 1901), vol. 2, p. 47. On the chronic problem of finding wood suitable for the ships of the Royal Navy see Robert G. Albion, *Forests and Sea Power: The Timber Problem of the Royal Navy, 1652–1862* (Cambridge, Mass: 1926), especially pp. 366–69 on India as a source of wood, and Ronald L. Pollitt, "Wooden Walls: English Seapower and the World's Forests," *Journal of Forest History* 15 (1971): 6–15.

5. On the origins of the war from different perspectives see, Maung Htin Aung, *The Stricken Peacock: Anglo-Burmese Relations, 1752–1948* (The Hague: 1965) and D. G. E. Hall, *A History of South-East Asia* (London: 1964), chapter 31.

6. Quoted in E. Stebbing, *Forests of India*, p. 135. See also R. Albion, *Forests and Sea Power*, pp. 35–36.

7. Ibid., pp. 66–67, 140ff.

8. Ibid., p. 244; and Oliver B. Pollack, *Empires in Collision: Anglo-Burmese Relations in the Mid-Nineteenth Century* (Westport, Conn.: 1979), chapters 2 and 3.

9. C. Keeton, *King Thebaw*, chapters 7 and 8.

10. E. Stebbing, *Forests of India*, chapters 13, 14, 20; J. Nisbet, *British Burma*, vol. 2, pp. 47–60; and J. R. Andrus, *Burmese Economic Life* (Stanford: 1947), pp. 98–102.

11. Food and Agriculture Organization of the United Nations, *Forest Resources in Asia and the Far Eastern Region* (Rome: 1976), pp. 40–41.

12. See, for example, J. S. Furnivall, *An Introduction to the Political Economy of Burma* (Rangoon: 1957); Cheng Siok-Hwa, *The Rice Industry of Burma, 1852–1940* (Kuala Lumpur-Singapore: 1968); or Michael Adas, *The Burma Delta: Economic Development and Social Change on an Asian Rice Frontier* (Madison: 1974).

13. Robert Gorden, *The Irrawaddy River* (London: 1885), p. 5; L. D. Stamp, "The Irrawaddy River," *Geographical Journal* 95 (1940): 34–35; K. E. Bruen, "The Agricultural Geography of the Irrawaddy River with Special Reference to Rice" (Ph.D. dissertation, University of London, 1939), pp. 1–4, 20–26, 33–38; Stebbing, *Forests of India*, p. 56; L. D. Stamp, "The Aerial Survey of the Irrawaddy Delta Forests," *Journal of Ecology* 13/2 (1925): 263, 265–67; and C. A. Fisher, *South-East Asia* (London: 1964), pp. 47–48.

14. Stebbing, *Forests of India*, pp. 42–43; Fisher, *South-East Asia*, pp. 45–46; P. W. Richards, *The Tropical Rain Forest: An Ecological Study* (Cambridge: 1952), pp. 329–31; and Stamp, "Survey", pp. 262, 266–69. The most complete accounts of forest life in Burma are included in L. D. Stamp, *Vegetation of Burma* (Calcutta: 1925), especially pp. 39–41 on the *kanazo* and mangrove forests; and S. Kurz, *Forest Flora of British Burma* (Calcutta; 1877), 2 vols., especially vol. 1, pp. 28–30.

15. The Fitzroy map is in the India Office Records map collection, no. A. 1. (4), Burma—India Office, London, England. See also R. Gordon, *Irrawaddy River*, p. 5; Michael Adas, "Agrarian Development and the Plural Society in Lower Burma, 1852–1941" (Ph.D. dissertation, University of Wisconsin, 1971), pp. 37–39; Government of Burma, "Report on the Administration of Pegu," India Office Records, *Secret and Political Correspondence*, 1858; and William J. Koenig and Frank N. Trager, eds., *Burmese Sit-tans, 1764–1826* (Tucson, Arizona: 1979).

16. B. N. Kaul, "Some Aspects of the Population Problem in Burma" (Ph.D. dissertation, University of London, 1930) p. 27; Government of Burma, *Insein District Gazetteer*, p. 60; T. A.

Trant, *Two Years in Ava* (London: 1827), pp. 234–37; Michael Symes, *An Account of an Embassy to the Kingdom of Ava. . . .* (London, 1800), vol. 2, pp. 15–16, 77–79, 96–97, 113 et passim; H. L. Maw, *Memoir of the Early Operations of the Burmese War* (London, 1832), p. 82; Hiram Cox, *Journal of a Resident in the Burmhan Empire* (London, 1821), pp. 10–11, 427–28; 430; John Crawfurd, *Journal of an Embassy. . . .* (London: 1829), pp. 5, 10 et passim; Government of Burma, *Settlement Reports—Ma-ubin, 1925–8*, pp. 14–15; *Bassein-Thongwa, 1888–9*, p. 23.

17. J. Crawford, *Journal*, p. 10.

18. Government of India, *Political and Foreign Proceedings*, Range 201, vol. 25 (13 July 1855), nos. 96–100.

19. Government of Burma, *Revenue and Agriculture Proceedings*, vol. 2887 (April 1887), no. 5.

20. Government of India, *Foreign Proceedings (Revenue)*, Range 205, vol. 30 (October 1861), no. 19. A similar view was expressed over seventy years later. See, *Ma-ubin Settlement Report*, p. 15.

21. *Report on Pegu, 1855–6*, paragraph 267.

22. Arthur Girault, *Principes de colonisation et de législation coloniale* (Paris: 1895), pp. 29–31; and Benjamin Kidd, *The Control of the Tropics* (London: 1894), pp. 316, 324.

23. Government of India, *Foreign Proceedings (Revenue)*, Range 205, vol. 39 (January 1865), no. 12.

24. *Ibid.*, *Political and Foreign Proceedings*, Range 203, vol. 13 (December 1857), no. 255.

25. Arthur Phayre, *History of Burma* (London: 1885), pp. 155–57; Government of Burma, *Syriam District Gazetteer* (Rangoon: 1914), p. 25; and *Bassein District Gazetteer* (Rangoon: 1916), p. 18.

26. For numerous expressions of these attitudes see Maung Htin Aung, *Epistles Written on the Eve of the Anglo-Burmese Wars* (The Hague, 1968).

27. R. Gordon, *Irrawaddy River*, p. 5; C. C. Ghosh, *Insect Pests of Burma* (Rangoon: 1940), pp. 53, 58, 59, 60, 67–68; and Government of Burma, *Settlement Reports—Myaungmya, 1916–19*, p. 26; *Thaton, 1897–98*, pp. 7–8; *Pegu, 1900–1901*, p. 5; and *Pyapon, 1921–22*, pp. 15, 18.

28. M. Symes, *Account*, vol. 2, pp. 166–67; and H. Maw, *Memoir*, pp. 83–84.

29. Symes, *ibid.*, vol. 1, pp. 353–54; vol. 2, pp. 60–62, 189–90.

30. Henry Bell, *An Account of the Burma Empire* (Calcutta: 1852), vol. 2, p. 57; and William Franklin, *Tracts, Political, Geographical, and Commercial on the Dominions of Ava. . . .* (London, 1911), p. 31.

31. For several excellent studies of this process see the essays on India in the British period in R. E. Frykenberg, ed., *Land Control and Social Structure in Indian History* (Madison: 1969). For British policy in Burma see Government of India, *Foreign Proceedings (General)*, Range 205, vol. 10, no. 59; and *Political and Foreign Proceedings*, Range 201, vol. 21, no. 165.

32. M. Adas, *Burma Delta*, pp. 28–38.

33. Government of Burma, *Secret and Political Correspondence*, Range 28, vol. 66, no. 642; Range 29, vol. 32, no. 297; Range 30, vol. 110, no. 537.

34. Government of India, *Political and Foreign Proceedings*, Range 200, vol. 1, nos. 119, 128–30; vol. 60, nos. 136–38; and *Report on Pegu, 1859–60*, p. 32; 1860–61, p. 26.

35. *Report on the Administration of the Province of Burma, 1861–62* (Rangoon: 1863), pp. 15, 33.

36. For detailed discussions of these demographic and market trends see M. Adas, *Burma Delta*, chapters 1, 2, and 4; and Cheng Siok-hwa, *Rice Industry*, chapters 3 and 8.

37. *Report on Pegu, 1856–7*, paragraph 66.

38. This account of the expansion of cultivation in different periods is based on M. Adas, "Agrarian Development," pp. 145–53.

39. Government of Burma, *Settlement Reports—Myaungmya-Thongwa, 1902–3*, pp. 1–2; *Ma-ubin, 1925–8*, p. 15; K. Bruen, "Agricultural Geography," p. 37; and J. W. Grant, *The Rice Crop in Burma* (Rangoon: 1932), p. 3.

40. L. Stamp, *Vegetation of Burma*, p. 41.

41. Government of Burma, *Settlement Reports—Thongwa, 1890–91*, p. 5; *Myaungmya-Thongwa, 1902–3*, p. 5; *Pyapon, 1921–2*, p. 18; and *Myaungmya, 1924–5*, pp. 1–2.

42. M. Adas, *Burma Delta*, chapter 6 and conclusions.

43. Government of Burma, *Settlement Reports—Myaungmya, 1916–19*, p. 19; *Henzada, 1900–1901*, p. 2; *Pegu, 1900–1901*, p. 2; and M. F. Boyd, *Malariology* (Philadelphia, 1949), vol. 1, pp. 316, 433, 619; vol. 2, p. 815.

44. M. Adas, *Burma Delta*, chapter 6.

45. Government of Burma, *The Origin and Causes of the Burma Rebellion (1930–32)* (Rangoon, 1934), p. 16.

46. For preliminary observations on many of these critical themes see Aye Hlaing, "Trends of Economic Growth and Income Distribution in Burma, 1870–1940," *Journal of the Burma Research Society* 47/1 (June 1964): 89–148.

47. Pierre Gourou, *The Tropical World* (London: 1953), p. 100ff.

48. David Hendry, *Fertilizers for Paddy* (Rangoon: 1929), pp. 1–2, 11–12; and Government of Burma, *Revenue and Agriculture Proceedings*, vol. 8633 (November 1911), p. 501. For a detailed study of the effects of soil exposure in the tropics (with special reference to Nigeria) see R. K. Cunningham, "The effect of clearing a tropical forest soil," *Journal of Soil Science* 14 (1963): 334–45.

49. Government of Burma, *Report on the Famine in Burma, 1896–7* (Rangoon: 1898).

50. T. C. Whitmore, *Tropical Rain Forests of the Far East* (Oxford: 1975), pp. 3–11; P. Richards, *Rain Forests*, chapter 10.

51. P. Richards, *Rain Forest*, p. 329.

52. K. A. Longman and J. Jenik, *Tropical Forest and Its Environment* (London: 1974), pp. 121–23.

53. T. Whitmore, *Tropical Forests*, pp. 235–36.

54. Ibid., p. 234–35.

55. Ibid., p. 236; Longman and Jenik, *Forest Environment*, pp. 17–19.

56. P. Richards, *Rain Forest*, p. 405.

57. On Thailand, see D. Ingram, *Economic Change in Thailand since 1850* (Stanford 1955); and on Indochina, Charles Robequain, *The Economic Development of French Indochina* (Oxford: 1944).

58. Lucien M. Hanks, *Rice and Man* (Ithaca, N. Y.: 1972), p. 73ff.

7. Deforestation in Modern China

A note on sources. There really are no sources specifically dealing with forests, apart from the general works mentioned in the footnotes. The best and most detailed of these is Norman Shaw's *Chinese Forest Trees and Timber Supply* (London: Unwin, 1914), but his account deals with the situation, as far as he could determine it, at the date of his study. Other, and briefer, accounts are still more impressionistic, especially for the nineteenth century. There are no official or unofficial figures or even estimates for forested areas or for cutting or timber production before the late 1920s, and even those are highly unreliable. There are a few scattered references to forests, at different (usually pre-Ch'ing) periods in Chinese history, in a few articles in Chinese periodicals and scholarly journals—none of them much help—plus of course highly generalized survey treatments in standard geographical works in both Chinese and Western languages, in which forests might be given one out of 400 or 500 pages. The figures, reports, and occasional Special Reports (none dealing specifically with forests or lumber) of the Maritime Customs Service beginning after 1864 are, as indicated, of very little use in the effort to estimate how much commercial timber was being cut or how much exported—very little of the latter (except for Manchuria) in any case, and much less than was being imported. The Annual and Decennial Reports of the Customs series for each major port are a mine of general information about a great variety of conditions and happenings in each area they cover, but (again except for Manchuria) almost none of these areas included forests or lumbering, more or less by definition. Impressionistic individual accounts of nineteenth century China by the large number of foreigners who wrote about it are for the most part similarly unhelpful and for similar reasons.

Probably the best way to pin down what can be pinned down is to undertake the gargantuan task of going through the district gazetteers for each prefecture. These were still being produced in most areas in the course of the nineteenth century by local initiative even as the official supervision and record keeping of the central government deterioriated, and in many areas they continued even into the 1920's. References to forests or to timber are scattered like occasional small needles in an immense haystack of other information, but it might be worth the time for someone, some time, to take at least a few test bores in this mass, still the richest single source of data at the local level but so far only slightly used by Western scholars.

A general work of the 1920s, *Forest Resources of the World*, by R. Zon and W. N. Sparhawk (2 vols.; New York: McGraw-Hill, 1923), contains a few pages on China which largely duplicate material available elsewhere but also includes a clear and detailed map of forested areas, based one must assume on the data available (whose problems have already been summarized) rather than on the painstaking and huge-scale field work which would have been necessary for accuracy, let alone an acceptable definition of "forest." S. D. Richardson's *Forestry in Communist China* (1966) is beyond the period of this treatment, but suffers similarly from inadequate data and from uncritical acceptance of official figures since withdrawn, corrected, or disproved.

1. This is true for China as a whole despite the continuation through the nineteenth century of small exports of timber cut in mountainous southern Chekiang, Fukien, northern Kwangtung, southern Kwangsi, and Hunan, wherever rivers or mountain streams made it possible to move the trees at bearable cost downstream to any of the many ports along the southeast coast (from Hangchow and Ningpo through Foochow, Amoy, and Swatow to Canton. Most of this timber was consumed in the port cities, but small amounts moved out, mainly to wood-hungry Japan. The much larger exports of wood from Manchuria, especially the Ch'ang Pai Shan area along the border with Korea, did not begin until the de facto Japanese takeover in 1905 and did not reach major scale until after 1931, by which time Manchuria was no longer Chinese.

2. As population increased, especially after about 1650, probably doubling or more by 1850, pressure mounted to bring more land into cultivation, and total cultivated land may nearly have doubled during the same period. Most of this was land earlier regarded as submarginal and hence neglected; a good deal of it, perhaps a third, was on the dry and already treeless outer fringes of China proper, especially in the northwest and in Inner Mongolia, but probably at least as much was slope land in north, central, and south China now newly cleared of trees. This expansion was however largely complete, especially in China proper, by the nineteenth century, when further efforts were concentrated on more irrigation, more fertilization, multiple cropping, and more intensive cultivation generally. For the best general account of this process, in the larger context of the agricultural system as a whole, see Dwight Perkins, *Agricultural Development in China, 1368-1968*, (Chicago, Aldine 1969).

3. For survey accounts of the traditional agricultural system, see Perkins, *Agricultural Development*; Evelyn Rawksi, *Agricultural Change and the Peasant Economy of South China*, (Cambridge: Harvard Press, 1972); R. H. Tawney, *Land and Labour in China*, (London: Allen and Unwin, 1932) J. L. Buck, *Land Utilization in China*, (Univ. of Chicago Press, 1937).

4. Norman Shaw, *Chinese Forest Trees and Timber Supply* (London: Unwin, 1914), p. 150.

5. This problem is pursued in greater detail in R. Murphey, *The Outsiders* (Ann Arbor: University of Michigan Press, 1977), especially Chapter 11.

6. Eliot Blackwelder, "A Country That Has Used Up Its Trees", *The Outlook* 82 (March 24, 1906), 693–700.

7. The standard work on China's population explosion is P. T. Ho, *Studies on The Population of China, 1368–1953*, (Cambridge: Harvard Press, 1959) but for a useful second view and revised estimates see Perkins, *Agricultural Development*.

8. The extent of commercialization and the role of foreign trade are analyzed, in the context of the impact of foreign enterprises and the treaty ports, in R. Murphey, *The Outsiders*.

9. Most of the very scanty Western language literature on forests in China refers to Jean Baptiste du Halde's *Description of the Empire of China*, published in Paris in 1735 and in English in London in 1738, as a source for the state of Chinese forests in the eighteenth century. In fact du Halde never went to China and based his (often fanciful) account entirely on the reports of the Jesuits, much of it two and none of it less than one century before his time.

10. On the several nineteenth century rebellions, see Philip Kuhn, *Rebellion and its Enemies in Late Imperial China*, (Cambridge: Harvard Press, 1970), and Albert Feuerwerker, *Rebellion in Nineteenth Century China*, Michigan Papers in Chinese Studies, No. 21, Center for Chinese Studies, (Ann Arbor: University of Michigan, 1975).

11. On Manchuria's development, see E. H. G. Lee, *The Manchurian Frontier in Ching History*, (Cambridge: Harvard Press, 1970), and K. C. Sun and R. W. Huenemann, *The Economic Development of Manchuria*, (Cambridge: Harvard Press, 1969).

12. The standard study of railway building in this period is still Chang Kia-ngau, *China's Struggle for Railway Development* (New York: John Day, 1943), but see also Albert Feuerwerker, *The Chinese Economy, 1870–1911* and *The Chinese Economy, 1912–1949* Michigan Papers in Chinese Studies, Nos. 1 (1968) and 5 (1969) respectively, Center for Chinese Studies, University of Michigan, Ann Arbor.

13. See for example the table given in G. B. Cressey, *Land of the Five Hundred Million* (New York: McGraw Hill, 1955), p. 127.

14. In S. Haden-Guest, J. K. Wright, and E. M. Terlaff, eds., *A World Geography of Forest Resources* (New York: American Geographical Society, 1956), pp. 529–50.

15. W. C. Lowdermilk, "Forest Destruction and Slope Denudation in the Province of Shansi," *China Journal of Science and Arts* 4 (1926): pp. 127–35.

16. W. C. Lowdermilk, "Forestry in Denuded China", *Annals of the American Academy* 152 (November 1930): pp. 127–41.

17. The best and most accessible survey treatment is Sigurd Eliassen, *Dragon Wang's River* (New York: 1958), but see also Charles Greer, *Water Management in the Yellow River Basin* (Austin: University of Texas Press, 1979).

18. Shaw, *Chinese Forest Trees and Timber Supply* (London: T. F. Unwin, 1914), p. 175.

19. E. A. Ross, *The Changing Chinese* (New York: Century, 1911), p. 129.

20. Blackwelder "Country," pp. 693–700.

21. This is mentioned in both Ross, *Changing Chinese*, and Shaw, *Chinese Forest Trees* and is also referred to in the German and American Consular and in Maritime Custom Reports.

22. For further details on post–1949 reforestation and forest management, see L. S. Ross, "Forestry Policy in China," Ph.D. thesis, University of Michigan, 1980, which also includes a map showing remaining forested areas in 1949 and major post-1949 reforestation areas.

23. Shaw, *Chinese Forest Trees*, pp. 48–49.

24. See W. S. Chepil, "Wind Erosion Control with Shelter Belts in North China," *Agronomy Journal* 41 (March 1949): pp. 147-29.

25. D. Y. Lin, in Haden-Guest, *World Geography*.

26. F. Garnier, *Voyage de l'exploration en Indo-Chine effectué pendant les années 1866, 1867, et 1868* (Paris: Hachette, 1873).

8. Forest Preservation in Tokugawa Japan

1. Deforestation in the seventeenth century is commonly attributed to these historical processes, but little quantitative information is available about their effects on tree depletion. See also Akino Funakoshi, *Nihon Ringyo Hattenshi* (Development of Forestry in Japan) (Tokyo: Chikyusha, 1966); Mituso Tokoro, "Ringyo" (Forestry) in Yukio Kodama, ed. *Sangyoshi* (History of Industries), vol. 3 (Tokyo: Yamakawa Shuppansha, 1965).

2. For further discussion of these stages in ecological action, see Cynthia Enloe, *The Politics of Pollution in a Comparative Perspective* (New York: David McKay Co., Inc., 1975).

3. For the geography of Japan, see George Cressey, *Asia's Lands and People* (New York: McGraw-Hill, 1963); Ryujiro Ishida, *Geography of Japan* (Tokyo: Kokusai Bunka Shinkokai, 1969); Edwin Reischauer, *Japan: The Story of a Nation* (New York: Knopf, 1974), pp. 3–16.

4. One cho is equal to 99 hectares.

5. One koku is equal to 1.75 hectoliters.

6. The figure of 18 million persons for the period 1573–91 is an estimate whose reliability is not firmly established. For the detailed discussion of population and crop yields during the Tokugawa period, refer to Mikiso Hane, *Japan: A Historical Survey* (New York: Charles Scribner's Sons, 1972), p. 230.

7. Among numerous monographs about the Tokugawa government, the following are particularly relevant to the present analysis: Reischauer, *Japan*, pp. 78–112; Conrad Totman, *Politics in the Tokugawa Bakufu, 1600–1843* (Cambridge: Harvard University Press, 1967).

8. For the discussion of the life of the peasantry during the Tokugawa Period, see Thomas C. Smith, *The Agrarian Origins of Modern Japan* (Stanford: Stanford University Press, 1950); Hane, *Japan*; pp. 168–73, 227–37; Goro Fujita, *Kinsei ni Okeru Nomish no Kaikyu Bunka* (Class Differentiation of Peasants in the Modern Period) (Tokyo: Nihon Hyoronsha, 1949); Honjo Eijiro, *Wagakuni Kinsei no Noson Mondai* (Social Problems in Farming Villages in Tokugawa Japan) (Tokyo: Kaizosha, 1932); Masamoto, Kitajima, *Nihon no Rekishi* (History of Japan), Vol. 18 (Tokyo: Chuokoronsha, 1966); Toshio Kojima, *Kinsei Nihon Nogyo no Kozo* (Structure of Agriculture during Tokugawa Period) (Tokyo: Nihon Hyoronsha, 1947).

9. The political and economic conditions of the village under the Tokugawa regime are discussed in Mitsuo Oka, *Bakuhan Taiseika no Chono Keizai* (Peasant Economy under the Tokugawa Regime) (Tokyo: Hosei University Press, 1976); Minoru Takamaki, *Bakuhan*

Kakuritsuki no Sonraku (Villages and Hamlets in Early Tokugawa Period) (Tokyo: Yoshikawa Kobunkan, 1976).

10. For details, see Smith, *Agrarian Origin*; Kojima, *Kinsei Nihon Nogyo*; Oka, *Bakuhan Taiseika*.

11. Reischauer, *Japan.*, pp. 99–103; Zensuke Nishikawa, *Rinya Shoyu no Keitai to Mura no Kozo—Iriaichi no Jisshoteki Kenkyu* (Empirical Analysis of Peasants' Rights for Usage of Communally Owned Forest Areas) (Tokyo: Ochanomizu-shobo, 1957).

12. Hane, *Japan*, p. 288.

13. Over several dozens monographs have been published in Japanese about the *iriaichi* practice prior to the Meiji period. Among them, the following are especially useful as they contain detailed empirical data: Hiroshi Hojo, *Rinya Iriai no Shiteki Kenkyu* (Historical Analysis of Peasants' Usage of Collectively Owned Forest and Pasture) (Tokyo: Ochanomizu Shobo, 1977; Toshio Kojima, ed., *Nihon Rinya Seido no Kenkyu—Kyodotai Teki Rinya Shoyu o Chushin ni* (Study of Forest and Pasture Utilization in Japan—Focus on Collective Ownership of Forested Areas) (Tokyo: University of Tokyo Press, 1956); Nishikawa, *Rinya Shoyu*.

14. See Kiyoto Hirosawa, *Kinsei Iriai Kanko no Seiritsu to Tenkai* (Formulation and Development of Iriai Practice in Tokugawa Japan) (Tokyo Ochanomizu-shobo, 1967); Michio Tsutsui, *Nihon Rinseishi Kenkyu Josetsu* (Introduction to the History of Forest Administration in Japan) (Tokyo: University of Tokyo Press, 1978), p. 161–76.

15. Tsutsui, *Nihon Rinseishi*, pp. 161–76.

16. See Tokoro, "Ringyo,"; Rinya-cho, ed. *Tokugawa Jidai ni Okeru Rinya Seido no Taiyo* (An Outline of Forestry During Tokugawa Period). (Tokyo: Yuhikaku, 1963); Doshisha Daigaku, Institute of Social Sciences. *Ringyo in Jujisuru Noson Shuraku* (Villages and Hamlets Engaged in Forestry) (Kyoto: Mineruva, 1969) pp. 399–483.

17. The factual account of this illustration is adapted from Mitsuo Oka, *Hoken Shuraku no Kenkyu* (Analysis of Feudal Villages and Hamlets) (Tokyo: Unikaku, 1963), pp. 97–104.

18. The castles were extremely vulnerable to fire hazard. The Edo Castle was burned down five times during the 270 years of the Tokugawa reign. The castle of Himeji was destroyed by fire only one year after the completion of its construction. The frequent fires of both the lords' estates and masses' houses taxed forest resources rather heavily.

19. See Tokoro, "Ringyo."

20. Ibid.

21. Quoted in Tokoro, "Ringyo," p. 208.

22. For the technical discussion of forest administration during Tokugawa Period, see Muneyoshi Tokugawa, *Edo Jidai ni Okeru Zorin Gijutsu no Shiteki Kenkyu* (Development of Afforestation Technologies during Tokugawa Period), (Tokyo: Nishigahara Kankokai, 1941); Hirosawa, *Kinsei Iriai Kanko;* Funakoshi, *Nihon Ringyo*.

23. For the analysis of Tokugawa social thought concerning forestation, see Eijiro Honjo, *Nihon Keizai Shisoshi Kenkyu* (History of Economic Thought in Japan) (Tokyo: Nihon Hyoronsha, 1944); Kyoji Kono, *Edo Jidai no Ringyo Shiso* (Ideologies about Forestry and Forest Administration during Tokugawa Period), (Tokyo: Genmashoten, 1961); Masao Maruyama, *Nihon Shisoshi Kenkyu* (Study of Japanese History of Thought) (Tokyo: University of Tokyo Press, 1958).

24. The listing of forbidden trees includes the information about those fiefs with relatively well organized forest administration policies. Both coniferous trees (e.g. cedar, ground cypress, pine, hemlock spruce, and *Torreyg nucifera*) and broad leaved trees (e.g. oak, zelkova, Japanese Judas-tree, *Magnolia hypoleuca* and walnut) are mentioned. In addition, several of the surveyed fiefs prohibited the cultivation of non-lumber producing trees (such as camphor trees, Japanese lacquer, loquat, plum, and ginkgo) which yielded nuts, fruits, and other goods that were extensively marketed.

25. Those fiefs which were leaders of conservation policy were known for a large area of extensive woodlands. But an adequate explanation for this and other regional variations requires an intensive study of individual fiefs.

26. See Hirasawa; *Kinsei Iriai Kanko*, pp. 272–82.

27. For further information, see Hojo, *Rinya Iriai*; Kojima, *Nihon Rinya Seido*; Nishikawa, *Rinya Shoyu*; Tsutsui, *Nihon Rinseishi*.

28. This episode is reported in Tokugawa, *Edo Jidai ni Okeru*, p. 333. For a fuller discussion of Nobumasa's forestation policy see Ryoji Kono, *Edo Jidai no Ringyo*.

29. Examples in this paragraph are quoted in Tokugawa, *Edo Jidai ni Okeru*, pp. 341–46.

30. Ibid., pp. 345–46.
31. Ibid., p. 345.
32. Ibid., p. 368.
33. The examples in this paragraph are adopted from Ibid., pp. 348–50.
34. The factual account of this case narrative is adapted from Hirasawa, *Kinsei Iriai Kanko*, pp. 272–88.
35. Ibid., p. 279.
36. Tokoro, "Ringyo," p. 208.
37. Rinya-cho, ed., *Tokugawa Jidai ni Okeru*, pp. 406–422.
38. Torao Haraguchi, *Kagoshima Kenno Rekishi* (History of Kagoshima Prefecture) (Tokyo: Yamakawa, 1973).
39. Funakoshi, *Nihon Ringyo Hattenshi*, chapter 3.
40. For the list of monographs on Tokugawa agriculture, consult notes 8 and 9 of this chapter.
41. Several dozen books and articles have been written in English and Japanese about the economic condition of Meiji Japan. For concise discussion, see Reischauer, *Japan*, pp. 113–44; Hane, *Japan*, pp. 297–344. For detailed analysis: James Nakamura, *Agricultural Production and Economic Development of Japan, 1873–1922* (Princeton: Princeton University Press, 1966): Thomas C. Smith, *Political Change and Industrial Development in Japan: Government Enterprise 1868–1880* (Stanford: Stanford University Press, 1955): William Lockwood, *The Economic Development of Japan: Growth and Structural Change, 1863–1938* (Princeton: Princeton University Press, 1954).
42. Lockwood, *Economic Development*. p. 94.
43. Ibid., p. 554.
44. The peasant's right for the *iriai* usage has been a focus of heated controversy in the history of social sciences in modern Japan, involving a large number of historians, economists, and legal specialists. A comprehensive summary of various theses on the topic advanced in the last several decades can be found in Nishikawa, *Rinya Shoyu*, pp. 403–503. Among numerous monographs on this subject, the most well-known works are Michitaka Kaino, *Iriai no Kenkyu* (Analysis of Iriai) (Tokyo: Iwanami Shoten, 1944). Takeshi Kawashima, *Shoyukenho no Riron* (Theory of Ownership). (Tokyo: University of Tokyo Press, 1958). See also: Yasuo Kondo *Makino no Kenkyu* (Study of Pasture Usage), (Tokyo: University of Tokyo Press, 1966) Kojima, *Nihon Rinya Seido*; Hiroshi Hojo, *Rinya Hosei no Tenkai to Sonraku Kyodotai* (Development of Laws concerning Forest and Pasture Usage and Village Community) (Tokyo: Ochanomizu Shobo, 1971; Tsutsui, *Nihon Rinseishi*.
45. Even though the *iriai* usage has been studied extensively by Japanese scholars, few have examined the relationship between the ownership pattern and resource conservation. The interpretation presented here is mine.
46. Hojo, *Rinya Hosei*, pp. 267–69.
47. Smith, *Agrarian Origin*; Hojo, *Rinya Hosei*, pp. 620–25; Hane, *Japan*, pp. 277–9, 304–06.
48. Hojo, *Rinya Hosei*, pp. 247–57.
49. Lockwood, *Economic Development*, p. 360. Imports were a negligible 0.7 million metric tons.
50. The import of American cedar, pines, and chestnut in the early 1920s nearly tripled the wood products manufactured in Japan from the period 1915–19 to 1920–24. See Lockwood, *Economic Development*, p. 115.

9. Forests of the Western Himalayas

1. The best general survey is O. H. K. Spate and A. T. Learmonth, *India and Pakistan: A General and Regional Geography*, 3rd ed. (London: Methuen, 1967). The standard regional work is Augusto Gansser, *Geology of the Himalayas* (London: Interscience Publishers, 1964).
2. See S. P. Raychaudhuri, et al., *Soils of India* (New Delhi: Indian Council of Agricultural Research, 1963).
3. Gerald D. Berreman, *Hindus of the Himalayas*, 2nd ed. (Berkeley and Los Angeles: University of California Press, 1972), chapter 2.
4. G. S. Puri, *Indian Forest Ecology*, 2 vols. (London: Oxford University Press, 1938).
5. For a few species whose terminology has changed over the past century, both the nineteenth-century name and the more recently adopted name are indicated.

6. For the pre-British history of Kumaon and Garhwal, see E. T. Atkinson, *The Himalayan Gazeteer*, 3 vols. (Allahabad: Government Press, 1882), vol. 2, chapters 3–7. For pre-British Himachal, see John Hutchison and J. P. Vogel, *History of the Panjab Hill States* (Lahore: Government Press, 1933).

7. M. I. Husain, "The Formation of British Land Revenue Policy in the Ceded and Conquered Provinces of Northern India, 1801–13" (Ph.D. dissertation, University of London, 1963-64); Thomas R. Metcalf, *Land, Landlords, and the British Raj: Northern India in the Nineteenth Century* (Berkeley and Los Angeles: University of California Press, 1979); Walter Neale, *Economic Change in Rural India: Land Tenure and Reform in Uttar Pradesh, 1800–1955* (New Haven: Yale University Press, 1973). In Sir Auckland Colvin, *Memorandum on the Revision of Land Revenue Settlements in the Northwest Provinces* (Calcutta: Government Press, 1872), we find statistics on the expansion of cultivation, but they are approximate; and he explicitly excludes the Kumaon Hill Division as being too problematical to calculate.

8. C. M. Johri, *Working Plan for the Gorakhpur Forest Division, United Provinces, 1944–45 to 1953–54* (Lucknow, 1949).

9. Ibid., p. 27.

10. Elizabeth Whitcombe, *Agrarian Conditions in Northern India*, vol. 1, *The United Provinces under British Rule, 1860–1900* (Berkeley and Los Angeles: University of California Press, 1972). Also Ian Stone, "Canal Irrigation and Agrarian Change: the Ganges Canal Tract, Muzaffarnagar, 1840–1900," in K. N. Chaudhuri and Clive Dewey, eds., *Economy and Society* (New Delhi: Oxford University Press, 1979).

11. William Hoey, *A Monograph on Trade and Manufactures in Northern India* (Lucknow: American Methodist Mission Press, 1880).

12. Atkinson, *Himalayan Gazetteer*, 3:463–87, discusses the early Revenue Settlements of Kumaon. For full detail see G. W. Traill, "Statistical Sketch of Kamaon," *Asiatic Researches* 16 (1828): 137–234.

13. A. Ross, *Report on the Settlement of Dehra Dun* (Agra, 1852).

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